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Driving Sustainable Development Goals Through Green Knowledge Management and Green Innovation: The Mediating Role of Green Behavioral Intention

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ABSTRACT

Organizational capacities to achieve the Sustainable Development Goals (SDG) have been the focus of the current study. This study examines green innovation, namely green technology and managerial innovation, as well as green knowledge management (GKM). The researcher collected information from 245 respondents from managers in manufacturing and service companies of all sizes, and utilized structural equation modeling to examine it. The findings demonstrate that GKM improves an organization's ability to achieve SDG and green innovation. Moreover, it has been found that green innovation considerably positively predicts corporate sustainable development (CSD). Furthermore, it is found that GBI enhances the relationship between green innovation and GKM to achieve SDG. Furthermore, it is shown that GKM is equally important for all sizes of manufacturing and service firms.

Introduction

The industrial revolution of the 19th century causes millions of people to get rid of poverty. However, the degradation of resources and the environment has been an unexpected consequence of this wealth (Abbas & Dogan, 2022). The economic growth of developing economies is threatened by the natural resource base's susceptibility to the consequences of global warming (Alkaraan et al., 2022). Governments everywhere have been eager to set rules and guidelines for products and services that are nearly entirely safe for the environment. Governments were asked to concentrate on practical goals for cutting greenhouse gas emissions (UNCOP26, 2021).

In order to protect and improve society and the environment, the UN also created the Sustainable Development Goals (SDGs) (UNDP, 2021). As a result, organizations started to realize how important it was to have a green environment, which motivated them to concentrate on improving their operations and management system (Ahmed et al., 2022). Expertise, quality, and eco-friendly practices are important strategies used by dynamic businesses to obtain a competitive advantage in the current economic environment (Al-Qudah et al. 2022). Whether a business succeeds or fails depends on its ability to learn and retain information.

Companies employ information to boost customer satisfaction and gain a competitive edge (Mohan et al., 2022).The corporate community's interest in knowledge management (KM) has increased significantly during the past few years. It is seen as a crucial component in managing operational processes, creating strategies, and creating new products and services (Pham et al., 2022). An organization's productivity can be increased with an effective knowledge management system. However, in light of environmental concerns, dynamic businesses have expanded the application of knowledge management (KM) and started integrating the environment into it.

Innovation is the most crucial component of corporate growth since it gives an organization a competitive edge, drives it toward excellence, and increases environmental efficiency, all of which contribute to the social capital required for future developments. A growing number of companies have made green innovation (GI) a key component of their strategy to lessen the negative consequences of traditional growth models. When evaluating a company's commitment to GKM practices, it is crucial to take into account how these activities impact the company's environmental performance and any potential environmental benefits (Cai et al., 2023).

As a result, green knowledge management, or GKM, has become an important strategic asset for many companies (Yu et al., 2022), giving them a competitive edge in achieving the United Nations' Sustainable Development Goal 9 (Dang & Wang, 2022). Among other things, SDG 9 aims to promote fair and sustainable industrialization and, through "green innovation," make it easier for businesses to produce eco-friendly goods. Businesses must distinguish between green management innovation (GMI) and green technology innovation (GTI) and give priority to both technological and management innovation in order to achieve social sustainability (Sianturi et al., 2022).

GTI combines ecological knowledge with contemporary technologies. Two nations that have recently set up state-level financial institutions to promote SD and follow the "Green Industry Plan" include Canada and Japan. These organizations may leverage public-private partnerships (PPPs) to support green infrastructure and technological innovation .In order to achieve sustainable development, GI reduces waste and resource consumption, making it easier to produce ecologically friendly items (Khan et al., 2021). GI is a key driver for SD (Awan et al., 2020) since green processes and green commodities offer customers equivalent value with minimal social and environmental consequences.

The success of an organization is determined by its ability to learn and retain information. Knowledge management, or KM, is widely recognized as being essential for developing strategies, developing new products and services, and supervising operational procedures. However, due to environmental concerns, contemporary businesses have broadened the scope of knowledge management and begun incorporating environmental factors. The application of green knowledge management (GKM) has emerged as a critical strategic tool for businesses, providing them with a competitive advantage in attaining corporate sustainable development (CSD), according to (Wang et al. 2022). It helps companies develop new or improved goods or processes that use the least amount of raw materials and other resources feasible, in addition to enhancing the manufacturing, economic, and environmental processes (Song et al., 2022). The main goals of GMI companies are improved production and management practices and reduced environmental impacts.

