Article

Blockchain Technology as a Game Changer for Green Innovation: Green Entrepreneurship as a Roadmap to Green Economic Sustainability in Peru

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Abstract: Blockchain technology has been heralded as a game changer for addressing severe environmental and economic sustainability challenges. In response to rising environmental concerns, blockchain technology (BCT) is transforming green innovation, culminating in green economic practices and well-established business models. Recognizing this, we investigated the role of blockchain technology in green innovation practices and its impact on green economic sustainability, which has an impact on green environmental sustainability. Moreover, 184 small- and medium-sized enterprises (SMEs) were surveyed in Lima, Peru. Data for this cross-sectional study were gathered using stratified random sampling. The positivist approach was implemented using a statistical induction method. Prior studies' research constructs were measured using validated measurement scales. For quantitative data analysis, using the partial least squares structural equation modeling (PLS-SEM) framework, this study provided two key findings. First, sustainability orientation and sustainability attitude have a positive and significant effect on the adoption of green innovation that employs green energy (solar) technology towards a sustainable green economy. Second, the intention to use blockchain technology mediates the relationship between sustainability orientation and social perception with the adoption of green innovation that employs green energy (solar) technology towards a sustainable green economy. We recommend that small- and medium-sized enterprises embrace green innovation and blockchain technology to protect the environment and boost community cohesiveness.

Keywords: blockchain technology; green entrepreneurship; green innovation; green economy; sustainability

1. Introduction

Technological advancements have made significant contributions to the development of the economy and the advancement of humanity, such as through blockchain open innovation. Because it is altering how economic transactions are carried out, blockchain open innovation is one of the technological developments that has a lot of promise for this progress [1,2]. Blockchain open innovation is already taking place all around the world; it's just an issue of scale or viewpoint [1,3]. Companies are now broadening its reach, especially through digital tools, into a universal strategy that is spreading in all directions, after keeping it purely for their local partners for so long. Individuals and small businesses are now being targeted by businesses, and users and customers are becoming

"cocreators" and are actively involved. Because blockchain open innovation has constraints, it needs to recreate itself on the basis of renewed trust and ideals that prioritize ethics [1,2]. Recognizing that BT is unmistakably occurring everywhere, it's fascinating to observe how blockchain open innovation may interact with blockchain technology, and one of the most intriguing things for us is its ability to revolutionize innovation processes [3]. Using BT can help us get closer to a fundamental rethink of how we conduct business and compete [3], which is one of the primary aims of blockchain open innovation.

Green entrepreneurship is a fundamental driver of the green economy. Rapid economic growth that uses green innovation has resulted in a significant increase in the consequences of environmental concerns in Peru [1,2,4]. As a result, eco-innovation has become a critical component in leveraging ecologically favorable opportunities and ecosystems to offset natural resource depletion [3,5]. Consequently, green innovation is recognized as the primary source of industry advancement, taking a variety of environmental considerations into account. Businesses are seriously considering making green innovation methods mandatory due to increased external demand from consumers (eco-friendly products), the environment (pollution, groundwater quality), the community (health dangers), and the government (governance of revenue). As a result, resource scarcity, expanding human wants and preferences, community pressure, and government regulations push firms to achieve a balance between long-term development and corporate expansion [2,3].

The notion of green entrepreneurship is growing in response to the need for sustainable development [3,6]. The green economy, on the other hand, is viewed as a means of achieving long-term prosperity and a higher standard of living. A green economy can help with environmental challenges, resource use, and the wellbeing of people at the bottom of the economic pyramid [5,7]. Numerous studies have shown that transitioning to a green economy has far-reaching economic and societal consequences [4,7,8]. With this level of logic, the "go green" message has been resonating all over the world. Green entrepreneurship is also seen as one of the most essential tools used in the transition to a green economy. As a result of the struggle for sustainability, an entrepreneurial attitude based on an intrinsic talent for managing organizations has emerged. Entrepreneurship's significance in creating a wealthier and more environmentally sustainable society is only now being recognized [7,9].

Blockchain technology is drawing the interest of a diverse variety of businesses, including energy firms, startups, technology developers, and financial institutions, as well as governments and academic institutions globally, as an emerging technology [5,8]. Several industry executives feel that blockchain technology has the potential to deliver significant benefits and innovation. Blockchain technology, for example, was inspired by decentralized digital currency [3,6]. Decentralization and its reliability in distributed systems, as well as its secure data storage technique and zero exchange transaction costs, are just a few of blockchain technology's noteworthy characteristics. A blockchain is essentially a distributed ledger network in which nodes communicate with one another to directly trade data and transactions. A blockchain's key characteristics are decentralization and immutability [1,10–12].

Blockchain technology has the potential to improve the energy economy's processes, markets, and users, making it more environmentally friendly as a result. Green energy can help to lessen the greenhouse effect and carbon dioxide (CO_2) emissions created by current usage [13,14]. Businesses such as banks, manufacturers, small- and medium-sized firms, and agricultural product manufacturers are already using blockchains to boost green innovation that necessitates automation and remote sensors. Blockchain technology, by establishing a secure and private mesh network, has provided Peruvian green innovation with a new framework that reduces the risks associated with central server architecture. Blockchain technology enables a safe and low-power architecture for remotely monitoring physical activity without the use of traditional centralized cloud servers. This results in a more ecologically friendly IoT ecosystem, also known as green innovation. Blockchain technology is increasingly being employed in green innovation [14,15].

