



## OPEN The role of environmental awareness, renewable energy, and green innovation in shaping climate change perceptions

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Globally, pollution is deteriorating the climate with air and water pollution, harboring more pathogens and parasites that affect the agriculture sector, food quality, and human life. The study aims to examine how pollution deteriorates the environment and focuses on renewable energy and the adoption of green innovation adoption as solutions to reduce the detrimental effects of traditional energy consumption practices with the help of spreading environmental awareness. VBN theory was applied to the framework that explores climate change via environmental awareness. In contrast, renewable energy adoption (REA) mediates the relationship between awareness and climate change, and green innovation strengthens the relationship between environmental awareness and renewable energy adoption. The data was collected from high-level managers of 368 Chinese SME firms, and PLS-SEM was applied to validate the data. This study explores how environmental awareness influences renewable energy adoption, green innovation adoption (GIA), and climate change perceptions in Chinese SMEs. This study is an essential contribution to the development of VBN theory at the organizational level by demonstrating how values and beliefs integrated in SME implementations lead to pro-environmental practices that sustain climate resilience. This study, by focusing on the theoretical perspective of VBN is instrumental for developing new insights regarding how organizational values and beliefs influence SMEs' sustainability strategy. The results also make policy recommendations and managerial actions that are based on environmental consciousness, renewable energy, and innovation to control climate risks.

**Keywords** Perceived severity of climate change, Environmental awareness, Renewable energy adaptation, Green innovation adoption

Climate change is one of the most pressing challenges of the twenty-first century, driven primarily by pollution, unsustainable resource consumption, and energy-intensive industrial practices (Kousar, et al., 2022). Rising greenhouse gas emissions have accelerated global warming, leading to more frequent extreme weather events, disruptions in agriculture, deteriorating food quality, and increasing health risks (Mandel & Lipovetsky, 2021). Traditional manufacturing processes remain central contributors to global warming and environmental degradation, and despite numerous policy interventions, governments alone have limited resources to fully mitigate these impacts (Fahad, Alnori, Su, & Deng, 2022; Fahad & Wang, 2020). This underscores the need for shared responsibility across businesses and individuals in addressing sustainability challenges (Stern, 2000).

Although often overlooked in global climate debates, small and medium-sized enterprises (SMEs) collectively account for the majority of industrial pollution and a significant share of carbon emissions worldwide (Hillary, 2004; Revell, Stokes, & Chen, 2010). Their cumulative environmental footprint exceeds that of many large corporations, making SMEs pivotal actors in the transition toward sustainability. Small and medium-sized

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enterprises (SMEs) play a critical role in economic growth, innovation, and employment generation, particularly in developing economies (Ayyagari, Beck, & Demircuc-Kunt, 2007; Alam, Du, Rahman, Yazdifar, & Abbasi, 2022). However, SMEs also contribute significantly to industrial pollution, with estimates suggesting they account for nearly 70% of harmful emissions (Hillary, 2004; Revell, Stokes, & Chen, 2010; Colsaet, Laurans, & Levrel, 2018). This dual role positions SMEs as both vital economic drivers and notable sources of environmental harm. In countries such as China, SMEs often rely on conventional, resource-intensive practices due to limited environmental awareness, scarce resources, and pressures to prioritize profitability (Zhu & Sarkis, 2006; Asanprakit & Kraiwanit, 2024). Consequently, SMEs represent both a challenge and an opportunity in the global effort to combat climate change (Madrid-Guijarro & Duréndez, 2024).

Previous studies indicate that environmental awareness can influence organizational behavior toward sustainability (Schultz, 2000; Stern, 2000). Yet, translating awareness into concrete actions remains inconsistent, with some research showing positive impacts on performance (Cordano, Welcomer, & Scherer, 2003) and others finding mixed results (Tilley, 1999). Renewable energy adoption (REA) is widely recognized as a critical strategy to reduce emissions, but firms' perceptions of climate change severity may decline after mitigation measures are implemented, creating risks of complacency (Anderson & Newell, 2004). Similarly, green innovation adoption (GIA) is essential for sustainable transformation, though barriers such as financial constraints, technological limitations, and cultural resistance persist (Horbach, Rammer, & Rennings, 2012; Takalo & Tooranloo, 2021). Despite these insights, few studies have examined the combined influence of environmental awareness, renewable energy adoption, and green innovation adoption within SMEs, particularly in developing economies. This leaves a significant gap in understanding how awareness translates into practices that mitigate environmental degradation (Bocken, Short, Rana, & Evans, 2014).

Although prior research has examined the influence of environmental awareness, renewable energy adoption, and green innovation, three critical gaps remain. First, much of the literature focuses on large firms, leaving SMEs, despite their significant cumulative environmental footprint, relatively underexplored. Second, studies typically investigate these factors in isolation, rather than integrating them into a comprehensive framework that captures their interactive dynamics. Third, empirical evidence from developing economies remains scarce, even though these contexts play a crucial role in global sustainability transitions. By addressing these limitations, this study contributes to the literature by examining how environmental awareness, renewable energy adoption, and green innovation jointly shape SMEs' perceptions of climate change severity, with a particular focus on the developing economy of China. Specifically, it explores the mediating role of renewable energy adoption and the moderating role of green innovation adoption in linking environmental awareness to perceptions of climate change severity. By doing so, it fills the gap of integrated empirical studies within SME contexts, especially in developing economies such as China. The study is guided by the following research questions:

- Does environmental awareness influence SMEs' perceptions of climate change?
- How does renewable energy adoption impact the perceived severity of climate change?
- Does renewable energy adoption mediate the relationship between environmental awareness and perceptions of climate change?
- How does green innovation adoption moderate the relationship between environmental awareness and renewable energy adoption?