Improved production and management practices and reduced environmental impacts are the primary goals of companies in the GMI. Numerous studies have examined the connection between KM and sustainable development. However, due to the novelty of the concept, GKM and its role in sustainable development and organizational green innovation are rarely discussed. Additionally, there hasn't been much focus on the GBI mediating role in strengthening the link between GKM and green innovation to achieve sustainable development. This study aims to fill this gap in the literature.

The two control variables employed in this study are the type of business, such as manufacturing and services, and the size of the businesses, such as small, medium, or large. There are two significant distinctions between the operational processes of the industrial and service sectors (Abbas & Sagsan 2019). First, the manufacturing company's production process is physical, while the services sector's output is varied and imperceptible. It's also crucial to keep in mind that the service sector delivers and consumes at the same time, unlike manufacturing. This is the case since these two businesses operate using separate systems.

The size of the company is the second control variable in the study. The size of the company is employed as a control variable because small and medium-sized enterprises have fewer resources than large corporations. Large companies may approach green innovation, sustainable development, and GKM differently from medium-sized companies, which could be explained by the way they function. A company is classified as small if it employs less than fifty people; medium-sized if it employs fifty to two hundred people; and large if it employs more than two hundred people.

This study aims to examine the influence of green knowledge management on green behavioral intention, green innovation, and corporate sustainable development. Specifically, it seeks to explore the relationship between green knowledge management and green behavioral intention and investigate the mediating role of green behavioral intention in the relationships between

green knowledge management and both green innovation and corporate sustainable development. Furthermore, the study aims to analyze the direct effects of green knowledge management on green innovation and corporate sustainable development. Overall, the research intends to provide insights into how effective management of green knowledge can strengthen environmentally responsible behavioral intentions, promote green innovation, and contribute to the achievement of corporate sustainable development.

Academics, businesses, ecological specialists, and other stakeholders will gain a better grasp of how to use the GKM system to harness green innovation and CSD to achieve environmental sustainability objectives. In the parts that follow, the researchers discuss the study's theoretical underpinnings, literature review, methodology, data analysis, findings, conclusions and implications, study conclusion, and recommendations for the future.

Literature Review

Green Innovation (GI)

GI gives businesses the ability to reduce the negative environmental consequences of their activities and ensures a competitive edge (Awan et al., 2020). It can help create new goods and manufacturing techniques that are less harmful to the environment and ecology (Khan et al., 2022). GI refers to "the production, application or exploitation of a good, service, process, organizational structure or management or business method that is novel to the firm and results in a reduction of environmental risk". There are several ways to define GI. For example, one definition is "green non-technological innovation," which includes organizational structure and management innovation, and another is "green technical innovation," which includes product and process innovation (Hilkenmeier et al., 2021).

The former seeks to include a variety of cutting-edge and innovative technologies that may enhance current processes and goods in order to lower energy consumption, avoid pollution, and sustain natural resources (Khan et al 2021, Xie et al. 2022). It makes references to innovation in both processes and products. The latter includes implementing or changing business management methods to reduce negative environmental consequences, such as those related to energy, environment, quality control, green supply chains, and green marketing (Klein et al., 2021).

Hardware or software innovation that is related to green products or processes, including the innovation in technologies that are involved in energy saving, pollution prevention, waste recycling, green product designs, or corporate environmental management. Long-term socioeconomic success is attributed to it as the primary motivator. The main factors that influence the adoption of GI, including the pressure from concerned stakeholders, strategic orientation, organizational learning, knowledge management, and absorptive capacity (Shahzad et al., 2020). Additionally, organizational innovation is a key factor in improving business excellence, industrial export, environmental performance and Sustainable Development Goal 9 (Li et al., 2020). It is a method by which businesses eliminate or reduce the adverse effects of their operations on the environment. It is the development of goods, procedures, technologies, and organizational frameworks with the intention of safeguarding the environment by reducing resource consumption, managing waste, and reducing pollution.

Green Knowledge Management (GKM)

Two types of knowledge exist that are distinct from the material world: implicit knowledge and explicit knowledge (Abbas & Kumari, 2021). Unwritten knowledge that is retained in people's brains is referred to as tacit knowledge. It is acquired from encounters with other people and life experiences. It is more difficult to transmit tacit information than explicit knowledge to others as it is unsaid and unwritten (Naqshbandi & Jasimuddin, 2022).

Knowledge management (KM) as transforming tacit knowledge into explicit knowledge to facilitate seamless knowledge transfer within an organization, taking into account implicit and explicit forms of knowledge. Verbalized, articulated, shared, and codified knowledge is explicit and typically documented in manuals, books, and reports (Zhao et al., 2022).

