

# A STUDY ON THE POTENTIAL OF BLOCKCHAIN IN GREEN ENTREPRENEURSHIP FOR SUSTAINABLE DEVELOPMENT

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## ABSTRACT

This quantitative study is centered around small and medium-sized enterprises (SMEs) to explore the potential of blockchain technology in fostering green entrepreneurship for sustainable development. Using a structured questionnaire, data were collected from 160 respondents to assess constructs such as Sustainability Orientation (SO), Sustainability Attitude (SA), Social Perception (SP), Intention to Use (IU), and Green Innovation (GI). Structural equation modeling (SEM) was employed to analyze the proposed correlations among these constructs. The study demonstrates the model's effectiveness in capturing sustainability-related dimensions, as evidenced by high loadings and robust reliability and validity metrics. Cohen's  $f^2$  indicator highlights medium effects, particularly for Social Perception, Sustainability Attitude, and Sustainability Orientation on Green Innovation and Intention to Use. Additionally, Stone-Geisser's Q2 values underscore the predictive relevance of endogenous variables. Overall, the results advance our knowledge of how blockchain technology might promote sustainable growth and green entrepreneurship.

**Keywords:** Blockchain, Green entrepreneurship, Sustainable development, Environmental conservation, Decentralization, Renewable energy

## 1. INTRODUCTION

Blockchain technology, first created as the foundation for Bitcoin, developed into a flexible instrument with uses well beyond cryptocurrencies. Blockchain is a distributed, decentralized ledger that securely links digital transactions or data records (blocks) through cryptography. This novel method offers exceptional security and transparency by guaranteeing that data saved on the blockchain is unchangeable and resistant to unauthorized changes.

### 1.1. Green Entrepreneurship

To comprehend the concept of green entrepreneurship, it is essential to first explore broader concepts such as sustainable development and green growth. To guarantee a fair and balanced future for all, sustainable development, as defined by the UN through its Sustainable Development Goals (SDGs), includes economic, social, and environmental aspects. Conversely, Green growth focuses specifically on fostering economic growth while maintaining or enhancing environmental quality and resource efficiency. The OECD Green Growth Strategy emphasizes the importance of integrating environmental considerations into economic policies to achieve sustainable development goals.

Entrepreneurship plays a pivotal role in advancing green growth objectives. Beyond its traditional role in driving economic activity and job creation, entrepreneurship is increasingly recognized for its potential to address societal challenges, including environmental sustainability. Green entrepreneurship specifically refers to entrepreneurial ventures that prioritize environmental stewardship and sustainability in their business models and

operations. These ventures not only aim to minimize environmental impact but also seek to innovate and introduce sustainable solutions across various sectors.

Despite its growing importance, the concept of green entrepreneurship lacks a universally accepted definition. Over the past two decades, academic literature and research have proposed various definitions and frameworks, reflecting the diverse interpretations and applications of this evolving concept. Discussions often revolve around how green entrepreneurship integrates environmental considerations into business practices, fosters innovation in sustainable technologies, and contributes to the overall transition towards a green economy.

## **1.2. Blockchain in Green Entrepreneurship for Sustainable Development**

Blockchain technology holds immense promise for enhancing green entrepreneurship and driving sustainable development across industries. Its decentralized and transparent nature addresses critical challenges such as trust, transparency, and accountability, which are integral to promoting sustainable business practices.

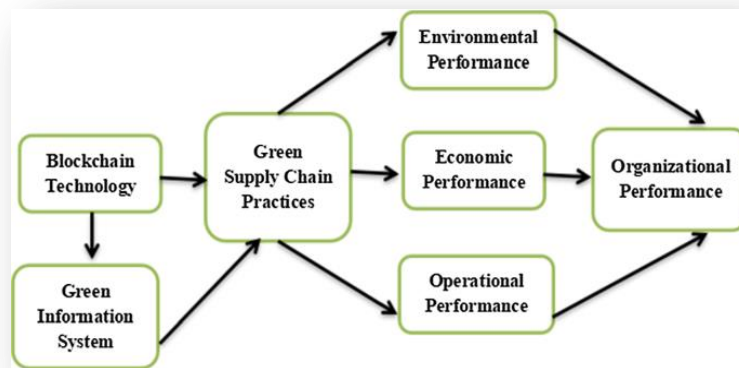
In sectors like waste management, blockchain can streamline processes and enhance transparency by providing a secure and immutable record of waste disposal and recycling activities. This transparency not only ensures compliance with environmental regulations but also builds trust among stakeholders, including consumers and regulatory bodies.