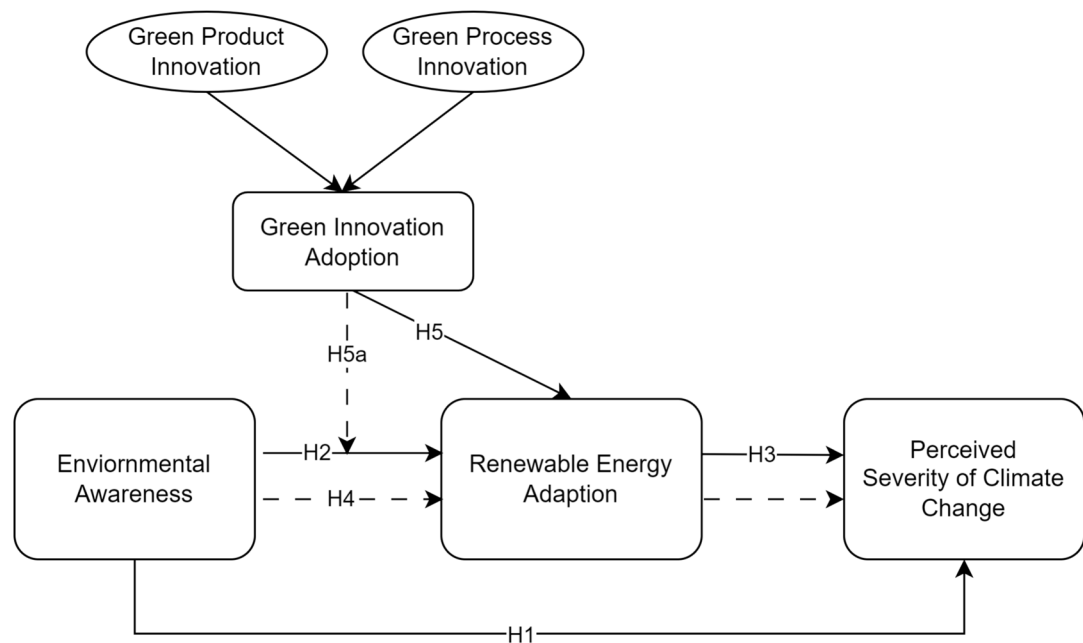
To examine these questions, the study applies the Value-Belief-Norm (VBN) theory, which posits that values influence beliefs, and beliefs activate personal norms that shape pro-environmental behavior (Stern, Dietz, Abel, Guagnano, & Kalof, 1999). Within this framework, environmental awareness reflects values, perceived severity of climate change represents beliefs, and renewable energy adoption and green innovation adoption represent behavioral norms. This theoretical grounding enables the development of a conceptual model that positions renewable energy adoption as a mediator and green innovation adoption as a moderator, thereby offering a more comprehensive understanding of how environmental awareness influences organizational responses to climate change. In doing so, this study extends prior research by demonstrating how values and beliefs within SMEs can translate into tangible practices that contribute to sustainability and mitigate environmental degradation.

The subsequent sections of the study detail the literature review, methodology, results, conclusions, and discussions, contextualizing them within both proposed and prior research and highlighting theoretical and practical implications. The paper concludes with a discussion of its limitations and suggestions for future research directions.

## Literature review

### Value-belief-norm theory

The value-belief-norm (VBN) theory explains that values shape pro-environmental behavior through beliefs and personal norms<sup>1</sup>. By identifying value orientations, egoistic, altruistic, and biospheric, it shows how recognizing environmental impacts activates norms that motivate sustainable actions (Aguilar-Luzón, Carmona, Calvo-Salguero, & Castillo Valdivieso, 2020). When individuals acknowledge responsibility and the effectiveness of their efforts, they adopt behaviors such as recycling or energy conservation (Jebarajakirthy et al., 2024). VBN provides a framework for linking environmental awareness, perceived severity of climate change, renewable energy adoption, and green innovation in Chinese manufacturing firms. Government initiatives that raise awareness heighten ecological worldviews, strengthen beliefs about climate risks, and trigger norms that foster renewable energy adoption and green innovation<sup>2</sup>, Stern, 2007; Dietz, Fitzgerald, & Shwom, 2005; Wang, Zhou, & Liu, 2018). Recent studies confirm VBN's role in promoting sustainable practices and shaping pathways to environmental action in China (Kim, Hall, Chung, Kim, & Sohn, 2023; Nguyen, 2022; Yechen Zhang, Zhao, Zhang, Zheng, & Yao, 2024). The proposed research framework is shown in Fig. 1.



**Fig. 1.** Research framework.

### Environmental awareness

In China's SME manufacturing sector, human activities have caused major environmental damage (Zeng et al., 2011), making sustainable practices essential. Environmental awareness (EA) plays a critical role by helping individuals understand the impact of products and processes and adopt pro-environmental behaviors (Palmer, 2002). Within the value-belief-norm (VBN) theory, EA can be seen as a key component: awareness strengthens environmental values, reinforces beliefs about human responsibility, and shapes the personal norms that drive behavior (Stern, Dietz, Abel, Guagnano, & Kalof, 1999). Thus, cultivating EA among SME executives can translate values and beliefs into concrete green innovation and sustainable practices (Bani-Melhem, Al-Hawari, & Mohd. Shamsudin, 2022). Governments, NGOs, and businesses are central to this process. Governments can establish policies and incentives, NGOs can push for stricter regulations, and SMEs can innovate eco-friendly products and services (Dewi, Nuryadin, Arsyad, & Diansari, 2019). Yet, inconsistent policies, resource limitations, and financial or technical constraints often hinder progress (Stekelorum, Laguir, & ElBaz, 2020). Addressing these barriers is essential to strengthening EA as a VBN-driven force for pro-environmental behavior, advancing climate action, urban sustainability, and biodiversity protection.

### Perceived severity of climate change

In China's SME manufacturing sector, the perceived severity of climate change (PSCC) is evident in global warming, extreme weather, and their cascading effects on ecosystems, food security, and human health (Duku, Alho, Leemans, & Groot, 2022<sup>3</sup>). Rising temperatures, melting glaciers, and urbanization worsen natural disasters, biodiversity loss, and disease outbreaks (Tang et al., 2010, Mariappan, David Raj, Kumar, & Chatterjee, 2023; Benatar, 2022). VBN theory emphasizes that beliefs about the severity of climate change shape personal norms and drive pro-environmental behaviors<sup>4</sup>. Thus, heightened PSCC among SME executives can translate into adopting renewable energy, green innovation, and environmental awareness initiatives, aligning business practices with pro-environmental values (Hampton, Blundel, Wahga, Fawcett, & Shaw, 2022).

### Renewable energy

Severe climate change is largely driven by fossil fuel-based energy, which generates 80% of global greenhouse gas emissions<sup>5</sup>, Gielen et al., 2019). Renewable energy (RE) sources such as solar, biomass, hydropower, wind, and geothermal, offer sustainable alternatives that reduce emissions and ecological damage (Srivastava et al., 2021; London, 2021; Martinez & Iglesias, 2024). In China, large-scale projects such as the Three Gorges Dam and Golmud Solar Park highlight the growing shift toward RE (Wang, 2024). According to VBN theory, values and beliefs about environmental responsibility encourage pro-environmental behavior<sup>1</sup>. Recognizing RE's environmental and economic benefits motivates SMEs to adopt green practices, cut carbon emissions, and support sustainable development (Alalwan et al., 2024; Naz & Haider, 2023). Global initiatives from India's Kamuthi Solar Project to Japan's Fukushima Wind Farm, further demonstrate RE's role in reducing carbon footprints and promoting socio-economic benefits (Kamble et al., 2024; Edwards et al., 2023; Fatima, Li, Ahmad, Jabeen, & Li, 2021). Thus, embracing RE aligns with VBN-driven values, advancing climate mitigation, sustainability, and environmental awareness (Shen, Wen, & Trutnevyte, 2023).