Three categories of knowledge—implicit, organized, and summarized—have been emphasized in the literature. "Organized knowledge" is defined as information that has been explicitly recorded, whereas "encapsulated knowledge" is defined as knowledge that is not observable. Comparatively, people's subconsciously stored, unwritten, and subtle information is known as tacit knowledge. The concepts of enablers and processes have been used to describe KM. By implementing KM techniques, which address all facets of acquiring, storing, using, applying, and developing knowledge, and organizations may become more competitive and successful. A company's culture is one of the things that makes it easier. KM processes and enablers have a significant potential to boost company innovation skills.

Knowledge, vitality, and sizes are the three facets of the contemporary knowledge-based dynamic capabilities (KBDC) perspective on the environment. Dynamism has a role in addressing environmental concerns emphasizing the necessity of a

planned reaction to environmental change. Knowledge refers to the know-how of transforming green, while capacity refers to an organization's ability to handle the adjustments needed to become a green business. Therefore, boosting innovation and, eventually, green performance requires the development of green knowledge competency. To comprehend this phenomena, culture might be a very useful resource (Pan et al., 2022).

Knowledge production involves engaging with people and creating new ideas and concepts through explicit and tacit knowledge. In order to maintain and improve the calibre of goods and services in response to changing consumer demands and a dynamic business environment, companies need to learn from their suppliers, workers, and clients. Consequently, organizations may analyze their deficiencies and build on their strengths by acquiring information. Employee awareness of the new knowledge is crucial, particularly for those working in related departments.

Corporate Sustainable Development Goal (CSDG)

The UN was presented with the "Our Common Future" report by the Brundtland Commission in 1987, which is credited with inspiring the creation of sustainable development objectives. Sustainable development is defined as development that satisfies current demands without endangering the capacity of future generations to satisfy their own needs. The notion of sustainable development has been expanded by including social sustainability as a third option. Therefore, the three pillars of corporate sustainable development, or CSD, are environmental, social, and economic sustainability.

According to the most recent study, an organization's capacity to use green knowledge enables it to deliver environmentally friendly goods and services through green innovation, therefore improving its environmental performance. An organization is more likely to innovate and behave sustainably if its GKM system is functioning well. The core of the green philosophy is achieved by these actions, which are closely related to attaining sustainability goals.

Green Behavioural Intention (GBI)

The recognition by social scientists and psychologists is that intentions behind conduct always have a significant impact on actual behaviour (Zafar et al., 2020). However, the behaviour prediction that is actually yet difficult. The degree to which an individual has determinedly deliberate to carry out or abstain from carrying out specific future behaviour is known as behavioural intention. The adoption of green innovation is greatly influenced by behavioural intention with relation to green knowledge management, as noted by the researcher.

A number of researchers use intention conduct as a stand-in for real adoption behaviour. Because of the best sustainability outcomes and increased environmental restrictions, GI is becoming a more competitive approach. Additionally, GI is a long-term endeavour that calls for a company to produce significant innovations in goods and processes, which invariably raises environmental hazards. Larger companies are more likely to control possible hazards because they are prepared to integrate new technologies, competences, and internal and external environments. So, in line with the underlying theory and research design, we anticipate that GBI will have a significant impact on GI.

Theory and hypotheses

The "knowledge management theory" and "green theory" serve as the foundation for the current study. The following hypotheses has been proposed:

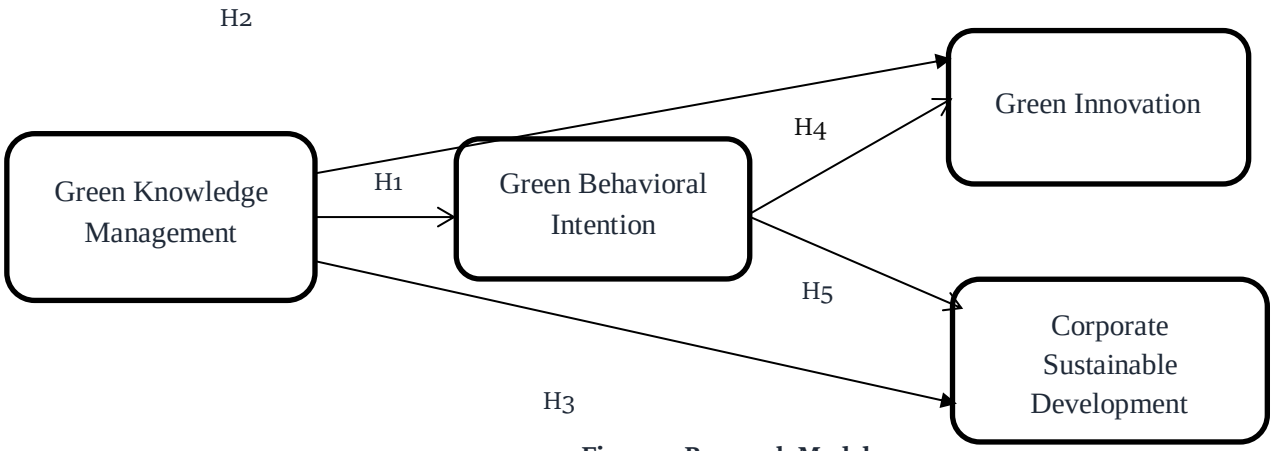


Figure-1 Research Model

- ***H1:*** There is a significant relationship between green knowledge management and green behavioral intention.
- ***H2:*** The green behavioral intention mediates the relationship between green knowledge management and green innovation.
- ***H3:*** The green behavioral intention mediates the relationship between green knowledge management and corporate sustainable development.
- ***H4*:** There is a significant direct relationship between green behavioral intention and green innovation.
- ***H5*:** There is a significant direct relationship between green behavioral intention and corporate sustainable development.

Green behavioural intention (GBI)

Social scientists and psychologists agree that intentions behind conduct always have a significant impact on actual behaviour (Zafar et al., 2020). Nevertheless, it is still difficult to anticipate real conduct. Behavioural intention refers to "the extent to which an individual has formulated conscious plans to perform or not perform some specified future behavior(s). Adopting innovation is greatly influenced by one's behavioural desire to do so. A number of researchers use intention conduct as a stand-in for real adoption behaviour.

Owing to stricter environmental laws and better sustainability results, GI is currently developing a competitive approach. GI is a long-term endeavour that requires an organization to make significant innovations in processes and products, which invariably trigger environmental concerns. More than smaller businesses, larger organisations are more likely to control possible hazards and are prepared to absorb new technologies, capabilities, and internal and external environments. According to the research model and underlying theory, we thus anticipate that GBI will have a significant impact on GI.

Green knowledge management and corporate sustainable development

GKM is a brand-new, environmentally friendly phenomena based on knowledge. Employers can guarantee that workers have timely access to pertinent information in an approachable and environmentally friendly style. In order to achieve organizational excellence and preserve the environment, it integrates information and people management (Song et al., 2022). GKM, or implicit and explicit knowledge of talents and skills, is what makes firms innovative and competitive. The connection between GKM and corporate social responsibility (CSR) has grown in importance for organisations in a knowledge-driven world. Green knowledge is more innovative and capable of exploring new sustainability paths.

The United Nations Global Compact (UNGC) has advised manufacturing enterprises to minimize their negative environmental effect by utilizing cutting-edge technology and ecologically friendly practices. Companies must prioritizes green knowledge exchange and research and development (R&D) in order to innovate. These technologies are used by organisations to develop new goods and procedures as well as enhance current ones in an effort to boost social, environmental, and economic performance (Khan et al., 2022). Acting, engaging, and speaking with others are all parts of creating knowledge. Organisations must commit enough funds to green projects in order to generate new green knowledge and technology advancements if they hope to achieve long-term sustainability. The majority of workers learn information from their peers and coworkers (Zwain et al., 2021). By participating in pro-environmental activities at work, employees can come up with innovative solutions to environmental issues.

Additionally, it supports the creation of an atmosphere that supports thinking and behaving sustainably as well as the formulation of strategies and choices (Ali et al., 2020). Organizations may gain a competitive edge, build new core capabilities, and improve their financial and environmental performance by using green knowledge (Ahmed et al., 2022). By putting their expertise to use, businesses might discover fresh approaches to enhance performance. The environment, economy, and society are the three dimensions that are associated with the notion of CSD (Xie et al., 2022). Ensuring clean air and water, protecting the environment, using fewer natural resources (particularly non-renewable ones), creating environmentally friendly goods, and cutting down on hazardous gas and liquid emissions are all important aspects of sustainability from an environmental perspective (Song et al., 2022). The social side of sustainability is centered on enhancing organizational interactions with society and individuals and advancing human well-being by better understanding their needs. In addition, it emphasizes the advancement of human rights, justice, equality in society, and the growth and support of social life (Abbas & Dogan, 2022).

In order to optimize a company's profit, the economic dimension of sustainability employs a practical strategy to boost sales and reduce operational expenses (Sianturi et al., 2022).

