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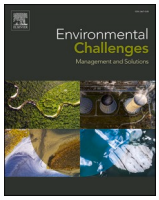

The nexus among employees' green concerns, green effectiveness, and green behavior through mediating role of employees' green knowledge: Evidence from Bangladeshi consumer goods industry

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ABSTRACT

The rapid growth of industrialization continuously creates challenges for the global environment, necessitating conscious and sustainable behavior across businesses to lessen their impacts. The Knowledge-Attitude-Behavior (KAB) model and Self-Efficacy Theory motivated the study. KAB indicates that Knowledge influences Attitude and Attitude influences Behavior and Self-Efficacy implies that self-confidence in capabilities leads to improved actions. This study aims to investigate the impacts of employee green concerns and green effectiveness on green behavior identifying the mediation effect of environmental knowledge of employees through a study on 261 workers and managers of the consumer goods industry in Bangladesh. The data were collected using a 20-item 5-point Likert scale structured questionnaire by adopting a purposive sampling method. Microsoft Excel was used to prepare the data for analysis, IBM SPSS 25 was used to assess the multicollinearity issues, and Smart PLS 4.0 was used to analyze the measurement model to assess the reliability and validity of the constructs while the structural model was used to test the hypotheses of this study. The results indicate noteworthy direct effects of employees' green concerns and green effectiveness as well as significant indirect effects of Employees' Green Knowledge as a mediator on employee green behavior. Managers can enhance employees' green knowledge to foster environmental awareness, boost self-confidence in their abilities, and ultimately promote green behavior in the workplace.

1. Introduction

The challenges of global environmental issues have forced organizations all around the world to recognize the necessity of ecological sustainability (Al-Ghalabi et al., 2024). It is claimed in previous research by Abbas and Dogan (2022) that in addition to achieving regulatory requirements, businesses should take proactive approaches toward environmental sustainability. Studies have shown that workplace training in green behavior, aimed at minimizing negative environmental effects, is a promising avenue for advancing sustainability projects (Sabbir, 2022). The identification of the factors is crucial for organizations that aim to make sustainability a top organizational value (Gazi et al., 2024; Chowdhury et al., 2022). The present article explores the enrichment of employee green behavior by examining employee green concerns (EGC) and employee green effectiveness (EGE) and elaborating on the mediating role of Employees' Green Knowledge (EGK)

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(Deshpande, 2023; Imam et al., 2022). Knowledge-Attitude-Behavior (KAB) model is the conceptual model on which this study is based (Register-Mihalik et al., 2013). It has a framework that states that increasing knowledge will lead to developing the right attitude, resulting in the right behavior (Teo et al., 2023). For this argument, when applied within the environmental sustainability field, this study argues that increasing the amount of green knowledge among the employees will create a positive perception of activities towards sustainability leading to green behaviors in the organization (Aboramadan, 2022). Thus, EGK is crucial in this framework as it provides knowledge that enables individuals to understand the environmental impact of their actions.

Ercantan and Eyupoglu (2022) propose that employees' attitudes toward sustainability might be positively influenced by this information if it is well conveyed and reinforced. According to Raza and Khan (2022), optimistic mindsets play an important role in inspiring personnel to adopt environmentally conscious behaviors, such as recycling, energy conservation, and involvement in environmental sustainability programs.

Furthermore, one of the key elements that promote green behavior is green effectiveness, or the perspective of how employees' actions affect the environment (Ercantan and Eyupoglu, 2022). This idea of perceived worth emphasizes the fact that employees will remain committed to their efforts if they believe their work matters (Alshaabani and Rudnák, 2022). However, employees' green knowledge mediates this relationship (Rubel et al., 2021; Amin and Rubel, 2020). Perceived relevance of green knowledge is associated with increased interest in environmental sustainability, which can be defined as a concern for the environment, as well as the capacity for employees to seek out and retain such knowledge and to accurately perceive their actions as being effective (Sahoo et al., 2023; Karim et al., 2023). EGK is thought to play an important mediating role in this relationship. EGK is the development of environmental awareness, sustainability, and the impact of one's actions on the environment (Galappaththi and Schlingmann, 2023). Employees with knowledge of the issues can use this knowledge to develop environmentally friendly green technology and employ sustainable practices (Sahoo et al., 2023). Additionally, EGK's contributions to enhancing in-role and extra-role green behaviors have been repeatedly supported by recent research. One interpretation is that the employees who are both the most motivated and concerned are the ones who need environmental knowledge to be able to act on their environmental intentions (Ercantan and Eyupoglu, 2022). The EGK successfully translates green concerns into behaviors, as it also increases the perceived effectiveness of the behaviors, thereby promoting further actions, creating a reinforcing feedback loop, and cultivating a habit of green behavior in the workplace (Darvishmotevali and Altinay, 2022).

Whilst various organizations have placed enhanced importance on environmental issues and more importantly environmental sustainability it is apparent from a literature review that there is a research gap as to how the employee's green concerns and green effectiveness plot the green behavior (Al-Swidi et al., 2021; Song et al., 2021; Farrukh et al., 2022). Research findings on green practices have primarily focused on the effects of organizational policies and leadership, often overlooking the individual behaviors of employees (Ansari et al., 2021; Liu et al., 2023).

Furthermore, although previous research has highlighted the role of attitudes and beliefs in affective employee behavior, there is limited understanding of how green knowledge plays a role in mediating the relationship between the employee's green concern, perceived effectiveness of the green action plan, and the subsequent action that is taken (Song et al., 2021; Farrukh et al., 2022; Simon, 2023). Research has also identified a gap in this more nuanced investigation of how perceived green concerns and perceived green effectiveness impact the green knowledge of employees and initiatives to translate these into actual green behaviors in the workplace (Ahmad et al., 2021; Mukherjee and Chandra, 2022).

The fundamental objective of this research is to identify the roles and complex interactions of three fundamental variables: green concern, green effectiveness, and green behavior, with EGK playing the mediation role. The specific objectives of this research are (i) to explore the link between employee green concerns and green behavior, (ii) to identify the relationship between employee-perceived green effectiveness and green behavior, (iii) to investigate the mediating role of green knowledge in the relationship between green concern and green behavior, (iv) to examine the mediating effect of employees' green knowledge in the relationship between green effectiveness and green behavior.

It is therefore the purpose of the study to offer a detailed understanding to enable organizations to design appropriate measures that would in turn be useful in improving on competency of educating and motivating employees to increase green behavior at the workplace.

The following is the structure of this paper: the literature review is introduced in Section 2, which includes underlying theories, the independent, dependent, and mediating variables; the development of hypotheses and conceptual framework is described in Section 3; The methodology, which comprises the study design, sample strategies, research tools, data collecting strategies, analytic tools and methodologies, and a methodology flowchart, is included in Section 4; The results, including the measurement model, structural model, and hypothesis testing results, are described in Section 5; the discussions of the results relating to earlier investigations are described in Section 6; the implications are discussed in Section 7, including the theoretical and managerial implications; limitations and potential areas for further research are discussed in Section 8, and finally the findings are summed up in Section 9 as conclusions.

2. Background of analysis

2.1. Underlying theories

The study intends to examine how green knowledge and green efficacy influence green behavior which is derived from the KAB model Proposed by Kallgren and Woods (1986) and the Self-Efficacy theory by Bandura and Wessels (1997). Other theoretical frameworks, in addition to the KAB model and Self-Efficacy Theory, provide insightful explanations of environmental behavior. In addition to attitudes, the Theory of Planned Behavior (TPB) offered by Ajzen (1991) presents the ideas of subjective standards and perceived behavioral control. By taking into account the social and normative forces impacting green behavior, organizations can develop more effective sustainability strategies, organizations can develop more effective sustainability strategies, and organizations can develop more effective sustainability strategies. The Social Cognitive Theory (SCT) proposed by Albert Bandura (1997) places a strong emphasis on reward and observational learning. Through peer observation or corporate benefits for sustainable practices, employees may learn green behaviors. The TPB shows how attitudes, social norms, and perceived behavioral control shape an individual's behavior and SCT helps to identify the appropriate behavior in a certain circumstance. However, the TPB complements the KAB model and the SCT extends the understanding of Self-efficacy theory while examining the nexus among employee green concerns, green effectiveness, and green behavior by identifying the mediating role of employees' green knowledge.