### Green innovation adaptations

Industrialization and reliance on conventional energy have intensified environmental degradation in China (Huang & He, 2023). Green innovation adaptations (GIA) offer solutions by promoting eco-friendly products and processes that reduce pollution, conserve resources, and link environmental compliance with economic growth (Shen et al., 2023<sup>6</sup>, Wasiq, Kamal, & Ali, 2023). GIA spans process, system, and managerial innovations that enhance sustainability (Del Río, Romero-Jordán, & Peñasco, 2017). VBN theory explains that values and beliefs shape norms, which can motivate firms to pursue GIA as part of pro-environmental behavior. For SMEs, this means aligning strategies, HR practices, and technologies with sustainability goals, despite barriers such as costs, limited expertise, and resistance to change (de Jesus Pacheco, ten Caten, Jung, Sassanelli, & Terzi, 2019; Kirchner-Krath et al., 2024). Government incentives, partnerships, and leadership commitment can help overcome these barriers (Tugyetwena, 2023; S. Liu, Thurasamy, & Mohamad, 2023). By embedding green values into business practices, SMEs not only improve performance but also contribute to climate mitigation and sustainable development<sup>7</sup>, Rivera Contreras & Gemelli, 2024).

### Environmental awareness and perceived severity of climate change

Environmental awareness is crucial for addressing climate change and environmental degradation. Issues such as biodiversity threats, hazardous waste mismanagement, water wastage, greenhouse gas emissions, population growth, and resource exploitation contribute significantly to these problems<sup>2</sup>. EA significantly influences the perceived severity of climate change in Chinese manufacturing firms and gives awareness regarding sustainable development to business managers, which helps decrease environmental issues. EA provides information on attitudes toward sustainability, environmental challenges, and implementing eco-friendly practices in the firms<sup>8</sup>. The managers recognize the opportunity and seriously implement the precautionary measures, which help in climate change, influencing their strategic decisions toward sustainable practices and regulatory compliance. This awareness drives firms to mitigate their environmental footprint, aligning with China's goals for a greener economy. However, heightened EA may paradoxically reduce the perceived severity of climate change among Chinese SME manufacturing firms. As a firm becomes more environmentally aware, it may develop a sense of efficacy and control, potentially downplaying the urgency of climate change<sup>9</sup>.

In the previous literature, researchers have explored that environmental awareness can negatively relate to the perceived severity of climate change. This suggests that as firms become more environmentally aware, they might perceive climate change as less critical due to their proactive measures in mitigating impacts<sup>10</sup>. This sense of control can lead to complacency, where managers believe their efforts are sufficient, resulting in a negative correlation between EA and the perceived severity of climate change. While EA is essential, it must be coupled with a realistic appraisal of the PSCC to drive meaningful action and adaptation, which enhances public trust, reduces corruption, supports green practices, and improves business competitiveness<sup>11</sup>. VBN theory explains that increased environmental awareness can lead to perceived control over climate change, causing firms to view its severity as less critical due to proactive mitigation efforts (Yang, Zhang, Xue, Wang, & Zhang, 2024, <sup>12</sup>). The hypothesis posits that EA has a negative relationship with perceived climate change severity, suggesting that informed individuals may view climate change as less severe due to optimism about mitigation strategies and psychological adaptation. Hence, based on the previous literature support and logical arguments, we can conclude that:

**H1:** Environmental awareness has a negative relation with the perceived severity of climate change

### Environmental awareness and renewable energy adaptation

EA supports actions that protect the environment and individuals' behaviors and motivates them to adopt practices that preserve the planet. Value-Belief-Norm theory further emphasizes the importance of EA in fostering a better world for future generations and the adaptation of renewable energy that drives sustainable business practices among SME firms<sup>13</sup>. Managers and business owners who are aware of environmental issues recognize the importance of protecting the environment and understand the benefits of renewable energy. This awareness encourages them to see renewable energy as a viable alternative to traditional energy sources and a strategic investment for long-term sustainability and cost savings<sup>14</sup>. Due to environmental awareness, the managers are always motivated to adopt renewable energy technologies like solar, wind, and bioenergy that understand the positive environmental impacts, like reducing carbon emissions and dependency on fossil fuels (Drosos, Kyriakopoulos, Ntanos, & Parissi, 2021).

Consequently, SMEs with high EA are more proactive in integrating renewable energy solutions into their business models, improving their environmental performance, reducing operational costs, and contributing to sustainable development<sup>15</sup>. This relationship between EA and renewable energy adaptation highlights the importance of raising environmental awareness to promote the adoption of renewable energy<sup>6</sup>. Renewable energy bridges EA and a healthy climate by mitigating carbon emissions, while non-renewable energy sources increase CO<sub>2</sub> emissions. For example, in 2019, using wind, biomass, and solar energy significantly reduced carbon emissions and pollution in developed countries<sup>16</sup>. Based on these arguments, we can hypothesize that environmental awareness positively relates to renewable energy adaptation.

**H2:** Environmental Awareness has a positive relationship with Renewable Energy Adaptation

### Renewable energy adaption and perceived severity of climate change

Over the past few decades, increased industrialization and manufacturing have led to significant environmental changes. The main causes of climate change and environmental degradation are the exploitation of natural resources, increased pollution, and hazardous waste, rather than the operations and new technologies<sup>17</sup>. Using natural energy resources, such as natural gas, fossil fuels, and coal, has proven harmful to the environment. REA significantly reduces greenhouse gases and CO<sub>2</sub> emissions, and building a relationship between RE adaptation

and the perceived severity of climate change can be paradoxical. SME manufacturing firms are increasingly adopting the RE and might perceive climate change as less urgent due to a sense of proactive mitigation<sup>18</sup>. This perception can lead to complacency, reducing the perceived need for broader environmental actions. The success of RE in reducing immediate environmental impacts may shift the focus to technological solutions, underestimating ongoing climate risks and diminishing motivation for other crucial environmental initiatives<sup>19</sup>.

Additionally, Chinese SMEs integrating RE technologies might develop a sense of environmental accomplishment, perceiving their efforts as sufficient to address climate challenges. This could lower their perceived severity of climate change and reduce support for necessary policy changes and broader climate actions<sup>20</sup>. Thus, RE adaptation is essential for reducing emissions and fostering sustainability, it can inadvertently contribute to the lower perceived severity of climate change, hindering a holistic approach to environmental stewardship<sup>21</sup>. According to the VBN theory, human beliefs and behavioral norms drive environment-friendly practices in Chinese firms, where governmental policies emphasize sustainability and play a pivotal role in climate change<sup>22</sup>. PSCC influences strategic planning and operational decisions that are reduced due to the RE accomplishments, these firms might not fully engage with comprehensive sustainability goals<sup>23</sup>.