GKM integrates social, economic, and environmental sustainability, which is essential to the success of this profession. Dynamic organisations prioritize integrating GKM with overall organizational strategy to achieve long-term sustainability. The environmental performance of organisations is greatly impacted by their ability to assimilate green information (Shahzad et al., 2020). In the long run, GKM can assist companies in becoming more sustainable. Although various scholars have emphasized the significance of GKM in general knowledge management, innovation, and organizational success there hasn't been much study on the topic of GKM's function in CSD.

Mediating influence of GBI

The goal of this study is to ascertain if GBI mediates decisions made by UTAUT and green innovation among their various constituents. The emphasis of behavioural intention is the desire for actual use or adoption; these impulses can be strong and uncontrollable, yet even so.
It doesn't really determine what is done. According to a number of research behaviour intentions have a crucial impact in the actual adoption of technology. Behaviour intentions are a predictor of podcast innovation adoption. Furthermore, eco-friendly behavioural intentions have a substantial impact on adoption decisions regarding green innovation and the achievement of the CSDG (J. Lee et al., 2021).

Prior research has focused a great deal on the relationship between green conduct and adoption intention and green thinking and motivation (Ali et al, 2020). Additionally, there has been emphasis on the importance of behavioural intention as a critical mediating factor between GKM and confidence in novel innovations. Thus, we hypothesize that GBI acts as a mediator between GI and the integrated construct based on the body of existing research. Between green knowledge management, green innovation, and CSD, green behavioural intention acts as a mediator.

Green knowledge management and green innovation

There is a long-standing correlation between innovation and knowledge. Green innovation may lessen or even eliminate the detrimental effects that organizational activities have on the environment (Ahmed et al., 2022). Reducing resource consumption, controlling waste, promoting recycling, and reducing pollution are some of the SDGs. GTI has the ability to develop new or enhanced goods or processes via the use of environmental science and technology. Furthermore, it has the potential to mitigate the ecological consequences of an entity's activities (Rehman et al., 2021). GTI is divided into two subcategories: innovation in green products and processes. The goal of innovative green processes is to increase the efficiency of turning raw resources into useable products (Shahzad et al., 2020). It also seeks to reduce waste production, boost the use of renewable resources, and preserve natural resources (Awan, 2020; Kumari et al., 2021). By adding non-toxic or renewable ingredients to current goods or creating brand-new ones, green product innovation aims to decrease the manufacturing process's negative environmental effects.

When a business implements a new management model or strategy to enhance its production processes, it is referred to as GMI. Businesses can profit financially and reduce their environmental effect by using GMI. Businesses can meet GMI objectives by implementing environmental management systems and regulations like ISO 14001. Businesses who pioneer GTI and GMI typically see a rise in customer trust, loyalty, and profitability (Rehman et al., 2021). Businesses that prioritize knowledge are preoccupied with optimizing resource utilization and reducing their ecological footprint. In addition to supporting and enabling the creation of green goods, these organisations frequently consider the ecological effect of their activities (Naqshbandi & Jasimuddin, 2022).

Knowledge management is critical to the innovation process because it provides a foundation for research and analysis. Green knowledge enhances organizational environmental performance. Additionally, innovation-related activities affect the link between social sustainability and organizational success. Governments ought to support companies in creating high-quality goods and services while using the fewest amount of natural resources. Dynamic businesses provide mechanisms, such as infrastructure, resources, and information that enable staff members to generate knowledge and creative ideas in order to promote the generation of new knowledge. Environmental practices must be included into research and development operations by organisations in order to meet the ever-changing needs of the market (Abbas & Dogan, 2022). They have to do things that encourage producing high-quality goods with less resources, which is good for the business and the environment (Song et al., 2022). According to recent study, businesses with a GKM framework are better positioned to innovate sustainably and meet sustainable development objectives (Odilova & Nawaz, 2025).

Methodology

Target Population & Data Collection

This study targets services and manufacturing firms in Pakistan. Data was collected from company managers using a non-probability convenience sampling technique through personal visits and electronic means, such as email. The survey used a 5-point Likert scale. The information was gathered exclusively from individuals in management positions, as they possess sufficient and up-to-date knowledge of their company's policies and practices. Additionally, managers are responsible for communicating and enforcing organizational policies within their departments. A total of 280 questionnaires were distributed, 245 responses were completed and used for analysis. Out of these, 35 questionnaires were rejected as incomplete and unsuitable for further analysis. Detailed demographics of the survey participants are presented in Table 1.

