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Article

# Fostering a greener workplace: Assessing the impact of green human resource and low carbon behavior

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**Abstract:** Businesses in China are embarking on a transformative agenda, as reflected in their environmental performance, which signals a strategic shift towards fostering sustainability initiatives in the workplace. Accordingly, the research explores how green human resource management, organizational commitment, and green innovation climate drive low-carbon behavior and environmental performance. The research gathered 580 responses from senior staff among Chinese small and medium-sized enterprises. The partial least square structural model was employed to assess the study hypothesis. Key study findings are enumerated: First, green human resource management boosts green organizational commitment, green innovation climate, and low-carbon behavior. Second, the data showed that a green innovation climate and organizational commitment enhance low-carbon behavior. Third, according to the study, low-carbon promotes environmental performance. Fourth, the paper analysis showed that low-carbon mediated the connection between green human resources and low-carbon behavior. Fifth, this research outcome highlighted that environmental knowledge moderates the linkage between low-carbon behavior and environmental performance. This finding enriches the debate on green human resource management and how to promote low-carbon behavior and environmental performance.

**Keywords:** green human resource management; green organizational commitment; green innovation climate; environmental performance; low carbon behavior

## 1. Introduction

One significant challenge affecting the sustainability of humanity and natural resources is global environmental degradation. Due to the high-rate trends of $CO_2$ emissions and greenhouse gas emissions, all countries must consider their economic and environmental challenges [1–3]. Moreover, as Wiredu et al. [4] indicated, humans must address the world's most critical concerns, such as environmental pollution, which has emerged due to the reckless pursuit of economic gains at the expense of social and ecological benefits. Although SMEs promote economic growth and create jobs, new business models and technological change have become increasingly necessary. Thus, it is worth solving these problems by investigating how SMEs can improve their environmental performance (EP). Since SMEs operate mostly in a community, they cause environmental pollution [5]. This research focused on China because the country stands among the globe's most populous nations and is a significant player in the world economy, especially in the SME sector. China has initiated numerous policies and plans to promote green practices as a country actively addressing ecological issues and challenges and is committed to

achieving sustainable development. Focusing on China, this paper seeks to contribute novel insight into the mechanisms that drive low-carbon behavior (LCB) from the perspective of SMEs operating in the evolving Chinese business sector.

Low-carbon behavior (LCB) has become a topic of discussion in improving environmental sustainability among businesses. LCB can be defined as the intentional awareness and practices people engage in to avoid potential adverse environmental effects [6]. LCB involves the implementation of eco-friendly and sustainable habits in industrial processes, business operations, and daily life to mitigate climate change. This concept encourages organizations, communities, and individuals to prioritize environmentally responsible actions, energy efficiency, and renewable resources. Therefore, it is essential to understand the drivers of SMEs' staff's LCB and how it affects their EP. Accordingly, GHRM, as demonstrated by prior studies, is an innovative approach to managing human capital within organizations that prioritizes sustainability and ecological responsibility [7,8]. Additionally, GHRM incorporates environmental factors into HR procedures, including hiring, training, performance reviews, and staff involvement [8]. The focal point of GHRM is to foster a culture of sustainability within the workforce, encouraging employees to adopt eco-conscious behaviors at work and in their personal lives. Moreover, to mitigate these toxic emissions, SMEs have begun creating a green innovation climate (GIC) to reduce the environmental repercussions of production processes. GIC is an innovation aspect that focuses on eliminating waste, controlling emissions, and integrating environmental practices [9,10]. Also, the GOC of employees has been established by existing literature to be a significant predictor of the LCB of individuals [11,12].

Additionally, environmental knowledge (ENK) is recognized as an essential internal resource that enables individuals to adapt and understand the dynamic ecological landscape. Thus, ENK empowers businesses to identify sustainable initiatives that comply with environmental regulations and reduce resource consumption, ultimately enhancing the company's resilience and reputation. Existing literature has also predicted the role of ENK in enhancing LCB and EP [13]. Hence, this research explores the moderation role of ENK in the research model. ENK is the classical sense of factual information, such as knowledge about ecosystem processes, functions, and structures [14]. Hence, this study argues that adding ENK as a moderator is essential to understanding how it can enhance LCB and EP. Subsequent literature has established the direct effect of ENK on LCB [15,16], but a theoretical gap exists on the moderation role of ENK in this relationship. Hence, this study fills this gap by providing empirical findings on the influence of ENK on the relationship between LCB and EP. The objectives of this research include:

(1) Exploring the influence of GHRM on GIC, GOC, and LCB.
(2) Investigate the impact of GIC and GOC on LCB.
(3) Analyze the impact of LCB on EP.
(4) Determine the mediation effect of LCB on the connection between GHRM and EP.
(5) Lastly, evaluate the moderation role of ENK on the link between LCB and EP.

Based on the research objectives, the formulated research questions are as follows:

RQ (1) How does GHRM influence green innovation climate, green organizational commitment, and low-carbon behavior? RQ (2) What is the impact of GIC and GOC on LCB? RQ (3) How does LCB affect environmental performance (EP)? RQ (4) Does LCB mediate the relationship between GHRM and EP? RQ (5) What is the moderating role of environmental knowledge (ENK) in the relationship between LCB and EP?

This article enriches the body of knowledge in environmental and GHRM literature by dissecting how green organizational commitment, green innovation climate, environmental knowledge, and low-carbon behavior stimulate environmental performance. This finding enriches the discussion on the importance of GHRM and the appropriate mechanisms needed to strengthen LCB and EP. The novelty of this paper involves the comprehensive assessment of the pathway toward fostering low-carbon behavior, incorporating a multi-dimensional framework. The paper uniquely integrates the domains of GHRM, GOC, and the GIC to elucidate their collective impact on promoting environmentally conscious behaviors. Furthermore, the research introduces the moderation effect of ENK, emphasizing the significance of individual awareness and understanding of environmental issues in influencing the interplay between organizational practices and LCB.

Theoretically, this study comprehensively analyses the pathway to fostering low-carbon behavior within organizations, drawing upon the ability, motivation, and opportunity (AMO) theory. The paper integrates key elements, including GHRM practices, GOC, and a supportive green innovation climate. In addition, the integration of GHRM, GOC, and GIC underscores the connection of these indicators in fostering LCB and EP. The study also recognizes the essential role individuals within the enterprise play in stimulating EP and emphasizes the importance of supportive organizational innovation and culture in improving LCB. The mediation analysis provides a holistic approach to understanding the mechanism through which LCB can improve the nexus between GHRM and EP. Hence, the current analysis provides enormous practical implications for scholars, stakeholders, and government, providing a roadmap for improving environmentally responsible practices among SMEs in China. Lastly, this paper employed the PLS-SEM, which provides a unique statistical tool to assess a research model's direct, indirect, and moderation effects.

This research is original in its integrated exploration of green human resource management, organizational commitment, and green innovation climate as key drivers of low-carbon behavior and environmental performance within Chinese SMEs. It uniquely identifies the mediating role of low-carbon behavior between green HR practices and environmental outcomes and the moderating effect of environmental knowledge on the relationship between low-carbon behavior and environmental performance. These novel insights contribute to the growing discourse on fostering sustainable workplace practices, offering practical implications for enhancing environmental performance through strategic human resource and innovation initiatives.