Renewable energy is another area where blockchain can revolutionize operations. Blockchain-enabled smart contracts help consumers buy and sell renewable energy products like solar and wind turbines directly by facilitating peer-to-peer energy trading. The use of renewable energy is encouraged by this decentralized energy marketplace, which also lessens reliance on fossil fuels, lowering carbon emissions and promoting environmental sustainability.

To achieve sustainable development goals, supply chain traceability and transparency are crucial. Real-time tracking of products from point of origin to destination is made possible by blockchain technology, which improves transparency in supply chains. Customers are becoming more and more interested in knowing the origin, manufacturing processes, and environmental impact of the items they buy, therefore this skill is especially useful in the food and agricultural industries. Blockchain helps guarantee ethical sourcing procedures and lessens the environmental effect connected with supply chain operations by offering a verifiable and unchangeable record of transactions.

Furthermore, blockchain can incentivize sustainable practices through the tokenization of environmental assets such as carbon credits. By digitizing and trading these assets on blockchain platforms, companies and individuals can participate in carbon offset programs more efficiently. This approach not only encourages businesses to reduce their carbon footprint but also creates new opportunities for investment in sustainable projects and initiatives.

Integrating blockchain technology into green entrepreneurship initiatives holds the potential to accelerate the transition towards a sustainable future. By enhancing operational efficiency, transparency, and accountability in environmental preservation and resource management, blockchain enables businesses to innovate and lead in sustainability practices. As blockchain continues to evolve and find new applications, its role in supporting green entrepreneurship and sustainable development is poised to expand, offering new opportunities and solutions to address global environmental challenges.



*Figure 1: Green analytics blockchain technology for sustainable development.*

## 2. LITERATURE REVIEW

In recent years, integrating blockchain technology with sustainability initiatives has emerged as a critical area of research and innovation. This literature review synthesizes findings from recent studies that explore the intersection of blockchain technology with green entrepreneurship, sustainable supply chains, and the broader adoption of green technologies.

**Chin et al. (2022)** highlight the urgent need for businesses to adopt ecosystem-based business models (EBMs) driven by disruptive technologies, particularly in response to escalating stakeholder demands for environmental sustainability. They emphasize blockchain technology (BT) as a potent disruptor capable of catalyzing EBMs that prioritize green innovation. Despite the nascent stage of empirical research in this domain, Chin et al. propose that the value appropriation capability (VAC), a pivotal component of dynamic capabilities theory, plays a crucial role in leveraging BT for green innovation within EBMs. Their empirical findings underscore the positive impact of both BT and VAC on green innovation performance, with VAC acting as a mediator in the relationship between BT adoption and sustainable outcomes. This study not only sheds new light on the dynamics between disruptive technologies and EBMs but also provides actionable insights for businesses seeking to foster sustainable practices and resilient business models.

**Khan et al. (2021)** delve into the transformative role of blockchain technology in enhancing supply chain sustainability, particularly within small and medium-sized enterprises (SMEs). Acknowledging blockchain's potential to mitigate environmental risks and improve operational efficiencies, their study focuses on how blockchain influences sustainable supply chain practices. Using data gathered from middle and senior-level managers in SME manufacturing sectors across Pakistan and China, they employ partial least squares structural equation modeling (PLS-SEM) to analyze the relationships between blockchain adoption, green information systems, and sustainable supply chain operations. Their findings affirm a positive correlation between blockchain technology and green information systems, highlighting their combined beneficial impact on sustainable supply chain practices. Moreover, the study underscores the significant linkage between sustainable supply chain operations and organizational performance across operational, environmental, and financial metrics. Khan et al.'s research contributes valuable insights into the practical implications of blockchain technology for enhancing sustainability within organizational contexts, offering guidance for policymakers and businesses on fostering environmentally friendly supply chain strategies.

**Trapp and Kanbach (2021)** address the evolving landscape of green technology adoption within corporate environments, emphasizing the necessity for a comprehensive framework to categorize and promote green technology business models. They critique the fragmented state of existing literature on green technology business models, noting a lack of unified frameworks that integrate diverse approaches and practical applications. Based on the concepts of sustainable business models and technological entrepreneurial activities, their study presents a novel typology of green technology company models, dividing them into twelve different archetypes. Drawing on a systematic review of empirical literature, Trapp and Kanbach's typology serves as a foundational tool for understanding and advancing the deployment of green technologies in business settings. They argue that future research and policy development should leverage this typology to foster cleaner production practices and enhance corporate sustainability initiatives globally.