Our hypothesis suggests that RE adoption has a negative relationship with the perceived severity of climate change, which means an increase in the REA correlates with a lower perceived severity. People aware of REA solutions might believe these solutions are effective in combating climate change and fostering a sense of progress and hope. REA can diminish the perceived severity of climate change by instilling a sense of control and optimism. When manufacturing firms and individuals implement renewable energy solutions, they often perceive themselves as actively mitigating climate change impacts<sup>5</sup>. This perception can lead to a diminished sense of urgency regarding the severity of the threat posed by climate change. Thus, REA contributes to a belief that proactive measures are effective, potentially reducing the perceived criticality of climate change<sup>24</sup>. This sense of efficacy and reduced perceived risk results in a negative relationship between renewable energy adoption and perceived climate change severity, supported by empirical research in environmental psychology and corporate behavior. Based on the existing literature, we posit the following hypothesis:

**H3:** Renewable energy adaptation has a negative relation with the Perceived Severity of Climate Change

#### Renewable energy adaptation as a mediator

According to Fu et al.<sup>25</sup> EA is the initial step in helping individuals address environmental concerns<sup>26</sup>. further argues that EA comprises environmental knowledge that explores its issues and the need to adhere to potential solutions. In this study, it is posited that one of the most effective solutions to CC is to transition from conventional energy sources to renewable energy<sup>27</sup>, which has been repeatedly proven to have positive environmental impacts. REA builds the relationship between EA and the perceived severity of climate change among Chinese SME manufacturing firms, meanwhile, managers give environmental awareness by recognizing the benefits and necessity of integrating renewable energy solutions into their operations<sup>28,29</sup>

Prior studies found that environmental concerns mediate the relationship between climate change beliefs and energy-conservation actions<sup>30</sup>. This highlights the potential for renewable energy adaptation to play a similar mediating role and increase environmental awareness, which leads to the greater adoption of renewable energy, thereby affecting perceptions of climate change severity<sup>28</sup>. The adoption of renewable energy thus acts as a concrete action that guides environmental awareness into measurable improvements for manufacturing firms' environmental performance<sup>31</sup>. Renewable energy adaptation impacts the perceived severity of climate change and is affected by environmental awareness, which ensures that an increase in environmental awareness leads to tangible sustainability outcomes<sup>9</sup>.

Furthermore, successfully implementing renewable energy projects can reinforce a firm's commitment to sustainability, creating a positive feedback loop that further enhances its overall environmental performance<sup>32</sup>. Based on previous studies, explore the mediating role of environmental protective behaviors in the relationship between environmental awareness and environmental quality<sup>33</sup>. Although not specific to China, it provides insights into how increased awareness can drive actions (like adopting renewable energy) that improve environmental outcomes and potentially alter perceptions of environmental threats<sup>29</sup>. This framework can be applied to understand similar dynamics within Chinese SMEs. This mediation role highlights the importance of promoting renewable energy technologies within the SME sector as standalone solutions and integral components of broader environmental strategies driven by heightened awareness and responsibility<sup>34</sup>. Othman and Khallaf<sup>35</sup> that deploying and promoting RE can reduce the negative impacts of CC in developing nations like China. Furthermore, the findings of this study were validated by Fatima et al.<sup>36</sup>, which highlighted that RE could help control environmental problems in China. Therefore, based on the literature, we can hypothesize the following:

**H4:** Renewable Energy Adaptation mediates the relationship between Environmental Awareness and Perceived Severity of Climate Change

#### Green innovation adoption as a moderator

Nowadays, people are becoming increasingly aware of their practices and their influence on the climate, motivating them to change their ways and reduce environmental problems<sup>37</sup>. This growing environmental awareness can be disseminated through good organizational practices<sup>38</sup>, prompting firms and consumers to adopt environmentally friendly procedures and products. In the context of Chinese SME manufacturing firms, adopting green innovation is a critical moderator in the relationship between EA and environmental performance. Environmental awareness provides foundational knowledge and motivation for sustainable practices. However, adopting green innovations such as advanced waste management systems, energy-efficient production technologies, and sustainable supply chain practices can significantly amplify the impact of this awareness on actual environmental performance. Green innovations enhance firms' abilities to implement

effective and efficient sustainable practices, translating environmental awareness into concrete actions that yield substantial environmental benefits<sup>39</sup> SMEs with high environmental awareness that adopt innovative technologies for reducing emissions or conserving resources will likely experience a greater improvement in environmental performance than those that do not embrace such innovations.

This moderating effect underscores the importance of fostering environmental awareness and encouraging the adoption of cutting-edge green technologies and practices to maximize the positive outcomes of such awareness<sup>40</sup>. In the context of Chinese SMEs, where resource constraints often limit the scope of sustainable initiatives, green innovation adoption provides the tools and methods to overcome these barriers, reinforcing the firm's overall commitment to environmental sustainability<sup>41</sup>.

VBN theory suggests that environmental awareness becomes a norm, and all stakeholders, including potential consumers, recognize the importance of protecting the environment and reducing existing damage. Green practices like RE utilization and GIA have become widely accepted and even demanded. GIA helps reduce pollution<sup>31,36</sup>, ultimately mitigating the adverse impacts of climate change. Additionally, the maximum utilization of renewable energy sources like biomass, geothermal, and hydropower can address energy shortages and provide cheaper energy, even in developing economies<sup>36</sup>.

Hence, based on the supporting theory and literature, environmental awareness, when coupled with adopting green innovations, can significantly enhance the environmental performance of firms, especially in resource-constrained settings like Chinese SMEs. This dual approach addresses immediate environmental concerns and promotes long-term sustainability.

**H5:** Green innovation adoption positively relates to the renewable energy adoption

**H5a:** Green innovation adaptation moderates the relationship between environmental awareness and renewable energy adaptation

### Mapping variables and hypothesized paths to VBN theory components

Consistent with the Value-Belief-Norm (VBN) model, the conceptual framework for this study categorizes variables and hypothesized pathways into one of three basic mechanisms that are central to the VBN theory: values, beliefs, and norms to help elucidate both theoretical logic and causal assumptions. According to VBN theory, the values held by individuals and organizations shape their beliefs about environmental impacts, which, in turn, activate personal norms that motivate behaviors such as recycling (Stern, Dietz, Abel, Guagnano, & Kalof, 1999). The study measured this in terms of three components within the context of Chinese SME manufacturing firms, specifically:

#### Values

Environmental Awareness (EA) problems and willingness to act values based on the biospheric values within VBN. This includes environmental values = High EA, which means that the environment is of such high intrinsic value to SME managers that it automatically results in pro-environmental action from them.

#### Beliefs

Perceived Severity of Climate Change (PSCC): PSCC is the belief element that projects the degree to which decision-makers see climate change as posing a threat to natural or human systems. H1: In line with the VBN proposition that values determine beliefs, EA is proposed to impact PSCC through an influence on managers' ecological worldviews.

H1: Environmental Awareness has a negative relation with the Perceived Severity of Climate change.

#### Norms

The behaviors are conceptualized as behavioral norms, REA, and GIA specific pro-environmental actions derived from activated personal obligations to take action against environmental harm. REA involves a shift from high-carbon forms of energy to cleaner alternatives, with GIA representing technological and managerial innovation that can reduce environmental impact.

### VBN pathway: The proposed hypotheses follow this direction of causal assumptions

**H1:** Increased self-efficacy can decrease perceived threat severity, which in turn reduces preventive raising confidence beliefs, such that EA values are negatively related to PSCC.