2.2. Knowledge-attitude-behavior (KAB) model

The KAB model is a foundational theoretical framework for exploring the system of behaviors for employees in organizational contexts (Patalinghug et al., 2023; Teo et al., 2023). The KAB model states that an individual's knowledge (K) of a concept affects their attitudes (A) towards that concept, which affects their behavior (B). This sequential nature emphasizes the fact that knowledge is a prerequisite for

attitudinal and behavioral change (Teo et al., 2023; Román-Augusto et al., 2022). KAB has been used by earlier researchers in a variety of settings, including as the literature on environmentally friendly behavior (Polonsky et al., 2012; Taufique et al., 2017) investigated the connection between ecologically friendly consumer behavior, attitude, and knowledge regarding environmental issues. Additionally, the studies of Khare and Sadachar (2017) in the context of green initiatives encourage the investigation of gap between knowledge and behavior.

This study uses the KAB model to explain how employees' green knowledge mediates the relationship between green concerns and green behavior in the workplace (Bresciani et al., 2022). Employees' environmental awareness and positive attitudes toward sustainability enhance their pro-environmental behaviors, such as energy conservation, waste reduction, and corporate sustainability initiatives (Shah et al., 2023). Therefore, the KAB model provides theoretical support to the idea that improving employee environmental knowledge is a key element to developing a pro-environmental workplace culture (Zacher et al., 2023).

2.2.1. Self-efficacy theory

Albert Bandura's self-efficacy theory is central to comprehending and encouraging employee green behavior in organizations (Bandura and Wessels, 1997; Albrecht and Marty, 2020; Tawde et al., 2023). This perspective emphasizes self-efficacy beliefs, designed to account for the differential impact of belief in capabilities on motivation and performance (Schunk, 1995; Bandura and Wessels, 1997). According to Chen et al. (2015) green self-efficacy, as it relates to environmental sustainability, is the belief in one's ability to do ecologically responsible behaviors. Specialized self-efficacy is essential for converting ecological understanding into observable actions (Gist and Mitchell, 1992). In this regard, by strengthening a person's confidence in his or her capacity to adopt sustainable behaviors, green self-efficacy may operate as a facilitator in the interaction between knowledge and behavior (Zacher et al., 2023). Both in-role and extra-role environmental initiatives have a greater possibility of being carried out by employees who have higher green self-efficacy (Tawde et al., 2023). Empirical results have shown that employees with high self-efficacy are more likely to take action to support environmental sustainability because they believe that their actions will have an impact on company-related behavior as well (Schunk, 1995; Zimmerman, 2000; Farooq et al., 2021).

Green effectiveness embodies the efficiency and the effect of employees' eco-friendly activities (Raza and Khan, 2022). This boosts green effectiveness since high self-efficacy employees are confident that they can implement green practices. This confidence helps them to take risks, to think creatively, and to keep trying to achieve better results for sustainability (Klabi and Binzafrah, 2022).

2.2.2. The link between the KAB model and self-efficacy theory

By combining the Self-Efficacy Theory with the KAB model, an improved comprehension of employee green behavior is possible. In the KAB process, self-efficacy could be used as a stimulus by boosting self-confidence requisite to transform knowledge of the environment into tangible actions (Klabi and Binzafrah, 2022). While the KAB model indicates that attitudes drive action, self-efficacy may reinforce this process by minimizing the perceived challenges and enabling people to take action based on their attitudes (Bresciani et al., 2022). Similarly, KAB model-shaped attitudes may be impacted by a person's self-efficacy, indicating a reciprocal link that merits more research.

2.3. Employee green concerns (EGC)

Employee green concerns (EGC) are the level of value given by employees to environmental issues (Muisyo et al., 2022). These concerns are employee awareness and motivation to mitigate environmental destruction. It has been found in research that if employees are environmentally concerned type, they are more likely to behave in an environmentally conscious way (Yeşiltaş et al., 2022; Joshi and Rahman, 2019). These issues are strongly influenced by factors such as personal values, societal norms, and organizational culture (Ercantan and Eyupoglu, 2022). It has been widely reported that there is a positive and direct relationship between employees who have higher green concern and their green behavior, which consequently leads them to take the appropriate steps to exert green behaviors (Aboramadan, 2022; Ababneh, 2021).

2.4. Employee green effectiveness (EGE)

Employee Green Effectiveness (EGE) is the employees' belief in their ability to be decent at contributing to organizational sustainability (Perez et al., 2023). The concept is rooted in self-efficacy theory, which states that people are generally more likely to pursue and sustain activities they believe they are capable of accomplishing and that will be rewarding (Brandstätter and Bernecker, 2021). There is much motivation for employees with the perception of higher self-efficacy to display green behavior than those who have less efficacy (Nisar et al., 2024; Bissing-Olson et al., 2013). According to Sh. Ahmad et al. (2022) the positive relationship between green effectiveness and green behavior means that by increasing employees' green efficacy they are more likely to show green behavior in the workplace.

2.5. Employees' green knowledge (EGK)

The knowledge that employees have concerning environmental issues and sustainable practices. This includes knowledge regarding the environmental effects of activities, sustainability theory, and applicable ways in which to minimize this environmental damage (Raza and Khan, 2022; Zeng et al., 2023). Research has shown a direct positive relationship between environmental knowledge and favorable attitudes to sustainability and environmentally responsible behavior (Hossain et al., 2022; Yadav and Pathak, 2016). Indeed, Abbas and Khan (2022) have shown that green concerns by employees are in part explained by the level of green knowledge that employees possess as they have enhanced environmental awareness and develop greater environmental concerns that subsequently promote green behavior.

2.6. Employee green behavior (EGB)

Green behavior of employees refers to the actions and behaviors that employees take to support environmentally benign practices within the organization (Zacher et al., 2023; Khan et al., 2020). Previous research has also identified that these behaviors are associated with reducing an organization's environmental footprint and thus improve the organization's overall performance on sustainability more generally (Darvishmotevali and Altinay, 2022). Organizational sustainability goals can be met through employee green behavior, which includes in-role and extra-role activities (Li et al., 2023). In-role green behavior (IRGB) represents overt actions expected by an organization that is part of a green job and are required by organizational policy and regulations (Khalid et al., 2022). They are not at all free, as they are critical of the actions that allow the organization to comply with environmental regulations and to the operational effectiveness needed to minimize its impacts on the environment (Tang et al., 2022). For instance, effective resource management, following recycling, and energy conservation. Results indicate that organization support, training program effectiveness, and resource availability significantly impact on employees' green behavioral engagement in performing organizational formal roles (Farrukh et al., 2022). In contrast to this, employee green behavior, which is extra from their formal role denotes additional, voluntary, discretionary acts that employees perform to support measures for environmental sustainability, which are outside their formal job duties. They are self-initiated acts with the sense of being responsible for the environment. Engaging in workplace sustainability projects, advocating for green policies, mentoring

your colleagues on sustainable practices, and leading environmental activities outside the workplace (Farrukh et al., 2022). In addition, the green knowledge of employees and their perception of the importance of their extra-role green behaviors were significantly related to the ERGB (Khalid et al., 2022). Studies have shown that, when organizations provide employees with green knowledge and promote awareness of employees' efforts towards environmental issues, employees are more willing to take the initiative to participate in ecological behaviors (Ribeiro et al., 2022; Khan et al., 2020).

