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Rural entrepreneurs behaviors towards green innovation: Empirical evidence from Bangladesh

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ABSTRACT

The study aims to investigate the effects of dimensions on the adoption of green innovation in order to design a clean energy strategy and eco-friendly SMEs among rural entrepreneurs in Bangladesh. The study also strives to evaluate if these interactions are mediated by the intention to use green energy technology. Using Smart PLS 3.3.9 (SEM) and SPSS V25, data from a sample of 288 rural Bangladeshi SMEs entrepreneurs were studied using a positivist approach to hypothetic deductive observation. Examining the effects of environmental concern, perceived ease of use, and attitude on adoption of green innovation in the direction of sustainable green SMEs and cities was the goal. The indirect impacts of these three factors have also been examined through the mediating prism of the intention to use green energy technology. The findings show that environmental concern and perceived ease of use are positively and significantly associated with adoption of green innovation. The data also supports the assumption that the intention to use green energy technology, namely solar energy, mediates the relationships between environmental concern and attitude with the adoption of green innovation. However, the intention to use green energy technology does not play a mediating role in the association between the perceived ease of use and adoption of green innovation. The findings of this study on green innovation add to the body of existing literature on rural green innovation and entrepreneurship in the field of information systems and help to pinpoint potential for rural green entrepreneurship and innovation in the digital age. Green innovation is still a relatively new concept in Bangladesh, hence there isn't much talked about it among rural entrepreneurs there. Lastly, the study discusses in some detail how important it is to take into account sustainability factors and eco-innovations that might encourage green innovation practices among rural entrepreneurs.

1. Introduction

With recent developments in a number of global social challenges, there is a rising interest in green energy technology to decrease future difficulties with conventional energy plants, which aids in the development of green SMEs (Hu et al., 2023; Silva et al., 2023). Rural entrepreneurs' behavior towards adopting green innovation is the most important fact for developing green SMEs. Many environmental

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scientists have lately classified rural entrepreneurs' behavior towards using solar energy technology as one of the most intriguing energy technologies usages among many other types of green energy usages (Roomi et al., 2021; Vlasov et al., 2022; Hu et al., 2023). Since the 1970 s oil crisis, rural entrepreneurs' behavior of energy-related issues has increased, inspiring a large quantity of study (Hu et al., 2023). According to preliminary findings (Roomi et al., 2021; Ma et al., 2017), environmental awareness motivates rural entrepreneurs behavior to cut energy use and migrate from traditional fossil-based energy sources to greener alternative (Triguero et al., 2013; Kim and Jin, 2022). Renewable energy sources include solar photovoltaic and thermoelectric energy, biomass, geothermal energy, and wind energy, to mention a few (Ma et al., 2017). Some rural entrepreneurs' behavior towards using green energy is positive and is now ready to pay a premium for branded green energy (Roomi et al., 2021; Alkaraki et al., 2022). Green Mountain Energy (in the United States), Ecotricity (in the United Kingdom), Lichtblick (in Germany), NaturEnergie (in Austria), and Iberdrola Energa Verde (Spain) are examples of such firms (Chowdhury et al., 2020). However, rural entrepreneurs' appetite for greener energy alternatives is not universal, and there is no agreement on what factors inspire or prevent the adoption of environmentally friendly alternatives. This study helps to fill that void. The aforementioned issues, as well as a gap in the literature, prompted this study, which attempted to reduce the amount of ambiguity around these linkages by addressing the following research questions:

RQ1. : What are the drivers that encourage green innovation implementation in the rural SMEs in Bangladesh?

RQ2. *: How closely are these drivers related to one another?*

RQ3. *: How effective is the implementation of green innovation in rural SMEs in Bangladesh?*

By resolving the aforementioned research questions, the current study contributes to the existing body of information. To begin, this study addresses a research gap by investigating the relationship between environmental concern, perceived ease of use, and attitude toward green innovation using multivariate analysis and structural equation modeling. Second, this research study focuses on an essential but little-understood feature of green energy technology and adoption of green innovation by rural entrepreneurs, all of which contribute to green environmental sustainability. Third, the emphasis of this research is on Bangladesh, a nation that has recently experienced rapid industrial growth but has gained little attention in the literature. Given that three leading practices have been identified as green innovation (), there is considerable incentive to investigate the influence of environmental concern, perceived ease of use, and attitude, intention to use green energy technology, and adoption of green innovation by rural entrepreneurs on a business.

The findings of this study on green innovation add to the body of existing literature on rural green innovation using green energy and entrepreneurship in the field of information systems and help to pinpoint potential for rural green entrepreneurship and innovation in the digital era. Green innovation is still a relatively new concept in Bangladesh, hence there isn't much talked about it among rural entrepreneurs there (de Jesus Pacheco et al., 2018; Kelliher et al., 2020). Lastly, the study discusses in some detail how important it is to take into account sustainability factors and eco-innovations that might encourage green innovation practices among rural entrepreneurs (Skordoulis et al., 2022). Many studies have been attempted to investigate the major factors and prospective drivers of environmental performance and energy efficiency towards green innovation (Mukonza, 2020; Kirby and El-Kaffass, 2022). Unfortunately, the results are shown to be unreliable. It has also not yet been investigated how green innovation as a whole affect eco-friendly environmental performance and green energy efficiency (Roomi et al., 2021). Consequently, the purpose of the current study is to investigate how environmental concern, perceived ease of use, and attitude connect to green innovation in terms of eco-friendly environmental performance and green energy efficiency. In this study, we develop and evaluate a model that explains and predicts the adoption of green innovation. As a result, the study is conceptualized using the Theory of Planned Behavior (TPB) and the technology acceptance model (TAM) (Ajzen, 1985; Davis, 1989).

Moreover, this study is the empirical confirmation of a previously hypothesized relationship between green innovation and its intended audience's proclivity to employ it. Green innovation is regarded as a part of the greater green technology movement. Green innovation, more particularly, comprises new applications of technology, craft, or remedies meant to minimize the externalities of resource-hungry businesses and the environmental costs inherent in product design, manufacture, distribution, and usage (Cao and Chen, 2019). Green innovation has received great public support as a result of its technological superiority in reducing pollution and predicted capacity to give its customers with a long-run competitive advantage in operational performance and decreased overhead (Li et al., 2018). Insiders in the industrial sector have been some of its most vociferous supporters due to the nature of its vulnerabilities (Weng et al., 2015). Meanwhile, some environmental concerns have become increasingly important in the expansion of modern service businesses, particularly in the transportation and logistics industries (Martínez-Ros and Kunapatarawong, 2019). While logistics services' primary activities include transportation, storage, packaging, and distribution, each service has the ability to contribute to long-term innovation and environmental goals (Sun et al., 2019a, 2019b). Because of these features, the manufacturing industry is an essential case study for understanding organizations' intentions to adopt green innovation. Furthermore, given this industry's proclivity to generate a significant amount of environmental waste, as well as its critical ties to the global supply chain, a better understanding of whether and how much this sector of the economy favors the adoption of green alternatives holds practical implications for the climate transition movement in general.

The energy crises, on-going poverty, and environmental deterioration are serious issues in Bangladesh. A sustainable energy plan approach includes the use of green energy, enhanced energy efficiency, and improved energy security (Islam et al., 2011; Khattak, 2019). When compared to fossil fuels, renewable energy sources emit much less greenhouse gas, and increasing energy efficiency makes it easier to reduce the primary use of fossil fuels, which helps to mitigate the effects of climate change while also improving the security of the energy supply and the provision of energy services (Sohag et al., 2020; Appiah et al., 2022). The connection between green energy and economic development is vital; the process of economic expansion necessitates the substitution of an energy mix in the accomplishment of industrial, residential, and agricultural duties (Apfel and Herbes, 2021). The costs of inadequate energy in rural Bangladesh extend beyond those of the individual and family to those of the entire country. The performance of firms in terms of sustainability is a key problem today, and firms are making efforts to accomplish this. So, implementing green innovation practices that might enhance sustainability performance may be best accomplished through the use of green energy (Islam et al., 2022).