Results and Findings

Demographic of respondents

The given below result shows the demographic characteristics of the respondents (n = 321). Men (40.4%) outnumbered women (59.6%). Regarding their age, 78.8% were between 25 and 35 years old, 16.7% were between 35 and 45 years old, & 4.5% were between 46 and 55 years old. Concerning education, 27.7% had a high school (metric & intermediate) education, 11.8% had a bachelor's degree, & 60.4% had a master's degree. The largest proportion of respondents worked in organizations with **201–250 employees 40.8%**, followed by **101–150 employees 25.3%, 151–200 employees 18.4%,** and **less than 100 employees 15.5%**. 53.1% respondents belonged to the **manufacturing sector**, whereas **46.9%** worked in the **services sector.** As for job levels, 27.8% were upper management, 46.9% were middle management, & 25.3% were lower management.

Table: 1

Particulars	Description	Values	%
Gender	Male	145	40.4%
	Female	99	59.6%
Age	26 to 35	193	78.8%
	36 to 45	41	16.7%
	46 to 55	11	4.5%
Qualification	Masters	148	60.4%
	Bachelors	29	11.8%
	Intermediate	52	21.2%
	Matric	16	6.5%
Size of Organization	Less than 100	38	15.5
	101 to 150	62	25.3
	151 to 200	45	18.4
	201 to 250	100	40.8
Nature of Business	Manufacturing	115	53.1%
	Services	130	46.9%
Job Position	Lower management	62	25.3
	Middle management	115	46.9%
	Upper management	68	27.8%

Measurement Instrument

The measurement instrument was divided into five sections. The first section of the questionnaire collected demographic data about the participants. GKM was measured using 19 items adapted from the studies by (Nazarian et al., 2024). Sustainable development practices of firms were assessed using 13 items environment (adapted from Laosirihongthong et al., 2013), economic (adapted from Eltayeb et al., 2011), and social (adapted from Abdul-Rashid et al., 2017).

The green innovation, utilized 6 items from (Ma et al. 2018 and El-Kassar & Sigh 2019) focusing on two aspects: GTI and GMI. For GBI, 3 items were sourced from (Venkatesh et al., 2003).To investigate the relationships between the variables, researchers employed the Structural Equation Modeling (SEM) technique. This method was chosen to construct a hierarchy of latent constructs and to mitigate biasing effects caused by measurement errors (Awang et al, 2016).

Evaluation of Measurement Modal

Through a two-stage evaluation process—the measurement model and the structural model—the PLS-SEM technique was utilized to forecast the associations between variables. A number of tests were used to verify the measurement model, including internal reliability consistency, convergent validity, and discriminant validity. The outer loadings of the indicator were used to determine the construct item reliability, which must be at least 0.70 to be considered reliable (Hair et al., 2019a). Convergent validity was assessed via three criteria: (1) factor loading needs to be more than 0.70, (2) Composite reliability needs to surpass 0.70, and (3) average variance extracted (AVE) needs to be greater than 0.50 (Hair et al., 2019a). Discriminant validity was evaluated to measure the uniqueness of each construct. The HTMT0.85 parameters were used to assess discriminant validity, in which connection the coefficient values should be less than 0.85 (Henseler et al., 2015). The respondents comprise employees from different companies throughout Pakistan. Participants have different histories; therefore, their gender, age, educational attainment, nature of business, and positions also vary. This diversity offers a comprehensive understanding of different characteristics of the both (manufacturing vs. service) sector's workforce in the country (Nawaz et al., 2025).

Statistical analysis

Table 2: Composite reliability and Convergent validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Corporate Sustainable Development	0.948	0.949	0.955	0.618
Green Behavioral Intention	0.812	0.812	0.889	0.727
Green Innovation	0.865	0.868	0.899	0.598
Green Knowledge Management	0.918	0.919	0.930	0.504

Cronbach's alpha values were calculated to assess the model's validity and dependability. Cronbach's alpha, composite reliability, and average variance extracted (AVE) values are shown in table 2. The values of Cronbach's alpha for Corporate Sustainable Development, Green Behavioral Intention, Green Innovation, & Green Knowledge Management are 0.948, 0.812, 0.856, and 0.918 respectively. All the values are greater than 0.70. The values of Cronbach's alpha should be greater than 0.70 in order to be considered acceptable. The value of Composite reliability was also measured to check the reliability of constructs.