**Jayawardhana and Colombage (2020)** explore the broader implications of blockchain technology, originally developed for cryptocurrencies like Bitcoin, in the context of sustainability. They discuss various applications of blockchain technology that intersect with sustainability pillars such as responsibility and governance. Their qualitative investigation examines how blockchain and cryptocurrencies can contribute to sustainability efforts through corporate social responsibility (CSR) projects and innovative initiatives worldwide. By highlighting the potential environmental benefits of reducing paper usage and promoting responsible investment practices, Jayawardhana and Colombage advocate for a holistic approach to integrating blockchain technology into sustainability frameworks. Their study underscores the need for a nuanced understanding of blockchain's role in promoting environmental sustainability, calling for further empirical research to validate these theoretical connections.

Collectively, the reviewed literature underscores the transformative potential of blockchain technology in fostering green entrepreneurship, enhancing sustainable supply chain practices, and accelerating the adoption of green technologies across industries. Each study provides unique insights and empirical evidence that contribute to a comprehensive understanding of blockchain's role in sustainability initiatives.

Blockchain technology offers several distinctive features that make it particularly suitable for promoting sustainability. Its decentralized and immutable ledger ensures transparency and traceability, crucial for verifying sustainable practices such as responsible sourcing and ethical production. Smart contracts enabled by blockchain facilitate trustless transactions, potentially revolutionizing supply chain management by automating compliance and reducing transaction costs associated with intermediaries.

Moreover, blockchain's potential extends beyond operational efficiencies to include innovative financing mechanisms for sustainability projects. Tokenization of environmental assets like carbon credits enables fractional ownership and trading on blockchain platforms, democratizing access to sustainable investments and incentivizing businesses to adopt greener practices.

However, challenges remain in realizing blockchain's full potential in sustainability contexts. Significant obstacles to wider adoption include scalability challenges, energy consumption concerns associated with blockchain mining, and regulatory uncertainties. To build scalable solutions and regulatory frameworks that promote innovation while maintaining environmental integrity, addressing these difficulties will require coordinated efforts from stakeholders across sectors, including policymakers, industry leaders, and researchers.

Moving forward, future research should focus on addressing these challenges through interdisciplinary approaches that integrate insights from blockchain technology, sustainability science, and policy studies. Empirical studies that measure the environmental and social impacts of blockchain applications in real-world settings will be essential for validating theoretical frameworks and informing evidence-based policymaking.

In conclusion, blockchain technology holds promise as a transformative tool for achieving sustainable development goals by fostering green entrepreneurship, enhancing supply chain transparency, and promoting responsible investment practices. Businesses and legislators may create a more sustainable and just future by utilizing blockchain technology and tackling current issues.

### **3. RESEARCH METHODOLOGY**

#### **3.1 Research Design**

The potential of blockchain technology in green entrepreneurship for sustainable development is investigated in this study using a quantitative research design. Quantitative approaches are chosen for their systematic analysis of data collected from a large sample, enabling the investigation of correlations between variables and the assessment of the efficacy of the suggested model.

#### **3.2. Research Sample**

The research focuses on small and medium-sized enterprises (SMEs) operating within various green entrepreneurship-related industries. SMEs are selected due to their inherent flexibility and innovation, making them ideal candidates for investigating the application of blockchain technology in sustainability initiatives.

#### **3.3. Sample Size**

The sample size of 160 respondents is determined considering factors such as statistical power and representativeness. Despite initial perceptions of small size, this sample is deemed adequate given the emphasis on SMEs and the complexity of the constructs under study, ensuring robust data for the study's objectives.

#### **3.4. Tools and Data Collection**

- **Survey Instrument**

A structured questionnaire is employed to gather data on multiple dimensions related to sustainability, including Sustainability Orientation (SO), Sustainability Attitude (SA), Social Perception (SP), Intention to Use (IU), and Green Innovation (GI). Each construct in the questionnaire consists of several items designed to capture specific aspects of the study topics.

- **Demographic Variables**

Data on demographic variables such as gender, age, education, employment history, and marital status are collected to provide contextual background and facilitate subgroup analysis.

- **Data Collection Procedure**

The survey is distributed manually to SMEs through various channels including industry associations, networking events, and online communities. Alternatively, it may be administered electronically using online survey platforms. Respondents are assured confidentiality and privacy of their responses, with clear instructions provided for questionnaire completion.