This study was divided into six central portions. The primary subjects of Section 1 are the study's history, objectives, and significance to ecological sustainability. Section 2 captures the theoretical background and statement of the

hypothesis. The procedures employed are described in Section 3. The conclusions from the PLS-SEM investigation are further provided in Section 4. Section 5 emphasizes this paper's interpretation, which has implications for theory and practice. Section 6 offers the conclusion and suggestions for additional research.

## 2. Literature review and hypothesis formulation

The literature review commenced by meticulously assessing relevant search engines, including Web of Science, Scopus, and PubMed platforms, to provide transparency and rigorous evaluation of prior literary works. Considering targeted search terms such as "GIC", "GOC", "LCB", "GHRM," and "EP", the study systematically went through the abundance of literature, making sure every piece was relevant to the main themes of the current. The literature process focused on peer-reviewed articles. Following stringent publication guidelines from 2002 to 2024, the study sorted through the papers we had retrieved and ensured they fit the objectives of the current study. Using a systematic approach made obtaining a large dataset of academic publications for analysis easier. It guaranteed that the publications were categorized according to their relevance to the research questions. The next section of the literature focused on the theory and hypothesis outlined in the study.

AMO theory proposed by Appelbaum et al. [17] has been generally applied in analyzing the performance of GHRM practices. As suggested by the AMO theory, GHRM practices affect staff's ability (for instance, training and development, recruitment process), motivation (for instance, compensation, reward system, and incentives), and opportunity (for instance, empowerment and teamwork) to promote overall SMEs performance [18]. The AMO theory provides a comprehensive theoretical model for understanding the nexus between the key variables influencing LCB and EP. GHRM is essential in improving employees' abilities by fostering knowledge and skills associated with environmental stability [19]. In addition, GOC contributes to the motivation aspect of the AMO by instilling a sense of shared direction and value to environmental goals. Furthermore, creating GIC provides the necessary opportunities for staff to participate actively in ecologically friendly actions. Additionally, ENK acts as a catalyst, facilitating the integration of green actions and practices within the firm. These concepts create a synergistic influence, aligning organizations and individuals' abilities, motivation, and opportunities towards engagement in LCB and enhancing firms' EP.

The RBV was proposed by Barney et al. [20], where the researcher argued that an enterprise's success or growth depends on internal resources, indicating that inadequate resources hinder a firm's growth and development. This theory focuses on a firm's internal resources to create a competitive advantage [21]. Internal resources combine all available facilities and strengths to help enhance the development of firm value co-creation activities [22]. Moreover, the RBV theory stresses that firm performance and competitive advantage depend on how it can utilize the available strategic internal resources that are valuable, rare, imitability, and organization (VRIO) to be copied by a rival enterprise in the market [23]. Hence,

in this study, the researcher applied the RBV to analyze the EP of firms; thus, these concepts were linked to this theory, which includes (GIP, GOC, and ENK).

## 2.1. Hypothesis on GHRM

GHRM refers to HR policies and practices that motivate, inspire, and empower employees in a firm to engage in GIC, GOC, and LCB, eventually improving enterprises' EP. This section of the paper provides empirical studies exploring the influence of GHRM on GIC, GOC, and LCB. For example, Elshaer et al. [24] reported that GHRM directly impacts two different types of LCB (proactive and task-oriented). Their research further revealed that employee LCB mediates the linkage between GHRM and EP. Moreover, in Malaysia, the analysis by Naz et al. [25] explored the role of GHRM practices toward the LCB. Their research outcome indicated that GHRM (green discipline and green training and development) are essential predictors of LCB among 374 green hotel workers. Also, their study showed that GHRM indirectly improves EP through the LCB of the workforce. In addition, Ansari et al. [26] assessed the influence of GHRM on GOC and LCB. The empirical outcomes showed that GHRM affects staff GOC and LCB. Moreover, their findings indicated that GOC mediates the connection between GHRM policies and LCB. Shah and Soomro [27] explored the connection between GHRM and GIC among automobile firms in Pakistan. The study found a direct nexus between GHRM practices such as performance, rewards, compensation, development, and GOC. Similarly, Meng et al. [28] assessed the influence of GHRM on LCB, and the research employed a green lifestyle as the intermediary indicator and green share values as the iterative factor. Their study received 347 responses from hotel staff in China. The empirical results from the PLS-SEM approach indicated that GHRM has a favorable linkage with staff LCB and green lifestyle. The conclusion from the research proved that GHRM stimulates employees' LCB. Therefore, based on empirical evidence and the AMO theory, this research suggests that:

H1: GHRM contributes positively and significantly to GIC among SMEs.

H2: GHRM contributes positively and significantly to GOC among SMEs.

H3: GHRM contributes positively and significantly to LCB among SMEs.

## 2.2. GIC and LCB

GIC relates to all aspects of innovation targeted at pollution control, energy preservation, waste reduction, waste reprocessing, and ecological management initiatives. GIC activities have been related to firms engaging in eco-friendly products, using advanced technology for production, green skills, clean technology, efficient use of resources, and creating a green workplace environment as outlined by the RBV model [29,30]. GIC is an intermediary mechanism enterprises use to control environmental pollution and improve the organization's EP. Moreover, GIC relates to enterprise environmental management strategies that stimulate LCB and environmental performance. The direct association between proactive actions such as GIC and EP through environmental practices has been established [31,32]. LCB denotes employees' attitudes and behavior towards GIC, climate change, and low-carbon society. These studies acknowledge that firms' GIC is an essential factor that

improves LCB [33–35]. Grounded on the above explanation and the AMO theory, this paper suggests that:

H4: GIC positively and significantly influences stimulating LCB among SMEs.

## 2.3. GOC and LCB

GOC is defined as the perceived feelings and obligation to protect environmental degradation, assuming employees more committed to the environment are more likely to participate in LCB. Organizational commitment toward a particular program ensures highly committed workers have a higher GIC and improve LCB, established in the RBV theory [36]. GOC optimizes the relative strengths of staff relationships and identification with green initiatives proposed by their firm. GOC develops employees' faith to help firms implement green projects and plans to enhance LCB [37]. The three most important GOC concepts are continuance, affective, and normative commitment [38]. Firms' recognition, affiliation, and participation in achieving set objectives, such as higher EP, can be classified as affective commitment. According to the RBV proposition, the awareness of the consequences of not engaging in the preservation of the environment leads to a continuance of commitment. Normative commitment relates to the alleged obligation to sustain a higher level of EP [39–41]. Likewise, Fatima et al. [42] indicated that these concepts of GOC have a significant association with other factors like employment sustainability and LCB. Accordingly, this study suggests that:

H5: GHRM contributes positively and significantly to building LCB among SMEs.

## 2.4. LCB and EP

LCB is defined as improving the concept of a low-carbon environment through behavior such as energy conservation, recycling, and promoting environmental sustainability. Achieving environmental sustainability is an urgent agenda item for firms that want to simultaneously achieve economic goals and more outstanding EP [25,43]. Furthermore, Darvishmotevali et al. [43] specified that worker LCB significantly impacts EP. Employees' active participation in environmental decisions and LCB that address environmental challenges are presumed to be effective mechanisms and strategies for firms to become environmentally responsible, thereby improving EP [44,45]. The AMO theory captures that people's actions, especially those of employees in a firm, can directly affect the achievement or the non-achievement of firms EP [46]. Hence, Sampene et al.'s [47] study revealed that various environmental efforts, including new sustainable product development, processes, models, and technological advancements, are strategies SMEs can utilize to mitigate environmental dilapidation and increase EP. In this study, the researcher contends that engaging in LCB at the workplace will enhance SMEs' EP. Thus, a higher level of LCB will lead to a higher level of EP. As a result, this study hypothesized that:

H6: LCB positively and significantly influences EP.