The results show that values for Corporate Sustainable Development, Green Behavioral Intention, Green Innovation, & Green Knowledge Management are 0.949, 0.812, 0.868, and 0.919 respectively. All the values of CR are greater than 0.7. The results of CR indicate that the model possesses acceptable level of reliability. The AVE values of the latent variables were also computed and reflected in table. The AVE value for GKM, GBI, GI and SD are 0.618, 0.727, 0.598 and 0.504, respectively. All these values are greater than 0.5 which shows the acceptable level of convergent validity.

Factor Loadings

The values of factor loadings show the reliability of individual indicators of constructs. The value for factor loading should be more than 0.7 for acceptance. The results (Table 2) show that all values of factor loading are significant except loadings for some indicators, such as GKM7 (0.696), GKM10 (0.636), GKM11 (0.690), GKM12 (0.697), and GKM14 (0.687), and GKM16 (0.686) are below the typical 0.7 threshold, which suggests these items are weaker measures of Green Knowledge Management.

Table: 3

	Corporate Sustainable Development	Green Behavioral Intention	Green Innovation	Green Knowledge Management
GBI1		0.877		
GBI2		0.860		
GBI3		0.821		
GI1			0.766	
GI2			0.744	
GI3			0.813	
GI4			0.754	
GI5			0.767	
GI6			0.793	
GKM10				0.636

GKM11		0.690
GKM12		0.697
GKM14		0.687
GKM16		0.686
GKM2		0.708
GKM3		0.745
GKM4		0.713
GKM5		0.765
GKM6		0.720
GKM7		0.696
GKM8		0.712
GKM9		0.764
SD1	0.810	
SD10	0.779	
SD11	0.806	
SD12	0.757	
SD13	0.787	
SD2	0.766	
SD3	0.745	
SD4	0.788	
SD5	0.818	
SD6	0.770	
SD7	0.799	
SD8	0.791	
SD9	0.800	

Discriminant validity

To assess the extent to which each and every variable is distinct from other constructs, Fornell Larker criterion and HTMT were used to verify and confirm discriminant validity. The results of these methods are shown in Tables.

Heterotrait-monotrait ratio (HTMT)

The values of HTMT should be less than 0.90 in order to establish discriminant validity. This criterion establishes that all HTMT values indicates a significant level of discriminant validity. The Table 4 shows that all indicators are within the acceptable range, confirming the discriminant validity of the model.

Table: 4

	Corporate Sustainable Development	**Green Behavioral Intention**	**Green Innovation**	**Green Knowledge Management**
Corporate Sustainable Development				
Green Behavioral Intention’]	0.825			
Green Innovation	0.859	0.883		
Green Knowledge Management	0.840	0.771	0.829	

Fornell-Larcker criterion

For discriminant validity, the diagonal value must be greater than all values in the same row and column. The findings demonstrate that all diagonal values are greater than non-diagonal values, indicating that the model's discriminant validity remains unaffected.

Table: 5

	Corporate Sustainable Development	Green Behavioral Intention	Green Innovation	Green Knowledge Management
Corporate Sustainable Development	0.786			
Green Behavioral Intention	0.725	0.853		
Green Innovation	0.781	0.746	0.773	
Green Knowledge Management	0.787	0.669	0.743	0.710

Evaluation of the Structural Model

To evaluate the structural model, we implemented a bootstrapping method (5,000 sub-samples, BC bootstrap, two-tailed, and 5% level of significance). First, we checked the structural model for collinearity issues among predictors. Variance inflation factor (VIF) values higher than 5 indicate collinearity issues. None of the VIF values were greater than 5, indicating that there are no collinearity problems. The coefficients of determination (R2) and the significance levels of the path coefficients were used to validate the structural model.

Collinearity Statistics (VIF)

The values of VIF were also computed to check the issue of multi collinearity in the model. The results of VIF values are shown in Table 6. The results show model VIF values are less than 5. Therefore, it is concluded that any problem of multi collinearity is not present among the variables.

Table: 6

	VIF
GBI1	2.160
GBI2	2.017
GBI3	1.531
GI1	1.743
GI2	1.642
GI3	1.975
GI4	1.734
GI5	1.903
GI6	2.037
GKM10	1.633
GKM11	1.863
GKM12	1.835
GKM14	1.772
GKM16	1.824
GKM2	1.986
GKM3	2.312
GKM4	1.950
GKM5	2.321
GKM6	1.810
GKM7	1.778
GKM8	1.891
GKM9	2.144
SD1	2.786
SD10	2.517
SD11	2.888
SD12	2.725

SD13	2.491
SD2	2.284
SD3	2.051
SD4	2.679
SD5	2.984
SD6	2.611
SD7	2.652
SD8	2.729
SD9	2.674

Path coefficients

The results of path coefficients show that relationship between GBI and SD, GBI and GI, GKM and SD, GKM and GBI, & GKM and GI, are positive having Beta values 0.360, 0.449, 0.547, 0.669, 0.443, respectively (Table 7). The result of path coefficient shows that the relation among them is significant. The t-value for the relationships between GBI and SD, GBI and GI, GKM and SD, GKM and GBI, & GKM and GI, which is greater than 2, shows the significance. The results in the Table 8 describe that all the Hypothesis are supported because their p-values are 0. It means that there is 99% significance level.