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Most importantly, the emphasis on comprehending environmentalism and sustainability strategic initiatives has proven that a green orientation can help firms' principal concerns and world natural resources. While green entrepreneurship is still seen as an appropriate development strategy, the literature reveals that it is underutilized [16]. A transformation in the public's perspective and attitude toward green activities, particularly in the workplace, is required for the green economy and sustainable development to take root and take hold [17].

Promoting green innovation is a tough endeavor due to the specific characteristics associated with standardized discoveries [3,18] in SMEs. To break free from the limited sandbox of standards, SMEs must go outside their typical industrial knowledge base for new sources of expertise, both within and externally. Firms, particularly small- and medium-sized enterprises (SMEs), cannot create knowledge solely through their own resources (research and development (R&D)). As a consequence, they communicate and collaborate with rivals and external partners, using each other's expertise, experience, and assets, as outlined by the notion of open innovation using blockchain technology [5,19]. In the case of environmental-related green technologies, where internal and external information borders are becoming permeable, firms are increasingly relying on open green innovation methodologies [6,20] using blockchain technology. A crucial policy concern for addressing environmental challenges is the extent to which green ideas may be improved through blockchain technology. Government authorities must intervene in this area to eliminate the impediments that inhibit the green effect of inventive openness. Such impediments can result in a pattern of failure in innovation [20], which can be avoided by adopting green innovation behavior when working with external partners to extend their knowledge base (and R&D) on green innovation and blockchain technology [6,10,19].

The study's objective was to investigate the factors that influence the use of blockchain technology for green innovation by employees of small- and medium-sized businesses in Lima, Peru. Here, the positivist method was used to acquire empirical evidence through the hypothetic deductive observation procedure [21]. Descriptive research is a study that has well-defined problem statements, established assumptions, and a substantial amount of data to support it [21,22]. A cross-sectional survey was utilized to choose 184 small- and medium-sized enterprises (SMEs) in Lima, Peru. Using structural equation modeling, the hypotheses' direct and indirect impacts were examined. Few studies have used empirical analysis to investigate the relationship between blockchain technology and the adoption of green innovation and whether entrepreneurs are motivated to adopt green innovation via blockchain technology in order to contribute to the green environment and green economic development. We also discuss outstanding issues and future research areas that must be taken into account when developing a sustainable green innovation ecosystem using blockchain technology.

Finally, we aimed to identify the main drivers of green innovation within SMEs and investigate the prospects of blockchain applications in this area that contribute to green economic growth. The research questions are as follows:

RQ1: *How is blockchain technology applied in business operations?*

RQ2: *What are the most important factors influencing green innovation in the small- and medium-sized enterprises (SMEs) sector?*

RQ3: *What are the possible benefits to a country's economic growth from implementing green innovation utilizing blockchain technology?*

A literature review is followed by the formulation of hypotheses, which is then followed by a research technique that comprises the design of a research project, data collection, and analysis of the results. Following that, the findings are scrutinized, including the demographic features of the respondents, model assessment measurement, discriminant validity, structural model evaluation, and hypothesis testing. The conclusion highlights the study's impact after a review of previous studies.

2. Literature Review and Hypothesis Development

2.1. Blockchain and Open Innovation

When discussing blockchain and open innovation, the term "coopetition" comes to mind. Indeed, with the new data science, classification algorithms, and artificial intelligence methods, it is clear that for rivals to take advantage of a market, they must pool their data [4,7,9]. To facilitate such sharing, a new type of governance based on the notion of a common data repository is required. Full blockchain open innovation isn't suited for all use cases, isn't straightforward to implement, and won't be achievable if the network has significant competitive pressures [7,11]. However, we believe that the most transformative value can be generated when blockchain open innovation, BT, and other intelligent open-source technologies are combined. Transparency and privacy in the service connection between humans and technology are at the heart of the dynamic of individuals and organizations being trust-free in blockchain business services. Because it permanently stores transaction history at every node of the blockchain, BT allows anyone to see the records of each transaction they conduct [6,8,12,23]. Furthermore, because blockchain transactions are recorded using public and private keys (i.e., lengthy strings of characters that no one can read), persons can opt to remain anonymous in order to safeguard their privacy while allowing other parties to authenticate their identity [6,10,24].

2.2. Sustainability Orientation

There are many various approaches to sustainability today, such as maintaining yield to keep up with increased demand, preserving a desirable way of life for the future, and promoting ecological balance [9,25–27]. All of the preceding ideas on sustainability are part of a broader perspective on sustainability that encourages partnering with the environment so that future generations are not deprived [11,28,29]. This approach is also stated to aid in the operationalization of sustainability by capturing the conditions of economic, environmental, and social components [9,30]. Persons who are more worried about the environment are more inclined to participate in sustainability exercises [12,23,31,32].