## 2.5. Mediation of LCB

LCB comprises employee behavior that contributes to the improvement of environmental sustainability. Such behavior is generally shown in the workplace (such as waste separation, energy preservation, and sharing information about ecological sustainability among employees) [48]. People's behavior significantly contributes to the destruction of the environment through water and land, loss of biodiversity, and pollution from chemicals. LCB is generally associated with environmental challenges [49]. Kim and Lee [50] suggest a tripod of antecedents that affect people's LCB, including their exceptional traits, their results and actions, and the environment in which people exist by mutually affecting each other. Prior literature has revealed different categories of a person's LCB depending on the level of effort and engagement (for instance, individual to collaborative engagement) [50,51]. From the perspective of the AMO theory, this will stimulate the employee's discretionary sense and responsibilities towards the GOC and increase their LCB. Thus, the staff becomes more responsible for tasks and activities that promote ecological sustainability and meet the GHRM targets, enhancing the firms' EP [52]. Accordingly, the current article proposes that LCB mediates the link between GHRM and EP.

H7: LCB mediates the link between GHRM and EP.

## 2.6. Moderation of environmental knowledge

ENK refers to an individual consciousness about the consequences of their actions and actions (use of harmful chemicals and products) on the natural ecosystem. Employees are known for applying their expertise, experience, and talents to meet the needs and objectives of the business. Nevertheless, one's ENK may or may not participate in LCB, and as a result, the effect of LCB on firms' EP may depend on employees' ENK level [53]. In support of the RBV theory, employees with ENK are essential resources for adopting, developing, and executing green marketing and innovation, which affect firms LCB and EP. Moreover, ENK of staff drives them to think outside the box, provide solutions to environmental problems, and further engage in LCB, improving firm EP [54]. ENK, according to the RBV model and Paço and Lavrador [55], is the pursuit of alertness and knowledge about environmental issues to solve this challenge. Environmentally conscious individuals are more likely to purchase organic, natural, and green items and participate in green initiatives [56,57]. Employees at ENK have the potency to motivate tasks and actions to promote environmental stewardship, which results in LCB and EP [58]. Naz et al. [25] found that ENK moderates the association between LCB and EP among Chinese firms. The influence of the moderation of ENK on the interplay among LCB-EP remains limited in environmental studies. Hence, this study argues from the RBV model context that the ENK level among employees can enhance the interplay between LCB and EP. Moreover, this paper proposes that staff with a greater level of ENK are expected to put this accumulation of knowledge into practice by demonstrating LCB compared to those with lower levels of ENK. Thus, this investigation hypothesizes that:

H8: ENK positively moderates the link between LCB and EP.

## 2.7. Knowledge gap

To further clarify the knowledge gaps and the theoretical foundation of this study, we elaborate on the gaps in the current literature and justify the importance of examining these relationships. Despite the extensive literature on GHRM, organizational commitment, and green innovation climate, there is limited research exploring the combined impact of these factors on fostering low-carbon behavior and enhancing environmental performance. Specifically, the mediating role of low-carbon behavior and the moderating influence of environmental knowledge have not been thoroughly addressed in prior studies. Utilizing the AMO theory, this study aims to fill these gaps by providing a clear framework on how GHRM practices enhance employee ability, motivation, and opportunity to engage in low-carbon initiatives, promoting an organizational climate conducive to green innovation and environmental performance. The assumptions underlying the proposed relationships are based on the premise that GHRM enables employees to adopt sustainable behaviors, subsequently leading to enhanced environmental outcomes. This approach, grounded in AMO theory, offers a comprehensive understanding of the mechanisms through which green HR practices can drive sustainability in the workplace, thereby contributing valuable insights to the ongoing discourse on environmental performance in organizational settings.

## 2.8. Conceptual model

The conceptual archetype for this paper is displayed in **Figure 1**.