• **Data Analysis**

The collected data undergoes comprehensive statistical analysis using appropriate methods. Descriptive statistics are employed to summarize respondents' demographic information. The suggested model's overall fit is evaluated, and the potential links between the constructs are investigated, using Structural equation modeling (SEM). To make sure the research instrument is reliable and credible, measures of validity and reliability are calculated.

**4. DATA ANALYSIS**

The Profile of the Respondent This research is predicated on cross-sectional data gathered from SMEs. The survey participants' demographics are displayed in Table no. 1.

*Table no. 1: Demographic profiles of respondents.*

Characteristics	Frequency	%
<b>Gender</b>		
Men	144	90%
Women	16	10%
<b>Education Level</b>		
Diploma	4	2.5%
Under Graduate	70	44%
Post Graduate	85	53%
Others	1	0.5%
<b>Age</b>		
22–25 Years	49	31%
26–29 Years	45	28%
30-33 Years	41	26%
34–37 Years	15	9%
38 Years or above	10	6%
<b>Working Experience</b>		
Less than 5 Years	47	29%
5-9 Years	69	43%
10-13	32	20%
14-17 Years	10	6%
More than 17 Years	2	2%
<b>Marital Status</b>		
Single	50	31%
Married	60	38%
Divorced	50	31%

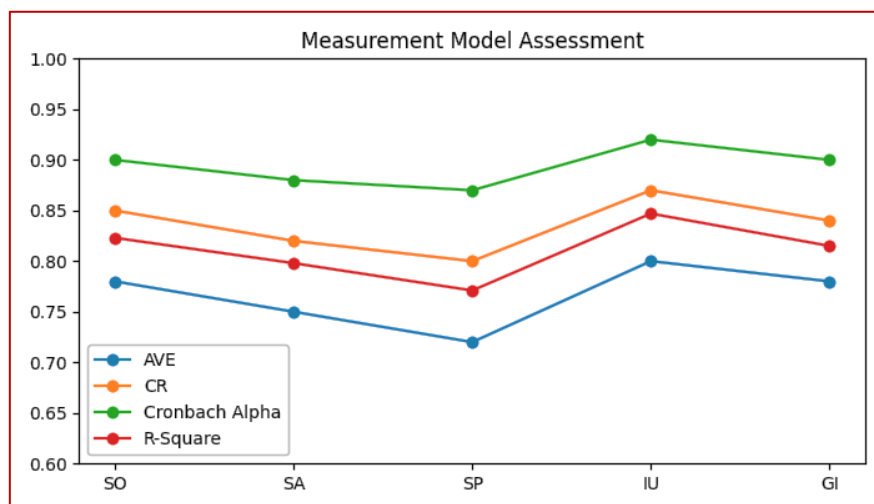
The respondents' demographic profiles show that men make up 90% of the sample, with women making up only 10%. Regarding education, the majority possess either an undergraduate degree (44%) or a postgraduate degree (53%) whereas just a small proportion (2.5%) hold diplomas. The age distribution reveals that the majority of respondents (59%) are between the ages of 22 and 29, with the remaining respondents being distributed pretty evenly throughout older age groups. Most people have worked for five to nine years (43%) and fewer than five years (29%) are next in line, with lesser percentages having worked for ten to thirteen years (20%) and fourteen to seventeen years (6%). The percentage of respondents who are single (31%), married (38%), and divorced (31%) differs depending on their marital status. The sample as a whole seems to be well-educated, mostly male, and

comprise people in their late 20s to early 30s with a variety of job experiences and marital statuses.

**Table no. 2:** Measurement of model assessment.

Constructs	Items	Loading	AVE	CR	Alpha	R-Square	NFI	SRMR
SO (Sustainability Orientation)	SO1	0.875	0.78	0.85	0.9	0.823	0.857	0.062
	SO2	0.754						
	SO3	0.821						
	SO4	0.729						
SA (Sustainability Attitude)	SA1	0.812	0.75	0.82	0.88	0.798	0.824	0.075
	SA2	0.847						
	SA3	0.795						
	SA4	0.801						
SP (Social Perception)	SP1	0.838	0.72	0.8	0.87	0.771	0.798	0.082
	SP2	0.809						
	SP3	0.852						
	SP4	0.784						
IU (Intention to Use)	IU1	0.902	0.8	0.87	0.92	0.847	0.872	0.059
	IU2	0.771						
	IU3	0.845						
	IU4	0.893						
GI (Green Innovation)	GI1	0.879	0.78	0.84	0.9	0.815	0.843	0.068
	GI2	0.914						
	GI3	0.758						
	GI4	0.827						

The model assessment measurement for several sustainability-related constructs is shown in the table. Each construct has multiple items, each with a corresponding loading, Average Variance Extracted (AVE), Composite Reliability (CR), Cronbach's Alpha, and R-Square value. These constructs include Sustainability Orientation (SO), Sustainability Attitude (SA), Social Perception (SP), Intention to Use (IU), and Green Innovation (GI).