It has been discovered that those who consider supporting sustainability while conceiving the activities have a strong appreciation for the movement [11,12,24,33]. A business strategy that integrates environmental and cultural issues is referred to as "sustainable orientation" [27]. An examination of the notion of sustainability orientation reveals that it was created with the sole purpose of supporting sustainable enterprise [23,31,34]. Numerous studies reveal that there is a positive and significant relationship between sustainability orientation and the adoption of green innovation [12,27,31]. Kuckertz and Wagner [28] discovered the beneficial impacts of a sustainability orientation focused on green innovation adoption in a study. Entrepreneurship is also said to have a keen and persuasive influence on sustainability orientation [24,32,33,35]. As a result, we arrived at the following hypothesis:

Hypothesis 1 (H1). *Sustainability orientation has a positive and significant relationship with the adoption of green innovation that employs green energy (solar) technology towards a sustainable green economy.*

2.3. Sustainability Attitude

Attitude is described as "the extent to which a person has a negative or foreboding perception or appraisal of the behaviour under consideration" [24,35,36]. People might have either a positive or negative attitude toward a given object, which influences their motivation to adopt green innovation. Furthermore, numerous studies have found that a person's attitude is a big and powerful motivator of their entrepreneurial urge that affects their intention to adopt green innovation [29,34,37]. According to Tih and Zainol [38,39], attitude is also a significant factor in influencing pro-environmental intention and sustainability commitment [37,40]. People's propensity to engage in specific behaviors is influenced in part by their own mental attitude. Furthermore, their way of thinking has a huge impact on green entrepreneurial ambitions that impacts the adoption of green innovation [41–43].

Numerous entrepreneurship studies have found that attitude influences the adoption of green innovation [39,42,44].

According to studies such as [45] and [44], researchers discovered that one's attitude influences one's pro-environmental behavioral intention that leads to green innovation. According to [46], an individual's positive or negative attitude may influence their motivation to execute sustainable actions that lead to green economic sustainability. Ahmad et al. [47] discovered that people's environmental behavior was influenced by their attitude. As a result, it was hypothesized that:

Hypothesis 2 (H2). *Sustainability attitude has a positive and significant relationship with the adoption of green innovation that employs green energy (solar) technology towards a sustainable green economy.*

2.4. Social Perception

Individual and group activities are influenced by social perception, which is an external factor. The sense of societal pressure that a person has impacts whether or not they will act [48]. Given that people are more concerned with how their social actions are seen by the general public, we investigated the impact of social perception on personal conduct and entrepreneurs' intentions to adopt green innovation that employs green energy technology and leads to green economic sustainability [49–51]. In general, social perception is one of the external factors that influences whether or not other people or groups accept or reject an individual's actions or statements that drives them to adopt green innovation that uses green entrepreneurship practices [33,36,43]. Social perceptions are also defined as a person's perception of social pressure to behave, whether positive or negative [29,43].

A growing number of studies claim that people's drive to become more entrepreneurial stems from their self perception in society, which increases their intention to adopt green innovation and causes their green entrepreneurship practices to lead them to adopt green innovation that employs green energy technology. People's decisions to engage in such acts are influenced more heavily by public opinion [43,51]. Today's rural people are more concerned with technological advancement, which gives them the courage to reject the notion that they are on the bottom rung of civilization [36,51,52]. No matter where they live on the planet, everyone has the same opportunities. Some of these people are well ahead of where they would be in the nineteenth century in terms of scientific progress, which was not even a consideration for both men and women. People can have positive emotions in response to the stressors they see in society [50,52]. Rural people's social perceptions of society are becoming more positive and grateful, which affects their adoption of green innovation intentions that use green entrepreneurship practices [33]. As a result, because of social perception, persons in developing countries are more likely to start green innovation adoption where they may use green energy technology that reduces CO_2 and leads to green economic sustainability. Thus, it was hypothesized that:

Hypothesis 3 (H3). *Social perception has a positive and significant relationship with the adoption of green innovation that employs green energy (solar) technology towards a sustainable green economy.*

2.5. The Importance of Blockchain Technology in Green Innovation That Employs Green Energy

Renewable energy sources have lately emerged as a crucial consideration for blockchain technology adoption due to their lower environmental impact compared to fossil fuels. Wind, geothermal heat, sunlight, and rain are all renewable energy sources that can be used to generate electricity [18,19,49,53–56]. Clean, renewable energy is produced as a result of the use of these resources. Due to improvements in renewable energy technologies, people can now generate their own electricity without relying on expensive fossil fuels [36]. This is where the smart grid comes in, allowing us to make use of all of the free and abundant green energy sources surrounding us. The smart grid, which is a mod-

ernized electrical system, makes use of information technology and analogue or digital communications [20,43,57–61].

Furthermore, the difficulties of security, interoperability, and data transfer are critical to smart grids. The fluctuating and unpredictable character of renewable energy sources necessitates the incorporation of complex technology into the current network [40,62,63]. A blockchain-based smart-grid design is used to incentivize the use of renewable resources and construct a better environment. The proposed paradigm is based on the inverted application of the recently introduced forking attack to the blockchain. In the energy grid concept, stakeholders are represented by a central authority and distributed peers. This technology is promising and could be used to improve ethical smart grid systems in order to build a greener planet [64–66].