**H2:** EA (values) increase REA (norms) by increasing moral obligations to the adoption of low-carbon technologies.

**H3:** Proactive mitigation efforts foster optimism about effective climate change management, which reduces interdependencies and highlights the distinctions between REA (norms) and PSCC (beliefs).

**H4:** REA mediates the EA-PSCC association, demonstrating how value-driven awareness is translated into empirical behavioral norms, which in turn influence the perception of climate risk.

**H5:** GIA has a positive relationship with REA because higher innovative capacity enables and accelerates the adoption of renewable energy technologies.

**H5a:** Moderating effect of GIA on the EA-REA relationship, such that higher innovation capacity (GIA) leads to greater realization of operationable messages translated from environmental corporate values due to RE projects.

## Research methods

### Context selection

Jiangsu Province was selected as the study's setting due to its high density of SMEs, robust innovation system, and strong governmental support for environmentally sustainable industrial development. The province is

considered one of China's economic engines, with SMEs engaged in manufacturing, technological innovation, and employment generation. These traits render Jiangsu a suitable and typical place to investigate the linkage among environmental awareness, renewable energy uptake, and green innovation in SMEs<sup>42</sup>.

### Construct operationalization

The environmental awareness was measured through 5 items adapted from the study by<sup>43</sup>. The green innovation accessed through 6 items from the study of<sup>44</sup>. The perceived severity of climate change was measured through 6 items adapted from<sup>3</sup>. Renewable energy adaptation was evaluated using 9 items adapted from a study by<sup>45</sup>. The survey questionnaire was designed on a 5-point Likert scale.

### Sampling and data collection

The study employs a deductive approach, which is highly suitable in the positivist paradigm, thereby enabling the formulation of hypotheses and testing at an acceptable probability level of expected results<sup>46</sup>. The SME manufacturing firms were selected for the survey, and the method used ensured that the results were unbiased and accurately represented the entities within those industries. A total of 513 manufacturing firms were targeted, and 368 were left for further analysis Miller and Brewer<sup>47</sup>. The methods used in gathering data for this work involved sending physical questionnaires and online/email surveys to a sample of target firms. It further ensured that the participants were adequately knowledgeable regarding their job descriptions. The data collection period spanned approximately five months, from November 2022 to March 2023. Therefore, the survey research achieved a response rate of 71.7%, which is considered satisfactory.

### Analysis methods

The interplay of constructs was determined using partial least squares-structured equation modeling, and data interpretations were made through SmartPLS. PLS-SEM is a flexible statistical technique that is used to analyze data that are not expected, and the sample size is small, according to Hair Jr, Sarstedt, Hopkins, and Kuppelwieser<sup>48</sup>. The purpose of examining the correlations between variables using PLS-SEM is stated as follows. As elsewhere argued by Manley, Hair, Williams, and McDowell<sup>49</sup>, and Henseler et al.<sup>50</sup>, Smart-PLS software assesses middle constructs in each route model and goes on to harmonize the mechanism of interactions between all the variables involved, SPSS v26 was used for primary data screening.

### Common method bias (CMB)

The first use of the Harman one-factor approach and CMB was tested. This study shows that the 41-item measurement model had eight apparent factors. However, the single-factor variance of the highest account was 32.07%, as indicated by Podsakoff, MacKenzie, Lee, and Podsakoff<sup>51</sup>. This is below the critical threshold of 40%; therefore, no CMB. The variance inflation factors (VIFs) were checked, Kock<sup>52</sup>, and the non-existence of CMB is confirmed as all VIFs are < 3.3.

## Results

### Demographics

Table 1 presents demographic variables, including gender, firm age, education level, managerial position, and job experience, that were examined in relation to the research model. These characteristics were chosen because they may influence managers' environmental awareness, renewable energy adoption, and perceptions of climate change severity. This more focused approach establishes a more apparent connection between respondent profiles and the hypothesized relationships.

### Convergent validity and reliability analysis

The study was conducted in two distinct stages for data analysis. Initially, we employed a measurement model using a covariance-based approach for structural equation modeling (SEM) with Smart-PLS 4. The data analysis involved the evaluation of both measurement models and structural models using confirmatory factor analysis<sup>53, 54</sup>.

Table 2 demonstrates the reliability and validity of the latent constructs, internal consistency, and discriminant validity. Cronbach's alpha was used to assess the reliability of the dataset, while composite reliability was employed to test the internal consistency of the constructs. Each construct's Cronbach's alpha values exceed the threshold of 0.700<sup>55</sup>. Composite reliability (CR) values range from 0.847 to 0.902, surpassing the threshold of 0.70<sup>56</sup>. Therefore, the survey instrument is valid across all aspects of the research design and consistently free from random error. To determine convergent validity, we considered composite reliability, standardized factor loadings, and average variance extracted (AVE). The AVE values and factor loadings for each item exceed the optimal value of 0.50, with composite reliability exceeding 0.7.

### Discriminant validity

To measure the four variables, established valid scales were utilized to estimate the outcomes for EA, GIA, PSCC, and REA. Discriminant validity is confirmed when the square root of the AVEs equals the corresponding correlation coefficients<sup>57</sup>. The VIF for each item ranges from 1.514 to 3.260, well below the threshold of 5.0, indicating no multicollinearity in the structural model and no adverse effects between items or predictors<sup>58</sup>. The Fornell-Larcker criterion was used to assess the discriminant validity and cross-loading values of all studied variables. Table 3 presents the correlations between the constructs, all of which are below the square roots of their AVEs. Consequently, Tables 3 and 4 confirm the absence of discriminant validity issues.

Table 4 details the Heterotrait-Monotrait Ratio (HTMT) values, which are within the acceptable range of 1 for all factors, indicating no issues with discriminant validity as all values fall within the threshold limits.

Particulars	Description	Frequency	Percentage
Gender	Male	298	80.97%
	Female	70	19.02%
Firm's age (in years)	1 ≤ 5 years	80	21.73%
	> 5 ≤ 10 years	132	35.86%
	> 10 ≤ years	59	16.03%
	> 10 years	97	26.35%
Educational qualification	High school	88	23.91%
	College level	110	29.89%
	University level	128	34.78%
	Technical education	42	11.41%
Respondent's managerial position	General manager	75	20.38%
	Marketing manager	45	12.22%
	Production manager	67	18.20%
	Frontline manager	51	13.85%
	R&D manager	72	19.56%
	others	58	15.76%
Job experience (Current Firm Employee)	> 3 years	78	21.19%
	> 3 ≤ 7 years	142	38.58%
	> 7 ≤ 10 years	86	23.36%
	> 10 years	62	16.84%

