

Achieving green innovation and sustainable development goals through green knowledge management: Moderating role of organizational green culture



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ABSTRACT

The authors have focused on organizational capabilities to achieve sustainable development goals (SDG) in the current study. In this regard, green knowledge management (GKM) and green innovation (specifically green technological and management innovation) are investigated. Moreover, it is also studied whether organizational green culture (OGC) strengthens organizational capabilities to innovate green and achieve sustainability goals via GKM. The researcher collected data from managers of different levels from manufacturing and service enterprises of all sizes and analyzed it through structural equation modeling. GKM strengthens organizational capabilities to achieve green innovation and SDG as per the findings. Moreover, green innovation has also been found to be a significant positive predictor of corporate sustainable development (CSD). It is also found that OGC strengthens the relationship between GKM and green innovation for achieving SDG. Furthermore, for all sizes of manufacturing and service organizations, GKM is found to be equally important.

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Introduction

The industrial revolution of the 19th century successfully brought millions out of poverty. However, the ensuing environmental and resource deterioration has been a side effect of this prosperity (Abbas & Dogan, 2022). Natural resource and their vulnerability to global warming impact jeopardize emerging markets' economic progress (Alkaraan et al., 2022). Over the years, authorities around the world have been eager to set standards and guidelines for products and services that are nearly environmentally safe (Kumar & Barua, 2022). Governments were encouraged to work on practical greenhouse gas emission reduction objectives by COP 26 (UNCOP26, 2021; Wynn & Beagley, 2021). United Nations also introduced Sustainable Development Goals (SDGs) to

protect and improve the environment and society (UNDP, 2021). Consequently, organizations started valuing the significance of a green environment, which motivated them to pay attention to redesigning their operations and management system (Ahmed et al., 2022). Dynamic firms are taking knowledge, quality, and environment-friendly practices as valuable strategies for creating a competitive advantage in today's business world (Al-Qudah et al., 2022).

A company's success or failure correlates to its ability to acquire and retain knowledge (Zhang et al., 2022a). Organizations utilize knowledge to improve customer satisfaction and competitive advantage (Mohan et al., 2022). Over the past couple of years, knowledge management (KM) has gained considerable attraction from the business sector. It has been considered a crucial component in formulating strategies, creating new products and services, and overseeing operational processes (Pham et al., 2022). An organization's efficiency can be improved through an effective KM system (Ahmed et al., 2022). However, considering the environmental challenges, dynamic firms have expanded the KM scope and have started integrating the environment into it (Ahmed et al., 2022). Green knowledge

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management (GKM) has thus become a vital strategic resource for many firms (Yu et al., 2022), giving them an edge over their rivals in achieving SDGs set forth by the United Nations (Dang & Wang, 2022).

One of the aims of SDGs is to make environmentally friendly product development easier for businesses through the notion of "green innovation" (Ahmed et al., 2022). Companies must focus on both technological and management innovation for social sustainability (Sianturi et al., 2022) and distinguish between two types of green innovation: green management innovation (GMI) and green technological innovation (GTI). GTI brings sustainable expertise and cutting-edge technology together. It helps companies produce new or improved goods or processes for the minimum utilization of raw materials and other resources while enhancing environmental, economic, and production processes (Song et al., 2022). Improved management and production processes and reduced environmental impacts are the core goals of companies in GMI (Ullah et al., 2022).

Several studies have been conducted on KM and sustainable development (Aamir et al., 2021; Abbas & Sağsan, 2019; Ahmed et al., 2022). However, considering the novelty of the GKM concept, rare attention is paid to GKM and its role in organizational green innovation and sustainable development. Moreover, little emphasis has been made on the moderating role of the OGC in strengthening the relationship between GKM and green innovation to achieve sustainable development. Thus, this study aims to bridge this literature gap. This study employs two control variables: the nature of firms, i.e., manufacturing and services, and the firm's size, i.e., small, medium, or large. Abbas & Sağsan (2019) highlight two significant distinctions between the manufacturing and service sectors' operating practices. First, the production process of the manufacturing company is tangible, whereas the output of the services industry is intangible and heterogeneous. It is also worth noting that while the service industry delivers and consumes concurrently, production does not. This is because these two businesses function on two separate systems. The size of the company is the second control variable in the research. Small and medium-sized firms have fewer resources than large corporations; hence, the company's size is employed as a control variable. How large companies function may explain why they approach GKM, green innovation, and sustainable development differently from medium-sized organizations. Those with fewer than 50 workers are categorized as small businesses; those with 50–200 workers are classified as medium-sized enterprises, whereas large companies have more than 200 workers. In light of the above discussion, the current research aims to investigate:

- The role of green knowledge management in organizational green innovation and sustainable development.
- The moderating role of organizational green culture in the relationship between green knowledge management, green innovation, and sustainable development.
- Whether organizational green innovation and sustainable development activities are influenced by the nature of industry and business size.