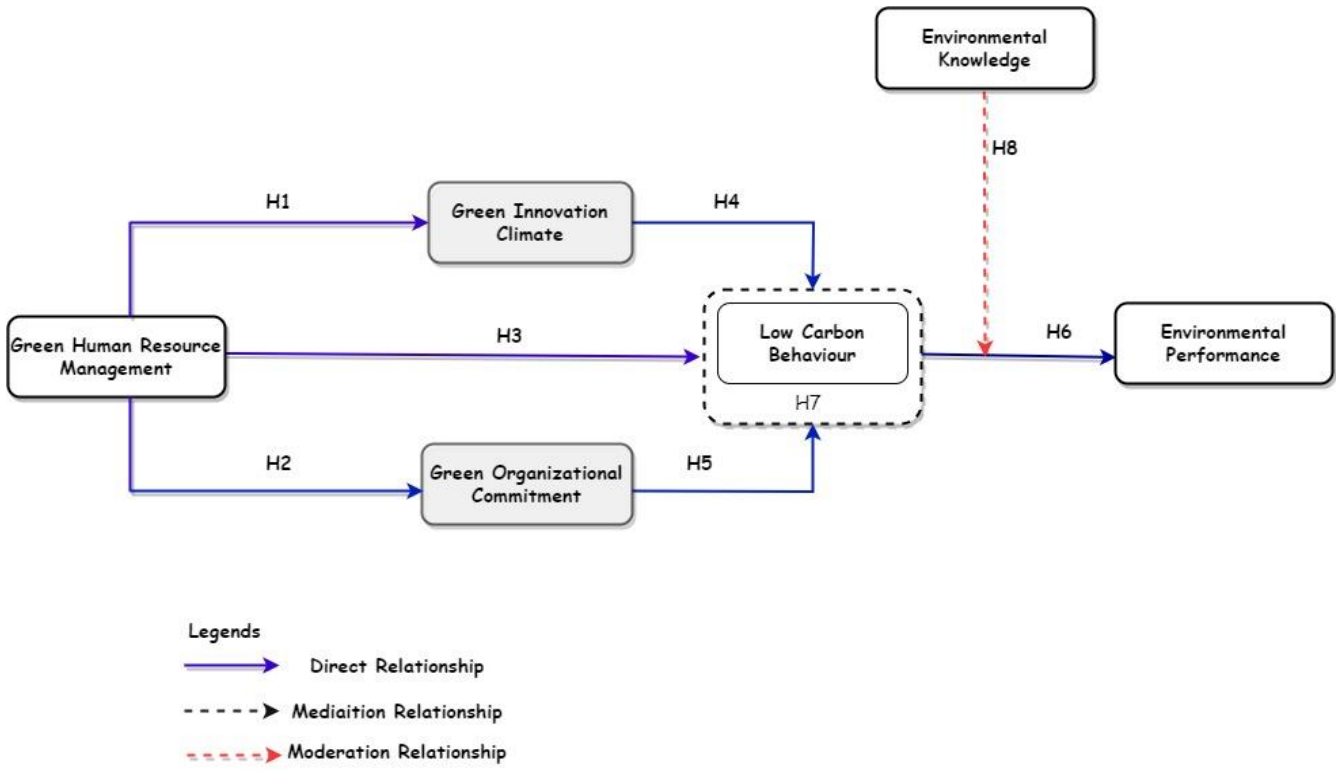


**Figure 1.** Conceptual model of the study.

# 3. Research methodology

## 3.1. Context selection

Ecological issues in China remain pressing, with industrial emissions exerting significant strain on water, air, and environmental quality. Despite efforts to curb pollution, challenges persist, affecting health and ecological balance nationwide. Hence, collaborative efforts and stringent regulations are imperative to alleviate the environmental pollution impacting China's landscape. Accordingly, this paper focused on top-level managers from SMEs in diverse cities in Jiangsu, including Nanjing, Zhenjiang, Suzhou, Wuxi, and Changzhou. The selection of Jiangsu province stems from its renowned economic and industrial prowess, making it an ideal setting to explore the dynamics of environmental initiatives within the workplace. In addition, Jiangsu's proactive approach to sustainable development and environmental conservation fits in nicely with the goals of our study, offering a favorable setting for analyzing how environmental knowledge influences workplace practices and performance results. The study targets small and medium-sized enterprises (SMEs) in Jiangsu, China, which represents a significant hub of industrial activities, with over 13,000 enterprises actively contributing to the province's economic output [59]. These SMEs are characterized by their adaptability, innovation potential, and substantial influence in local supply chains, which makes them critical drivers of regional sustainability efforts. The enterprises selected for this research vary in size, industry, and stages of digital transformation, providing a diverse representation of the SME sector. Focusing on Jiangsu is justified by the province's strategic role in China's economic development and its prominence in manufacturing and technological innovation. SMEs in this region are particularly under pressure to align with China's sustainability agenda, making them a relevant context for understanding how green human resource management practices and low-carbon behaviors can enhance environmental performance.

## 3.2. Operationalization of constructs

Employing a comprehensive strategy and improving the questionnaire's precision, the research employed the five-point Likert scale questionnaire designed for conducting surveys and gathering data. Considering the participants' diverse backgrounds and acknowledging English as a predominant communication channel, ensuring language accessibility was important in this study. Hence, the questionnaire was meticulously translated into Chinese to address this issue. Five bilingual experts with extensive international academic experience were recruited to evaluate the questionnaires' ease of understanding. These experts worked together to guarantee that the questionnaires were adapted as smoothly as possible. To improve the validity of the questionnaires, professionals from business and academia were consulted, and the survey questions were refined to adhere to established constructs. Additionally, pilot research was conducted, and the target audience was provided with updated survey questionnaires to fill out. This pilot study provided invaluable input for improving indicators and supporting the validation procedure, emphasizing the iterative process inherent in creating questionnaires.

The main questionnaire was categorized into two main sections. Thus, the first section included descriptive information about the participants. The second section outlined the measurement of the constructs. The construct of GHRM was retrieved from Ren et al. [60] and Bin Saeed et al. [45] and measured with six items. GIC was evaluated with five items taken from the research by Fatoki [61] and Makhloufi et al. [62]. GOC was evaluated with six items generated by Iqbal et al. [63]. Also, the studies retrieved LCB constructs, including seven items by Lange [64] and Bin Saeed et al. [45]. Five items were employed to assess ENK, and the measures were sourced from Karmoker et al. [18] and Usman et al. [65]. The study measured EP with five items adapted from Ubeda-Garcia et al. [66]. The appendix contains information about measuring items, including their respective codes and sources.

### 3.3. Sampling approach and data collection process

The research's philosophical background aligns with the positivist paradigm, which uses deductive mechanisms to understand an underlying phenomenon [67]. The study used purposive sampling to select the SMEs. The purposive sampling approach ensured the inclusion of SMEs with varying capacities and challenges in sustainability, allowing for an in-depth exploration of the factors driving green initiatives in this crucial economic sector. Therefore, the study applied Brewer and Miller [68] to calculate the sample size, which is outlined as follows:

$$n = \frac{N}{1 + N(\propto^2)}$$

here

$N$ = represents the sample frame

$n$ = depicts the size of the sample

$\propto$ = identifies the level of significance

The sample size calculation included a confidence level of 95% with a 5% margin of error. Hence, the level of significance is set at 0.05. Hence:

$$n = \frac{1300}{1 + 1300(0.05^2)}$$

$$n = \frac{1300}{4.25}$$

Hence, $n = 305.88$.

Based on the result from this calculation, the study's sample size is estimated to be 306. Accordingly, the study increased the sample size to 675 respondents from different SMEs across the Jiangsu province to gather accurate data and cover incomplete, unreturned, and unanswered questionnaires. The study employed online (use of emails) and physical data collection modules to gather the participants' responses. The authors employed diverse approaches through visitation, telephone calls, and emails to remind participants about the importance of engaging in this survey. After two to three rounds of reminders were sent to the participants, the study received 625, out of which 45 were deemed incomplete responses. The data collection process lasted almost six months (August 2023 to January 2024). The final analysis was evaluated with 580 responses, indicating a response rate of 92.28%.

This study engaged participants with direct experience with GHRM practices, individuals committed to the establishment's green agenda, and those working in an environment that fosters green innovation.

### 3.4. Analytical approach

This study applied the PLS-SEM because it is well-suited for predictive modeling. It can be used to develop and validate models explaining the link between latent and observed indicators, enabling the study to make predictions and test hypotheses [69]. The PLS-SEM provides insights into the quality of the measurement items and allows for identifying and removing items that do not contribute significantly to the model [70]. Moreover, PLS-SEM allows for integrating different data sources and measurement methods. It can handle both reflective (e.g., Likert scales) and formative (e.g., composite) measurement models, allowing researchers to combine diverse data types in their analysis [71]. In addition, this method is well-suited for exploratory analysis and theory development. It can identify underlying latent dimensions or constructs in a dataset and generate new insights or theories based on the relationships uncovered. It provides various methods for comparing alternative models and evaluating model fit [72].

### 3.5. Common method bias

Common method bias (CMB) can lead to increased standard errors of regression coefficients, making it difficult to distinguish the specific effects of each predictor variable on the dependent variable. By identifying and handling multicollinearity, the study can obtain more precise and informative interpretations of the interactions between variables. The likelihood of multicollinearity among the studies was therefore investigated using the variance inflation factor (VIF) assessment. The outcomes of this research demonstrate that all of the component's VIF scores of 50% (< 5.00) are below the suggested threshold by Harman [73], proving that the study was free of collinearity and CMB problems. Without accounting for the potential CMB issues with the study dataset, the VIF in this study was 29.37%. Furthermore, steps were taken to mitigate the possible effects of social desirability bias, including informing those participating on the goals of the investigation and guaranteeing their privacy.

## 4. Results

### 4.1. Demographic analysis

The sample comprised 58% male and 42% female respondents (see **Table 1**). Regarding firm age, 23% were 1–5 years old, 37% were 6–15 years old, 27% were 16–20, and 13% were more than 20 years old. Educational backgrounds varied, with 24% having a high school education, 50% holding a degree, 14% with a master's, and 12% with a PhD or higher. Job positions were distributed among senior managers (30%), supervisors (44%), and middle-level managers (26%). Respondents represented various industrial sectors: food and beverage (22%), basic iron and steel (16%), petroleum and chemical products (27%), textile and clothing (23%), and

furniture and others (12%). Firm sizes were divided into small (46%) and medium (54%) enterprises.