**Table 1.** Respondents demographics.

Constructs	Items	loadings	VIF	Cronbach's Alpha	Composite Reliability	AVE
Environmental awareness	EA1	0.831	2.155	0.864	0.903	0.654
	EA2	0.897	2.757			
	EA3	0.887	2.710			
	EA4	0.701	1.709			
	EA5	0.704	1.514			
Green innovation adoption	GIA1	0.759	2.310	0.853	0.891	0.577
	GIA2	0.795	2.614			
	GIA3	0.816	2.148			
	GIA4	0.705	1.586			
	GIA5	0.756	1.886			
	GIA6	0.722	1.791			
Green innovation adoption	PSCC1	0.834	2.872	0.902	0.924	0.670
	PSCC2	0.824	2.429			
	PSCC3	0.767	1.853			
	PSCC4	0.812	2.647			
	PSCC5	0.820	2.635			
	PSCC6	0.850	2.801			
Renewable energy adaptation	REA1	0.759	2.747	0.847	0.884	0.523
	REA2	0.824	3.260			
	REA3	0.685	1.657			
	REA4	0.634	1.525			
	REA5	0.668	1.600			
	REA8	0.729	1.743			
	REA9	0.744	1.883			

**Table 2.** Confirmatory Factor Analysis (CFA).

### Predictive relevance

Table 5 presents the  $R^2$  and  $Q^2$  values. The  $R^2$  values of 0.682 and 0.565 indicate strong explanatory power<sup>59</sup>. Additionally, the  $Q^2$  values, which estimate effect size, range from 0.451 to 0.621, reflecting medium-range effects.

Constructs	EA	GIA	PSCC	REA
Fornell-Larcker Criterion (FLC)				
EA	<b>0.808</b>			
GIA	0.378	<b>0.759</b>		
PSCC	0.326	0.419	<b>0.818</b>	
REA	0.438	0.431	0.483	<b>0.723</b>

**Table 3.** Fornell-Larcker criterion. **Note:** “Diagonal and bold values are the square root of the average variance extracted from each construct. Pearson correlations are shown below the diagonals.  $p < 0.05$ .”

Constructs	EA	GIA	PSCC
Green innovation adoption	0.818		
Perceived severity by climate change	0.829	0.794	
Renewable energy adaptation	0.721	0.806	0.771

**Table 4.** Heterotrait-monotrait ratio (HTMT) – Matrix.

Construct	SSO	SSE	Q <sup>2</sup>	R <sup>2</sup>
PSCC	3235.000	1415.145	0.563	0.682
REA	2636.000	1223.425	0.536	0.565
EA	3425.000	1878.780	0.451	
GIA	2365.000	895.679	0.621	

**Table 5.** R-Square and Q<sup>2</sup>.

Hypotheses	Effect of	Effect on	$\beta$	p-value
H1	EA	PSCC	-0.483	0.000
H2	EA	REA	0.480	0.000
H3	REA	PSCC	-0.400	0.000
H5	GIA	REA	0.403	0.000

**Table 6.** Path estimates. *Note:* \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

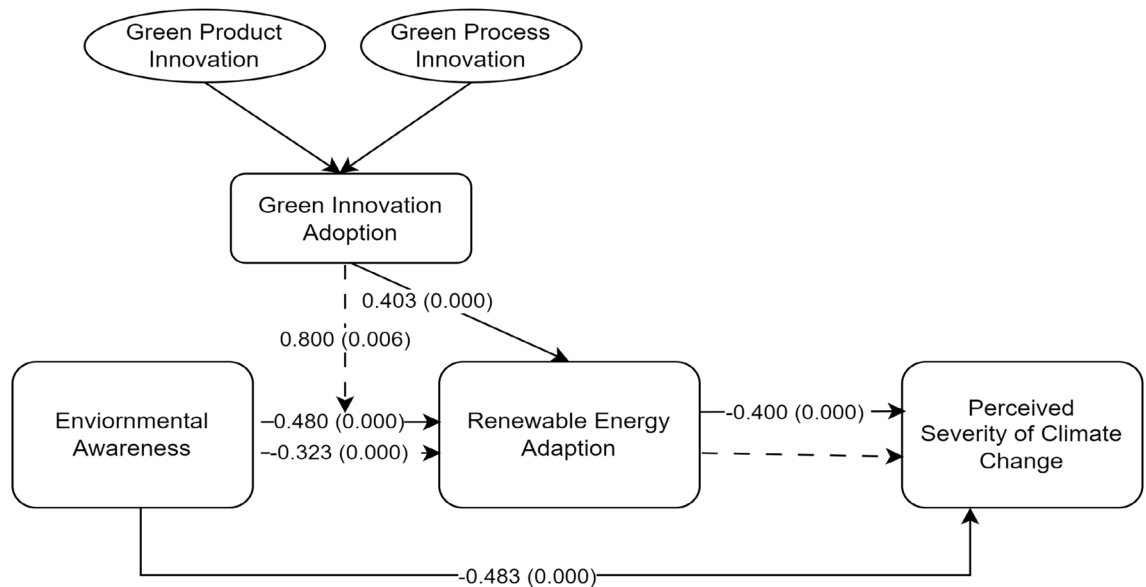
Path	Relationships	B	SD	t-value	f <sup>2</sup>	p-value	Bootstrapping		Results
							LLCI	ULCI	
H4	EA → REA → PSCC	-0.323	0.063	4.681	0.36	0.000	0.3487	0.6521	Supported
H5a	GIA*EA → REA	0.088	0.029	3.034	0.10	0.006	0.5401	0.7401	Supported

**Table 7.** Mediation and moderation estimates. *Note:* \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

### Path model analysis

The structural model was validated through PLS-SEM on 5,000 bootstraps. The fit index of the model was also in line with those recommended in<sup>59</sup>, (SRMR = 0.049, which is less than the average threshold of around 0.08). The PSCC and the REA are thereby posited to have explanatory power of 0.682 (PSCC) and 0.565 (REA), while they exhibit predictive relevance with Q<sup>2</sup>-values ranging from 0.451 to 0.621. Table 6 shows that H1, results from the path model indicated that Environmental Awareness had an insignificant impact on PSCC ( $\beta = -0.483$ ,  $p < 0.01$ ), and H2 EA was positively influenced by environmental consciousness ( $\beta = 0.480$ ,  $p < 0.01$ ). Further, H3 REA negatively predicted PSCC ( $\beta = -0.400$ ,  $p < 0.01$ ). H5 green Innovation Adoption was a strong predictor of REA ( $\beta = 0.403$ ,  $p < 0.01$ ). Mediation analysis with the model revealed that REA mediates the EA–PSCC relationship ( $\beta = -0.323$ ,  $p < 0.01$ ). The moderation results found that GIA enhances the EA–REA path ( $\beta = 0.088$ ,  $p < 0.01$ ). Small to large effect sizes (f<sup>2</sup>) supported the model stability.

Table 7 and Fig. 2 show the mediating and moderating relationships of latent constructs, employing bootstrapping with 5,000 resamples and a 95% confidence interval (CI). Cohen<sup>60</sup> defines f<sup>2</sup> as the proportion of the endogenous construct represented by the moderator construct; an f<sup>2</sup> effect size of 0.10 suggests a small effect,



**Fig. 2.** The results of the structural model, path coefficients.

0.30 a medium effect, and 0.35 a significant effect. H4: REA mediates the relationship between EA and PSCC among Chinese manufacturing firms, is significant ( $\beta = -0.323$ ;  $p = 0.000$ ) with a large effect size ( $f^2 = 0.36$ ). H5a: GIA moderates the relationship between EA and REA and is also significant ( $\beta = 0.088$ ;  $p = 0.006$ ) but has a small effect size ( $f^2 = 0.10$ ), indicating both strong statistical supports.