The application of green certificates in an industrial operating system may be achieved using blockchain technology. The possibility of peer to peer energy exchanges using a microgrid design and blockchain [67] was investigated. It is believed that a blockchain-based system could be used to accurately assess and monitor the environmental impact of energy-related assets [67,68]. It is possible to go greener as a result of blockchain's potential to improve the energy supply chain. Blockchain technology has enabled energy-sharing economy applications, leading to various authors advocating new market models and the democratization of energy supplies [69–71]. Blockchains, when combined with smart contracts, promise transparent, tamper-proof, and secure platforms capable of delivering creative, environmentally responsible business solutions [72,73]. Thus, it was hypothesized that,

Hypothesis 4 (H4). *The intention to use blockchain technology mediates the relationship between sustainability orientation and the adoption of green innovation that employs green energy (solar) technology towards a sustainable green economy.*

Hypothesis 5 (H5). *The intention to use blockchain technology mediates the relationship between sustainability attitude and the adoption of green innovation that employs green energy (solar) technology towards a sustainable green economy.*

Hypothesis 6 (H6). *The intention to use blockchain technology mediates the relationship between social perception and the adoption of green innovation that employs green energy (solar) technology towards a sustainable green economy.*

Figure 1 reveals the framework of the study. Figure 1 illustrates the hypotheses that there is a positive and significant relationship between the adoption of green innovation and sustainability orientation, sustainability attitude, and social perception (H1, H2, H3). Furthermore, it illustrates the hypotheses that the intention to use blockchain technology mediates the relationship between the adoption of green innovation and sustainability orientation, sustainability attitude, and social perception (H4, H5, H6).
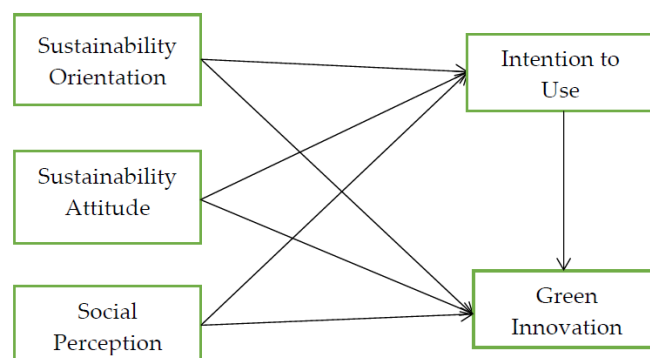

Figure 1. The framework of the study.

3. Methodology of the Study

3.1. Study Context

This study focuses on Peruvian small- and medium-sized enterprises (SMEs). Manufacturing accounts for roughly one-third of global energy consumption and CO_2 emissions [74]. Peru is the greenest city among the top greenest cities in the world [75]. In contrast, a "green worldview" has grown in popularity in recent years [76]. This probe is made much more necessary by the current situation of the law. The Paris Climate Accord has a direct impact on Peru. Our research provides a current assessment of the impact of environmental management issues on green entrepreneurship and green innovation as well as firm success.

3.2. Research Design

A positivist approach was adopted, which allows deducing empirical knowledge from data-driven hypotheses [21]. Because there were so many factors, a comprehensive quantitative investigation was also conducted. [22]. Peruvian firms were ideal subjects for this study because the Peruvian government has implemented a number of sustainability policies and has established a number of training initiatives to encourage participation in the production of environmentally friendly green technologies in manufacturing.

3.3. Questionnaire Design

A total of five variables were used in the final survey, which included 25 questions. To confirm the validity of the questionnaire's content, a pretest had to be conducted before the final survey was executed. Four sustainability orientation items were used to construct the survey instrument adopted from Appendix A [76]. It was based on [77] that the four sustainability attitude items were adopted. Social perception has been adopted from [78]. Four items adopted from [79,80] were used to measure the intention to use. Green innovation was measured by adopting four items from [81]. Likert scales ranging from strongly disagree (1) to strongly agree (5) were employed to measure the constructs

3.4. Sampling and Data Collection

More than 216 rural SMEs in Lima, Peru, were provided as self administered questionnaires between September and October 2021. It was possible to select a representative sample of 184 complete and valid responses. Due to a lack of specifics, 32 responses went missed. A lack of confidence in the survey could be a factor. Only face-to-face participation was permitted. As a whole, our results are in line with the standards set out by [82] for a sufficient sample size. Our survey's response rate was 85.19 per cent, according to a survey-based sample. The study's findings were then tested by a survey of 184 participants. Everyone in the study was made aware of the fact that their data would be kept confidential and that they had given their consent to participate in the research. It was also noted that the data could only be used for research purposes. In advance of launching the final survey, a pilot study involving a total of 16 participants was completed. These respondents are not included in the final survey.

Data from stratified random sampling were processed by a team of locally trained research assistants. Our limited resources were better managed thanks to random stratification. For each respondent who took the survey, it took no more than a few minutes to complete. Using a double-back translation method, the primary survey was translated into Spanish to better understand the respondents. It was possible to carry out the time trend extrapolation test that was described by [83] and widely used in business, psychology, and academics by implementing the nonresponse bias. Nonresponse bias cannot be seen in our findings because we compared early respondents (the first 25%) to late respondents (the last 25%). VIF values more than 10 but less than 0.1 indicate the presence of multicollinearity, according to [84]. Because the inner VIFs in this investigation were less than 5, multicollinearity was not an issue in this study.

3.5. Data Analysis

An SEM (structural equation modelling) validation was performed on the research model to ensure its accuracy. Smart PLS 3.2.9 was used to test the data analysis and study model's feasibility, reliability, and validity. We were able to obtain a required sample size for SEM analysis using the minimum R-square method suggested by [84]. As a result, PLS-SEM is the most accurate method for predicting outcomes. Both measurements and structural models can be simultaneously handled by it. In addition, it is a useful method for analyzing complex route models [85]. Small sample volumes may be handled by the PLS-SEM while still delivering highly accurate results for the first time. As a result, PLS-SEM was an appropriate tool for our investigation. Measurement and structural mode was evaluated using the alpha coefficient and other statistical tests such as convergent validity and discriminant validity.