**Table 1.** Profile of respondents.

| Demographic Indicator | Characteristics | Frequency | Percentage (%) |
|---|---|---|---|
| Gender | | | |
| | Male | 325 | 58 |
| | Female | 255 | 42 |
| Age of firm | | | |
| | 1–5 years | 133 | 23 |
| | 6–15 years | 216 | 37 |
| | 16–20 years | 155 | 27 |
| | More than 20 years | 76 | 13 |
| Educational Background | | | |
| | High School | 144 | 24 |
| | Degree | 288 | 50 |
| | Master | 80 | 14 |
| | PhD and above | 68 | 12 |
| Job Position | | | |
| | Senior Manager | 178 | 30 |
| | Supervisor | 254 | 44 |
| | Middle-level Manager | 148 | 26 |
| Industrial Sector | | | |
| | Food and Beverage | 127 | 22 |
| | Basic Iron and Steel | 95 | 16 |
| | Petroleum and Chemical Products | 160 | 27 |
| | Textile and Clothing | 128 | 23 |
| | Furniture and Others | 70 | 12 |
| Firm Size | | | |
| | Small | 268 | 46 |
| | Medium | 312 | 54 |

## 4.2. Convergent validity and reliability of constructs

The paper applied various tests, including Crochbach reliability, Cronbach's alpha, factor loadings, and average extracted variance (AVE). These tests are conducted to examine the internal reliability of the constructs. Manley et al. [74] proposed that the Crochbach reliability, Cronbach's alpha factor loadings, and statistical values should exceed 0.70. As indicated in **Table 2**, the data analysis for the indicators is reliable and valid. Hence, the statistical values of all the constructs were within the recommended threshold, inferring that the scales in this research have internal reliability among the constructs.

**Table 2.** Outcome of the measurement model.

| Indicators | Items | Factor Loadings | Cronbach's alpha ($\alpha$ > 0.7) | Composite reliability(ρc) (> 0.7) | AVE (> 0.5) | VIF |
|---|---|---|---|---|---|---|
| | GHRM1 | 0.737 | 0.851 | 0.869 | 0.602 | 1.695 |
| | GHRM2 | 0.800 | | | | 2.177 |
| GHRM | GHRM3 | 0.862 | | | | 2.879 |
| | GHRM4 | 0.881 | | | | 1.291 |
| | GHRM5 | 0.875 | | | | 1.458 |
| | GHRM6 | 0.878 | | | | |
| | GIC1 | 0.722 | 0.815 | 0.822 | 0.528 | 1.425 |
| | GIC2 | 0.781 | | | | 1.015 |
| GIC | GIC3 | 0.848 | | | | 2.937 |
| | GIC4 | 0.876 | | | | 1.204 |
| | GIC5 | 0.866 | | | | 2.293 |
| | GOC1 | 0.803 | 0.837 | 0.944 | 0.673 | 2.424 |
| | GOC2 | 0.848 | | | | 2.441 |
| GOC | GOC3 | 0.830 | | | | 2.260 |
| | GOC4 | 0.835 | | | | 2.725 |
| | GOC5 | 0.873 | | | | 2.508 |
| | LCB1 | 0.826 | 0.851 | 0.850 | 0.631 | 2.664 |
| | LCB2 | 0.809 | | | | 1.798 |
| LCB | LCB3 | 0.784 | | | | 1.695 |
| | LCB4 | 0.771 | | | | 2.177 |
| | LCB5 | 0.818 | | | | 2.879 |
| | LCB6 | 0.844 | | | | 1.294 |
| | LCB7 | 0.710 | | | | |
| | ENK1 | 0.878 | 0.902 | 0.915 | 0.633 | 1.081 |
| | ENK2 | 0.891 | | | | 2.586 |
| ENK | ENK3 | 0.756 | | | | 2.941 |
| | ENK4 | 0.810 | | | | 2.629 |
| | ENK5 | 0.803 | | | | 2.821 |
| | EP1 | 0.813 | 0.833 | 0.927 | 0.589 | 1.813 |
| | EP2 | 0.715 | | | | 1.774 |
| EP | EP3 | 0.708 | | | | 2.837 |
| | EP4 | 0.878 | | | | 2.871 |
| | EP5 | 0.790 | | | | 1.844 |

## 4.3. Discriminant validity

Discriminant validity is a crucial aspect of construct validity, which refers to the extent to which a measurement precisely captures the intended theoretical construct. According to Henseler et al. [75], a study model is considered valid if the structural model constructions fall under the cutoff of 0.90. The study applied the Heterotrait-Monotrait (HTMT) and Fornell and Larcker criterion. The HTMT and Fornell and

Larcker [76] results, as indicated in **Table 3**, demonstrate that the proposed model of this study had good psychometric properties.

**Table 3.** Results of discriminant validity.

| **Fornell and Larcker, (1981) Criteria** | | | | | | |
|---|---|---|---|---|---|---|
| | GHRM | GIC | GOC | ENK | LCB | EP |
| GHRM | 0.776 | | | | | |
| GIC | 0.322 | 0.632 | | | | |
| GOC | 0.637 | 0.408 | 0.671 | | | |
| ENK | 0.997 | 0.329 | 0.694 | 0.766 | | |
| LCB | 0.775 | 0.369 | 0.233 | 0.820 | 0.795 | |
| EP | 0.805 | 0.132 | 0.390 | 0.628 | 0.649 | 0.706 |
| **HTMT Criteria** | | | | | | |
| | GHRM | GIC | GOC | ENK | LCB | EP |
| GHRM | | | | | | |
| GIC | 0.274 | | | | | |
| GOC | 0.272 | 0.474 | | | | |
| ENK | 0.176 | 0.328 | 0.772 | | | |
| LCB | 0.414 | 0.115 | 0.665 | 0.367 | | |
| EP | 0.367 | 0.474 | 0.702 | 0.596 | 0.656 | |

Note: GHRM: Green HRM; LCB: Low carbon behaviour; GIC: Green innovation climate; GOC: Green organizational commitment.

## 4.4. Predictive relevance

**Table 4.** Goodness of fit indices.

| **Variables** | $R^2$ | $F^2$ | $Q^2$ |
|---|---|---|---|
| GHRM | 0.502 | 0.396 | 0.141 |
| Green innovation climate | 0.931 | 0.472 | 0.172 |
| Green Organizational Commitment | 0.885 | 0.256 | 0.254 |
| Environmental Knowledge | 0.885 | 0.748 | 0.192 |
| Low carbon behaviour | 0.631 | 0.356 | 0.341 |
| Environmental Performance | | 0.646 | 0.397 |
| **Model Fitness Indicators** | **Saturated Model** | **Estimated Model** | |
| RMSE | 0.030 | 0.031 | |
| NFI | 0.950 | 0.922 | |
| (RMS_theta) | 0.006 | 0.007 | |

Note: RMSE: Standardized Root Means Square; NFI: Normal Fit Index test.

Measuring the effective size is an essential complement to testing the significance level (*p*-value) of the relationship among the constructs. Thus, the effective size offers an evaluation technique to measure practical significance in testing the magnitude of the effect among research models. Therefore, this study examines the effect size with a series of tests, which include $F^2$, $R^2$, and $Q^2$. As indicated in **Table 4**, the results from this analysis revealed that all the statistical

coefficients of the $F^2$, $R^2$, and $Q^2$ for the construct range from small to large effect sizes. In addition to these tests, the research explored the goodness of fit through the RMSE, RMS_theta, and NFI. This result verified that the analysis's findings are solid and trustworthy and that policy-makers can base their choices on this study.