Furthermore, Bangladesh is one of the significant numbers of rising economies countries since it is a tiny open economy in the South Asian area (Huang and Li, 2017; Sun et al., 2019a, 2019b). This is because Bangladeshi policies exhibit similarities in terms of trailing behind growth in emerging countries. For example, as compared to developed nations, the Bangladeshi SMEs sector is still in its infancy in terms of environmental management and green practices. Green innovation practice remains exceedingly low in this sector, especially among rural entrepreneurs, which accounts for a sizable share of the business (Albort-Morant et al., 2016; Singh et al., 2020). As a result, before implementing regulations to force or urge enterprises to adopt greener solutions that aid in the establishment of smart cities (Albort-Morant

et al., 2016), it is critical to have a thorough understanding of the factors that impact the adoption of green technologies by rural SME entrepreneurs.

After revealing the idea and merits of this paper, it presents a historical backdrop that influences the study. The pre-existing understanding of the elements that drive SMEs adoption of green innovation developed through several stages. Earlier studies (Abdullah et al., 2016; Tang et al., 2018; Song and Yu, 2018) concentrated on external factors such as government regulations, technology, and the market, rather than internal ones. As a result, some researchers began to pay more attention to internal business components such as strategy, resources, and capabilities (Küçükoğlu and Pınar, 2015). Researchers recently have shown the benefits of green innovation for the logistics business (Song and Yu, 2018). A variety of characteristics have been explored as predictors of rural SMEs' entrepreneur's intention to adopt green innovation. These factors include technology qualities, regulatory and consumer pressure, environmental unpredictability, organizational support, and human resource quality (Zailani et al., 2015; Arfi et al., 2018). As a result, by elucidating internal variables relevant to the adoption of eco-friendly entrepreneurship, various fields in clean technology, energy strategy, and firm management stand to profit.

The main objective of the study is to identify the factors that influence Bangladeshi rural small and medium-sized firm entrepreneurs' adoption of green innovation through the use of green energy technology. The study employs a hypothetic deductive observation approach, assisted by hand-collected primary data sufficient enough to allow descriptive and inferential statistical assessment (Polas and Afshar Jahanshahi, 2021; Polas and Raju, 2021). A total of 288 Bangladesh-based SMEs were sampled at random using a cross-sectional technique. The hypothesized direct and indirect effects were investigated using structural equation modeling. Despite a significant reputation for modeling behavioral intention dynamics, this technique has received very little attention in studying rural entrepreneur's adoption of green innovation. As a result, even in terms of scope, our study is unique. Following the discussion of the results, it examines outstanding issues and suggests future research subjects that might broaden the empirical and theoretical scope and contribute to the development of a long-term green innovation ecosystem based on green energy technology in the rural SMEs.

The subsequent sections of the article are organized as follows: The "Literature review" section includes summaries of the literature on green innovation, its drivers, and research gaps. The study's research methodology is described in the "research methodology" section, which also includes SEM findings and discussion. The "conclusion" section contains insight about the study's effect, contributions, implications, limitations, and future research effort.

2. Literature review and hypotheses development

2.1. Green innovation

Green innovation has been discussed by a multitude of authors in a variety of ways. Innovation in the green sector is a transformative process that incorporates new methods of doing things that have direct and beneficial impacts on the environment (Küçükoğlu and Pınar, 2015; Song and Yu, 2018). It is a revolutionary concept that incorporates energy conservation, pollution avoidance and recycling, green product designs as well as corporate environmental management. Urgency of climatic change and regulatory demands of reducing emissions have forced stakeholders to seek alternative ways to achieve organizational goals without harming the environment (Song and Yu, 2018). Today green innovation plays a significant part in the advancement of sustainability in the global economy. Researchers have recognized the importance of green innovation in firms' operational decisions and long-term strategic planning (Zailani et al., 2015; Küçükoğlu and Pınar, 2015). Policy shifts and the social costs associated with being "green shy" has driven firms to contemplate green innovation strategies and engage build and develop to become relevant to their stakeholders (Abdullah et al., 2016). For most forward looking firms this is thus a matter of survival and remaining competitive in order to remain competitive. Whether businesses in certain industries are open or averse to embracing green technology is closely monitored by policymakers since it is important to coordinate policies on various fronts of the economy in a streamlined way to achieve harmonious sustainable development goals without compromising the macro ambitions of being powerful regional or global players (Albort-Morant et al., 2016; Abdullah et al., 2016; Song and Yu, 2018).

Green innovation has been the subject of numerous studies, most of which have concentrated on Western and European nations (Bossle et al., 2016; Del Río et al., 2016; García-Quevedo et al., 2020; Xie et al., 2019; Tang et al., 2021). Surprisingly few studies have been conducted in developing nations, necessitating further research. Given that it is challenging, if not impossible, to generalize studies from one country to another due to significant differences in national innovation systems, business maturity, consumer demand for eco-products, organizational size, and culture (Bossle et al., 2016; Tang et al., 2021), this is a good justification for the need to recognize regional dynamics of green innovation. Studies conducted in Bangladesh context up to this point have not produced a sufficient roadmap for adopting green innovations. In addition, no such studies have been conducted in Bangladesh scenario where researchers have designed a framework with wide variety of drivers for identifying drivers' inner links and quantifying their connection using driving and reliance power. The identification and compilation of green innovation drivers was done in order to address these gaps in the literature by incorporating research gaps into a unique framework (Xie et al., 2019; Tang et al., 2021).

2.2. Environmental concern

Research on green innovation has come to the forefront of academic community interest in recent times because of its multifarious connection to various disciplines: most importantly business, management, corporate and energy strategy (Takalo and Tooranloo, 2021). Green innovation is often regarded to imply how to enhance ecological sustainability in SMEs through the use of green energy technologies. SMEs employ resources in attempting to maximize their performance and limiting the possible downside risk of environmental concerns through sustainable practices leveraging green energy, which leads to green innovation. Experts emphasized in their findings that there is a link between environmental concern and the adoption of green innovation (Tang et al., 2018; Takalo and Tooranloo, 2021). Green innovation plays a vital role in shaping the ecological balance of the environment. In this regard, environmental concern among entrepreneurs should be increased that contributes to the adoption of green innovation. However, business's commitment to ecological sustainability is also a debated topic in academia. This is because the standard economic theory of a firm promotes maximization of shareholders' wealth, regardless of external human, social, or environmental costs. As a result, it has been less frequent in the past for business managers to see environmental concern and sustainability as determining whether or not their firm would continue to exist (Takalo and Tooranloo, 2021). After all, standard economic theory scarcely presents resource allocation as a dilemma between destroying the environment or not. Therefore, the push to ecological sustainability has been an exogenous stimulant from policymakers because most firms shy away from long-term investments or commitments that do not directly benefit them—at least in the immediate short run (Zhang et al., 2020; Melander and Arvidsson, 2022). Cognitive frames do help entrepreneurs through all the information and choose the best course of action regarding green innovation. Firms that want to encourage green innovation prioritize environmental preservation or concern, and describe general management and environmental policies in order to improve their overall performance.

Generally, firms can take two basic methods to managing environmental risk (i.e., controlling and preventing) (Takalo and Tooranloo, 2021).