3.6. Mediation Analysis

As stated by [86], a two-step technique was employed to explore the mediating influence of the intention to use in this study, by looking at the impact of SO, SA, and SP on green innovation adoption through intention to use in the first step. The indirect effect of SO → IU → GI and SP → IU → GI were significant in this study (details are given in Section 4.5. Using SO, SA, and SP without eliminating the mediator (IU), the researchers looked at the effects on the GI for H4 and H6. Furthermore, the positive sign of these indirect and direct effects was observed; it is possible to conclude that SO → IU → GI has full complementary mediation that supports H4. Complementary partial mediation thus supports H6 (SP → IU→ GI).

4. Results and Analysis

4.1. Respondent's Profile

This study is based on cross-sectional data collected from Peruvian small- and medium-sized firms (SMEs). Table 1 shows the demographics of those who took part in the survey. Men made up 78.26 per cent of the population, 31.52 per cent were between the ages of 34 and 37, 70.11 per cent were married, 51.09 per cent had postgraduate degrees, and 48.37 per cent had five years of working experience.

Table 1. Demographic profiles of respondents.

Characteristics	Frequency	Percentage	Characteristics	Frequency	Percentage
Gender			*Education Level*		
Men	144	78.26	Diploma	8	4.35
Women	40	21.74	Under Graduate	74	40.22
Age			Post Graduate	94	51.09
22–25 Years	14	7.61	Others	8	4.35
26–29 Years	33	17.93	*Working Experience*		
30–33Years	57	30.98	Less than 5 Years	66	35.87
34–37 Years	58	31.52	5–9 Years	89	48.37
38 Years or above	22	11.96	10–13 Years	18	9.78
Marital Status			14–17 Years	7	3.8
Single	46	25	More than 17 Years	5	2.72
Married	129	70.11			
Divorced	9	4.89			
			Total-184		

4.2. Model Measurement, Validity and Reliability

Table 2 shows the model's evaluation. The outer loading can be as high as 0.50 [87]. Table 2 shows that the outer loading of the study is more than 0.50. If the composite reliability score is greater than 0.70, it is advised that the internal consistency of the reliability be evaluated. As shown in Table 3, the overall reliability of the study is more than or equal to 0.70. Vinzi et al. [88] suggests that the Cronbach's alpha be greater than 0.70. Table 2 shows that the Cronbach alpha is more than 0.70. As a result, all constructs with the same value disclose Cronbach's alpha criteria. The convergent validity was estimated using the average variance extracted (AVE) [88]. In order for convergent validity to hold, the loading factors of both items must be more than 0.50. Table 2 displays AVE values greater than 0.50.

Table 2. Measurement of model assessment.

Constructs	Items	Loading	AVE	CR	Alpha	R-Square	NFI	SRMR
	SO1	0.907						
Sustainability Orientation (SO)	SO2	0.790	0.704	0.905	0.858			
	SO3	0.870						
	SO4	0.783						
	SA1	0.850						
Sustainability Attitude (SA)	SA2	0.878	0.725	0.913	0.873			
	SA3	0.840						
	SA4	0.835						
	SP1	0.861						
Social Perception (SP)	SP2	0.849	0.728	0.914	0.875			
	SP3	0.883						
	SP4	0.818						
	IU1	0.914						
Intention to Use	IU2	0.804	0.774	0.932	0.902	0.903		
	IU3	0.880						
	IU4	0.918					0.901	0.078
	GI1	0.895						
Green Innovation (GI)	GI2	0.939	0.758	0.926	0.892	0.912		
	GI3	0.780						
	GI4	0.861						

Table 3. Values of the Stone–Geisser indicator (Q^2) and Cohen's indicator (f^2) of the model in the SEM.

Variables	Q^2	GI (f^2)	Intention to Use (f^2)
Green Innovation	0.589		
Intention to Use	0.613	0.152	
Social Perception	0.533	0.052	0.497
Sustainability Attitude	0.531	0.103	0.035
Sustainability Orientation	0.501	0.079	0.101
Large effect > 0.34; medium effect > 0.14; small effect > 0.01 (Cohen, 1988)			

Table 2 shows that in order to compute R^2, we had to take into account changes in the endogenous variable. It was proposed [89] to use three different R^2 values (R^2 of 2%, R^2 of 13%, and R^2 of 26%) to evaluate the three distinct impacts. In other words, independent

factors have a considerable impact on the intention to use (0.903 or 90.3 percent). The intention of respondents to use could have a significant impact on whether or not they adopt green innovation as a strategy (0.912 or 91.2 percent). The model's NFI is near to one, indicating that it was well-suited to the study's objectives [85]. Low SRMR values of 0.08 imply that the model was appropriate for these data [85]. In this case, the NFI is high, at 0.901.

The model's ability to predict outcomes is seen in Table 3. In other words, the model's predictive value is greater than zero [90]. Cross-validated communality methodologies are used to evaluate the predictive value of the well-established PLS path model. As seen in Table 3, the model has predictive relevance. Finally, the intention to use has a medium impact on green innovation adoption. Overall, the model has an outstanding fit and a high degree of prediction accuracy.