As a result of this research, academics, industrialists, ecologists, and other stakeholders will be better equipped to use green innovation and CSD to achieve ecological sustainability goals by capitalizing on the GKM system. In the following sections, the authors discuss the study's theoretical foundation, followed by the literature, explaining the methodology with data analysis and findings, discussing the results with implications, and concluding the study with future recommendations.

Theory and hypotheses

Theoretical foundation

The current research is based on the "theory of knowledge management" and "green theory." Knowledge is a concept that exists

outside of the physical world and can be divided into two categories: tacit knowledge and explicit knowledge (Abbas & Kumari, 2021). Information that exists in people's minds but is not recorded is known as tacit knowledge (Maravilhas & Martins, 2019). It is gained through interaction with others and experience. Because it is unspoken and unwritten, tacit knowledge is more challenging to transfer to others than explicit knowledge (Naqshbandi & Jasimuddin, 2022). Verbalized, articulated, shared, and codified knowledge is explicit and typically documented in manuals, books, and reports (Aamir et al., 2021; Zhao et al., 2022). Yang (2008) defined KM as converting tacit knowledge into explicit knowledge to facilitate seamless knowledge transfer within a company, taking into account implicit and explicit forms of knowledge.

Three different types of knowledge have been highlighted in the literature: tacit, codified, and encapsulated. The term "codified knowledge" refers to knowledge that has been documented explicitly, whereas "encapsulated knowledge" refers to knowledge that cannot be observed (van den Berg & Kaur, 2022). In comparison, tacit knowledge is inconspicuous, unwritten, and hidden in people's minds (Nupap, 2022). KM has been discussed in terms of processes and enablers. Organizational effectiveness and competitiveness can be improved by employing KM procedures, which are concerned with all aspects of obtaining, storing, using, applying, and producing knowledge. It is facilitated by factors such as an organization's culture (Naqshbandi & Jasimuddin, 2018). Sahibzada et al. (2020) proved that KM enablers and procedures have enormous potential to increase business innovation capabilities.

The modern knowledge-based dynamic capabilities (KBDC) view concerning the environment has three aspects, i.e., knowledge, dynamism, and capacities. Dealing with environmental challenges is a function of dynamism (Kaur & Mehta, 2017), highlighting the need for a strategic response to environmental change. The aspect of knowledge deals with the know-how of going green (Kaur, 2022; Kumari et al., 2022), and capability is the competence of an organization to deal with the changes required to become a green firm (Pundziene et al., 2022). As a result, developing green knowledge capability is critical for driving innovation and, ultimately, green performance. Culture can be an invaluable resource for understanding this phenomenon (Pan et al., 2022).

According to Gauthier & Zhang (2020), knowledge creation entails interacting with others and developing new ideas and concepts through tacit and explicit knowledge. To sustain and enhance the quality of the products and services in light of customers' evolving preferences and a dynamic business environment, organizations must acquire knowledge from suppliers, employees, and consumers (Chaithanapat et al., 2022). As a result, through knowledge acquisition, businesses can play on their strengths while also reviewing their weaknesses. Employees, especially those in relevant departments, must be aware of the new information (Ahmed et al., 2021). Employees in learning organizations are encouraged to participate actively in various issues. Participation from employees enables managers to see challenges from different outlooks (Khan & Abbas, 2022). It also aids in the development of workable solutions. In order to improve processes, it is crucial to implement knowledge in the appropriate key areas.