In addition to continuously improving existing production facilities and introducing new technological processes (Khan and Johl, 2019; Takalo and Tooranloo, 2021) and total quality management (Guo et al., 2020), the management team of a firm can reduce or prevent an environmental threat by using green energy within the firm to develop themselves against environmental issues (Yousaf, 2021). Firms' environmental management concerns can be rated on a scale of high to low in this regard. When it comes to establishing green innovation activities, it is considered that a company with a managerial focus on the environment will be more pro-active about environmental concerns (such as environmental norms and regulations) and will propose creative measures. To the contrary, a low-management environmental firm is assumed to be either inactive or reactive to environmental issues (e.g., showing resistance to change) (Hobman and Frederiks, 2014; Wang et al., 2021).

The current attention to green innovation is an outgrowth of the green environmental movement which puts environmental concerns (EC) at the forefront of business decision making and energy strategies. It is believed that environmental concern among entrepreneurs in the firms increases the intention to adopt green innovation (Hobman and Frederiks, 2014; Xie and Zhao, 2018; Wang et al., 2021). It refers to the magnitude to which the public (and consumers) are aware of environmental issues and are willing to adopt necessary measures to solve the sustainability concerns affecting the society. In short, environmental concern personalizes the decision making of the individual and reflects to what extent the economic agent is willing to personally forego access to (or enjoyment of) economic resources to facilitate a more sustainable future (Khan and Johl, 2019). Studies in this regard have typically measured environmental concerns by factoring in how much in monetary terms entrepreneurs are willing to pay for certain (if not all) green innovation (Xie and Zhao, 2018; He et al., 2021). This concern extends to the entrepreneurial sector as well. Some scholars have studied how much SMEs and their entrepreneurs are willing to pay for energy with less anti-sustainability features (He et al., 2021). Given the lack of long time series data, it has proven difficult to quantify how well this green innovation translates to reduction in pollution and energy conservation (Khan and Johl, 2019). A more modern strand of research deals with growing public awareness whether this awareness likewise yields any environmental concern (Gkargkavouzi et al., 2019; Ikram et al., 2021). The results generally appear positive but are far from unanimous. Some researchers exhort policymakers to adopt techniques from behavioral economics and psychology to encourage stakeholders to raise awareness about green innovation adoption (Ikram et al., 2021). It is worth noting that in documenting environmental concerns, most experts have used environmental and ecological terms as substitutes (Taale and Kyeremeh, 2016). In this paper, we too do not make a distinction between the two.

Furthermore, there has been used increasingly frequently to assess entrepreneurs' environmental concern with regard to a variety of topics (Hsu et al., 2021). There is a broad environmental concern that can be used to adopt green innovation (Chien et al., 2021; Hsu et al., 2021). There is evidence that environmental concern can influence the green innovation adoption (Taale and Kyeremeh, 2016; Gkargkavouzi et al., 2019; Ikram et al., 2021). However, findings from meta-analysis show a poor link between environmental concern and adoption of green innovation (Ma et al., 2017; Kraus et al., 2020; Ikram et al., 2021). As a result, it is believed that another variable may have an indirect impact. When it comes to green behavior, entrepreneurs are willing to pay more for electricity that comes from renewable sources like wind and solar power (Ikram et al., 2021). Environmental concern, in particular, has a significant effect on entrepreneurs' proclivity to acquire environmentally friendly innovation (Weng et al., 2015; Kraus et al., 2020). Entrepreneurs who care about the environment may also influence others' behavior by acting as "significant others" who accept or reject others' adoption of green innovation. To put it another way, when perceived complexity in terms of resources and time increases, entrepreneurs' subjective norms decrease. Entrepreneurs are increasingly worried about the environment now that they are aware of the positive benefits of green innovation on the firm environment (He et al., 2021). Thus, it is hypothesized that,

H_1. *: Entrepreneur's environmental concern has a positive and significant impact on the adoption of green innovation.*

2.3. Perceived ease of use

The term "perceived ease of use" (PEOU) refers to a person's assumption that a certain piece of technology would be straightforward to use (Al-Rahmi et al., 2021). Moreover, the degree to which a new technology can be simply understood, operated, and maintained is referred to as its ease of use. Access to green energy can be simplified by using quality control systems that are both dependable and responsive to changes in entrepreneur's lifestyles (Raza et al., 2017; Jadil et al., 2021). Green energy may gain public acceptability and adoption by being viewed as user-friendly, family-friendly, and consistent with the typical entrepreneur's standard of life (Chen and Lu, 2016; Daragmeh et al., 2021). The perceived ease of use of new technology influences implementation of green innovation adoption decisions (Daragmeh et al., 2021; Yuen et al., 2021). Entrepreneur's intention to adopt new technology is primarily driven by how simple they think it to be to use, according to the Technology Acceptance Model (TAM). The installation, regular use, maintenance, and recycling of new technology all have an impact on how simple it is to be used (Kardooni et al., 2016; Malaquias and Hwang, 2019; Alkire et al., 2020). From a technological viewpoint, the simplicity of use of green energy is explained. According to studies, there are several technological impediments to the broad use of green energy in the rural SMEs. As a result, rural many entrepreneurs are hesitant to invest in green energy. Green energy technology that is firm and environment friendly will have a significant influence on the intention to use green energy that leads to adopt green innovation (Chen and Lu, 2016; Wang et al., 2020; Daragmeh et al., 2021).

Moreover, perceived ease of use (PEOU) are important components of the TAM because they influence how people interact with technology (Siyal et al., 2019; Daragmeh et al., 2021). Many studies in diverse situations have revealed the significant influence of perceived ease of use on the adoption of green innovation (Kardooni et al., 2016; Malaquias and Hwang, 2019; Alkire et al., 2020; Al-Rahmi et al., 2021; Yuen et al., 2021). For the purposes of this study, the term "PEOU" refers to the level of comfort and willingness of firms' entrepreneurs to learn about and implement environmentally friendly technologies in their organizations. Green energy technology, for example, has the potential to boost corporate efficiency while also assisting organizations in offering better customer service. One of the most important criteria in deciding whether or not green energy technology is accepted is the simplicity of usage of the technology. In this regard, green energy is comparatively comfortable and easy to use in the rural firms (Saunila et al., 2018; Al-Rahmi et al., 2021).

Furthermore, the perceived ease of use of new technology influences implementation decisions (Tang et al., 2018). The ability of a new technology's users to understand, operates, and maintains it is referred to as its ease of use. A well-functioning quality control system can make green energy more accessible to the general population (Yuen et al., 2021). Because green energy is a renewable energy source, installing it should not need the aid of a technical professional. It's also critical that the rules for use and maintenance are simple. In the realm of new

technologies, there is a statistically significant relationship between perceived ease of use and adoption of green innovation (Tang et al., 2018; Malaquias and Hwang, 2019; Alkire et al., 2020). Studies show that perceived ease of use of green energy boosts entrepreneurs' intention to adopt green innovation. Unusually, green innovation services that are convenient, pleasurable, and straightforward to use are more likely to be used (Ajzen, 2011; Amallia et al., 2021). High-quality systems are designed to be simple to use, not just for learning and navigating the system, but also for carrying out a job or task (Tang et al., 2018; Alkire et al., 2020; Amallia et al., 2021). Thus, it is hypothesized that,

H2. *: Entrepreneur's perceived ease of use has a positive and significant impact on the adoption of green innovation.*

2.4. Attitude

An attitude toward an activity refers to how much a person believes the behavior is significant or unpleasant (Ajzen and Fishbein, 1980; Chen et al., 2017). Furthermore, attitude includes a judgment on whether the action under consideration is good or undesirable, as well as whether the actor intends to engage in the activity themselves (Yang and Lin, 2020). An attitude is considered as a person's perception of the consequences of their actions. Attitude is a major determinant of behavioral intention (Chen et al., 2017). It has been shown that a person's attitude may influence their actions (Yang and Lin, 2020). In this regard, studies reveal that entrepreneurs attitude has a positive and significant effect on the adoption of green innovation (Ahmad and Thyagaraj, 2015; Raza et al., 2020). If an entrepreneur's attitude is positive, their behavior is more likely to be in line with that attitude (Raza et al., 2020; Nekmahmud et al., 2022). In psychology, an individual's attitude is defined as "a predisposition to favorably or unfavorably evaluate [a certain item]" (Aslam et al., 2021). "Green attitude" refers specifically to one's attitude toward environmental conservation, resource protection, or mitigation of environmental damage (Ardyan et al., 2017). In most cases, human activity is directly responsible for environmental damage. After this, attitudes have been shown to be a positive and significant predictor of environmental behavior to adopt green innovation (Ardyan et al., 2017; Raza et al., 2020; Mehraj and Qureshi, 2022).