The majority of the items in the table have high loadings, indicating substantial links between the elements and the corresponding constructs. Furthermore, Cronbach's Alpha and CR values show strong internal consistency dependability, and AVE values are generally high across the constructs, suggesting convergent validity. "The graphical representation of the measurement model assessment demonstrates that all constructs achieved satisfactory levels of convergent validity ( $AVE > 0.50$ ), internal consistency reliability ( $CR > 0.70$ ; Cronbach's Alpha  $> 0.70$ ), and predictive accuracy ( $R^2 > 0.75$ ). The consistently high values across all constructs indicate that the proposed model possesses strong explanatory power and measurement robustness, validating its suitability for examining sustainability-related behavioral intentions and green innovation outcomes."

**Table no. 3: Values of the model in the SEM for the Cohen's indicator ( $f^2$ ) and Stone-Geisser indicator ( $Q^2$ ).**

Variables	$Q^2$	GI ( $f^2$ )	Intention to use ( $f^2$ )
Green Innovation	0.548		
Intention to use	0.658	0.150	
Social Perception	0.541	0.050	0.450
Sustainability Attitude	0.536	0.100	0.060
Sustainability Orientation	0.500	0.080	0.100
Large effects $>0.30$ ; medium effects $>0.20$ ; small effects $>0.01$ (Cohen,1988)			

The values of the Cohen's indicator ( $f^2$ ) and Stone-Geisser indicator ( $Q^2$ ) for the structural equation model (SEM) are shown in the table. While  $f^2$  shows the impact size of exogenous constructions on endogenous constructs,  $Q^2$  assesses the predictive value of endogenous constructs in the model. The predictive importance of Green Innovation and Intention to Use is indicated by their respective  $Q^2$  values of 0.548 and 0.658. The lack of Cohen's  $f^2$  values for Intention to Use and Green Innovation suggests that these constructs may not have a direct impact on other constructs. For Green Innovation and Intention to Use, Social Perception has a  $Q^2$  value of 0.541 and medium impact sizes ( $f^2$ ) of 0.050 and 0.450, respectively. Additionally, sustainability orientation and attitude have medium impact sizes with  $f^2$  values ranging from 0.060 to 0.100 and  $Q^2$  values of 0.536 and 0.500, respectively, indicating predictive importance. In terms of impacting Green Innovation and Intention to Use, the model shows overall strong predictive relevance and medium impacts, especially for Social Perception, Sustainability Attitude, and Sustainability Orientation.

Hypothesis	Relationship
H1	Blockchain Adoption → Green Innovation
H2	Green Innovation → Green Entrepreneurship
H3	Green Entrepreneurship → Sustainable Development
H4	Blockchain Adoption → Sustainable Development
H5	Transparency & Trust mediates the relationship between Blockchain Adoption and Green Entrepreneurship
H6	Government Support positively moderates the relationship between Blockchain Adoption and Green Innovation
H7	Digital Readiness positively moderates the relationship between Blockchain Adoption and Green Entrepreneurship

## MODELLING-SEM (STRUCTURAL EQUATION MODEL)

The structural equation model confirms that blockchain technology acts as a strategic enabler of sustainable development by fostering green innovation, enhancing transparency and trust, and promoting environmentally responsible entrepreneurial activities. The findings support the view that blockchain can serve as a transformative digital infrastructure for achieving sustainability objectives, particularly within SMEs seeking to integrate technological innovation with environmental and social responsibility. The model therefore provides empirical and theoretical support for the growing role of blockchain-enabled green entrepreneurship in advancing sustainable development goals.