The origin of sustainable development goals is linked to the "Brundtland Commission" report "Our Common Future," put forward to the UN in 1987 (UNDP, 2021). Sustainable development is referred to as development that meets the needs of the present generation without jeopardizing the ability of future generations to meet their own needs. Munasinghe (1993) added a third approach to the sustainable development concept called social sustainability. As a result, Corporate Sustainable Development (CSD) includes three dimensions, i.e., economic, social, and environmental sustainability. It relates to green theory, a modern and multidisciplinary approach that states that businesses must prioritize implementing green management

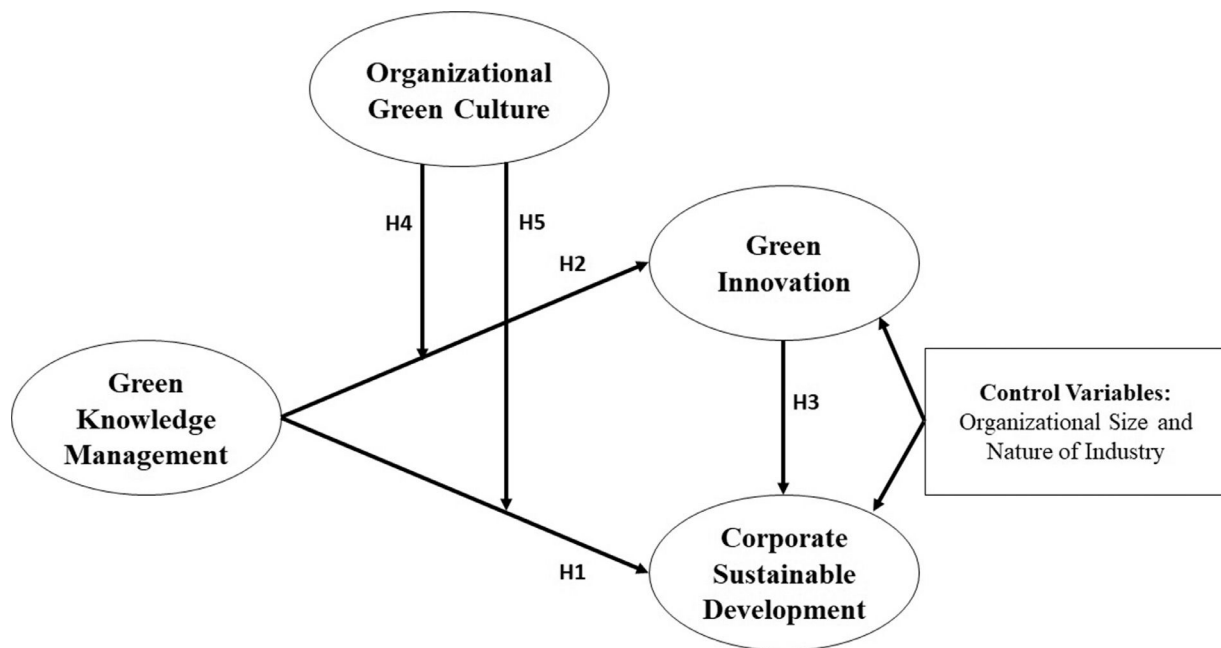


Fig. 1. Conceptual framework.

strategies and leveraging them to produce green products and services linked to sustainable development concepts (Xiao et al., 2022). The current research claims that organizational capability to capitalize on green knowledge helps them offer environment-friendly products and services through green innovation, further strengthening their environmental performance. The more effective an organization's GKM system, the more it is likely to innovate and act green. These activities are directly associated with achieving sustainability goals which is the spirit of the green theory (see Fig. 1).

Green knowledge management and corporate sustainable development

GKM is a novel and pro-environmental knowledge-based phenomenon. Companies can ensure that their employees have timely access to relevant information in an eco-friendly and user-friendly format (Gauthier & Zhang, 2020; Zhang et al., 2022b). It combines information and people management to achieve organizational excellence while protecting the natural environment (Song et al., 2022). GKM is the implicit and explicit knowledge of abilities and skills that helps businesses compete and innovate. In a knowledge-driven society, the relationship between GKM and corporate social responsibility (CSR) has become significant for organizations. In the words of Song et al. (2020), green knowledge is more innovative and capable of exploring new sustainability paths.

Manufacturing companies have been urged by the United Nations Global Compact (UNGC) to use environmentally friendly processes and cutting-edge technology to minimize businesses' negative impact on the environment (UNGC, 2018). Research and development (R&D) and green knowledge sharing are critical for innovation by companies (Qu & Liu, 2022). Organizations use such technologies to create new products and processes and improve existing ones to improve organizational performance economically, environmentally, and socially (Khan et al., 2022).