Moreover, research on the relationship between entrepreneurs' attitude and green innovation adoption has also come up empty. According to the findings of several research such as those by Wu et al. (2021) and Bigliardi et al. (2022), the adoption of green attitudes is required but not sufficient to promote green environmental adoption (Karuppiah and Ramayah, 2022). In this regard, many studies have shown a significant connection between entrepreneurs attitude and their adoption of green innovation (Ardyan et al., 2017; Policarpo et al., 2022; Keles et al., 2023). Usually, a person is more likely to engage in an action if their attitude toward it is more positive, according to the TPB (Keles et al., 2023). We've come to the conclusion, based on the debate above, that entrepreneurs are more likely to adopt green innovation if their green views are positive (Mehraj and Qureshi, 2022). Moreover, Researchers in the green hotel field have found that attitude has a good impact on the intention of entrepreneurs (Ahmad et al., 2020). A significant link between attitude and adoption of green innovation has been found in organic food choice behavior (Cheam et al., 2021; Elahi et al., 2022), concluding that attitude-intention rationale predominates in green consumption environments. According to our literature assessment, a shift in entrepreneur's attitudes toward green energy is expected to lead to an increase in green innovation adoption intentions (Ahmad et al., 2020; Keles et al., 2023). Thus, it is hypothesized that:

H_3. *: Entrepreneur's attitude has a positive and significant impact on the adoption of green innovation.*

2.5. The role of intention to use

People who want to establish a firm are more encouraged than those who do not have such objectives for the green entrepreneurial innovation (Bandara and Amarasena, 2018; Gangakhedkar and Karthik, 2022). Entrepreneurs will take action if they are determined to reach a certain objective. No further action may be taken if such motivation is missing (Gangakhedkar and Karthik, 2022). In the study of green innovation, a lot of attention has been paid to the link between intention to use green energy and adoption of green innovation (Widianto, 2021; Yin et al., 2023). Studies show that the intention to use green energy has been shown to have a significant link between environmental concern, perceived ease of use and attitude with adoption of green innovation (Widianto, 2021; Yin et al., 2023). Entrepreneur's environmental concern improves when they have an intention of protecting nature through using green energy (Yin et al., 2023). According to Sangroya and Nayak (2017), millennials are more likely to purchase environmentally friendly goods than their elder counterparts. According to these past researches, individuals are more likely to act in a certain way if they have a significant intention to do so (Yin et al., 2023).

Most importantly, green energy sources, particularly solar energy, are becoming more popular as alternatives to traditional energy sources. According to various studies, there is a progressive increase in public awareness of solar photovoltaics (PVs) among rural entrepreneurs (Jabeen et al., 2021; Gangakhedkar and Karthik, 2022; Yin et al., 2023). Nevertheless, technical inefficiencies and investment constraints remain a challenge for implementing solar PV systems in the rural SMEs, especially in developing countries (Liobikienė and Dagiliūtė, 2021). The implementation of the Paris Agreement and the recent COP 26 has established the notions of differentiated obligations to compel every country to take measures for climate change mitigations and creates obligations, including developed, developing and least-developed countries. Hence, experts believe that the increasing prices of fossil fuels will ignite the interest in green energy usage that contributes to increase intention among entrepreneurs to adopt green innovation (Puertas and Marti, 2022; Fraccascia et al., 2023). Nevertheless, the governments must create positive public opinions and provide financial incentives to enrich the energy mix through solar PVs (Zeng et al., 2022). These streams of literature documenting the behavioral intentions that underpin the adoption of solar PVs are still relatively scarce (Zeng et al., 2022; Fraccascia et al., 2023). Picking up this mantle is one of our contributions having detailed our survey of literature leading to our hypothesis development; we also wish to contextualize our motivation for studying the behavioral antecedents of green innovation via solar PVs usage (Jabeen et al., 2021; Puertas and Marti, 2022). Prior studies show that entrepreneurs' intentions are shaped by a variety of personal and societally influenced ideas such as environmental concern, perceived ease of use and attitude, making it simple for them to carry out their actions (Liobikienė and Dagiliūtė, 2021; Puertas and Marti, 2022; Zeng et al., 2022). This follows psychological literature which argues that entrepreneurs are more likely to put on a show when the influence of attitudes on behavior is positive and significant (Jabeen et al., 2021; Zeng et al., 2022).

Moreover, entrepreneurs' noticeable ideas have a key role in their interest in green energy prior to use, according to a large number of research works (Zeng et al., 2022). In Khan et al. (2022), for example, the authors investigated the roles of specific variables in impacting entrepreneur's care for the environment: environmental concern and attitude (Aron and Molina, 2020). The authors report that the subjects

who were less concerned about the environment and engaged in green activities were susceptible to peer pressure (Qamar et al., 2022). As a result, high levels of environmental concern were more likely to manifest themselves in green innovation (Arslan et al., 2021). On the basis of the TPB model, Jabeen et al. (2021) studied how the three diverse perceptions about green innovation influenced the intention to use of entrepreneurs. In order for entrepreneurs who don't already have pro-environmental attitudes and behaviors to develop them, they must be exposed to these cues and be positively predisposed to adopting green cinnovation (Aron and Molina, 2020). Additionally, Liu et al. (2022) expanded their research to include habits, emotions, individual's efficacy perceptions, and situational aspects in order to better predict green innovation (Zhou et al., 2021; Khan et al., 2022). Various attitudes about using green items should be elicited prior to green consumption with the purpose of increasing their interest (Zameer et al., 2020; Singh et al., 2022). The TPB believes that the influence of variables that serve as predictors (i.e. attitude and perceived ease of use toward green innovation) on subsequent action, i.e. behavior towards green items, should be totally mediated by intention to use green innovation towards green innovation (Khan et al., 2022). It was expected in this research that the intention to use green innovation has a mediating influence on entrepreneur behavior, and that there is a relationship between entrepreneurs' significant environmental concern, perceived ease of use and attitude with adoption of green innovation. Guided by these prior works, we formulate the following hypotheses:

H4. *: Intention to use green energy technology mediates the connection between entrepreneur's environmental concern and adoption of green innovation.*

H5. *: Intention to use green energy technology mediates the connection between entrepreneur's perceived ease of use and adoption of green innovation.*

H6. *: Intention to use green energy technology mediates the connection between entrepreneur's attitude and adoption of green innovation.*

3. Research and data methodology

3.1. Study context

The Bangladeshi manufacturing industry (SMEs) is the subject of this study. In terms of global energy use and CO2 emissions, manufacturing accounts for around a third of the total (Alam et al., 2014). However, in recent years, there has been a strong push to embrace a "green mindset" (Cao and Chen, 2019). This study is all the more necessary in light of the current legal climate. A timely evaluation of the impact of management environmental concern on the relationship between green product and process innovation, and firm success, is provided by our study.