## Discussion, conclusion, and limitation

### Discussion

The purposes of this study are to investigate the impacts of environmental awareness, renewable energy adoption, and green innovation adoption on Chinese SMEs' perceptions of climate change severity, based on the Value-Belief-Norm theory". This analysis reveals both anticipated and counterintuitive trends that enhance our understanding of the interrelationships between values, beliefs, and norms within organizational settings.

The results indicate that EA is negatively associated with PSCC ( $\beta = -0.483$ ,  $p < 0.01$ ). Although VBN theory posits that values such as pro-environmental tendencies should increase perceived environmental risks<sup>61</sup>. Our findings do not support this assertion. This paradox can be rationalized through an efficacy complacency effect<sup>62</sup> whereby managers who believe in their ability to tackle risks see climate change as less severe. It also relates to the notion of environmental fatigue, where repeated warnings and attention to sustainability discourse can decrease one's sensitivity to risk<sup>63</sup>. Accordingly, in SMEs, awareness can de-dramatize climate risks, rather than exaggerating them. This result contradicts the linear VBN assumption that higher values directly deter stronger threat perceptions.

As expected, EA is a positive predictor of REA ( $\beta = 0.480$ ,  $p < 0.01$ ). This is consistent with the VBN argument, which posits that values trigger pro-environmental norms and behavior<sup>64</sup>. Environmentally conscious managers have adopted renewable energy as a firm's strategic initiative in response to meet regulatory requirements, improve efficiency, and decrease costs, yielding consistent findings with those of<sup>65</sup>. This also reinforces the traditional VBN route where values lead to behavioural intentions. Contrary to the paradoxical result of H1, this time VBN plays its expected role and thus proves to be robust in predicting the adoption of sustainable practices at the organizational level.

Renewable energy is negatively correlated with the perception of climate change severity among SMEs in China. These findings suggest that SMEs implementing renewable energy are more likely to take proactive steps to address climate change. Research by J. Chen, Cheng, Gong, and Li<sup>66</sup> indicates that SMEs adopting renewable energy tend to perceive climate change as less severe, reflecting their commitment to environmental sustainability. The Value-Belief-Norm (VBN) theory supports this by suggesting that normative beliefs and behaviors can shape perceptions of environmental issues, as demonstrated by the adoption of renewable energy<sup>67</sup>.

For the EA-PSCC, the REA significantly mediates the relationship ( $\beta = -0.323$ ,  $p < 0.01$ ). This suggests that awareness primarily affects climate risk perceptions through the adoption of renewable energy. This corresponds within the framework of VBN theory to an indication that norm, as a stronger concept, activates value (EA), leading to norms (REA), which then impacts beliefs (PSCC)<sup>68</sup>. However, the mediated route, rather than heightening threat perceptions, has the opposite effect. The G. Zhang et al.<sup>69</sup> notion that organizational responses or activities may foster reassurance and complacency. The mediation, therefore, draws attention to a metamorphosis of VBN. In SMEs, values may take stronger forms as concrete practices rather than enduring beliefs or perceptions of risk (substantiating the non-linearity embedded in the relationships between value-belief-norm).

Findings verify that GIA does not have a negative influence on REA ( $\beta=0.403$ ,  $p<0.01$ ). Firms that are capable of innovating more effectively can also implement renewable energy solutions efficiently<sup>70</sup>. In terms of VBN, innovation advances the transformation from values to norms through technological and managerial capacity<sup>71</sup>. This illustrates that organizational pro-environmental values are a product of structural capacities. The result validates previous studies that associate green innovation with better sustainability performance and more renewable use<sup>72</sup> and<sup>73</sup>.

The moderated analysis indicates that GIA enhances the positive association between EA and REA ( $\beta=0.088$ ,  $p<0.01$ ,  $f^2=0.10$ ). This implies that the dissemination of bubbling technology may not be only a result of awareness but also of innovative capacity. Under the VBN rubric, GIA strengthens the value–norm path, enabling SMEs to respond to their environmental awareness through specific renewable energy practices<sup>74</sup>. This result confirms recent research that highlights the role of technological and organizational innovations in shaping ecological values<sup>4,75</sup>.

The findings advance the VBN theory in three essential directions. First, they note a paradox where environmental concern and engagement with renewable energy mitigate rather than increase perceptions of climate severity, thereby pointing to non-linearities in value–belief connections. Second, they provide evidence of reverse causation, indicating that norms shape beliefs and suggesting that organizational practices can alter risk perceptions. Third, they demonstrate innovation as a crucial contextual moderator that facilitates the translation of values into norms. These findings reinforce awareness that VBN processes localized in SMEs are not strictly mental but grounded in organizational and technological frames, influencing the routes from awareness to adoption and perception.

## Conclusion

Chinese manufacturing SMEs are influenced by the perceived severity of climate change, environmental awareness, the adoption of renewable energy, and green innovation. The Value-Belief-Norm theory explains how values and beliefs influence pro-environmental norms and behaviors, revealing a reliable relationship between firms' environmental awareness and the perceived severity of climate change (C.-P. Wang, Zhang, Wong, & Wang, 2023). Firms with high environmental consciousness are more likely to invest in renewable energy, thereby reducing carbon emissions and energy costs while generating economic benefits. This awareness is crucial for the large-scale deployment of renewable energy solutions, aligning with the VBN theory's emphasis on the link between environmental values, beliefs, and behaviors. Green innovations also play a significant role in enhancing the efficiency and competitiveness of SMEs. Firms that adopt green innovations can implement renewable energy solutions more effectively, thereby supporting sustainability and efforts to mitigate climate change<sup>76</sup>. The evidence highlights the need for integrated solutions that incorporate awareness, innovation, and practical adaptation strategies to foster a more sustainable manufacturing industry in China.

Prior studies confirm that SMEs with greater environmental awareness perceive a lower severity of climate change, motivating them to adopt sustainable practices<sup>77</sup>. The relationship between environmental awareness and renewable energy adoption is empirically supported, with environmentally conscious SMEs more likely to invest in renewable energy technologies<sup>78</sup>. This reduces their environmental awareness concerns and increases market competitiveness. Renewable energy adoption helps reduce the perception of climate change severity among SMEs, enabling them to contribute more towards mitigating climate change effects<sup>66</sup>. Environmental awareness promotes renewable energy adoption, transforming intentions into practical actions<sup>69</sup>. The VBN theory explains how environmental values and beliefs lead to the development of pro-environmental norms and behaviors.