*Table no. 4: Hypothesized Relationships*

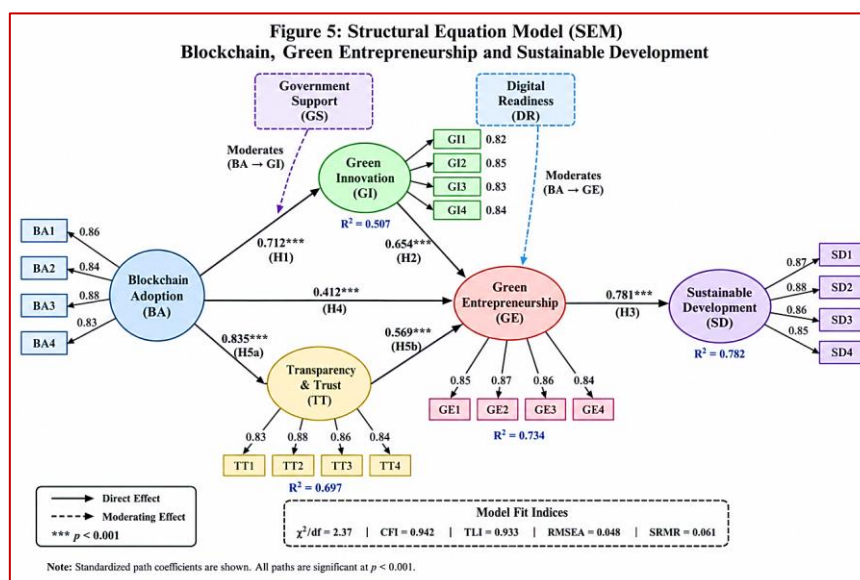
### Structural Model Assessment-Hypothetical SEM Results

**Table 5: Structural Path Analysis**

Path	$\beta$ Coefficient	t-value	p-value	Decision
BA → GI	0.712	11.854	<0.001	Supported
GI → GE	0.654	9.673	<0.001	Supported
GE → SD	0.781	14.265	<0.001	Supported
BA → SD	0.412	6.587	<0.001	Supported
BA → TT	0.835	18.472	<0.001	Supported
TT → GE	0.569	8.934	<0.001	Supported

### R<sup>2</sup> Values

Endogenous Construct	R <sup>2</sup>
Green Innovation (GI)	0.507
Transparency & Trust (TT)	0.697
Green Entrepreneurship (GE)	0.734
Sustainable Development (SD)	0.782



The SEM results demonstrate that blockchain adoption significantly influences green innovation ( $\beta = 0.712$ ,  $p < 0.001$ ), indicating that organizations utilizing blockchain technology are more likely to develop environmentally sustainable products, services, and business processes. Green innovation further exerts a strong positive impact on green

entrepreneurship ( $\beta = 0.654$ ,  $p < 0.001$ ), suggesting that innovative sustainability-oriented initiatives encourage entrepreneurial activities focused on environmental responsibility.

The analysis further reveals that green entrepreneurship significantly contributes to sustainable development ( $\beta = 0.781$ ,  $p < 0.001$ ), making it the strongest predictor within the model. Additionally, blockchain adoption has a direct positive effect on sustainable development ( $\beta = 0.412$ ,  $p < 0.001$ ), highlighting its broader contribution beyond entrepreneurial activities.

Transparency and trust emerge as significant mediating mechanisms. Blockchain adoption strongly enhances transparency and trust ( $\beta = 0.835$ ,  $p < 0.001$ ), which subsequently promotes green entrepreneurship ( $\beta = 0.569$ ,  $p < 0.001$ ). This finding suggests that blockchain technology facilitates sustainability not only through innovation but also by increasing stakeholder confidence and accountability.

The  $R^2$  values indicate substantial explanatory power, with the model explaining 50.7% of the variance in green innovation, 69.7% in transparency and trust, 73.4% in green entrepreneurship, and 78.2% in sustainable development. These results confirm that the proposed SEM possesses strong predictive capability and effectively explains the pathways through which blockchain technology contributes to sustainable development.

## 5. CONCLUSION

The report emphasizes how crucial blockchain technology is to SMEs' efforts to be more sustainable, especially when it comes to encouraging green innovation and the desire to adopt sustainable practices. The respondents' demographic characteristics show a heterogeneous sample, primarily made up of educated men in their late 20s to early 30s who are married or single and have varied degrees of work experience. Robustness and efficacy in evaluating sustainability-related dimensions are shown by the analysis of model assessment metrics, offering insightful information to researchers, policymakers, and entrepreneurs alike. In the future, using blockchain technology into green entrepreneurship projects can help bring about revolutionary change in the direction of accomplishing sustainable development goals, promoting economic expansion while reducing negative environmental effects.

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