3.2. Research design

Researchers in this study used a positivist research strategy, which enables them to derive empirical knowledge via the use of hypotheses deduced from observations (Polas and Raju, 2021). An extensive quantitative analysis was also carried out because of the specific issues, precise assumptions made and the large range of information involved (Hair et al., 2014). Due to the Bangladeshi government's implementation of a number of sustainability policies and the establishment of various programs tailor-made for advocating production and participation in climate conscious technologies in the industrial sector, the Bangladeshi sample is an attractive choice to conduct a study (Cao and Chen, 2019).

3.3. Questionnaire design

The final survey unit consisted of 26 items (see appendix), and five variables were employed to address those issues. It was necessary to perform a pre-test to ensure the validity of the questionnaire's content before the final sample could be drawn. In order to create the survey instrument, we used four items (see appendix) from Alam et al. (2014) and Paul et al. (2016) for environmental concern. From Alam et al. (2014), the four perceived ease of use items (see appendix) was adopted. There are four attitude items (see appendix) adopted from the Paul et al. (2016). To measure Intention to use four items (see appendix) was used adopted from Paul et al. (2016). Finally, four items (see appendix) adopted from Cao and Chen (2019) were used to measure adoption of green innovation. We applied a Likert scale which contains five categories of responses between strongly disagree = 1 to strongly agree = 5.

3.4. Sampling and data collection

To collect data 350 self-administered questionnaires were distributed to rural SMEs entrepreneurs in Dhaka Division (Dhaka, Manikganj, and Narayanganj) in June and July 2022. There were 288 complete and legitimate responses from which to select a sample, however 62 went overlooked because the information was ambiguous or non-existent. A lack of trust in the survey might be one cause. Respondents may only participate in face-to-face. As a whole, our results are in line with the standards set out by Hair et al. (2016) for a sufficient sample size. Our survey has an 84.29% response rate based on a survey-based sample. The study's findings were then assessed using a survey of 288 persons. They were informed of the confidential nature of their data as well as the fact that they had freely consented to participate in the study. Furthermore, it was emphasized that the data may only be used for research purposes. Before the final survey was issued, a pilot research with 20 participants was done. These respondents are not included in the final survey.

We assembled a professional team of Bangladeshi research field assistants to gather and process data generated via stratified random sampling. This approach has also helped us better manage our scarce resources. The splitting of a population into smaller subgroups known as strata is an important component of the stratified random sampling approach. The strata are formed based on the participants' common attributes or characteristics, such as income or degree of education. We defined the strata based on business size (number of entrepreneurs). This classification supports the authors in achieving an adequate balance of small and medium-sized businesses in our final sample. The purpose of sampling is to choose a sample that is representative of the population (Polas et al., 2022). Only a few minutes were needed to complete the survey for each respondent. Since our respondents have a rural background and many do not possess high levels of English proficiency, we chose to utilize a local dialect version of Spanish translation (using a double back method).

A time-trend extrapolation test was used to realize the non-response bias reported by Armstrong and Overton (1977) and widely used in business, psychology, and business academics. The average age of early respondents was 35.67 years (standard deviation = 6.56), and the average working experience was 13.56 years (standard deviation = 5.34). Besides, the average age of late respondents was 33.32 years (standard deviation = 5.78), and the average working experience was 12.87 years (standard deviation = 6.44). A comparison of early responders (first 25%) and late respondents (final 25%) revealed no significant differences in respondent's age or working experience. As a result, the findings of this study were free of nonresponse bias. To discover significant common method variance, the Harman one-factor test was used. The findings revealed that the first component could only

account for 25.34% of the variation; so, no single factor appeared, and the single factor did not account for the majority of the variance. Also, the order of the items was standardized to eliminate common-method variance (CMV). We investigated the multicollinearity issue by estimating variance inflation factors (VIF) for all variables under consideration (Tabachnick and Fidell, 2007). The greatest VIF was 2.345, which is much below the conventional threshold of 5. As a result, collinearity is not a serious issue in our study.

3.5. Data analysis

For the study's research model to be validated, SEM (Structural Equation Modeling) was employed. We applied Smart PLS 3.3.9 and SPSS V.25 software packages to ensure that the study model is feasible; the data is valid and reliable and will lead to meaningful statistical inferences. Using the minimum R-square method proposed by Hair et al. (2016), we surpassed the minimum sample size required for SEM analysis. Thus, PLS-SEM is the best way to make predictions (Hair et al., 2016). It has the ability to deal with measurements as well as structural models simultaneously. In addition, it is an effective technique for examining route models that are very complex (Hair et al., 2016). For the first time, the PLS-SEM is able to manage tiny sample volumes while still producing very precise findings. Therefore, the PLS-SEM approach emerges as a fitting estimation technique for our study's scope. We undertake a variety of tests to appraise the measurement and structural modes of the different variables. These include checking for coefficients indicating convergence, validity of convergence and discriminant, etc.

3.6. Mediation analysis

We employed a two-step procedure proposed by Hair et al. (2016) to verify whether the intention to use holds any mediating influence (Roh et al., 2022a, 2022b, 2022c; Kim and Roh, 2022). Additionally, we account for the indirect effects of EC, PEOU and A on adoption green innovation through intention to use in the first step. We observe statistically significant results signaling an indirect effect for the following relationships: EC→ IU → AGI; PEU → IU → AGI; A → IU → AGI. The exact particulars of these results are viewable in Table 8 several pages below. Next, we focus on the direct effect of EC, PEU and A on GI keeping intact the role of the mediator (IU). Significant positive effects emerge for H4 and H6 only. We are able to deduce from the positive signs in both direct and indirect results that EC → IU → AGI. This signals a wholly complementary mediatize phenomenon, which is consistent with H4. A partial support for the same phenomenon is observed in H6 (A → IU → AGI).

4. Results and discussion

4.1. Respondent's profile

Table 1 shows the cross-sectional particular data from Bangladeshi small and medium-sized enterprises (SMEs). Table 1 displays the demographics of those who took the survey. There were 65.63 per cent men, 37.85 per cent of them were between the ages of 30 and 33, 68.75 per cent of them were married, 41.32 per cent of them were postgraduates, 42.01 per cent of them has Less than 5 Years working experience.

4.2. Descriptive correlations

The Table 2 above enumerates the stylized facts of the sampled responses. Of particular interests are the mean, correlation, and standard deviation values. As seen in Table 2, the major research factors (environmental concern, perceived ease of use; Attitude; attitude; intention to use; and adoption of green innovation) have positive relationships with each other.

4.3. Model measurement, validity and reliability

Meanwhile, Table 3 shows an estimate of the model's evaluation. According to Vinzi et al. (2010), outer loading might be 0.50 or more. According to Table 3, the outer loading of this study is greater than 0.50. If the composite reliability score is more than 0.70, Hair et al. (2016) recommend assessing the internal consistency of the reliability. According to Table 3, the overall reliability of this study is more than 0.70. According to Hair et al. (2016), Cronbach's alpha should be greater than 0.70. The Cronbach alpha value is more than 0.70, as seen in Table 3. Thus, the value of all constructions illuminates the prerequisites for Cronbach's alpha. The Average Variance Extracted (AVE) was used to measure convergent validity (Hair et al., 2016). Hair et al. (2016) discover that when the loading factor for both items is larger than 0.50, convergent validity is maintained. According to Table 3, all variables have AVE values larger than 0.50. R^2 necessitates the computation of changes in the endogenous variable, as shown in Table 3.

Table 1
Respondents' Demographic Profile.

Characteristics	Frequency	Percentage	Characteristics	Frequency	Percentage
Gender			***Working Experience***		
Male	189	65.63	Less than 5 Years	121	42.01
Female	99	34.38	5–9 Years	111	38.54
Age			10–13 Years	32	11.11
22–25 Years	22	7.64	14–17 Years	16	5.56
26–29 Years	77	26.74	More than 17 Years	8	2.78
30–33Years	109	37.85			
34–37 Years	56	19.44			
38 Years or above	24	8.33			
Marital Status					
Single	64	22.22			
Married	198	68.75			
Divorced	26	9.03			
Education Level					
Diploma	22	7.64			
Under Graduate	118	40.97			
Post Graduate	119	41.32			
Others	29	10.07			
Total-288					

Table 2
Descriptive Correlations.