4.3. Discriminant Validity

4.3.1. Fornell–Larcker Criterion Analysis

Table 4 shows a comparison of the square roots of latent variables (LVs) and AVEs. In order to determine the model's validity, we used the Fornell–Larcker [91] criterion. AVE (in bold) for all variables is equal to the square root of the number in this range (0.839–0.880). As a result, the variables' discriminant validity was preserved and identified for use in the current study model.

Table 4. The Fornell–Larcker criterion analysis for discriminant validity.

		1	2	3	4	5
1	Green Innovation	**0.871**				
2	Intention to Use	712	**0.880**			
3	Social Perception	646	571	**0.853**		
4	Sustainability Attitude	569	532	582	**0.851**	
5	Sustainability Orientation	548	451	555	476	**0.839**

The diagonal values are the square root of the AVE (in bold) of the latent variables and indicates the highest in any column or raw. Note: LV—Latent variable.

4.3.2. Heterotrait-Monotrait (HTMT) Analysis

When the discriminant validity was tested, it was discovered that HTMT values were always less than 0.85 (Table 5). The discriminant validity of the variables was validated using an HTMT value of 0.85 [92].

Table 5. The heterotrait-monotrait (HTMT) analysis for discriminant validity.

		1	2	3	4	5
1	Green Innovation					
2	Intention to Use	0.423				
3	Social Perception	0.455	0.351			
4	Sustainability Attitude	0.345	0.356	0.344		
5	Sustainability Orientation	0.244	0.389	0.254	0.298	

Note: Discriminant validity exists if the HTMT < 0.85 (Henseler et al., 2005); Discriminant validity exists if the HTMT <0.90 (Gold et al., 2001).

4.3.3. Cross Loads

Load values or crossing loads [91] determine the discriminant validity that exists only when load values are greater than the original load values. Crossing load values would be undesirable if the major diagonal values and correlations between latent variables (LV) and

square roots of AVE values were more dissimilar. The model's validity was maintained by displaying AVE values in (see Table 6) between the LV and the square roots.

Table 6. Values of the cross loads of individual items in the SEM.

Items	Green Innovation	Intention to Use	Social Perception	Sustainability Attitude	Sustainability Orientation
GI1	**0.895**	0.810	0.801	0.821	0.782
GI2	**0.939**	0.878	0.827	0.881	0.889
GI3	**0.780**	0.762	0.701	0.621	0.655
GI4	**0.861**	0.796	0.839	0.851	0.821
IU1	0.885	**0.914**	0.827	0.848	0.837
IU2	0.695	**0.804**	0.786	0.681	0.756
IU3	0.841	**0.880**	0.803	0.859	0.796
IU4	0.849	**0.918**	0.854	0.748	0.814
SP1	0.761	0.732	**0.791**	0.751	0.717
SP2	0.726	0.718	**0.780**	0.728	0.722
SP3	0.766	0.816	**0.849**	0.673	0.709
SP4	0.772	0.754	**0.759**	0.840	0.806
SA1	0.728	0.691	0.693	**0.794**	0.739
SA2	0.796	0.755	0.721	**0.835**	0.744
SA3	0.722	0.703	0.718	**0.770**	0.708
SA4	0.775	0.810	0.801	**0.832**	0.807
SO1	0.722	0.731	0.733	0.717	**0.790**
SO2	0.689	0.799	0.742	0.809	**0.870**
SO3	0.744	0.711	0.637	0.706	**0.783**
SO4	0.725	0.748	0.761	0.723	**0.793**

4.4. Assessment of the Structural Model

Figure 2 depicts the evaluation of the structural model. The t-values and R squares were calculated using a 5000-sample bootstrapping approach.
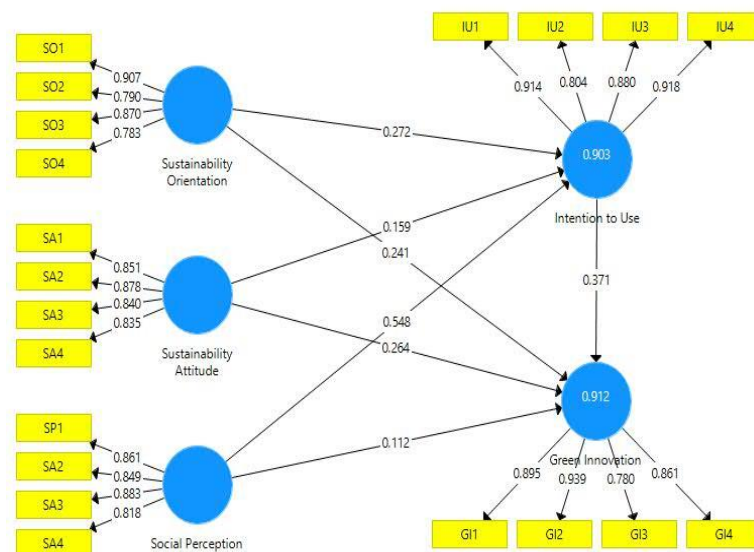

Figure 2. Standardized results of SEM calculations.

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Smart PLS 3.2.9 was used to produce the standardized SEM values shown in Figure 2. Outer loading appeared to be pretty high on these two things. The path coefficients of all variables appeared to be in decent condition.

4.5. Hypotheses Testing (Direct and Indirect Effects)

Table 7 displays the results of direct and indirect hypotheses. Bootstrapping was used to assess statistical t-values. A 95 per cent confidence interval can be employed in social science studies, according to the *p*-value of Smart PLS 3.2.9 [93].