2.7. A summary of literature review

Authors & Time of Study	Focus Area	Key Findings	Methodology	Measurement Methods
Ababneh (2021)	Green HRM & Employee Green Behaviors	Green HRM positively influences employee engagement in green behaviors	Surveys	Likert Scale
Bissing-Olson et al. (2013)	Sustainable Workplace Behaviors	Daily effects and pro-environmental attitudes impact green behavior	Surveys	Likert Scale
Ercantan & Eyupoglu (2022)	Prosumer Behavior & Workplace Sustainability	Employees who act as prosumers align more with corporate sustainability goals	Case Study	Behavioral Tracking
Hair et al. (2012)	Structural Equation Modeling (SEM)	PLS-SEM is an effective tool for evaluating green behavior relationships	SEM	PLS-SEM
Joshi & Rahman (2019)	Sustainable Consumption	Environmental attitudes strongly shape consumer green behavior	Surveys	Likert Scale
Khan et al. (2020)	Consumer Green Behavior	Green behavior significantly contributes to environmental sustainability	Surveys	Likert Scale
Nisar et al. (2024)	Self-Efficacy & Green Behavior	High self-efficacy leads to increased workplace sustainability efforts	SEM	Likert Scale
Register-Mihalik et al. (2013)	Knowledge-Attitude-Behavior (KAB) Model	Knowledge influences attitudes, which then shape behaviors	Theoretical Review	Conceptual Analysis
Teo et al. (2023)	Environmental Sustainability Theories	KAB Model provides insights into workplace sustainability actions	Conceptual Analysis	Theoretical Review
Yadav & Pathak (2016)	Green Knowledge Impact	Green knowledge enhances employee sustainability attitudes	Surveys	Likert Scale
Zacher et al. (2023)	Measurement of Green Behavior	Validity of different behavioral measurement approaches	Experimental	Behavioral Tracking

3. Hypotheses development

3.1. Employee green concern (EGC) and employee green behavior

Employee pro-environmental concern as a promoter of green behavior inside or outside of formal roles (Naz et al., 2023; Khan et al., 2020; Joshi and Rahman, 2019). This apprehension is ingrained in morale, society, and the workplace culture where the employees work. When green concern is high, employees are typically more motivated to engage in pro-environmental behaviors beyond the role requirements (Naz et al., 2023). In-role behaviors that are within the roles of individual employees, such as resource conservation, appropriate recycling behavior, and task performance energy conservation (Ercantan and Eyupoglu, 2022). Existing studies have found that employees with high environmental concerns are more inclined to act in their job-related behaviors toward environmental performance (Bhatti et al., 2021; Joshi and Rahman, 2019).

On the other hand, extra-role green behavior states the voluntary, discretionary actions that are not included in the employee's formal job requirements (Bhatti et al., 2021). Specifically, these include behaviors initiated from personal initiative and a sense of environmental responsibility, like participating in sustainability projects at work, advocating for green policies, mentoring colleagues in sustainable practices, and engaging in environmental activities outside of work (Kim and Lee, 2022; Ababneh, 2021). Workers with high green concerns are more likely to take on these extra roles because they feel a personal and ethical duty to help contribute to environmental sustainability (Lu et al., 2022; Joshi and Rahman, 2019).

H1a. *Employee green concerns (EGC) favorably correlated with green behavior among employees (In-role) (IRGB).*

H1b. *Employee green concerns (EGC) favorably correlated with green behavior among employees (Extra-role) (ERGB).*

3.2. Employee green effectiveness (EGE) and employee green behavior

Employee Green Effectiveness represents employees' perceptions of how they can influence environmental sustainability positively with their behaviors (Donaldson and Preston, 2023). Employees behave in more sustainable ways in their practices through the influence of green effectiveness. The more competent employees believed to be in contributing to environmental sustainability, the more they were found to consistently engage in such behaviors (Irani et al., 2022). This proposed relationship between perceived green effectiveness and employee green behavior has been confirmed by some empirical evidence that shows perceptions of effectiveness are a primary determinant of behavior (Naz et al., 2023; Bissing-Olson et al., 2013). Employees who think they can make good sustainability contributions: those employees are more likely to behave in ways that are consistent with environmental goals (Bhattacharya et al., 2022). This relationship is derived from self-efficacy theory, which posits that perceived capability is a key component of behavioral motivation (Bandura, 1997; Rahman et al., 2024). An earlier study by Haque et al. (2024) demonstrated that employees higher in green self-efficacy are more likely to be engaged in eco-initiatives. This finding indicates that augmenting green efficacy may increase involvement in sustainable activities (Bissing-Olson et al., 2013). Finally, employee green effectiveness was also found to strengthen the relationship between organizational support and green behavior, which suggests that improving green effectiveness will reinforce the influences of organizational support on green behavior (Munawar et al., 2022).

H2a. *Employee green effectiveness (EGE) favorably correlated with green behavior among employees (In-role) (IRGB).*

H2b. *Employee green effectiveness (EGE) favorably correlated with green*

behavior among employees (Extra-role) (ERGB).

3.3. Employee green concerns (EGC) and employees' green knowledge (EGK)

The link between employee green concerns and employees' green knowledge is symbiotic and is a key to driving sustainability initiatives in organizations (Zhang et al., 2023). In general, green concern creates the ordinary impulse within the workforce to drive proactive participation in sustainable practices highlighting the intrinsic motivation and commitment of individuals towards green issues (Ibrahim Elshaer et al., 2023). So, this fear makes their career a reflection of the environmental issues for which they are already working. Second, green knowledge can be considered fertile soil for transforming employee green concern potential energy into real green behaviors.

H3. *Employee green concerns (EGC) positively related to Employees' Green Knowledge (EGK)*

3.4. Employee green effectiveness (EGE) and employees' green knowledge (EGK)

Even green effectiveness has a bi-directional relationship with EGK and forces them to incorporate environmentally sustained behaviors in their respective organizational workflows (Naeem et al., 2021). Green Knowledge Perceived by employees as high in environmental effectiveness motivates them to gain further knowledge about environmental practices to help increase their efficacy and effectiveness in promoting sustainability (Islam et al., 2020). This helps employees develop themselves to increase their green behavior self-efficacy whether performing in-role or extra-role activity, which leads to more active pursuit of learning about environmental issues (Katz et al., 2022). Conversely, having a good understanding of green may enhance the sense of green effectiveness of the employee. This understanding provides employees with the knowledge and the awareness to enact green practices (Hooi et al., 2021). While providing information on the consequences of their behaviors and on the strategies to reduce environmental damage, employees become more confident in their ability to help to increase the sustainability (Usman et al., 2022). Previous research by Algarni et al. (2022) also revealed that green knowledge and green effectiveness have positive reinforcement effects on each other, contributing to stronger and more consistent green behavior.

H4. *Employee green effectiveness (EGE) positively related to Employees' Green Knowledge (EGK)*

3.5. Employees' green knowledge (EGK) and employee green behavior

The nexus between employees' green knowledge and green behavior in performing inside the prescribed role and outside the prescribed role functions is significant to organizational sustainability (Tuan, 2022; Yadav and Pathak, 2016). EGK, which reflects an understanding of environmental problems and sustainable practices, can enable individuals to enact environmentally friendly behaviors not only within their formal job requirements but also outside of them (Camilleri, 2021). It is vital because literature illustrated that employees with higher levels of green knowledge are expected to show more eco-friendly job behaviors, such as saving resources, producing less waste, and promoting sustainability activities not only in their jobs but also outside their jobs (Gold et al., 2021). This infers that environmental knowledge stimulates green behaviors and hence supports the instrumental value of providing employee education and training initiatives for environmental sustainability to perform formal roles or voluntary extra-role (Pham et al., 2023). Organizations hold the key to developing a more conscious and responsible relationship with the environment while cultivating a change-making culture by inviting people by people, from their local and personal businesses and taking initiatives in the veins of the institution (Karasvirta and Teerikangas, 2022).

H5a. *Employees' Green Knowledge (EGK) favorably correlated with green behavior among employees (In-role) (IRGB).*

H5b. *Employees' Green Knowledge (EGK) favorably correlated with green behavior among employees (Extra-role) (ERGB).*

3.6. Mediating role of employees' green knowledge (EGK)

Employees' green knowledge (EGK) serves as a vital control mechanism linking organizational learning variables with both formal and voluntary green behaviors, contributing to sustainable behavior (Wang et al., 2022). According to the KAB model, which asserts that knowledge and attitude influence behavior, employees' green knowledge (EGK) mediates the relationship between employee green concerns (EGC) and employee green effectiveness (EGE), leading to environmentally friendly employee behavior (Roh et al., 2022). Higher EGK leads to employees being more prone to take their eco-friendly beliefs to the grassroots level (Shah and Soomro, 2023). It makes them a little bit environmentally concerned on the frontline in their professional capacity and in turn, influences the communities they also contribute to, beyond their job (Muisyo and Qin, 2021). Not only does the EGK program educate employees on environmental issues and general best practices, but it also arms employees with the knowledge and tools they need to execute such practices most effectively (Yu et al., 2022). This is consistent with the KAB theory, which posits that knowledge precedes pro-environmental concerns which proceed to employee green behaviors (Shehzad et al., 2023). In addition, EGK facilitates employees perceived green effectiveness to engage in environmentally conscious actions, subsequently also fostering their engagement in green behaviors (Kamalanon et al., 2022). Thus, EGK performs the role of a mediator between EGC, EGE and IRGB, ERGB, highlighting its importance in promoting sustainable culture within organizations (Freire and Pieta, 2022). Organizations can help foster the adoption of EGK behaviors in employees in their assigned roles and beyond by valuing the importance of EGK and investing in employee education and training programs for environmental awareness that links with their sustainability goals (Zameer and Yasmeen, 2022; Yadav and Pathak, 2016).