Variables	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9	10	11
Gender	1.432	0.544	1										
Age	2.456	0.178	0.045	1									
Marital Status	1.67	0.455	0.067	0.102	1								
Level of Education	2.77	0.981	0.048	0.185**	0.205**	1							
Working Experience	2.766	0.567	0.078	0.195**	0.297**	0.365*	1						
Monthly Income	1.664	0.277	0.532**	0.067	0.062	0.289**	0.277**	1					
Environmental Concern	3.675	0.567	0.555**	0.066	0.007	0.087	0.046	0.172	1				
Perceived Ease of Use	3.569	0.494	0.566***	0.074	0.044	0.066	0.061	0.109	0.544**	1			
Attitude	3.889	0.777	0.088	0.076	0.047	0.077	-0.079	0.166	0.621**	0.578**	1		
Intention to Use	3.889	0.811	0.077	0.043	0.013	0.078	0.029	0.089	0.578**	0.539**	0.543***	1	
AGI	3.765	0.044	0.092	0.054	0.013	0.055	0.026	0.086	0.562**	0.556**	0.544**	0.556**	1

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed)

Three unique R2 values (R^2 = 2%, R^2 = 13%, and R^2 = 26%) were proposed Chin (1998), and are frequently used to evaluate three distinct impacts. The independent factors have a high influence (0.903 or 90.3%) on the intention to utilize in this case. In terms of a respondent's intention to use, this might have a substantial influence on their uptake of green innovation. As the NFI value is close to one, this shows that the model is well-suited to the study's purpose (Hair et al., 2016). As long as the SRMR value is 0.08 or below, the model well fits the data (Hair et al., 2016). In this situation, the NFI score is 0.902, which is over the permitted range. VIF values more than 10 and less than 0.1 indicate the presence of multicollinearity, according to Pallant and Tennant (2007), as the inner VIF values in the current research were less than 5, there was no concern with multicollinearity. To verify the model's predictive relevance, the predictive relevance (Q^2) must be larger than zero (Chin, 1998).

Table 4 shows how well the model predicts outcomes. Each result implies that the predictive significance of the model is greater than zero (Chin, 1998). To test the prediction reliability of the developed PLS Path model, cross-validated communality approaches are used. As seen in Table 4, the model contains predictive relevance. Finally, intention to use has a minor influence on adoption of green innovation. In general, the model is well-fitting and has a high degree of predicted accuracy.

4.4. Discriminant validity

4.4.1. Fornell-Larcker criterion analysis

Table 5 shows the square roots of LV (Latent Variables) and AVE (Average Variance Extracted). The model's validity was tested using the Fornell and Larcker (1981) criteria. In this range, the AVE (in bold) of all variables is determined by their square root (0.843–0.879). As a result, the discriminant validity of the variables is kept and acknowledged for use in the current study model.

4.4.2. Heterotrait-Monotrait (HTMT) analysis

In order to validate the discriminant validity, HTMT values must always be less than 0.85. Because the test statistic value scores are less than 0.85, we can assume legitimate discriminant validity (Henseler et al., 2005). Table 6.

4.4.3. Cross loads

The discriminant's validity, according to methodological literature, is only valid when the loading values surpass the original loadings. Crossed loads are a frequent representation of this (Chin, 1998). These crossing load levels would be preferable if the primary diagonal values and correlations between latent variables (LV) and square roots of AVE values differed significantly (Chin, 1998). Table 7 displays the AVE values in the structural equation model's principal diagonal, nestled between LV and the square roots. This demonstrates that the model's discriminant validity is appropriate. Fig. 1.

4.5. Assessment of the structural model

Fig. 2 states the structural model evaluation. The t-values and R squares were calculated using a 5000-sample bootstrapping procedure.

The standardized SEM results in Fig. 2 were estimated using Smart PLS 3.3.9. These two items appear to have a significant amount of outer loading. The route coefficients of all variables appear to be in good shape (Hair et al., 2016).

4.6. Hypotheses testing (direct and indirect effect)

The findings of the direct and indirect impact hypotheses are shown in Table 8. Bootstrapping was employed to assess statistical t-values. Using a 95 per cent confidence interval, Smart PLS 3.3.9 has a p-value that is appropriate for research in social science (Bickel, 2012). In the

Table 3
Measurement of Model Assessment.

Constructs	Items	Loading	AVE	CR	Alpha	R-Square	NFI	SRMR
Environmental Concern	EC1	0.909	0.710	0.907	0.863			
	EC2	0.810						
	EC3	0.865						
	EC4	0.782						
Perceived Ease of Use	PEU1	0.850	0.726	0.914	0.874			
	PEU2	0.864						
	PEU3	0.850						
	PEU4	0.846						
Attitude	A1	0.873	0.741	0.921	0.883			
	A2	0.847						
	A3	0.885						
	A4	0.838						
Intention to Use	IU1	0.913	0.773	0.931	0.901	0.903	0.902	0.078
	IU2	0.802						
	IU3	0.879						
	IU4	0.917						
Adoption of Green Innovation	AGI1	0.896	0.76	0.926	0.874	0.913		
	AGI2	0.951						
	AGI3	0.768						
	AGI4	0.861						

Table 4
Values of the Stone Geisser indicator (Q^2) and Cohen's indicator (f^2) of the model in the SEM.

Variables	Q^2	AGI (f^2)	Intention to Use (f^2)
Adoption of Green Innovation	0.496		
Attitude	0.441	0.021	0.461
Environmental Concern	0.443	0.067	0.081
Intention to Use	0.491	0.157	
Perceived Ease of Use	0.461	0.131	0.046

Large effect > 0.34; Medium effect > 0.14; Small effect > 0.01 (Chen et al., 2017)

Table 6
The Heterotrait-Monotrait (HTMT) analysis for discriminant validity.

		1	2	3	4	5
1	Adoption of Green Innovation					
2	Attitude	0.343				
3	Environmental Concern	0.356	0.356			
4	Intention to Use	0.466	0.334	0.455		
5	Perceived Ease of Use	0.346	0.345	0.349	0.534	

*Discriminant validity exists if the HTMT < 0.85 (Henseler et al., 2005)

first hypothesis, it was assumed that the environmental concern has a positive and significant impact on adoption of green innovation. Environmental concern was shown to be connected positively with adoption of green innovation ($\beta = 0.225$, $t = 2.884$; $p < 05$, see Table 8). In this sense, we can confirm our first hypothesis. Studies by Song and Yu (2018) and Zhang et al. (2020) lend credence to this hypothesis. In the second hypothesis, we predicted that perceived ease of use has a positive and significant impact on the adoption of green innovation. The findings show that perceived ease of use is not positively linked with adoption of green innovation ($\beta = 0.100$, $t = 1.082$; $p > 05$, see Table 8). In this sense, our second hypothesis is unconfirmed. This idea is not supported by the data of Wang et al. (2018, 2020). This suggests that if perceived ease of use for green energy technology is implemented, adoption of green innovation will not rise. Rural entrepreneurs are likely concerned about environmental challenges, which drive them to adopt green innovation.

As a result, we argue that perceived simplicity of use will not promote acceptance of green innovation, hence enhancing any country's economic development. Moving on to the third hypothesis, we predicted that attitude has a positive and significant impact on the adoption of green innovation. The findings show that attitude is positively connected with the adoption of green innovation ($\beta = 0.289$, $t = 4.507$; $p < 05$, see Table 8). In this sense, our third presumption is verified. This hypothesis is supported by the findings of Ahmad et al. (2020) and Yousaf (2021). Because of this, we believe that high attitude will improve adoption of green innovation, hence increasing the economic growth of any country.