## 4.5. Assessment of structural model

### 4.5.1. Direct path analysis

The structural model PLS-SEM is a crucial component that allows researchers to examine the relationships between latent constructs and test hypotheses regarding these relationships [74]. This model goes beyond the measurement model and focuses on understanding how latent constructs are interrelated and how they influence each other. The path analysis for this research is structured as follows: Direct, indirect path analysis (mediation), and moderation (iteration) assessment. The analysis proposed six direct connections in the research model. The empirical outcome concluded that GHRM has a direct and substantial influence on GIC H1 ($\beta$ = 0.695, $p$-value = 0.001), GOC H2 ($\beta$ = 0.573, $p$-value = 0.000), and LCB H3 ($\beta$ = 0.590, $p$-value = 0.000). The analysis further revealed that GIC H4 ($\beta$ = 0.484, $p$-value = 0.001) has a positive influence on LCB. Likewise, the analysis confirmed that GOC H5 ($\beta$ = 0.501, $p$-value = 0.001) has a direct association with LCB. In addition, the study revealed that LCB H6 ($\beta$ = 0.208, $p$-value = 0.002) positively affects EP. The result of the structural archetype has been represented in **Figure 2** and **Table 5**.

**Table 5.** Outcome of path estimates.

| Hypothesis | Effect of | Effect on | $\beta$ | $P$-value |
|---|---|---|---|---|
| H1 | GHRM | GIC | 0.695*** | 0.000 |
| H2 | GHRM | GOC | 0.573*** | 0.000 |
| H3 | GHRM | LCB | 0.590*** | 0.000 |
| H4 | GIC | LCB | 0.484*** | 0.000 |
| H5 | GOC | LCB | 0.501*** | 0.000 |
| H6 | LCB | EP | 0.208*** | 0.002 |

Note: ***significance level at 1%.

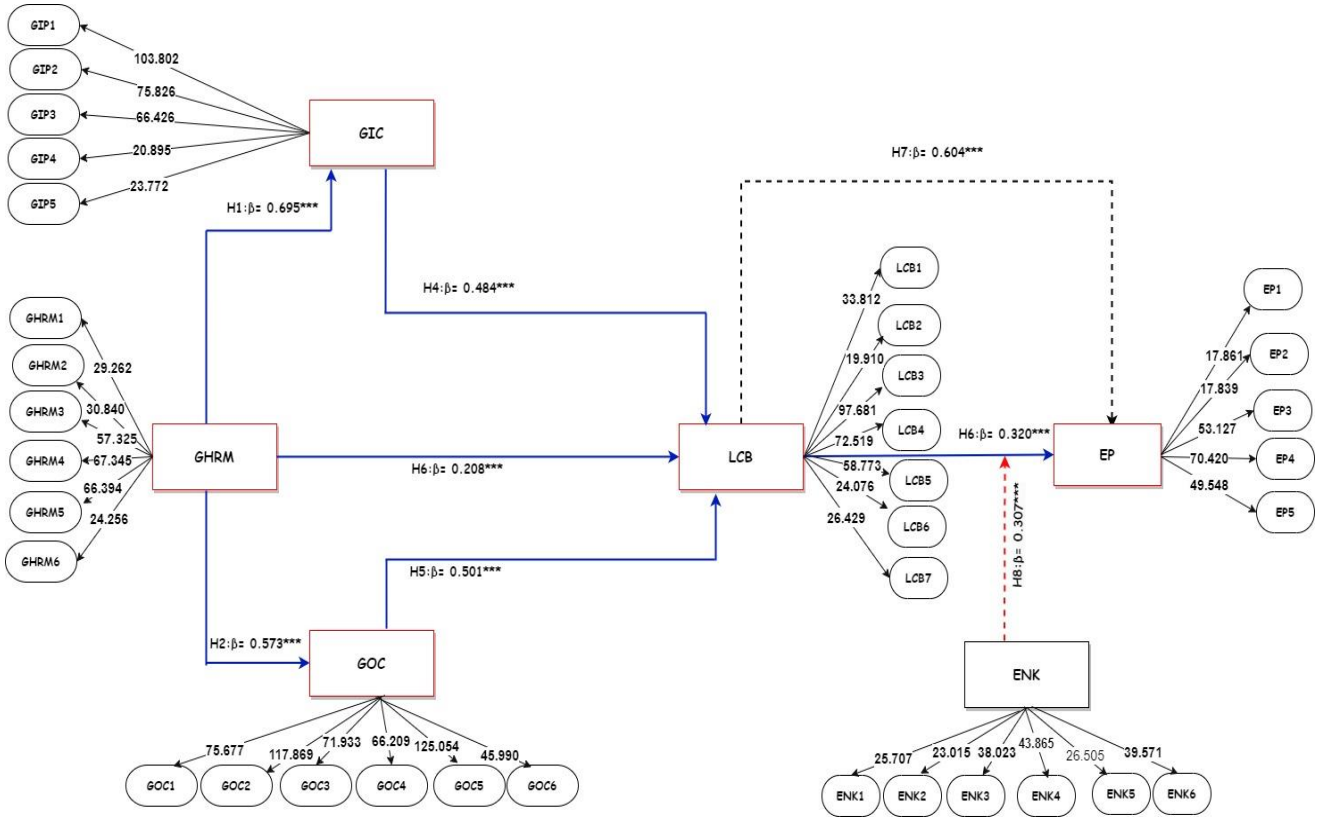


**Figure 2.** Outcome of the structural model.

### 4.5.2. Mediation and moderation analysis

The study research explored the mediation effect of LCB on the connection between GHRM and EP. The outcome has been captured in **Table 6**. The empirical findings from the study revealed that the indirect influence of LCB on the nexus between GHRM-LCB was statistically significant (H7) ($\beta$ = 0.407; *t*-value = 40.283; $p$ = 0.000). The extrapolation from this outcome indicates that LCB has a significant mediation impact on the GHRM-EP nexus.

**Table 6.** Estimates for mediation and moderation.

| Hypothesis | Relationships | $\beta$ | *P*-value |
|---|---|---|---|
| H7 | LCB → GHRM → EP | 0.604*** | 0.000 |
| H8 | ENK*LCB → EP | 0.307*** | 0.000 |

Note: ***significance level at 1%.

Moreover, the results of the moderation assessment have been provided in **Table 5** and **Figure 3**. The empirical outcome indicated that ENK, H8 ($\beta$ = 0.307, $t$ = 40.283; $p$-value = 0.000) has a substantial and positive moderating influence on the association between LCB and EP. The graphical representation of the moderation impact of ENK has been demonstrated in **Figure 3**. The figure indicates that the simultaneous increase of ENK can reduce the strength between LCB and EP.