H6a. *The connection between employee green concerns and behavior among employees (In-role) is mediated by green knowledge*

H6b. *The connection between employee green concerns and behavior among employees (Extra-role) is mediated by green knowledge*

H7a. *The connection between employee green effectiveness and behavior among employees (In-role) is mediated by green knowledge*

H7b. *The connection between employee green effectiveness and behavior among employees (Extra-role) is mediated by green knowledge*

3.7. Conceptual framework

Based on the present research objective, attaining the research question, and with the support of the above literature discussion, the following conceptual framework in Fig. 1 is proposed. The following Fig. 1. represents the hypothesized research framework:

4. Methodology

4.1. Research design

This quantitative empirical study intends to use PLS-SEM to explore the impacts of employee green concerns and green effectiveness on employee green behavior in the consumer goods industry in Bangladesh. EGK has been proposed as a mediating construct in the above-mentioned

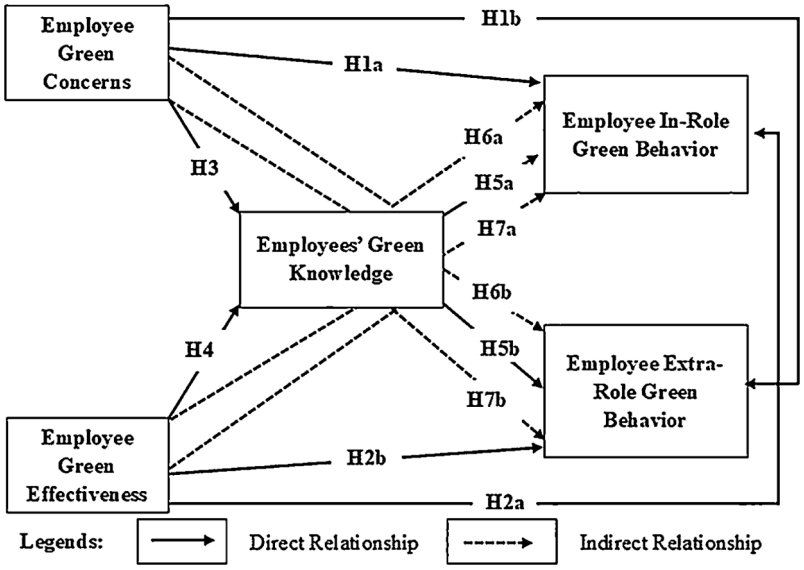

Fig. 1. Hypothesized research framework; *Source: Developed by the Authors.*

framework in Fig. 1. However, the following Fig. 2 represents the flow chart of the methodology of this study:

4.2. Participants and methods

Primary data were collected from 261 workers and managers working in different private firms in Bangladesh using a purposive sampling method. In the PLS-SEM analysis, a standard guideline states that the minimum sample size needed should be ten times the maximum number of indicators of one construct (Barclay et al., 1995). Therefore, the maximum number of indicators in a construct is five in this study, thus the sample size (261) is sufficient for a PLS-SEM analysis, per Barclay et al. (1995).

Responses were collected from the respondents using a 20-item 5-point Likert scale structured questionnaire. For better understanding, the questionnaire was translated into Bengali, which is the official language of Bangladesh. The questionnaires were delivered to the respondents using the Internet. The following Table represents the details of the participants in the research (Table 1):

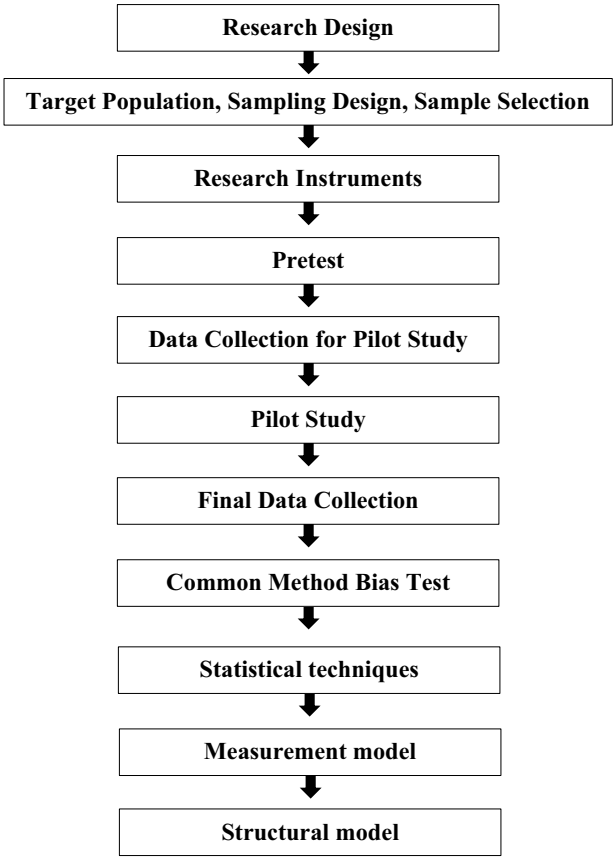

Fig. 2. Flow chart of methodology.

4.3. Statistical techniques

Microsoft Excel was used to prepare data for analysis. IBM SPSS 25 was utilized to test multicollinearity issues among the measurement items through Harman's Single factor analysis. The study also used partial least squares structural equation modeling (PLS-SEM) adopting Smart PLS 4.0 to assess reliability, validity and test the hypotheses. The reliability of the constructs (Factor Loadings > 0.7, Cronbach's α Value > 0.7, CR > 0.7, AVE > 0.5) and the validity of the measurement instruments (Fornell and Larcker criterion and HTMT values) were assessed through the measurement model (Hair et al., 2012) and the

Table 1
Participants details.

Characteristics	Details	Frequency	Percentage
Age	18–24	53	20.31 %
	25–31	115	44.06 %
	32–38	52	19.92 %
	39–45	27	10.35 %
	46 and above	14	5.36 %
Gender	Female	87	33.33 %
	Male	174	66.67 %
Educational Qualifications	SSC or Equivalent	37	14.18 %
	HSC or Equivalent	51	19.54 %
	Graduate	27	10.34 %
	Postgraduate	123	47.13 %
	Professional or other degrees	23	8.81 %
Level of Experience	Less than one year	32	12.26 %
	1 to 5 years	123	47.13 %
	5 to 10 years	66	25.29 %
	10–15 years	27	10.34 %
	>15 years	13	4.98 %

structural model was utilized to test the anticipated hypotheses considering path coefficient (β), t-values, p-values through a one-tailed bootstrapping with 5000 subsamples. PLS-SEM has been widely used in various business research to assess the relationships among variables while identifying the direct and indirect links (mediating effects) (Hair et al., 2012; Sarstedt et al., 2014; Ali et al., 2018; Guenther et al., 2023).

4.4. Research instruments

Employee Green Concerns (EGC) were examined using the five-item scale adopted from the study by Yadav and Pathak (2016) to evaluate the impacts of employees' EGC on Employee Green Behavior in the workplace. An example of item "To survive, humans must maintain a harmonious relationship with nature." Cronbach's alpha = 0.842. Employee Green Effectiveness (EGE) was tested using four items by Kim and Choi (2005). An example of an item is "I can contribute to preserving the environment by purchasing environmentally friendly items." Cronbach's alpha = 0.794. EGK was examined using the five-item scale adopted from the study by Yadav and Pathak (2016) to evaluate the mediating role in the relationship between EGC, EGE, and green behavior in and outside roles. An example of item "I am more knowledgeable about recycling and reuse than the average person." Cronbach's alpha = 0.896. Employee green behavior (in-role) (IRGB) was measured with a three-item scale adopted from the study by Bissing-Olson et al. (2013). An example of item "I fulfill responsibilities expected of me in an environmentally responsible manner (those are not harmful to the environment)." The Cronbach's alpha = 0.797. Employee green behavior (extra-role) (ERGB) was assessed using a three-item scale for voluntary green behaviors taken from the research by Bissing-Olson et al. (2013). An example of item "I take on more environmental responsibilities at work than I am required to do." The Cronbach's alpha = 0.745.