Table 7. Result of direct and indirect effect hypotheses.

Hypotheses	Relationship	Std Beta	Std Error	*t*-Value	*p*-Value	Decision
H1	Sustainability Orientation → Green Innovation	0.229	0.079	3.062	0.002	Supported
H2	Sustainability Attitude → Green Innovation	0.264	0.071	3.701	0.000	Supported
H3	Social Perception → Green Innovation	0.116	0.086	1.306	0.192	Rejected
H4	Sustainability Orientation → Intention to Use → GI	0.103	0.039	2.624	0.009	Supported
H5	Sustainability Attitude → Intention to Use→ GI	0.065	0.048	1.226	0.221	Rejected
H6	Social Perception→ Intention to Use → GI	0.203	0.060	3.382	0.001	Supported

Note: GI—Green innovation.

The first hypothesis proposed that sustainability orientation has a positive and significant relationship with the adoption of green innovation that employs green energy (solar) technology towards a sustainable green economy. According to the findings, sustainability orientation was found to be positively associated with the adoption of green innovation ($\beta = 0.229$, $t = 3.701$; $p < 0.05$, see Table 7). In this aspect, we can infer that our original hypothesis was supported. Studies conducted by Guo et al. [94] and Weng et al. [95] support this hypothesis.

The second hypothesis proposed that sustainability attitude has a positive and significant relationship with the adoption of green innovation that employs green energy (solar) technology towards a sustainable green economy. According to the findings, sustainability attitude was found to be positively associated with the adoption of green innovation ($\beta = 0.264$, $t = 3.062$; $p < 0.05$, see Table 7). In this aspect, we can infer that our original hypothesis was supported. The findings of Yousaf [96] and Guo et al. [97] support this hypothesis.

The third hypothesis proposed that social perception has a positive and significant relationship with the adoption of green innovation that employs green energy (solar) technology towards a sustainable green economy. According to the findings, social perception was not found to be positively associated with the adoption of green innovation ($\beta = 0.116$, $t = 1.306$; $p < 0.05$, see Table 7). In this aspect, we can infer that our original hypothesis was not supported. The findings of Wang et al. [98] and Zhang et al. [99] do not support this hypothesis.

Furthermore, in the fourth hypothesis, it was assumed that the intention to use blockchain technology mediates the relationship between sustainability orientation and the adoption of green innovation that employs green energy (solar) technology towards a sustainable green economy. Green innovation adoption and sustainability orientation were discovered to be linked through a mediating role of intention to use ($\beta = 0.103$, $t = 2.624$; $p < 0.05$, see Table 7). This evidence supports our fourth hypothesis.

Moving forward to the fifth hypothesis, it was assumed that the intention to use blockchain technology mediates the relationship between sustainability attitude and the adoption of green innovation that employs green energy (solar) technology towards a sustainable green economy. Green innovation adoption and sustainability orientation were revealed to be unrelated due to the mediating impact of intention to use ($\beta = 0.065$, $t = 1.226$; $p > 0.05$, see Table 7). This evidence does not support our fifth hypothesis.

Moreover, in the sixth hypothesis, it was assumed that the intention to use blockchain technology mediates the relationship between social perception and the adoption of green innovation that employs green energy (solar) technology towards a sustainable green

economy. Green innovation adoption and social perception were discovered to be linked through a mediating role of intention to use ($\beta = 0.203$, $t = 3.382$; $p < 0.05$, see Table 7). This evidence supports our sixth hypothesis.

5. Conclusions

Blockchain technology has the potential to improve the administration of energy systems, financial markets, e-governance, and smart cities, resulting in a greener IoT ecosystem and green innovation [100]. Finally, there is blockchain technology where transactions are safe, transparent, and unalterable, and they are protected against tampering. Blockchain technology is rapidly adopting IoT research and development technology and is capable of overcoming issues and bottlenecks. Blockchain technology is increasingly becoming popular [101]. As a result, the focus of this study was on the role that blockchain technology may play in developing a more environmentally friendly Internet of things ecosystem, as well as critical factors that can be addressed via blockchain technology. The objective of this study was to provide a timely and convenient assessment of blockchain in the green IoT sector. When creating a sustainable green IoT ecosystem that ultimately contributes to the growth of the green economy, the findings show unresolved issues and future research directions that should be addressed.

According to the findings of this study, sustainability orientation, sustainability attitude, and social perception all play an important role in the establishment of green mindsets and endeavours. The findings of this study on green innovation may assist the government of Peru in developing a mindfulness program or educational program framework that focuses a stronger emphasis on green innovation and sustainability economy. Because of their ability to produce more environmentally friendly firms, these activities have the potential to help Peru achieve its goal of becoming a green economy. To ensure that economic gains completely adhere to the green agenda, the green economy focuses on cultivating green innovation and a green mindset among small- and medium-sized business entrepreneurs. This is an absolute requirement. The findings of the study will encourage the development of sustainability in organizations as well as the evaluation of green entrepreneurship that avoid acts that harm the natural environment in order to boost the value of associations. Eco-friendly entrepreneurship has the ability to significantly influence how businesses run. Sustainability as a value and the drive to profit go hand in hand, resulting in a firm philosophy that is both environmentally and socially responsible.