The creation of knowledge includes acting, interacting, and communicating with others (Chamba-Rueda et al., 2021). If organizations aim for long-term sustainability, they must allocate sufficient resources to green initiatives to create new green knowledge and technological development (Khan et al., 2022; Konno & Schillaci, 2021). In their research, Zwain et al. (2021) found that most workers get

information from their co-workers and fellow employees. Employees can develop creative solutions to environmental problems by engaging in pro-environmental activities at the workplace (Attia & Salama, 2018). In addition, it aids in formulating plans, making decisions, and creating an environment conducive to thinking and acting green (Ali et al., 2020). The application of green knowledge is a powerful tool that organizations can use to enhance their financial and environmental performance (Ode & Ayavoo, 2020) while also developing new core competencies and achieving competitive advantage (Ahmed et al., 2022). Companies can find new ways to improve their performance by applying their knowledge.

The concept of CSD is linked to three dimensions, i.e., environment, economy, and society (Xie et al., 2022). The environmental aspect of sustainability emphasizes ensuring clean air and water, preserving the environment, reducing the use of natural resources (especially non-renewable ones), developing environmentally friendly products, and reducing harmful gas and liquid emissions (Song et al., 2022). According to Abbas & Dogan (2022), the social aspect of sustainability focuses on improving organizational relationships with people and society and promoting human well-being through a better understanding of their needs. It also focuses on promoting cultural life, equity in society, social life development and support, human rights, and justice. The economic aspect of sustainability takes a pragmatic approach to increasing sales and lowering operating costs to maximize profit for a company (Sianturi et al., 2022).

Environmental, social, and economic sustainability are all intertwined in GKM, which is critical to this field's success. To ensure long-term sustainability, dynamic organizations focus on integrating GKM and overall organizational strategies (Chaithanapat et al., 2022). Organizations that can absorb green knowledge significantly impact their environmental performance (Shahzad et al., 2020a). GKM can help businesses become more sustainable in the long run. There has been little research on GKM's role in CSD, even though several researchers have highlighted its importance in general knowledge management, innovation, and organizational performance (Abbas & Sağsan, 2019; Gauthier & Zhang, 2020; Shahzad et al., 2020). It is thus hypothesized that:

H1: Green knowledge management is a significant positive predictor of corporate sustainable development.

Green knowledge management and green innovation

Knowledge and innovation have a long-lasting relationship (Piñeiro-Chousa et al., 2020). The negative impact of organizational operations on the natural environment can be reduced or eliminated through green innovation (Ahmed et al., 2022). Some SDGs are reduced resource consumption, waste control, recycling promotion, and pollution reduction (UNDP, 2021). Using environmental science and technology, GTI can improve or create new products or processes (Lv et al., 2021). It can also reduce the environmental impact of an organization's operations (Rehman et al., 2021). There are two sub-categories of GTI: the first is innovation in green processes, and the second is innovation in a green product. Innovation in green processes aims at making raw materials into usable products more efficient (Shahzad et al., 2020). It also aims to conserve natural resources, increase the use of renewable resources, and lessen the generated waste (Awan, 2020; Kumari et al., 2021). A primary goal of green product innovation is to reduce the environmental impact of the manufacturing process by incorporating renewable or non-toxic materials into existing products or developing entirely new ones (Qu & Liu, 2022; Zhang et al., 2019).

GMI refers to a company adopting a new management model or strategy to improve its production processes (Chaithanapat et al., 2022). Through GMI, businesses can reap financial rewards while minimizing their environmental impact (Naqshbandi & Jasimuddin, 2022). By adopting environmental management systems and policies such as ISO 14001, firms can achieve GMI goals. Customers' trust, loyalty, and profitability tend to increase for companies that pioneer GTI and GMI (Rehman et al., 2021). Knowledge-focused businesses are concerned with maximizing the use of resources and minimizing environmental impact (Muñoz-Pascual et al., 2020). The ecological impact of these organizations' operations is taken into account regularly, in addition to encouraging and facilitating the development of green products (Fu et al., 2022; Naqshbandi & Jasimuddin, 2022).

As a basis for research and analysis, knowledge management is essential to the innovation process (Chaithanapat et al., 2022). Organizational environmental performance is boosted by green knowledge (Gauthier & Zhang, 2020). Moreover, according to Guerrero-Villegas et al. (2018), innovation activities mediate the relationship between organizational performance and social sustainability. Azhar & Yang (2021) suggested that governments should help businesses produce high-quality products and services while utilizing the minimum natural resources possible.