4.5. Pretest and pilot study

In this study, the researchers employed a structured questionnaire form. To improve the survey items' understanding for the participants, a pre-test of the items was given using a debriefing test involving fifteen (15) people: eight managers from the manufacturing sector, four educators, and three expert researchers. Consequently, while filling out the survey, participants were observed, and questions that they struggled to answer were addressed.

The data from the pilot research served as the basis for all questions. An English and Bengali survey was created for the expectant detractors. Lastly, a pilot study is carried out to determine whether the instrument for study is effective and whether the primary scale can be executed flawlessly (Van Teijlingen and Hundley, 2001). Forty (40) participants were chosen at random to take part in the experiment (Connelly, 2008). The pilot study's Cronbach's alpha revealed that the scales' internal consistency was greater than 0.7 and that their quality was good (Fassih-Ramandi et al., 2020).

4.6. Multicollinearity analysis: common method bias

Common Method Bias was assessed using Variance Inflation Factors (VIF) values of all the measurement items and the Harman single factor test for analyzing multicollinearity issues (Kyriazos and Poga, 2023). According to Kock (2015), if the VIF score is <3.3, then there are no multicollinearity issues. In this study, VIF scores varied from 1.283 to 1.408 which indicate the absence of multicollinearity issues. As stated by the Harman single factor test, Common Method Variance (CMV) may show up as a complex problem, if the initial element explains most of the variation, (Aguirre-Urreta and Hu, 2019). The researchers found that only 39.46 % of the variation is explained by the initial component (see Appendix 2) after doing un-rotated exploratory factor analysis on each item. As a result, it can be concluded that CMV had nothing to do on the outcomes of the study.

5. Results

5.1. Measurement model

Loadings for each item of measurement scale were validated using factor analysis. The scores of items loading ranging between 0.73 to 0.90 are shown in Table 2. To confirm the reliability of the constructs the average variance extracted (AVE) and composite reliability (CR) were calculated. The results shown in Table 2 and Fig. 3 indicate all the constructs confirmed AVE scores ranging from 0.612 to 0.713 which is higher than 0.5 and higher CR score ranging from 0.856 to 0.923 which is >0.70, signifying that the convergent validity and internal consistency of the data has met the standard (Hair et al., 2012).

To ensure discriminant validity this study adopted the Fornell and Larcker (1981), which contrasts the intercorrelations between the variables and the square root of AVE. The findings shown in Table 3 signifies the fulfillment of discriminant validity requirements. On the contrary, HTMT ratios confirmed the discriminant validity. According to Hulland's (1999) suggestion, all ratios in Table 4 appear to be below 0.80, indicating that the components were validly discriminated against.

The results of the reliability test are shown in Table 2 and results of validity test are shown in Tables 3 and 4.

5.2. Evaluation of structural model

Several criteria were established to assess the structural model. The R square statistic (R^2) values of EGK are 0.220, ERGB is 0.482, and IRGB is 0.431 shown in Table 5. These values are thought to be suitable based on Chin (1998)'s recommendations. Second, for EGC on ERGB, the f-square effect size was 0.037 (small), but for EGK on ERGB, it was 0.255 (medium) (Cohen, 1988). Ultimately, computing predictive relevance—also called Stone-Geisser's Q2 was used to establish the Q2 values for EGK, ERGB, IRGB. Considering that Stone-Geisser Q2 values were greater than zero, Hair et al. (2018) claimed the predictive significance was strong as shown in Table 5.

The following Table 5. Shows the results of predictive significance, Table 6. Shows the results of effect size, and Table 7. Represents the results of common method bias.

Table 2
Results of reliability of the constructs and items.

Constructs	Measurement Items	Loading	Cronbach's α Value	CR	AVE
Employee Green Concerns (EGC)	EGC1	0.749	**0.842**	**0.887**	**0.612**
	EGC2	0.769			
	EGC3	0.750			
	EGC4	0.809			
	EGC5	0.831			
Employee Green Effectiveness (EGE)	EGE1	0.757	**0.794**	**0.866**	**0.619**
	EGE2	0.740			
	EGE3	0.857			
	EGE4	0.787			
Employees' Green Knowledge (EGK)	EGK1	0.820	**0.896**	**0.923**	**0.706**
	EGK2	0.860			
	EGK3	0.802			
	EGK4	0.839			
	EGK5	0.876			
In-role green behavior (IRGB)	IRGB1	0.771	**0.797**	**0.881**	**0.713**
	IRGB2	0.894			
	IRGB3	0.864			
Extra-role green behavior (ERGB)	ERGB1	0.734	**0.745**	**0.856**	**0.666**
	ERGB2	0.802			
	ERGB3	0.904			

Source: Smart-PLS 4.

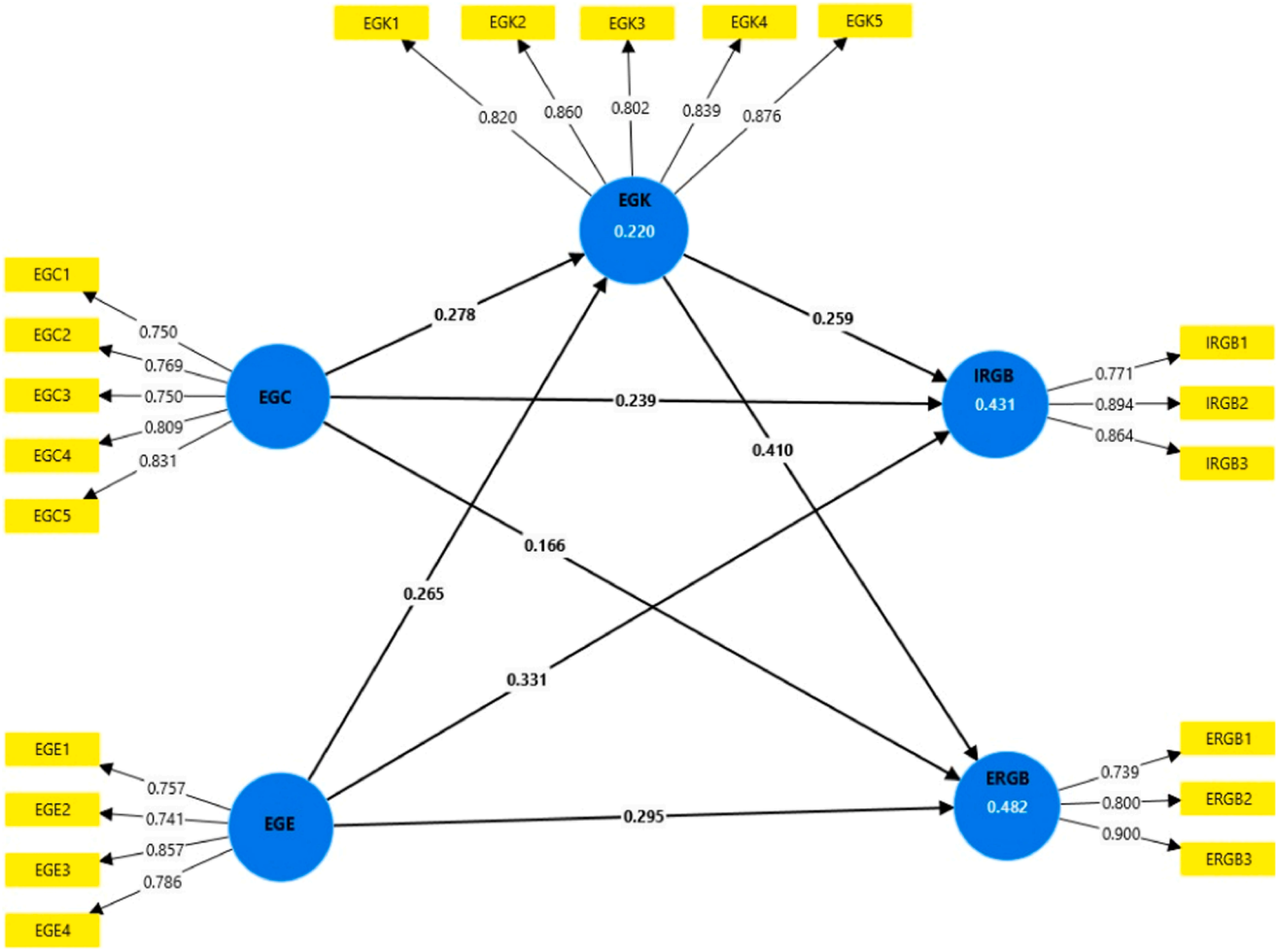

Fig. 3. Output from the measurement model.