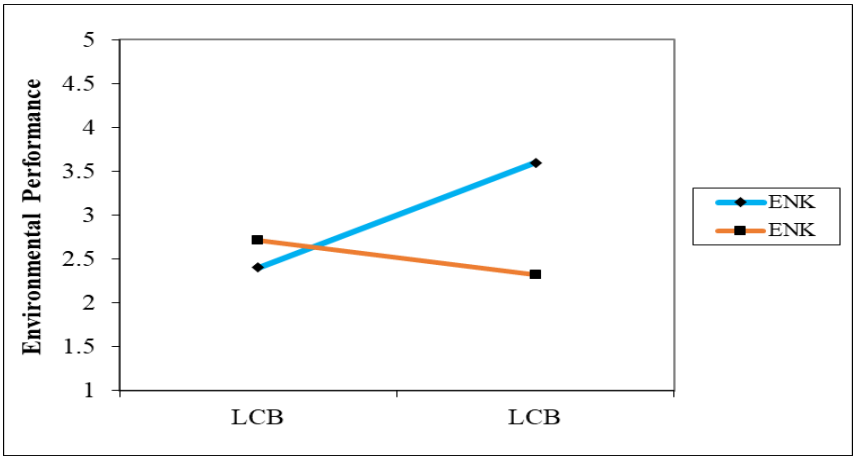


**Figure 3.** Moderation role of ENK between GHRM and LCB.

## 5. Discussion

The paper examined the influence of GHRM on GOC, GIC, and LCB on EP. Additionally, the research explored the indirect impact of LCB on the connection between GHRM and LCB. Moreover, the moderate impact of ENK was evaluated. The empirical evidence from the research revealed that GHRM has a favorable influence on GIC, GOC, and LCB, confirming the study's H1–H3 findings. This finding highlighted that GHRM promotes firms' GIC, GOC, and LCB among employees. The possible explanation for this outcome is that SMEs' adoption of GHRM strategies demonstrates the dedication to environmental sustainability, encouraging workers to engage in behaviors that promote ecological stability. The outcome of this study supports existing studies that proved that proper GHRM practices outlined by SMEs significantly impact their level of GOC [19,21,63,77]. As espoused by the AMO theory, the staff's comprehension of the necessity and urgency of adjusting the GHRM system would facilitate the accomplishment of higher-level LCB, GIC, and GOC among employees at the workplace [19]. The results from this investigation imply that GHRM practices improve workers' green motivation, capabilities, and desire to achieve SMEs' green goals. The findings of this study are comparable to erstwhile studies that highlighted that GHRM predicts GIC, GOC, and LCB [78–81].

In addition, the study outcome revealed that GIC substantially influences LCB, supporting the paper's H4. This outcome implies that SMEs can use GIC to proactively outline new standards to strengthen and enhance their LCB [47]. Promoting SMEs' GIC strategies and capacity can provide new approaches and strategic advantages for achieving environmental goals. Moreover, GIC includes the enterprise's ability to integrate green processes and products to produce eco-friendly products with lower energy consumption and a clean atmosphere at the workplace [62,82]. GIC supports responsiveness and efficiency capabilities to government regulations, customer preferences, and societal needs that emphasize the sustainability of the environment [83]. The findings of this investigation align with existing research that emphasizes that SMEs' investment in GIC can help them achieve higher LCB among employees [84–86].

Furthermore, the findings confirmed that GOC substantially influences LCB, implying the fifth hypothesis of this research was supported. The inference from this outcome is that the level of GOC verifies the mechanism and way the workforce is passionately and unequivocally attached to their enterprise. Such practice helps identify whether the staff is willing to engage in LCB. The study's findings reinforce the results by Kim et al. [87] that GOC influences the green behavior of employees in a business. Their study opined that staff with a strong and loyal commitment to their enterprise GOC results in proactive LCB and eco-friendly conduct, enhancing their firms' EP. The present paper confirms that GOC is an essential determinant of individual staff LCB behavior and is congruent with these existing studies [88–90].

This analysis revealed that the LCB of staff directly and substantially interacts with firms' EP, which was confirmed (H6). This outcome proves that if employees indulge themselves in LCB, it affects the environmental performance of SMEs. The interaction between individual action, behavior, and the preservation of the environment is intertwined. Thus, the engagement of workers towards green environmental interventions can be stimulated by the individual LCB, which influences the ecological performance of SMEs. As espoused by prior studies, LCB, such as waste reduction at the workplace, water conservation, reduction in the firm's overall cost, and usage of renewable resources, affects EP [91–93]. Another substantial inference from this study outcome is that the LCB of workers can better bolster environmental management goals.

The paper further assessed the mediation influence of LCB on the linkage between GHRM and EP. This finding supports (H7) of this paper. The implications of this research highlighted that the connection between GHRM and EP can be improved through employees' LCB. Thus, empirical evidence by Channa et al. [94] confirmed that the LCB of employees has an indirect and significant impact on the connection between GHRM and EP. In addition, Ojo et al. [80] proved that GHRM success generally depends on the LCB of employees in Malaysia. Erst while literary works have further pointed out that workers' LCB positively and substantially interacts among GHRM and EP [25,95–98].

Lastly, the findings from the analysis supported the positive moderating impact of ENK on the link between LCB and EP. A possible explanation for this finding implies that a deeper understanding of environmental issues empowers entities to optimize their eco-friendly initiatives, making them more effective in mitigating environmental impact. Essentially, environmental knowledge acts as a catalyst, amplifying the positive impact of LCB on overall EP and reinforcing the notion that informed actions contribute substantially to achieving sustainable outcomes. This nuanced relationship highlights the importance of educational initiatives and awareness campaigns in shaping environmentally conscious behaviors and ultimately driving positive environmental outcomes. The result of the present investigation is consistent with prior studies, which postulated that firms could improve ENK to help promote LCB and EP [9,56].

This study contributes to the overall body of knowledge by providing empirical evidence on the mechanisms through which green human resource management (GHRM), green innovation climate (GIC), and green organizational commitment (GOC) influence low-carbon behavior (LCB) and environmental performance (EP)

in SMEs. By highlighting the mediating role of LCB and the moderating impact of environmental knowledge, this research advances our understanding of how GHRM practices can foster a culture of sustainability and enhance environmental outcomes, particularly in the context of SMEs in emerging markets like China. Additionally, it enriches the application of AMO theory in green workplace practices, demonstrating the importance of employee motivation and organizational climate in achieving sustainability goals.

## 6. Conclusions and research implications

### 6.1. Conclusions

International organizations like the United Nations and the recent Glasgow Agreement are championing the need for carbon emissions and preserving the environment for future generations. This call has necessitated the importance of this study, which focuses on low-carbon behavior among employees of SMEs in China. The research hypothesis was evaluated using the SEM-PLS methodology. The research's empirical outcome delineated that GHRM positively influences GIC, GOC, and LCB. Second, the findings captured that GIC and GOC have a substantial and beneficial influence on LCB. Third, the research results discovered that EP can be promoted through LCB. Fourth, the outcomes approved the mediation influence of LCB on the linkage between GHRM and LCB. Fifth, the moderation effect of ENK on the linkage between LCB and EP was supported in this analysis.

### 6.2. Research implications

#### 6.2.1. Theoretical implications

The theoretical implications of this study lie in its advancement of the AMO theory within the context of sustainability and environmental management in SMEs. This research expands the AMO framework by integrating GHRM as a core component that enhances employees' abilities, motivations, and opportunities to engage in low-carbon behavior. By demonstrating how GHRM practices positively influence GIC, GOC, and low-carbon behavior, this study adds depth to our understanding of how strategic HR practices can drive ecological outcomes. Specifically, it emphasizes that environmental sustainability can be approached through employee-oriented practices focusing on technical training and nurturing. Additionally, this research provides new insights into the mediating role of LCB in linking GHRM with environmental performance and the moderating effect of environmental knowledge, thereby enriching the literature on the complex interactions between organizational resources, employee behaviors, and sustainability outcomes.