To encourage the creation of new knowledge, dynamic companies provide systems, including infrastructure, resources, and information, that allow employees to create knowledge and innovative ideas (Gauthier & Zhang, 2020; Habib et al., 2019). Organizations that want to comply with dynamic market demands must incorporate environmental practices into their research and development activities (Abbas & Dogan, 2022). They must engage in activities that promote the production of high-quality products with minimal resources, which benefits both the environment and the company (Song et al., 2022). The current research claims that firms having a GKM system have more potential to innovate green and achieve sustainable development goals. In light of the above discussion on GKM, CSD, and green innovation, the following hypotheses are put forth:

H2: An organization's green innovation performance is positively impacted by green knowledge management

H3: Green innovation strengthens organizational capabilities to achieve corporate sustainable development goals

Moderating role of organizational green culture

To influence organizational behavior and attitude toward achieving common corporate goals, management teams develop a shared system of beliefs, ideas, and values known as an "organizational

culture" (Al-Swidi et al., 2021; Wang, 2019). A company's green culture (OGC) can be defined as one in which environmental protection is considered fundamental. A core value of the firm's employees is thus incorporated into the firm's mission statement, making every team member feel responsible for protecting the environment (Abbas & Dogan, 2022).

As a result of green culture, employees are more concerned about environmental issues (Lee et al., 2022), which positively impact their work. To flourish green culture, managers must show more concern for environmental protection (Azhar & Yang, 2021). Creating a green culture in an organization challenges the status quo and catalyzes innovative performance (Cherian et al., 2021). Green culture also significantly encourages employees to take environmental issues seriously (Azhar & Yang, 2021).

"Eco-environmental values," the foundation of a formal framework for green culture, can help an organization implement environmentally-friendly changes in its operations (Tahir et al., 2020). A company's pro-environment strategy can be translated into green innovation through a company's green organizational culture (Cherian et al., 2021). On the other hand, green corporate culture can benefit companies dealing with environmental issues (Al-Swidi et al., 2021). A company's ability to implement green innovation is boosted by its ability to absorb green waste (Naqshbandi & Jasimuddin, 2022). When they work in a green environment, employees are more concerned about the environment (Abbas & Dogan, 2022). An organization's ability to address environmental issues may further motivate its employees to protect the environment as data indicates that an OGC influences team members' attitudes and behaviors in a positive way toward environmental protection (Azhar & Yang, 2021; Gürlek & Tuna, 2018). As a result, the more environmentally conscious a company's culture is, the more concerned its employees will be about the environment. To produce eco-friendly goods, scholars say companies must embrace green organizational culture values (Banerjee et al., 2003).

Considering the importance of culture and its impact on organizational activities, this study takes green culture as a boundary condition between GKM, green innovation, and CSD. It claims that being the boundary condition, green culture strengthens the relationship between the said variables. Thus, the following hypotheses are proposed;

H4: Organizational green culture strengthens the relationship between green knowledge management and green innovation.

H5: Organizational green culture strengthens the relationship between green knowledge management and sustainable development.

Research methodology

Target population and sampling procedure

The focus of this study is on services and manufacturing firms in Turkey. Implementing a non-probability convenience sampling technique collected the information from 151 companies' managers via personal visits and electronic means (such as email) on a 5-point Likert scale. Only those firms were selected which had MERSIS number, a central registration number of companies in Turkey. Only those in management positions could provide information because they have adequate and up-to-date knowledge of its policies and practices. Moreover, organizational policies are communicated and enforced within departments by managers. A total of 963 questionnaires were distributed. There were 81 responses from small businesses, 121 responses from medium-sized companies, and 149 responses from large-sized businesses, out of a total of 351. In addition, 219 men and 132 women participated in the study; 5 participants did not want their gender revealed. The detailed demographics of the survey participants are shown in Table 1.

Table 1
Demographic of respondents.

Particulars	Description	Values	%
Overall received responses	Large-size firms	149	42.45%
	Medium-size firms	121	34.47%
	Small-size firms	81	23.07%
Gender	Male	219	62.39%
	Female	132	37.61%
Industry type	Manufacturing	199	56.70%
	Services	152	43.30%
Job Position	Lower management	125	35.61%
	Middle management	152	43.30%
	Upper management	74	21.08%

The measurement instrument

The measurement instrument was divided into five sections. The first section of the questionnaire contained demographic data about the participants. GKM was measured using 17 items adapted from Abbas & Sağsan (2019), Lee & Wong (2015), and Song et al. (2020). Sustainable development practices of firms were measured using 14 items taken from Shahzad et al. (2020) and Abbas & Sağsan (2019). Eight items from Wong's (2012) studies were used in the fourth section, which dealt with two aspects of green innovation, i.e., GTI and GMI. For OGC, seven items were taken from Mendis and Welmilla (2021). A pilot test was conducted for the validity and reliability of the adopted items. In the pilot survey, all constructs were internally consistent with values between 0.82 and 0.93, which met the 0.7 standards Hair et al. (2010) set. Based on this, the researchers began a comprehensive study.