Table 3
Fornell-Larcker criterion.

	EGC	EGE	EGK	ERGB	IRGB
EGC	0.782				
EGE	0.491	0.787			
EGK	0.409	0.402	0.840		
ERGB	0.477	0.539	0.597	0.816	
IRGB	0.508	0.553	0.490	0.606	0.845

Table 4
Results of discriminant validity analysis (HTMT Ratio).

	EGC	EGE	EGK	ERGB	IRGB
EGC					
EGE	0.604				
EGK	0.466	0.471			
ERGB	0.590	0.688	0.727		
IRGB	0.616	0.694	0.575	0.782	

Table 5
Outputs of predictive significance.

Outcome Variables	R^2	R^2 Adjusted	Q^2 predict
EGK	0.220	0.214	0.200
ERGB	0.482	0.476	0.329
IRGB	0.431	0.425	0.356

5.3. Hypotheses testing results

Table 8 shows the results of the hypotheses testing (direct effects): *H1a:* EGC → IRGB (β = 0.239; $t = 3.846$; $p < .05$); *H1b:* EGC → ERGB (β = 0.165; $t = 3.748$; $p < .05$); *H2a:* EGE → IRGB (β = 0.331; $t = 5.588$; $p < .05$); *H2b:* EGE → ERGB (β = 0.293; $t = 5.175$; $p < .05$); *H3:* EGC → EGK (β = 0.278; $t = 4.067$; $p < .05$); *H4:* EGE → EGK (β = 0.265; $t = 4.178$; $p < .05$); *H5a:* EGE → IRGB (β = 0.259; $t = 4.310$; p=.000<0.05); *H5b:* EGE → ERGB (β = 0.412; $t = 5.588$; $p < .05$). All the results are statistically significant, and all the hypotheses (*H1a to H5b*) are highly supported (Fig. 4).

This finding of the study proves that employees' and EGK has a noteworthy effect on green behavior of employee in and extra role among the employees of consumer good industry in Bangladesh.

Later, a (two-tailed) bootstrapping approach with 5000 subsamples were used in SMART PLS 4 to find out the mediation effect of EGK on the

Table 6
Outputs of effect size (f-square).

Paths	f-square values
EGC → EGK	0.075
EGC → ERGB	0.037
EGC → IRGB	0.071
EGE → EGK	0.068
EGE → ERGB	0.117
EGE → IRGB	0.137
EGK → ERGB	0.255
EGK → IRGB	0.092

Table 7
Outputs of common method bias (VIF).

	EGC	EGE	EGK	ERGB	IRGB
EGC			1.318	1.418	1.418
EGE			1.318	1.408	1.408
EGK				1.283	1.283
ERGB					
IRGB					

impacts of EGC and EGE in cultivating employee green behavior (Sarstedt et al., 2022). The result shown in Table 9 represents the mediation effects of EGK: *H6a:* EGC → EGK→IRGB (β = 0.072; $t = 2.636$; $p < .05$); *H6b:* EGC → EGK→ERGB (β = 0.115; $t = 3.028$; $p < .05$); *H7a:* EGE → EGK→IRGB (β = 0.069; $t = 3.002$; $p < .05$); *H7b:* EGE→ GK→ERGB (β = 0.109; $t = 3.256$; $p < .05$). These findings indicate that EGK significantly mediates the relationships, and all the relationships are statistically significant and all the hypotheses *H6a to H7b* are highly supported (Fig. 4).

The following Table 8 represents the results of hypotheses testing direct effects and Table 9 Shows the results of hypotheses test indirect effects.

5.3.1. *H1a: EGC→IRGB*

EGC has a positive effect on IRGB according to the result shown in Table 8 (path value = 0.239, t value=3.846 and p-value < 0.01) meaning that employees with environmental consciousness are more likely to merge green practices into their day-to-day work activities.

5.3.2. *H1b: EGC→ ERGB*

Employees' Green Concerns (EGC) was significantly related to ERGB as shown in Table 8 (path value = 0.165, t value=3.748 and p-value < 0.01). It shows that when employees care about the environment, they

Table 8
Total direct effects.

Hypo-theses	*Paths*	*Beta (β)*	*Std. Error*	*2.5 % LLCI*	*97.5 % ULCI*	*T Statistics*	*P-values*	*Decisions*
H1a	EGC → IRGB	0.239	0.081	0.155	0.471	3.846	0.000	*Supported*
H1b	EGC → ERGB	0.165	0.075	0.136	0.428	3.748	0.000	*Supported*
H2a	EGE → IRGB	0.331	0.072	0.260	0.536	5.588	0.000	*Supported*
H2b	EGE → ERGB	0.293	0.078	0.245	0.549	5.175	0.000	*Supported*
H3	EGC → EGK	0.278	0.068	0.142	0.411	4.067	0.000	*Supported*
H4	EGE → EGK	0.265	0.063	0.145	0.392	4.178	0.000	*Supported*
H5a	EGK → IRGB	0.259	0.060	0.142	0.380	4.310	0.000	*Supported*
H5b	EGK → ERGB	0.412	0.074	0.262	0.550	5.588	0.000	*Supported*

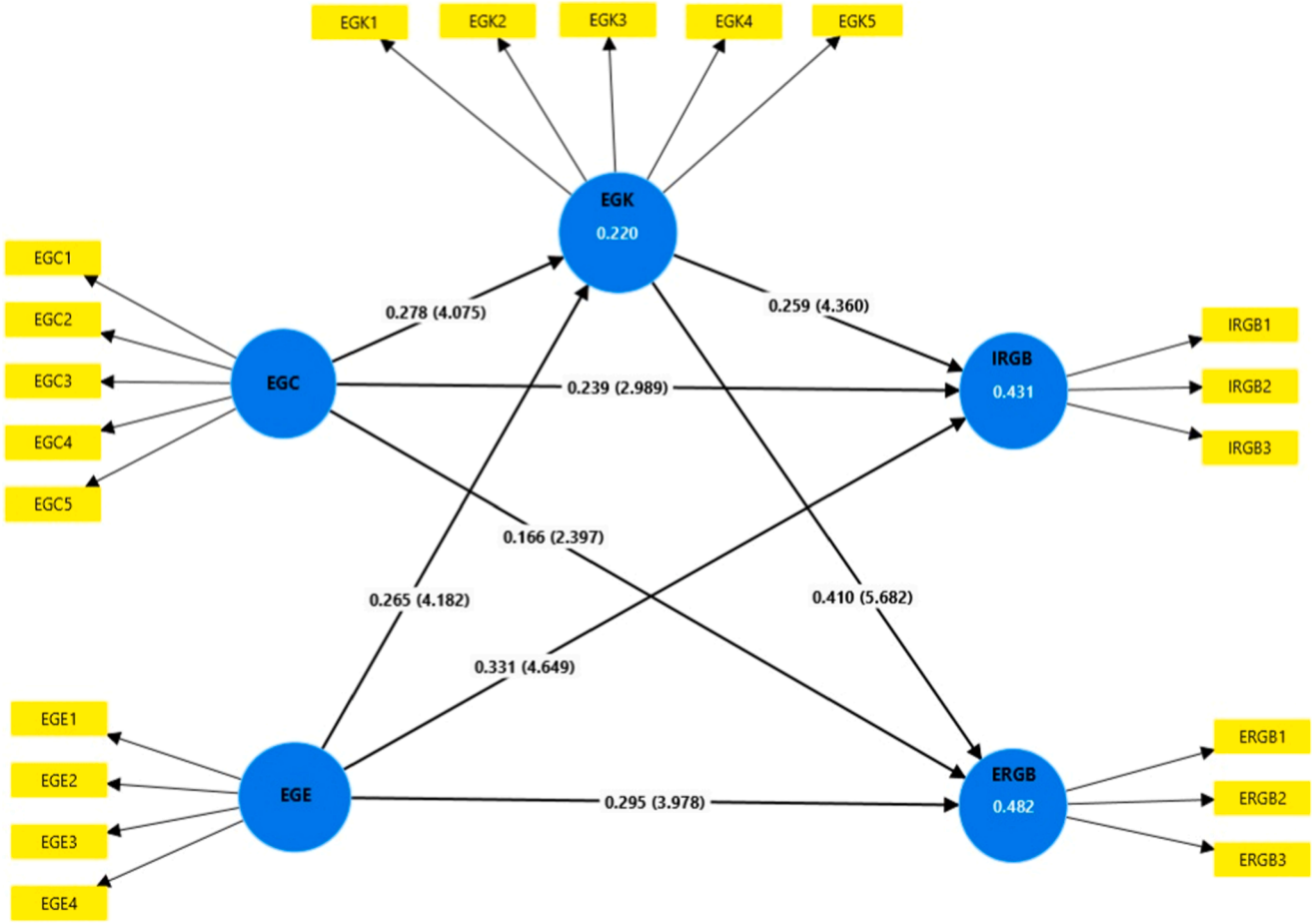

Fig. 4. Output from the structural model.