Moreover, the fourth hypothesis suggests that the intention to use mediates the connection between environmental concern and adoption

Table 5
The Fornell-Larcker criterion analysis for discriminant validity.

		1	2	3	4	5
1	Adoption of Green Innovation	0.872				
2	Attitude	0.544	0.861			
3	Environmental Concern	0.554	0.433	0.843		
4	Intention to Use	0.432	0.543	0.543	0.879	
5	Perceived Ease of Use	0.456	0.456	0.433	0.554	0.852

Note: LV- Latent Variable

Table 7
Values of the cross loads of individual items in the SEM.

Items	Attitude	Adoption of Green Innovation	Environmental Concern	Intention to Use	Perceived Ease of Use
A1	0.876	0.334	0.168	0.254	0.191
A2	0.878	0.478	0.176	0.245	0.169
A3	0.856	0.445	0.456	0.223	0.198
A4	0.845	0.367	0.334	0.269	0.149
AGI1	0.211	0.943	0.232	0.146	0.298
AGI2	0.222	0.788	0.223	0.204	0.233
AGI3	0.255	0.876	0.189	0.191	0.344
AGI4	0.299	0.964	0.225	0.344	0.344
EC1	0.222	0.233	0.817	0.244	0.223
EC2	0.261	0.255	0.889	0.445	0.277
EC3	0.286	0.256	0.834	0.332	0.268
EC4	0.278	0.234	0.832	0.255	0.289
IU1	0.249	0.221	0.277	0.882	0.223
IU2	0.288	0.245	0.169	0.812	0.246
IU3	0.266	0.287	0.238	0.867	0.267
IU4	0.262	0.268	0.268	0.799	0.222
PEU1	0.293	0.265	0.222	0.333	0.867
PEU2	0.265	0.278	0.212	0.345	0.823
PEU3	0.298	0.265	0.263	0.379	0.823
PEU4	0.245	0.289	0.237	0.354	0.854

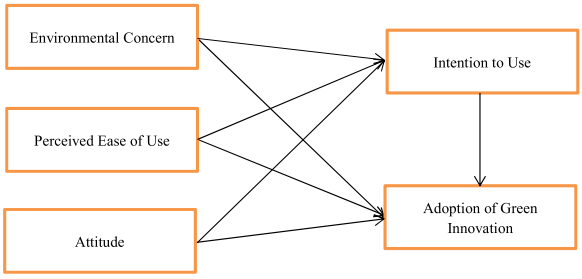

Fig. 1. The Framework of the study.

of green innovation. We discovered that intention to use mediates the connection between environmental concern and adoption of green innovation (β = 0.093, t = 2.551; p < .05, see Table 8). This finding supports the fourth hypothesis. Moving on to the fifth hypothesis, we predicted that the intention to use mediates the connection between perceived ease of use and adoption of green innovation. We explored that intention to use does not mediate the connection between perceived ease of use and adoption of green innovation (β = 0.070, t = 1.398; p > .05, see Table 8). As a result, the fifth hypothesis is rejected. This suggests that if perceived ease of use with the mediating effect of green energy technology is increased, adoption of green innovation will not rise. Rural entrepreneurs are likely concerned about environmental challenges, which drive them to adopt green innovation through green energy. Furthermore, the sixth hypothesis indicates that the intention to use mediates the connection between attitude and adoption of green innovation. Our findings show that intention to use indeed mediates the connection between attitude and adoption of green innovation (β = 0.203, t = 3.645; p < .05, see Table 8). In this way, hypothesis sixth is also supported.

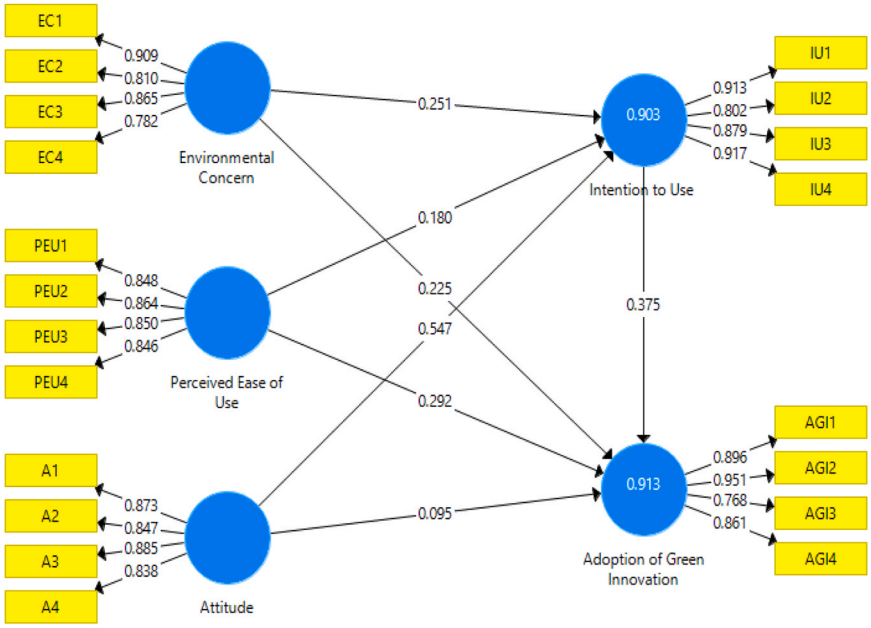

Fig. 2. Standardized results of SEM calculations.

Table 8
Result of Direct and Indirect Effect Hypotheses.

Hypotheses	Relationship	Std Beta	Std Error	t-value	p-value	Decision
H1	Environmental Concern → Adoption of Green Innovation	0.225	0.078	2.884	0.004	Supported
H2	Perceived Ease of Use → Adoption of Green Innovation	0.289	0.065	4.507	0.000	Supported
H3	Attitude → Adoption of Green Innovation	0.100	0.088	1.082	0.280	Rejected
H4	Environmental Concern → Intention to Use → AGI	0.093	0.037	2.551	0.011	Supported
H5	Perceived Ease of Use → Intention to Use→ AGI	0.070	0.048	1.398	0.163	Rejected
H6	Attitude → Intention to Use → AGI	0.203	0.056	3.645	0.000	Supported

5. Conclusion

5.1. Theoretical contribution

This study provides three theoretical contributions to the subject of green innovation research. Firstly, this study addresses a research gap by evaluating the link between environmental concern, perceived ease of use, and attitude toward green innovation using multivariate analysis and structural equation modeling. In this study, we develop and evaluate a model that explains and predicts the adoption of green innovation. As a result, the study is conceptualized using the Theory of Planned Behavior (TPB) and the technology acceptance model (TAM) (Ajzen, 1985; Davis, 1989). We extended the TAM model adding environmental concern to the proposed model in this study.

Secondly, this research study focuses on an important but little-understood element of green energy technology and rural entrepreneurs' adoption of green innovation, all of which contribute to green environmental sustainability. The exponential expansion in global industrial activity enabled by globalization, as well as the concomitant rapid growth of many low-income nations, has an unquestionably big negative externality: a significant contribution to man-made global warming. As the globe becomes more conscious of the dangers of pursuing unbridled growth at any cost, interest in greener energy is growing (Zhou et al., 2021). Green innovation in the SMEs fields is further stimulating this awareness by opening up more avenues to transition into a more sustainable future (Zhang et al., 2020; Dong et al., 2023). Motivated by these factors, we developed an empirical study on the antecedents of adoption of green innovation by 288 rural Bangladeshi SME entrepreneurs. Green energy usage and environmental pollution are non-negligible difficulties even if rural firms will not be actively engaged in production.