Preliminary Analysis and Results

To investigate the relationship between the said variables, researchers used the SEM technique to build a hierarchy of latent constructs and remove biasing effects due to measurement errors (Awang, 2012). Data were analyzed using AMOS v.25 and SPSS v.27. A sample size of 200 was suggested by Hoelter (1983) for factor analysis. With a sample size of 351, this study meets Hoelter's minimum requirements. Moreover, the Kaiser-Meyer-Olkin test also presented a value of 0.911, confirming the adequacy of the sample where the minimum required value is 0.6 (Kaiser & Rice, 1974). A value of 2.249 for the variance inflation factor (VIF) indicated that multicollinearity was not exiting in the dataset. The researchers used Harman's single factor test to investigate Common-Method-Bias (CMB). The single-factor contribution was 38.91%, well below the 50% threshold, indicating that CMB was not a problem.

Analysis of measurement and structural model

The researcher examined the measurement model using confirmatory factor analysis (CFA). Using CFA, a measurement model can be guaranteed to be valid and unidimensional (Hinkin, 1998). The measurement's reliability was evaluated using Cronbach's alpha, which scored 0.901. Peterson (1994) recommended an excellent value of above 0.8 for Cronbach's alpha, which was in line with that. The convergent and discriminant validity tests were used to examine the method's validity. According to Awang (2012) and Hair et al. (2010), factor loading can assess convergent validity. The ideal loading for established items is above 0.5. It is also recommended that all constructs' average variance extracted (AVE) should be greater than 0.5 (Molina et al., 2007). All constructs had item loading and AVE values greater than 0.5, indicating convergent validity. AVE values and composite reliability are shown in Table 2 and the item loading details.

Table 2
Reliability and validity of the instrument.

Construct	Items	Factor Loading	Composite Reliability ¹	AVE ²
Green Knowledge Management	17	0.719-0.889	0.887	0.673
Green Innovation	8	0.721-0.874	0.891	0.702
Sustainable Development	14	0.710-0.901	0.875	0.653
Green Culture	7	0.771-0.899	0.902	0.657

¹ Ideal value ≥ 0.7 (Molina et al., 2007).

² Ideal value ≥ 0.5 (Molina et al., 2007).

Fornell & Larcker's (1981) method facilitated researchers in assessing the discriminant validity. They suggested that a construct's correlation should be more in weight than the other constructs. A higher correlation between square root values of AVE and the pair indicators designates that discriminant validity exists. Moreover, correlations between predictor variable pairs should be less than 0.90 (Hair et al., 2010). Discriminant validity is demonstrated in Table 3, which meets the criteria of Fornell & Larcker (1981) and Hair et al. (2010). The goodness of fit index (GFI), adjusted goodness of fit index (AGFI), normative fit index (NFI), comparative fit index (CFI) and standardized root mean squared residuals (SRMR), chi-square to the degree of freedom (χ^2/df) and root mean square error of approximation (RMSEA) are comprehensive indicators of a measurement model's fit (Kaynak, 2003). Moreover, the Tucker-Lewis index (TLI) was also included to ensure the model's measurement and structural fit. All indicators complied with the ideal recommended values (see Table 4). Thus, it can be concluded that both the structural and measurement models are adequately fit.

Testing of hypotheses and discussion

Analyzing the hypotheses was done using SEM. Each structural parameter's statistical significance helped to validate path hypotheses. CSD was significantly affected by GKM with a β -value of 0.289 and a p -value of 0.004, which is a statistically significant result (see Table 5). Based on this result, the first hypothesis, i.e., "green knowledge management is a significant positive predictor of corporate sustainable development," is accepted. Abbas & Sağsan (2019) also found a link between CSD and knowledge management, supporting this conclusion.

Furthermore, this supports the finding of Lutchen (2018), according to which improved economic performance can be achieved through cross-organizational collaboration on knowledge. The result indicates that the sampled firms in Turkey effectively utilize green knowledge resources and encourage workers to create, acquire, share, and apply pro-environmental knowledge to achieve sustainable development goals. GKM makes it easier for workers to collaborate and share environment-friendly knowledge. Employees can access external information that would otherwise require significant research and development efforts by working together.