Table 9
Specific indirect effects (mediation effects).

Hypo-theses	*Paths*	*Beta (β)*	*Std. Error*	2.5 % LLCI	*97.5 % ULCI*	*T Statistics*	*P-values*	*Decisions*
H6a	EGC → EGK→IRGB	0.072	0.027	0.027	0.133	2.636	0.008	*Supported*
H6b	EGC → EGK → ERGB	0.115	0.038	0.049	0.196	3.028	0.002	*Supported*
H7a	EGE → EGK → IRGB	0.069	0.023	0.029	0.118	3.002	0.003	*Supported*
H7b	EGE → EGK →ERGB	0.109	0.034	0.050	0.182	3.256	0.001	*Supported*

are more likely to perform green citizenship behaviors beyond their formal job scope.

5.3.3. *H2a: EGE→IRGB*

In this case, the positive relationship between EGE and IRGB according to the result shown in Table 8 (path value = 0.331, t value=5.588 and p-value < 0.01) can be explained as that of employees who believe in their proficiency in performing green tasks so they would implement these practices into their job roles.

5.3.4. *H2b: EGE→ERGB*

In addition, EGE positively affects ERGB as shown in Table 8 (path value = 0.293, t value=5.175 and p-value < 0.01) which revealed that the more employees perceive own green effects, ability to generate environmental benefits, the higher a level of extra role green behaviors. This reinforces arguments that permeability in self-efficacy across formal job roles can enable employees to act on their own inclinations for sustainability.

5.3.5. *H3: EGC→EGK*

EGC positively relates to EGK according to the results shown in Table 8 (path value = 0.278, t value=4.067 and p-value < 0.01), so a concern for the environment is associated with an increased likelihood of searching out and gaining environmental knowledge.

5.3.6. *H4: EGE→EGK*

The positive effects of EGE on EGK as shown in Table 8 (path value = 0.265, t value=4.178 and p-value < 0.01) that indicate employees who feel themselves effective in green practices also have a propensity to attain or use green knowledge.

5.3.7. *H5a: EGK→IRGB*

There is a positive link between EGK and IRGB according to the result shown in Table 8 (path value = 0.259, t value=4.310 and p-value < 0.01), meaning that when employees have an awareness of environmental practices, they would be more likely to incorporate such practices in their jobs.

5.3.8. *H5b: EGK→ERGB*

EGK also positively impacted ERGB as shown in Table 8 (path value = 0.412, t value = 5.588 and p-value < 0.01), indicating that those with a higher depth of environmental knowledge outside their formal job role exhibit more extra-role green behaviors.

5.3.9. *H6a: EGC → EGK →IRGB*

EGK indeed plays a pivotal mediating role between employee green concerns and employee green behaviors. Understanding ecology allows one's worries for the environment to manifest into environment-friendly actions suitable for diverse occupational duties. Learning is paramount for changing what we know about concerns into green behaviors no matter the occupational responsibilities we have. While various job roles exist, knowledge acts as a channel for compassion to impact conduct in a way that is advantageous for both work and the world.

5.3.10. *H6b: EGC → EGK →ERGB*

The relationship of employee green concern and voluntary green behaviors was mediated by EGK, indicating that environmental knowledge aids in facilitating employees' intention to perform ERGB. Additionally, employee environmental knowledge acquisition is to be a salient social mechanism enabling the employees to act on their environmental concerns beyond their formal job roles.

5.3.11. *H7a: EGE → EGK →IRGB*

These findings highlight the nature of EGK as a mediator in that it is necessary for employees to have enough environmental knowledge to translate their EGE into IRGB. Environmental knowledge strengthens the link between perceived effectiveness and employee green behaviors while performing in a formal role. Employees' knowledge about sustainability is key to assisting employees in executing their job descriptions.

5.3.12. *H7b: EGE → EGK →ERGB*

Preceded by the direct effect, EGK additionally significantly mediates the link between EGE and ERGB implying that environmental knowledge is crucial in driving employee-perceived green effectiveness into their voluntary engagement with environmentally responsible activities. The impact of perceived effectiveness on extra-role green behaviors was reinforced via environmental knowledge.

6. Discussion

This research examines how Employee Green Concerns (EGC), Employee Green Effectiveness (EGE), and Employee Green Knowledge (EGK) influence in-role and extra-role green behavior, with EGK acting as a mediator in these relationships. Results reveal a significant positive relationship among EGC, EGE, and employee green behavior while EGK mediates the relationship among these variables.

The findings of this study unveiled that employees' green concerns promote pro-environmental behavior which is in accordance with a study by Tian et al. (2020) that based on actual performance measures, found that employees' green attitudes foster initiatives towards the environment related to their formal roles assigned by organizations. The study of Zacher et al. (2023) reported that organizational sustainability goals correspond with individual values and hence influence IRGB which supports the environment. In line with the findings of Ababneh (2021) which revealed that employees with pro-environmental values are more expected to exhibit voluntary extra-role environmental behaviors.

The results also explored that employees' greater green effectiveness encourages them to perform in a green manner while performing formal roles or extra roles out of personal interest. These findings also correspond with Faraz et al. (2021) and Sachdeva and Singh (2024) where they suggested that greater self-efficacy related to environmental tasks leads employees towards more environmentally engaged behavior in terms of performing those tasks. In addition, Nisar et al. (2024) also found that the employees' engagement in green behavior inside their formal role is facilitated by the employees' perceived effectiveness of their sustainability action. In another study in the context of sustainable consumption behavior, Schutte and Bhullar (2017) found that perceived self-efficacy in the realm of sustainability translates into increased pro-environmental behaviors as well. This finding is also in line with the past research by Dhir et al. (2021) according to it environmental concern motivates employees towards an increased perceived need for performing both formal and extra roles associated with sustainable

knowledge & skills.

Furthermore, it was evident from this research that environmentally concerned employees are more likely to learn more about green practices and their outcomes. Likewise, the study of Munawar et al. (2022) revealed that environmentally concerned employees are more motivated to learn about green practices implementation in their jobs. This finding also supports Sh. Ahmad et al. (2022) argued that employees' perceived ability to perform environmental tasks enhances Employees' Green Knowledge-seeking and application motivation. Farooq et al. (2021) further argued and demonstrated that green self-efficacy can promote the cognitive process among employees to invest more into learning new environmental knowledge in their role. This result also matches the findings of the study conducted by Fawehinmi et al. (2020), that employees' ability to perform green responsibilities within the organizational roles are much facilitated when having adequate knowledge of environmental issues. Moreover, the result of Farrukh et al. (2022) indicates that workers with high levels of green knowledge are likely to participate in-role green behavior and sometimes a high-level understanding of the green subject matter tended to behave in ways that extend their desire for sustainability, beyond their normal constraints.

Moreover, EGK indeed performs a pivotal mediating role between employee green concerns, green effectiveness, and employee green behaviors in the role and outside the formal role played by employees in their workplace. Having an understanding of ecology allows one's worries for the environment to manifest into environment-friendly actions suitable for diverse occupational duties. This finding is relevant to Fawehinmi et al. (2020), who surveyed academicians at Malaysian research universities and discovered that green knowledge mediates how much care for the environment translates into green actions in and outside formal roles. Separately, Jermsittiparsert (2021) argued that learning is paramount for changing what we know about concerns into green behaviors no matter the occupational responsibilities we have. While various job roles exist, knowledge acts as a channel for compassion to impact conduct in a way that is advantageous for both work and the world. Additionally, employee environmental knowledge acquisition is a salient social mechanism enabling employees to act on their environmental concerns beyond their formal job roles as shown by Rusyani et al. (2021). Previous researchers argued that environmental knowledge strengthens the link between perceived effectiveness and employee green behaviors while performing in a formal role (Pham et al., 2023). They also argued that employees' knowledge about sustainability is a key to assisting employees in executing their job descriptions. Lou and Li (2023) also argued that the impact of perceived effectiveness on extra-role green behaviors was reinforced via environmental knowledge. Similarly, these findings indicate that knowledge is key to translating employee perceived capability into action for sustainability beyond the formal job role since Galván-Mendoza et al. (2022) conducted a study on a similar topic in the context of Baja California and found similar observations.