Table: 7

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Green Behavioral Intention -> Corporate Sustainable Development	0.360	0.357	0.085	4.229	0.000
Green Behavioral Intention -> Green Innovation	0.449	0.449	0.099	4.536	0.000
Green Knowledge Management -> Corporate Sustainable Development	0.547	0.550	0.081	6.764	0.000
Green Knowledge Management -> Green Behavioral Intention	0.669	0.674	0.043	15.592	0.000
Green Knowledge Management -> Green Innovation	0.443	0.444	0.088	5.015	0.000

R-square

The values of R square and Adjusted R square for the variables are presented in Table 8. The values for R square for Corporate Sustainable Development, Green Behavioral Intention and Green Innovation General Entrepreneurial Intention are 0.691, 0.448 and 0.664, respectively. Similarly the values for Adjusted R square for SD is 0.689, GBI is 0.446 and for GI is 0.661. It means that new variable has relatively small impact on the relationship among the variables.

Table: 8

	R-square	R-square adjusted
Corporate Sustainable Development	0.691	0.689
Green Behavioral Intention	0.448	0.446
Green Innovation	0.664	0.661

Practical Implications and Theoretical Contributions

Managers of small and medium-sized businesses can derive practical benefits from the current research findings, which demonstrate that GKM can help them achieve sustainability goals akin to large corporations. Both manufacturing and service businesses stand to gain from the effective implementation of GKM. Policymakers should consider various preparatory measures to ensure the successful performance of GKM, including organizing practical training and education sessions for employee development, aiming to transform organizations into sustainable entities that generate greater revenue while minimizing environmental impact. Moreover, this study underscores the importance of green innovation in assisting organizations in achieving sustainable development through GKM. Top management must promote an environment-friendly culture to bolster

individual capabilities to innovate green and align with SD goals. Ultimately, such practices can benefit society by improving quality of life, the environment, and societal well-being.

Theoretically, this research contributes to the scarce body of knowledge concerning the relationship between GKM, green innovation, and CSD. It advocates for a gradual convergence between knowledge management and green theory as a critical resource for actualizing green innovation and CSD. According to green knowledge management theories, GKM—a dynamic capability—can significantly influence a company's competitive advantage and green performance. This research marks a pioneering effort in this area, employing multivariate statistical techniques and SEM to explore the understudied relationship between CSD and GKM. It underscores the pivotal role of green innovation in bridging GKM and sustainable development, a connection that has received scant attention previously. As demonstrated in this study, achieving green innovation and sustainable development goals hinges on the effective implementation of GKM systems.

Limitations and Future research directions

However, there are some limitations to this study. It solely focused on middle and upper management data, overlooking operational staff who may possess valuable insights. Future studies should encompass them to gain a more comprehensive understanding of the topic. Additionally, the reliance on managerial perceptions to operationalize the research instrument could introduce bias. Despite efforts to mitigate bias, it cannot be entirely eliminated. Future researchers should incorporate data from diverse sources, such as annual financial reports. Moreover, validating the examined model by expanding the study's scope to other countries is recommended. It's also suggested to enrich the main constructs, such as 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 explore the relationship between GKM, green innovation, and CSD, while also considering the moderating role of OGC. Investigating four GKM practices—knowledge creation, acquisition, sharing, and application—the researchers examined how these processes impact organizational green innovation capabilities and sustainable development activities, including environmental, social, and economic aspects. The findings indicate that GKM significantly enhances green innovation and sustainable performance activities in both manufacturing and service firms, aligning with the study's first objective. This underscores the importance for policymakers to integrate GKM initiatives with overall business policies to enhance both business performance and environmental outcomes.

Furthermore, the study emphasizes the critical role of green culture in organizational activities and its strengthening effect on the relationship between GKM and green innovation, addressing the second objective. Lastly, the study reveals that firm size and industry type play a significant role in organizational capabilities to innovate green, while having an insignificant role in CSD, fulfilling the third objective of the study.

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