Furthermore, the study contributes to the body of knowledge on green innovation by highlighting the role of GIC as a mechanism that empowers SMEs to align their strategic goals with environmental objectives. By illustrating how GIC and GOC can foster proactive low-carbon behavior, the findings provide a theoretical basis for understanding the role of internal organizational climate and commitment in promoting sustainable practices. This research also underscores the

importance of contextual factors, such as firm size and regional characteristics, in shaping the effectiveness of GHRM practices, thereby contributing to the contextualization of the AMO theory in different environmental and economic settings. The study's focus on SMEs in Jiangsu, China, adds to the limited empirical evidence on applying green HR practices in emerging economies, thus offering a valuable perspective that enriches the theoretical discourse on sustainability in diverse organizational contexts.

### 6.2.2. Practical implications

The practical contributions from the paper are presented as follows: Since the investigation findings demonstrated that GHRM is integral to improving employees' green behavior, the study suggests that organizations should incorporate sustainability principles into their HR policies and procedures. This includes integrating eco-friendly criteria into recruitment and selection processes, emphasizing sustainability-related competencies during employee training and development programs, and establishing performance metrics measuring employee contributions to environmental goals. Again, fostering a culture of sustainability is crucial. Organizations should encourage open communication about sustainability initiatives, promote employee engagement in green teams or environmental projects, and recognize and reward environmentally responsible behaviors.

Considering the relevance and centrality of these concepts (GOC, GIC on LCB), SMEs are expected to provide the needed support to their workforce to enable them to contribute to the business's ecological sustainability plan. In addition, by evaluating the mediation role of LCB between LCB-EP linkage, this study stressed the importance of LCB to SMEs. Hence, as a matter of practical significance, the study recommends that to improve LCB, managers should focus on the green involvement of employees in decisions regarding the environment. Employees' opinions, suggestions, viewpoints, creative ideas, and recommendations can be fostered into firms' environmental management plans. Employees generally show higher commitment and dedication once their firms recognize them and listen to their views regarding the firm's EP actions. Moreover, GHRM managers should outline measures that can empower and involve staff in green issues and help them have autonomy in addressing these challenges. These actions can be instituted under the firm's HRM auspices and captured under these themes (green empowerment and involvement strategies). Providing green feedback to workers on green performance can also be a strategic tool to enhance GOC and GIC.

Lastly, the study results supported the moderate influence of ENK on the interaction between LCB and EP. Hence, this study suggests that senior management and the GHRM section of SMEs should invest in employee training and development associated with ecological stability. In this regard, the GHRM department should educate staff about environmental protection issues, which will assist them in comprehending the firms' environmental policies and improve their understanding of the significance of engaging in LCB at the workplace. Moreover, the awareness and understanding gained through these environmental training activities can help the workforce become more considerate about ecological issues and devise prevention techniques. Thus, employees can be tasked to read about

current carbon emission trends and gather salient information about waste recycling. Once the individual has gained insight into some of these environmental degradation issues, they provide solutions and the necessary steps to mitigate such occurrences.

### 6.3. Limitations and future direction

While the research gives valuable insights, it is vital to acknowledge certain limitations. Firstly, the study might face challenges in generalizability due to its potential to concentrate on particular businesses or organizational contexts. Future studies could also explore how GHRM practices translate into tangible low-carbon outcomes, exploring employee perceptions and behaviors. Furthermore, investigating the potential moderating effects of external factors, such as regulatory environments or industry characteristics, would enhance understanding of the complexities of fostering sustainable organizational behavior. Another limitation of this study is the lack of a multi-group analysis to examine potential differences between small and medium-sized firms. Future research should consider conducting such an analysis to explore whether firm size influences the relationships within the investigated model. Lastly, exploring the role of technology and digital innovation in promoting green practices could be a promising avenue for future research, as technological advancements increasingly play a pivotal role in shaping organizational sustainability efforts.

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# Appendix

| Construct | Item Code | Items | Source |
|---|---|---|---|
| GHRM | GHRM1 | At our enterprise, environmental issues are a necessity for job descriptions. | Ren et al. [60]; Bin Saeed et al. [45] |
| | GHRM2 | My firm chooses candidates sufficiently knowledgeable about greening to fill open positions. | |
| | GHRM3 | Recruitment communications incorporate environmental commitment and conduct requirements. | |
| | GHRM4 | This firm establishes an environment management system and environmental audit. | |
| | GHRM5 | Our enterprise engages the employees in establishing environmental strategies. | |
| | GHRM6 | Our firm recognizes employees as essential actors in environmental decisions and initiatives. | |
| GIC | GIC1 | Our enterprise has enhanced environmentally friendly packaging for both used and new products. | Fatoki [61]; Makhloufi et al. [62] |
| | GIC2 | Our enterprise produces goods and offers services while taking ecological considerations into mind. | |
| | GIC3 | Our enterprise uses modern technology to neutralize pollution. | |
| | GIC4 | Our enterprise uses repurposed and recycled materials when providing services to consumers. | |
| | GIC5 | Our enterprise uses less material when providing services to clients. | |
| GOC | GOC1 | I have an emotional attachment to the environmental goals of my enterprise. | Iqbal et al. [63] |
| | GOC2 | I have a stronger sense of responsibility for the environmental goals of my enterprise. | |
| | GOC3 | I feel ethically bound to support this enterprise's ecological goals, which is one of the reasons I will not leave this firm to work elsewhere. | |
| | GOC4 | Despite a better employment opportunity from another firm, I wouldn't think it was appropriate to leave my current employer because of its commitment to the environment. | |
| | GOC5 | Many of my career would be disrupted if I decided I wanted to quit my job immediately because I identify with its environmental obligations. | |
| LCB | LCB1 | I take part in eco-initiatives at the workplace. | Lange [64]; Bin Saeed et al. [45] |
| | LCB2 | I educate and share knowledge about environmental issues with my co-workers. | |
| | LCB3 | I generate various proposals for procedures to help my company operate better regarding environmental sustainability. | |
| | LCB4 | I enjoy being mindful of turning off technological devices to save energy. | |
| | LCB5 | I use ecologically friendly methods to complete jobs that are required of me. | |
| | LCB6 | I enjoy being mindful of turning off technological devices to save energy. | |
| | LCB7 | I appreciate recycling and practicing energy efficiency. | |
| ENK | ENK1 | I am aware of the issue of chemical-issued industrial contamination. | Karmoker et al. [18]; Usman et al. [65] |
| | ENK2 | I have a thorough understanding of environmental issues. | |
| | ENK3 | I am constantly mindful of how the environment is degrading. | |
| | ENK4 | I know how to prevent pollution from putting the environment in danger. | |
| | ENK5 | I am knowledgeable about environmental climate. | |
| EP | EP1 | Our enterprise minimizes the influence of its products and procedures on the environment. | Ubeda-Garcia et al. [66] |
| | EP2 | Our firm has switched to a renewable power source and reduced its fossil fuel use. | |
| | EP3 | Our enterprise has drastically decreased the amount of solid waste it produces. | |
| | EP4 | The current business operations of our firm are automated. | |
| | EP5 | Our business uses ecologically friendly methods to dispose of waste. | |