7. Implications of the study

7.1. Theoretical implications

The present study has major theoretical implications, especially with the KAB model and Self-Efficacy Theory. The relationships between EGC, EGE and EGK are positively related with KAB model which argue involvement from cognitive to affective in behavior (Dhir et al., 2021). The main theoretical contribution of this study is that, by showing how green knowledge not only reinforces pro-environmental attitudes but also mediates the transmission process from these attitudes to in-role and extra role environmentally conscious behaviors, this study has extended the KAB model previously used by Keum (2013) and Pouratashi and Zamani (2022). Moreover, self-efficacy is demonstrated to play a key role in enabling employees perform green behaviors. The results provide evidence that Self-Efficacy Theory extends to the context of green behaviors, as employees' EGE significantly relates with their actions towards the environment (Faraz et al., 2021). Outcomes based on empirical data from a study, the paper contributes to theoretical understanding of how environmental knowledge and self-efficacy can be employed for promoting sustainable behaviors in organizations and presents an elaborated version regarding nexus between push factors (knowledge) - pull factor s (attitudes) - behavioral in performing inside and outside the formal role green behavior (Farooq et al., 2021).

7.2. Managerial implications

Managers can take initiatives to develop employee green concerns, employee effectiveness and green knowledge for enhancing employees' environmentally sustainable behaviors (Saeed et al., 2019). Mangers may promote open discussions about environmental issues and can invest in rigorous training that will greatly improve employees' knowledge of and ability to address the key environmental problems while recognizing formal inside role behaviors and voluntary outside role green behaviors through formal programs which reward sustainable actions, so that a climate of genuine care about the environment is established (Zimon et., 2019).

Establish mentorship programs for experienced employees to help guide their peers in following eco-friendly protocols (Hu et al., 2021). Through training initiatives that teach the employees about environmental knowledge and to ensure optimal knowledge implementation and retention, these programs must incorporate hands-on experiences. Additionally, by fostering green self-efficacy by means of practical seminars and mentorship initiatives. Moreover, public recognition of sustainability initiatives or prizes for creative environmentally friendly solutions would boost confidence in the employees. In addition, by determining and removing obstacles to eco-friendly conduct could assist in lessening perceived barriers is to provide resources like recycling bins or guidance for energy-efficient behaviors. Integrating sustainability goals into strategic objectives and performance reviews to cultivate an organizational culture that values sustainability and frequent dissemination of these objectives helps reaffirm their significance and bring employee behavior into line with company principles. Furthermore, if managers can integrate environmental goals with appraisals and underpin the principles of their organizations a conscientious proactive environmentally aware workforce will emerge; individuals working will try to meet organization-wide sustainability goals.

Thus, managers can take initiatives to enhance the green knowledge of employees (K) to change the attitude of the employees through enhancing their concerns for the environment (A) and develop self-confidence towards their abilities (Self-Efficacy) to create an impact which ultimately leads to employee green behavior (B).

8. Limitations and future scopes

Further research is needed to examine the specific role of Employees' Green Knowledge in green concerns, effectiveness, and behaviors. Longitudinal studies might demonstrate changes in these interrelationships over time and in environmental training programs on employee behavior concerning proxy indicators. In addition, systemic implications between organizational culture and leadership dimensions of environmental management strategies among respondents which are conducive to green behaviors may provide a more holistic approach towards these variables so that situational prerequisites influencing such trends can be highlighted. Therefore, this study examines the influence of employees' green behavior on organizational outcomes and proposes a comprehensive research framework to help future researchers understand how to implement this concept in their organizations.

9. Conclusion

This research investigated the relationship among employee green concerns (EGC), green effectiveness (EGE), and green behavior with the mediation effect of Employees' Green Knowledge (EGK). Collecting the data from the Bangladeshi consumer goods industry, The findings indicate that employees' environmental concerns and green effectiveness significantly influence both formal in-role behaviors and voluntary extra-role green behaviors, with EGK playing a crucial mediating role by enhancing employees' learning and reinforcing sustainable practices. These findings are consistent with the previous research conducted in different contexts around the globe which serve as a reminder of why a well-informed and environmentally skilled workforce is essential to attain organizational sustainability objectives. This research has extended the theoretical implications and proposed managerial implications for understanding and utilizing these findings in their organizations to implement green practices more effectively into their day-to-day activities, develop a sustainability culture, and improve overall environmental performance while suggesting future research scopes to extend the literature on this field of study.

CRediT authorship contribution statement

Md. Hafizur Rahman: Writing – review & editing, Writing – original draft, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mohammad Bin Amin:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Funding acquisition, Data curation, Conceptualization. **Md. Nahid Hasan:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Noshin Yasmin:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Md. Atikur Rahaman:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Funding acquisition, Data curation, Conceptualization. **Judit Oláh:** Writing – review & editing, Writing – original draft, Project administration, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendices

Appendix I: Measurement Items

Variables	Items	Source
Employee Green Concerns (EGC)	EGC1: I have serious concerns about the state of the environment today and what might come in the coming days.	(Yadav and Pathak, 2016)
	EGC2: Human activity is significantly harming the environment.	
	EGC3: Disasters may arise when people harm the natural environment.	
	EGC4: Nature's balance is highly sensitive and easily disturbed.	
	EGC5: To survive, humans must maintain a harmonious relationship with nature.	
Employee Green Effectiveness (EGE)	EGE1: Each person can positively influence society by supporting environmental initiatives through their actions.	(Kim and Choi, 2005)
	EGE2: I believe that careful usage of water can assist in solving the issues related to natural resources.	
	EGE3: I can contribute to preserve the environment by purchasing environmentally friendly items.	
	EGE4: I believe I can contribute to the solution of environmental issues.	
Employees' Green Knowledge (EGK)	EGK1: I know environmentally safe and green practices those are not be harmful to the environment, or trying to help the environment.	(Yadav and Pathak, 2016)
	EGK2: I am more knowledgeable about recycling and reuse than the average person.	
	EGK3: I know very well about the environmental issues like air, water and odor pollution.	
	EGK4: I understand the various phrases and symbols related to environmental practices.	
	EGK5: I know how the green practices reduce the environmental impacts.	
In-role green behavior (IRGB)	IRGB1: I sufficiently perform the prescribed responsibilities in an ecologically sound manner (those are not harmful to environment).	Bissing-Olson et al. (2013)
	IRGB2: I carry out the duties stated in my job description in ecologically responsible manner. (those are not harmful to environment)	
	IRGB3: I fulfill responsibilities expected of me in an environmentally responsible manner. (those are not harmful to environment)	
Extra-role green behavior (ERGB)	ERGB1: At work, I take acts to be more ecologically responsible.	Bissing-Olson et al. (2013)
	ERGB2: I capitalize the opportunity to play an active role in green initiatives at work.	
	ERGB3: I engage in ecologically friendly duties in my position than required.	

Appendix II. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.893	39.464	39.464	7.893	39.464	39.464
2	2.213	11.066	50.529			
3	1.553	7.767	58.296			

(*continued on next page*)

(*continued*)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
4	1.216	6.082	64.378			
5	1.125	5.623	70.001			
6	0.881	4.405	74.406			
7	0.700	3.498	77.904			
8	0.640	3.200	81.104			
9	0.612	3.061	84.165			
10	0.509	2.547	86.712			
11	0.464	2.319	89.031			
12	0.412	2.058	91.088			
13	0.351	1.754	92.843			
14	0.297	1.486	94.329			
15	0.263	1.316	95.646			
16	0.239	1.194	96.840			
17	0.202	1.008	97.848			
18	0.172	0.858	98.706			
19	0.160	0.798	99.505			
20	0.099	0.495	100.000			

Extraction Method: Principal Component Analysis.

Data availability

Data will be made available on request.

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