Similarly, a significant impact of GKM on green innovation was observed with β 0.310 and 0.002 p -values. This supports the findings of Song et al. (2020), who claimed that a company's ability to use resources and innovate green efficiently is backed by green knowledge. This means that the ability of organizations to manage green knowledge is directly related to their green innovation capabilities; the more they can manage green knowledge, the better they will be able to innovate green. Firms can minimize the negative impact of their operations on the natural environment through green innovation. However, in this regard, they must pay significant attention to managing green knowledge, such as its acquisition, sharing, application, and creation.

Examining the green innovation relationship with CSD presented a strong result, with β being 0.331 and the P -value being 0.003. Thus, the third hypothesis, i.e., "green innovation strengthens organizational

Table 3
Constructs' discriminant validity.

Construct	Green Knowledge Management	Green Innovation	Sustainable Development	Green Culture
Green Knowledge Management	0.820			
Green Innovation	0.481	0.838		
Sustainable Development	0.529	0.532	0.810	
Green Culture	0.538	0.457	0.575	0.811

Table 4
Structural and measurement models.

The goodness of fit measures	CMIN/DF	NFI	GFI	AGFI	CFI	TLI	RMSEA	SRMR
Suggested value	≤3 ¹	≥0.9 ²	≥0.9 ²	≥0.9 ²	≥0.9 ²	≥0.9 ²	≤0.08 ³	≤0.08 ⁴
Measurement Model	1.131	0.911	0.918	0.909	0.908	0.917	0.031	0.0391
Structural Model	1.143	0.917	0.922	0.916	0.913	0.921	0.036	0.0412

¹(Bagozzi & Yi, 1988)

²(Byrne, 1989; Bentler and Bonett, 1980; McDonald & Marsh, 1990)

³(Browne & Cudeck, 1992)

⁴(Hu & Bentler, 1998)

Table 5
Results of hypothesis testing.

Hypothesis	Constructs	Estimate	Critical ratio	p-Value	Decision
H1	GKM → CSD	0.289	3.112	0.004*	Supported
H2	GKM → GI	0.310	3.289	0.002*	Supported
H3	GI → CSD	0.331	3.421	0.002*	Supported
H4	GKM*OGC*GI	0.226	2.310	0.008*	Supported
H5	GKM*OGC*CSD	0.202	2.221	0.011*	Supported
Control Variables					
Firm size	FS → GI	0.191	2.127	0.037*	Significant
	FS → CSD	0.149	1.552	0.062*	Insignificant
Industry type	Ind-Typ → GI	0.196	2.144	0.031*	Significant
	Ind. Typ → ENS	0.199	2.284	0.029*	Significant

* p ≤ 0.05;

**p ≤ 0.01; GKM = green knowledge management; GI = green innovation; CSD = corporate sustainable development; OGC = organizational green culture; FS = firm size; Ind-Typ = industry type.

capabilities to achieve corporate sustainable development goals," is accepted. Abbas & Sağsan (2019) also mentioned identical findings in their study. They stated that environmental innovation strengthens manufacturing firms' capabilities to achieve sustainability goals in Asian emerging economies. It also confirmed Ahmed et al.'s (2022) study findings, which stated that green innovation significantly influences organizations' financial and environmental performance. One of the critical roles of green innovation is to spur the development of new technologies and processes that help businesses be more environmentally friendly while also ensuring their long-term financial viability. Poor waste management and industrial operations have devastating results. Developing countries have made significant strides in promoting environmentally friendly business practices by investing in green technology and innovation. Green innovation appears to be used effectively by the sample companies to achieve sustainable development goals.

Following this, the authors examined the moderating effect of OGC in the relationship between GKM and green innovation and GKM and CSD. The moderation effect was studied by establishing an interaction term formulated by multiplying GKM as an independent variable with OGC as a moderator studying its impact on organizational green innovation capabilities. The result indicated a 0.226 value for standardized estimates and a 0.008 p-value. This led to the acceptance of the fourth hypothesis, i.e., green organizational culture strengthens the relationship between green knowledge management and green organizational innovation. Similarly, the OGC's moderation effect analysis between GKM and CSD presented a value of 0.202 for

the standardized estimates and a 0.011 p-value. Thus, the fifth hypothesis, i.e., green organizational culture strengthens the relationship between green knowledge management and sustainable corporate development, is accepted. These findings indicate that the green culture of firms supports organizational capabilities to innovate green and achieve sustainability goals by capitalizing on GKM. These findings also relate to Muisyo & Qin (2021) study. They examined the relationship between green human resource practice and green organizational performance via the moderating effect of green culture and found that culture strengthens the relationship between said variables. Thus, it is fair to mention that green culture adequately facilitates firms to enhance their performance concerning green innovation and CSD by strengthening the relationship between GKM and green innovation and GKM and CSD.