In order to deal with environmental and sustainable challenges of rural firms, it is necessary to incorporate green technologies. To this purpose, it is essential to recognize the factors that influence the willingness of firms to adopt green technologies before they have any practical consequences. In contrast, earlier researches have frequently focused on the direct impact of the factors, while few have paid attention to the underlying structures and interactions between these determinants (Zeng et al., 2022). Rural SMEs' adoption of green innovation was significantly influenced by environmental concerns as well as a significant perception of the technology's ease of use. The influence of attitude was also not significant, contrary to assumptions. Aside from environmental concern and attitude, it was also shown that intention to use green energy technology may have influenced the adoption of green innovation (Yang and Roh, 2019; Yousaf, 2021).

Today, sustainability is a critical concern in business. The United Nations' sustainable development objectives state that environmental sustainability has a direct impact on the economic and social well-being of the world's young, making them significant drivers of green marketing initiatives (Zameer et al., 2020). Academics are paying greater attention to green marketing. However, little is known about the ways in which ideas like "green knowledge" and "green attitude" affect the entrepreneurs in Bangladesh. Thus, the importance of this research is crucial. Researchers found that corporate managers and academics need to take into account the different green aspects that impact purchase decisions by Bangladeshi youth, who make up a majority of the continent's customer base (80%). Youth in both rich and developing nations are more concerned about environmental concerns, according to a new survey (Yuen et al., 2021; Roh et al., 2022a, 2022b, 2022c).

6. Implications of the study

6.1. Managerial implications

This study contributes to the Bangladeshi rural entrepreneurs' behavior towards adoption of green innovation choices are influenced more by environmental concern than by perceived ease of use, according to the research. Firms interested with green sustainability should carefully plan and execute sustainable initiatives that target the young rural entrepreneurs as vital stakeholders of green innovation (Abdullah et al., 2016; Roh et al., 2021). There should be a strong focus on environmental concern and how it might assist the general population. Budgetary support and dedication from the top management are necessary to achieve good, long-term green results. We observe that the rural entrepreneurs' intention to adopt green technology fails to mediate the nexus between perceived ease in use and adoption of green innovation (Zhang et al., 2020; Roh et al., 2022a, 2022b, 2022c).

However, the value of the green environment might lead marketing and communication tactics, particularly with regards to the youths (Arfi et al., 2018). As a result, firms must boost their green innovation habit by improving their green understanding. Managers who are concerned about the long-term viability of their firms and society as a whole may be guided by the realization that entrepreneur's choices are influenced by their level of green awareness and attitude (Ahmad et al., 2020). Environmental strategies for both private and public sector firms may benefit from these insights. These results may be used by governments to implement policies that encourage young people to become involved in sustainable development initiatives. For example, a lottery system at the point of sale may reward young people who buy items from firms that practice green innovation (Amallia et al., 2021). Religious and other leaders in the community should show their passion for the environment in order to inspire the next generation of leaders to embrace environmental stewardship and conservation. Because significant green environmental concerns are strongly linked to human behavior, corporate communication managers should utilize green communications to encourage young people to adopt environmentally friendly habits and practices (Alkire et al., 2020).

6.2. Implications for strategy

The findings of this study have consequences for corporate strategy. Innovating green innovation using green energy (solar) technology does not seem to harm business performance. Rather, both positively impact business success. Product innovation requires considering both input and conversion costs. Increasing low-level green product innovation seems to improve firm performance, but not among the top half of green product innovators. Managers should look at process innovation possibilities, particularly if they face product cannibalization or

increased expenses to produce green products. Furthermore, product innovation needs environmental inputs, therefore the firm's capacity to innovate depends on resource availability (Aslam et al., 2021). Green innovation using green energy (solar) technology seems to improve firms performance at all levels. It improves input efficiency and/or conversion efficiency. Unlike green innovation, it is less reliant on external forces, allowing the business to control the outcome. The impact of management environmental concern is a key strategic result. Managerial concern boosts the impact of green process innovation on business performance (Bigliardi et al., 2022).

Furthermore, managers must recognize the value of green innovation and be willing to adopt green innovation strategies. Corporate environmental commitment centralizes the cause and enhances management environmental care, eventually improving business performance (Chowdhury et al., 2020). The data shows that no longer an afterthought or a minor strategic consideration. The impact of management environmental concerns on performance is increased. Firms may support green innovation as a method of improving performance by making the environment a management priority (Elahi et al., 2022).

6.3. Implications for policy

Green innovation helps both businesses and society. Governments and authorities should encourage the rural entrepreneurs' behaviors. Green process innovation had a substantial influence on company performance, while green product innovation did not (Gkargkavouzi et al., 2019). Government policy may encourage green innovation by rewarding it with grants and rebates or penalizing it with tariffs and quotas. These methods improve managers' understanding of green innovation and thereby encourage managerial environmental concern. Green product innovation, which has a smaller influence on firm performance beyond certain levels, may require more government assistance than green process innovation (Guo et al., 2020).

7. Limitations and future research

There are, of course, some limitations to this study, which can serve as a springboard for future researches. This study is unable to provide any direct insight into the dynamic process of green innovative practices within companies because of the lack of panel data. The second issue is that, while the sample is impressive, this study is limited to a single country, Bangladesh in this case. Although Bangladesh has more manufacturers, the sample size of 288 is small. Future studies could benefit from using different contexts, alternative data sources, or tracking firms and their innovative efforts through time. It is possible that future researches will look more closely at individual businesses and examine how the relevance of green technology can be changed by those firms. Finally, future studies can further unlock the black box of how managers' environmental concern, and the related cognition and action, affect the link between green innovation, strategic behavior, and strategic outcomes such as firm success.

Author Contributions

M.R.H.P. is the author of the manuscript and the general manager of the research project, manager of the research resources, and responsible for preparing the methodology, results, and conclusions of the study by A.I.K., A.A.J. & A.S.M.S.Z. collaborated with the general review of the document and with the construction of the hypotheses from the empirical and theoretical context of the model. R.K., M.I.T. collaborated with the review of the writing of the document and the review of the introduction of the manuscript. All authors have read and agreed to the published version of the manuscript.

Informed Consent Statement

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

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Data availability

Not applicable.

Conflicts of Interest

The author declares no potential conflicts of interest with respect to the research, authorship, and publication of this article.

Appendix

Measurements Items

a. **Environmental Concern (**Alam et al., 2014; Paul et al., 2016)

1. Environmental concern has significant benefits.
2. Renewable energy will reduce pressure on energy production.
3. I am very concerned about the environment.
4. Anti-pollution laws should be enforced more strongly.

a. **Perceived Ease of Use** (Alam et al., 2014)

1. Easy to install renewable energy materials.
2. Renewable energy installation would be clear and understandable.
3. Learning to operate renewable energy would be easy.
4. It would be easy for me to become skillful at using renewable energy.

a. **Attitude** (Paul et al., 2016)

1. I have a favorable attitude toward using green energy technology.
2. I believe I have the ability to use green energy technology.
3. I see myself as capable of using green energy technology in future.
4. I have resources, time and willingness to use green energy technology.

a. **Intention to Use** (Paul et al., 2016)

1. I will consider using green energy technology because they are less polluting in coming times.
2. I am sure that I would be able to make a difference by using renewable energy.
3. I am confident that I would use renewable energy in future.
4. Using renewable energy is entirely within my control.

a. **Adoption of green innovation** (Cao and Chen, 2019)

1. I reduce the use of traditional fuels by the substitution of some less polluted energy sources.
2. I adjust my house activities in terms of using green energy to reduce the damage to the ecological environment.
3. Although the government does not require, the house still takes environmental remedial actions.
4. I reduce the use of traditional fuels by the substitution of some less polluted energy sources.

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