6. Implications of the Study

This study contributes to the green economy by offering an up-to-date, academically led assessment of the energy sector. Initial blockchain technology research focused on system architectures, distributed consensus processes, and performance difficulties. The authors of this study then explored the benefits of blockchain technology in connection to various energy use scenarios. Following that, we performed a thorough assessment of a wide range of blockchain activities, highlighting the specific areas in which energy system stakeholders and industrial parties are pursuing green innovation [102]. We discovered that most projects are still in the early stages of development, and research on crucial improvement areas that would allow for desired scalability, decentralization, and security is still happening. A multitude of impediments, including legal, regulatory, and competitive constraints restrict the widespread implementation of blockchain technology, which has the potential to jeopardize energy firms. Research, testing, and collaborations will indicate whether the technology can reach its full potential, demonstrate commercial feasibility, and finally be accepted by the general community in its entirety.

Furthermore, the findings provide motivation and excitement for the continuation of green entrepreneurial firms, particularly among small- and medium-sized businesses (SMEs). The purpose of the project was to inspire and educate future entrepreneurs about green entrepreneurship by fostering entrepreneurial mindsets and intentions that are strongly related to sustainability orientation, sustainability attitude, and social perception.

This would lead to more growth, as well as more sustainable behaviors and a more sustainable style of life [80,103]. According to the study's results and conclusions, people are more likely to believe they have all of the knowledge needed for a new endeavor. Finally, this research contributes to the body of information on how to enhance eco-economic success through the development of national habitats [80,103–106].

Moreover, in order to successfully deliver robust green innovation performance, it is proposed that technological absorptive ability be combined with technological orientation, Industry 4.0, and open innovation perspectives. Firms should encourage collaborative innovation initiatives that focus on green innovation and a long-term view. Not only will they contribute to ecological and environmentally friendly innovation for long-term gain, but certain governments also give tax advantages and bonuses for green innovation, allowing businesses to profit from these incentives and lower their expenses. In this context, open innovation-based partnerships might help to promote green innovation, which is seldom achieved without incentives in the usual course of business [107–113].

7. Limitations and Directions for Future Research

Like some other studies, this study is not beyond limitations. This study focuses on Peruvian entrepreneurs in Lima where a quantitative methodology was used to assess the magnificence of green innovation. The cross-sectional data were used to achieve the study objectives. It was difficult to collect data from SME entrepreneurs as the number of samples is small in this study. Only one location was used to collect data from respondents. Finally, the use of a survey questionnaire limits the area of the research even further. As a result, we urge that further study be performed in a variety of national contexts, as well as in economic sectors other than the SMEs sector. Furthermore, these additional economic sectors offer exciting prospects for future research, which might include green economy social ventures. Ideas of sustainability transformations can finally be used when it comes to understanding the role that businesses play in the green economy. The boundless potential of blockchain technology and its problem-solving abilities will profoundly alter the landscape of efforts to develop a long-term green innovation ecosystem. The research direction for this study will provide the framework for future study and urge scholars to thoroughly investigate the application of current theories to better explain new phenomena at the junction of blockchain technology and the green innovation ecosystem. Future research should focus on Gen Z and Y to understand their nascent entrepreneurial propensity that leads to adopt green innovation using green entrepreneurship practices.

We suggest that policymakers and strategists incorporate the open innovation method, which is a commonly used approach in innovation management, in the context of boosting green innovation. Furthermore, we propose that because our study focused on SMEs, which are typically in greater need of open innovation due to limited resources and a low risk-taking proclivity. We looked at the supplied factors in Peruvian SMEs in general, regardless of their function, influence, and implementation in specific industries. As a result, we recommend that future studies analyze sectors such as electrical and electronics, chemical, and others separately, and then compare their levels of green innovation success.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of United International University and approved by the Institutional Review Board (or Ethics Committee) of the Institute for Advanced Research.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data and the questionnaire used in the study are available to other authors who require access to this material.

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Appendix A

Sustainability Orientation [76]:

1. Typically initiate actions which competitors then respond to.
2. Is very often the first business to introduce new products/services, administrative techniques, operating technologies, etc.
3. A strong tendency to be ahead of others in introducing novel ideas or products.
4. Typically adopts a very competitive 'undo the competitors' posture.

Sustainability Attitude [77]:

1. Being an entrepreneur is more lucrative.
2. A career as entrepreneur is attractive for me.
3. I'd like to start a firm if I had the opportunity and resources.
4. I prefer to be an entrepreneur among various career options.

Social Perception [78]:

1. I can usually recognize others' traits accurately by observing their behaviour.
2. I can usually read others well—tell how they are feeling in a given situation.
3. I can tell why people have acted the way they have in most situations.
4. I generally know when it is the right time to ask someone for a favour.

Adoption of Blockchain Technology [79,80]:

1. I believe our company should implement blockchain technologies in NEAR future.
2. I am actively cultivating agreement among other relevant members in the company to adopt blockchain technologies.
3. We are working out/already have an implementing plan with budget for blockchain technologies.
4. We have spent/scheduled to spend remarkably on implementing blockchain technologies.

Green Innovation [81]:

1. The enterprise adjusts its business practices or operations to reduce the damage to the ecological environment.
2. The enterprise adjusts its business practices or operations to reduce wastes and emissions.
3. The enterprise reduces the use of traditional fuels by the substitution of some less polluted energy sources.
4. The enterprise adjusts its business practices or operations to reduce energy consumption.

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