Green innovation adoption moderates the relationship between environmental awareness and renewable energy adoption, enhancing the implementation of renewable energy solutions<sup>7</sup>. The VBN theory suggests that innovative practices strengthen SME pro-environmental norms and behaviors. The findings highlight the complex processes linking environmental awareness to renewable energy adoption, green innovation, and perceptions of climate change in SMEs in China. In conclusion, environmental awareness has a significant impact on the adoption of renewable energy, green innovation, and perceptions of climate change in Chinese SMEs. Viewing this through the VBN theory lens reveals that environmental values and beliefs are crucial for achieving sustainability and climate resilience goals.

## Limitations & future recommendations

Although this study adds valuable insights in the context of Chinese SMEs, the transferability of its findings to other contexts needs to be undertaken with caution. The empirical model is based on the VBN theory, which suggests that there are universal psychological processes that connect values, beliefs, and norms. Hence, the central relationship between the ability of pro-environmental behavior to modulate perceived severity via efficacy–complacency is a transferable concept. Nevertheless, the extent to which practical recommendations can be adopted is also influenced by factors beyond the control of MNCs, such as regulatory strictness, stage of economic development, cultural values, and the formulation of green technology markets. For example, in areas with weaker enforcement of regulations, the influence of international standards and non-governmental organizations on shaping SME behavior may be more significant. Conversely, more developed economies might transition from an unconditional subsidy to a conditional carbon tax. It is recommended that the model be formally tested in various socio-economic contexts to determine when and how these relationships vary, thereby producing a more contingent understanding of appropriate policy and management guidance.

In the future, two key strategies are proposed to enhance the robustness and scope of these outcomes significantly. First, longitudinal integration is essential to move beyond static, freeze-frame presentations, such as those provided by this cross-sectional study. By tracking SMEs over time, researchers can dynamically explore how the relationships between awareness, action, and perceived severity evolve, leading to a deeper

understanding of phenomena such as the efficacy-complacency bias. Second, future research should involve comparative studies between countries. A cross-cultural, regulatory, and economic analysis of the proposed model could help test its boundary conditions within VBN theory as it applies to SMEs, thereby contributing to the development of a contingency framework that identifies the factors most influencing sustainability transitions in SMEs across different geographical contexts. Combining these approaches would yield a more comprehensive and temporally sensitive understanding of the conditions that shape pro-environmental behavior in this vital SME sector.

This study provides valuable insights, but it has several limitations, particularly related to the national geographical context in which it was conducted. As a result, the findings may not be readily generalizable to different cultural, regulatory, and economic environments. Future research on awareness of environmental issues, adoption levels of renewable energy, and risk perceptions regarding climate change severity would benefit from being conducted in broader regional or transnational settings. This could reveal contextual differences in key variables. Additionally, the cross-sectional nature of our study limits our ability to establish causality.

### Theoretical Implications

This study significantly advances both theory and practice by integrating the perceived severity of climate change, environmental awareness, renewable energy adaptation, and green innovation adoption with the VBN theory in the context of Chinese manufacturing SMEs. Traditionally applied to individual behaviors, the VBN theory is expanded to the organizational level here, showing that SMEs' values and beliefs influence their sustainability practices. Key findings demonstrate that Chinese SMEs with higher environmental awareness perceive climate change as less severe, indicating they feel more capable of addressing it. This supports the theory's applicability beyond Western settings and highlights the importance of cultural and regulatory contexts.

Empirical evidence confirms that environmental awareness drives renewable energy adoption, which is consistent with VBN theory. It shows that environmentally conscious SMEs are more likely to invest in renewable technologies, gaining efficiency and competitive advantage. The study also identifies renewable energy adaptation as a mediator between environmental awareness and climate change perception and green innovation as a moderator enhancing the effectiveness of sustainability practices. These findings offer practical guidance for policymakers to enhance environmental awareness and education in SMEs. Policies should encourage the adoption of renewable energy and green innovation by leveraging the values and beliefs highlighted by the VBN theory. This approach can help SMEs integrate sustainability into their business strategies, gain competitive advantages, and meet regulatory requirements.

### Practical & managerial contribution

The study is practically significant for Chinese manufacturing SMEs as it outlines a path for enhancing sustainability through environmental awareness, renewable energy, and green innovation. It emphasizes the critical role of environmental education and training, delivered via workshops, seminars, and partnerships, in fostering a sustainable culture. Additionally, technologies such as solar, wind, and biomass have expanded the options for renewable energy. Initiatives such as energy audits and government support are crucial for achieving the desired outcomes. Furthermore, investing in research and development, in collaboration with research institutions, improves the efficiency of renewable energy use, maximizes adoption while reducing costs, and creates new markets to facilitate green innovation.

The application of VBN theory helps integrate business strategies with environmental standards, leading to a reduced perception of climate threats and fostering collective action. Compliance with regulations, leveraging incentives, and proactively engaging with regulators significantly promote sustainable initiatives. SMART environmental performance metrics provide a comprehensive account of progress and serve as an excellent tool for transparency and accountability. Increased access to renewable energy grants, the introduction of green incentives for SMEs, and the strengthening of public-private partnerships can fully leverage the global reach of companies in encouraging sustainability. The study confirms the symbiotic relationship between skills, technology, and policies in facilitating the sustainability of SMEs.

The findings from this study are not limited to China, but rather serve as a basic blueprint that can be applied in other locales. The secret lies in focusing on the principles, fighting complacency by linking awareness to action through continuous improvement, and driving down costs by innovating and then adapting the implementation mechanisms to local circumstances. This could involve, for policymakers in developing countries, prioritizing access to green technology and international climate funds. It might mean that managers of mature markets would align their sustainability key performance indicators with the global reporting standards to become more competitive. Accordingly, the contribution of this study extends beyond China by constructing a VBN-based template for explaining and influencing SME sustainability behavior, which can be further tailored to different institutional milieus.

### For policy makers

The study advocates for education programs to focus on increasing environmental awareness, as well as the provision of subsidies for renewable energy sources, tax rebates, and low-interest green loans. The research also argues for sector-specific ecological performance standards to encourage smaller firms to continue improving their environmental practices. This study's recommendations are based on the insights provided by our empirical results, which show that environmental consciousness (in the context of renewable energy) has a significant direct impact on perceptions of renewable energy and its potential to mitigate the seriousness of climate change.

## For SME managers

The study suggests that internal sustainability task forces be formed, that climate risk assessments be integrated into strategic planning, and that collaboration with government and NGOs be tapped for technical and financial support. This research also reiterates the importance of business training to prevent complacency in pro-environmental behavior, as higher awareness and renewable energy adoption may, if taken alone, reduce the perceived risk of climate change.

## Data availability

The dataset used in this study is available from the corresponding author on reasonable request.

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## Author contributions

Conceptualization: A.H. and N.E.; Methodology: S.K. and N.Z.; Formal analysis and investigation: S.N. and U.P.; Writing—original draft: A.H. and S.N.; Supervision: Z.S. and M.A.; Revision: A.H., S.K., and N.E.; Visualization: U.P. and S.N.; Writing—review and editing: A.H., S.K., and N.E.; All authors read and approved the final manuscript.

## Declarations

### Competing interests

The authors declare no competing interests.

### Additional information

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