Finally, firm size and industry type were examined concerning organizational green innovation and sustainable development performance. With respect to green innovation, firm size presented significant positive results, which means that large firms tend to engage in green innovation activities higher than small or medium-sized firms. However, an insignificant result concerning sustainable organizational performance was found for firm size. This indicates that effective implementation of GKM practices equally facilitates all firms in achieving sustainability goals, whether a firm is large or small. Similarly, the role of industry type was examined concerning green innovation and CSD, which presented significant results for both paths. This indicates that green innovation activities quantum for GKM varies from industry to industry, and manufacturing firms are

more actively engaged in green innovation activities than services. A similar result is found for CSD concerning industry type with respect to GKM. To ensure the flow of environmental knowledge to the appropriate stakeholders for its translation into green innovation and CSD, they must be mindful of establishing organizational knowledge-based capacities to respond to the complex dynamics of the workplace. Stakeholders' interest in CSD projects may be piqued due to such measures raising their ecological consciousness.

Research implications and limitations

Managers of small and medium-sized businesses can benefit from the current research results, showing that GKM can help them achieve sustainability goals like large corporations. Manufacturing and service businesses benefit from the effective implementation of GKM. This study suggests that policymakers should take various preparatory steps to ensure the successful performance of GKM, along with organizing practical training and education sessions for employees' development to become a sustainable organization that generates more significant revenue and minimizes the environmental impact of its operations. The current research also emphasizes the importance of green innovation in helping organizations achieve sustainable development through GKM. However, in this regard, top management must promote environment-friendly culture to strengthen individual capabilities to innovate green and perform as per SD goals. Such practices will ultimately benefit society by resulting in a better quality of life, environment, and society.

Theoretically, this research contributes to the rare body of knowledge about the relationship between GKM, green innovation, and CSD. This study recommended a gradual convergence between knowledge management and green theory as the most valuable resource for making green innovation and CGP a reality. According to green knowledge management theories, GKM (a dynamic capability) can be an important factor in the company's competitive advantage and green performance. This research is the first of its type in this area. The current study uses multivariate statistical techniques and SEM to examine the understudied relationship between CSD and GKM. It highlights the importance of green innovation in bridging GKM and sustainable development, a relationship that has rarely been thoroughly examined. As this study shows, green innovation and achieving sustainable development goals require effective implementation of the GKM system.

As a result, there are a few drawbacks to this study. This study focused solely on middle and upper management data, ignoring operational staff who may have helpful information to share with the researcher. Including them in future studies is essential to gain more insight into the topic. Because managers were asked to operationalize the research instrument, data were gathered based on what they perceived their organizations to be doing, which could have led to bias. Despite the author's efforts, biases cannot be eliminated completely. Thus, future researchers should incorporate data from multiple sources, such as annual financial reports. Moreover, the examined model could be validated by expanding the scope of the study to other countries. It is also suggested to test the main constructs, i.e., GKM and green performance, by integrating other variables, such as the supervisor's role, employee work engagement, personal moral norms, etc.

Conclusion

The study aimed to investigate the relationship between GKM, green innovation, and CSD, along with the moderating role of OGC. Using four GKM practices: knowledge creation, knowledge acquisition, knowledge sharing, and knowledge application, the researchers examined how GKM processes impact organizational green innovation capabilities, as well as sustainable development activities: environmental, social, and economic. GKM, as per the findings,

significantly strengthens green innovation and sustainable performance activities of manufacturing and service sampled firms to address the study's first objective. Thus, policymakers should link the GKM initiatives with the overall business policies to accelerate their business performance and the environmental one. It also indicates that green culture is critical in organizational activities and strengthens the relationship between GKM and green innovation, addressing the study's second objective. Finally, firm size and industry play a significant role in organizational capabilities to innovate green. However, it has an insignificant role in CSD, addressing the third objective of the study.

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