Economic Research-Ekonomska Istraživanja

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rero20

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To cite this article: Leping Huang, Qiang Liang, Lidi Xu & Adnan Khan (2023) Mediating effect of sustainable development practices on the relationship between information management practices and green innovation in China, Economic Research-Ekonomska Istraživanja, 36:2, 2142261, DOI: 10.1080/1331677X.2022.2142261

To link to this article: https://doi.org/10.1080/1331677X.2022.2142261

Published online: 13 Dec 2022.

ECONOMIC RESEARCH-EKONOMSKA ISTRAŽIVANJA
2023, VOL. 36, NO. 2, 2142261
https://doi.org/10.1080/1331677X.2022.2142261

Mediating effect of sustainable development practices on the relationship between information management practices and green innovation in China

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ABSTRACT

This research examines the role of information management practices termed as knowledge acquisition, knowledge dissemination, and knowledge application towards green innovation among the Small and Medium Enterprises (SMEs) working in China's region. Moreover, the mediating role of sustainable development practices is also observed in the relationship between knowledge management and green innovation. An online survey questionnaire collected a valid sample of 364 respondents from different SMEs after the COVID-19 period to integrate its aftershocks. Furthermore, structural equation modelling was applied, and the measurement model confirms the reliability, convergent validity, and discriminant validity of latent constructs and selected items'. We confirm a direct and significant relationship between knowledge acquisition, knowledge dissemination, application, and green innovations through PLS-SEM. Besides, sustainable development indicators confirm their mediating role in the relationship between knowledge management and green innovations. This research offers meaningful theoretical and empirical contributions and suggestions for SME industries and policymakers.

ARTICLE HISTORY
Received 17 May 2022
Accepted 25 October 2022

KEYWORDS
Green innovation; sustainable development; knowledge management

JEL CODES
O3; O34; O44; Q01

1. Introduction

The emission of hazardous gases and enhanced utilisation of natural sources due to increased economic development has detrimental impacts on environmental quality; particularly climatic conditions are more vulnerable in emerging countries (Irfan et al., 2022; Ozturk & Ullah, 2022). According to the 'Sustainable Development Goals (SDGs) reports, many countries have failed to cope with the issues of environmental degradation. Scaling the technical evidence of detrimental impacts; caused by increased utilisation of natural resources on the environment has developed external

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enforcement on organisations to effectively counter the challenges of the damaged environment (Awan et al., 2021; Sun & Razzaq, 2022). The increased pressure has intensified the organisational focus on sustainable and green development and fostered the issues of whether SDGs can resolve environmental problems while increasing sustainability and competitiveness (Wang, 2020). In this regard, organisations have acknowledged the importance of the 'Knowledge Management Process (KMP)' for measuring organisational development (Ooi, 2014). Knowledge is the primary indicator of innovation as organisations receive, share, and utilise it for benefits (Cui et al., 2021). Access to knowledge from different stakeholders allows managers to devise a strategic plan for organisational development in revenue generation and help them achieve sustainable and green objectives. Many multinational organisations utilise knowledge management, such as Unilever, Tesla, Ikea, Honda, Canon, Nike, Anderson consultation, and Boeing (Davenport et al., 2019). The practice of knowledge management empowers organisations to cope with the dynamic variations and improve their operational sustainability. This way, organisations develop strategies to enhance their green innovation technology agenda (Abbas & Sağsan, 2019).

Researchers have given much-anticipated importance to 'Corporate Green Innovation' (CGI) due to the scarcity of natural resources and increased environmental challenges (Jun et al., 2019). Organisations must implement CGI to produce eco-friendly items and services, thus, attaining sustainable development goals (Abdul-Rashid et al., 2017). However, manufacturing firms continue to cope with the crucial challenges of achieving SDGs due to the diminished sustainable and green practices that effective KMPs can enforce. The knowledge management process (KMP) is an essential aspect that proposes strategies to implement sustainable practices within organisations to influence CGIs. Thus, the Global Innovation Index (GII) also focussed on the necessary factors that inhibit development: creativity and knowledge (GII, 2018). According to the GII, China is ranked 12th, surpassing developed economies such as Japan and Canada in 2021. Better provisions can be found in the implementation strategies of KMP in controlling environmental pollution in emerging economies such as China, which is transitioning from a less-developed economy to a modern, innovative, and industrial economy.

China is a developing upper-middle-income country. The absence of appropriate KMP in organisational procedures is a compelling factor in technology innovation that is the fundamental concern of this research study. KMP is essential as it can hinder SDG implementation in manufacturing organisations (Cheng et al., 2017). In addition, CGI can be improved by implementing SDGs. Green innovation can enhance environmental performance while ensuring global environmental strategies (Song et al., 2020). Evidence demonstrates that developed countries and big organisations have shifted from the traditional model of product making to customer-oriented and innovative methods by regenerating and designing improved systems in the present knowledge-based market (Razzaq et al., 2021). Governments around the globe have been significantly more active in enacting strict regulations on production firms to combat environmental issues in the wake of the Paris Agreement 2015 (Jun et al., 2019).

Studies on implementing KMP and its impacts on CGI have determined external aspects that affect the organisational capability in promoting green development, such as environmental regulations, market demands, and sustainable resources (Vickers, 2017). Others have investigated the internal aspects affecting CGI, including technology innovation, corporate environmental ethics, and knowledge management techniques (Chang, 2016). Information collection, utilisation, and transfer are vital in clean and green development. In addition, Shahzad, Qu, Zafar, et al. (2020) determined that sustainable environmental processes can positively impact green development, and green innovation is strongly affected by green practices and capabilities. Tecchio et al. (2017) argued that social, environmental, and economic sustainability affect green innovation. A detailed analysis focussing on implementing SDPs for CGI in emerging countries is urgently needed. However, various empirical studies employing samples from industrialised and developing nations have sought to resolve these difficulties. Since its mega project named BRI, China has adopted developing strategies by actively sharing knowledge, technologies, and production expertise (An et al., 2021).

Revolutionized technologies and increased industrial developments have posed several environmental, technological, and social challenges that have pressurised organisations to shift towards clean and green growth. Thus, dynamic organisations must implement strategies to deal with environmental issues to bring CGI to achieve SDGs. Knowledge management is vital in developing an organisation in production and liable services. Dynamic organisations satisfy their customers with sustainable products and implement green innovation technologies (Mothe et al., 2018). KMP has attained significant progress in the past few years and has been essential in developing strategies, innovative products, and liable services (Mardani et al., 2018). Firms' size also plays an essential role in implementing the KMP for CGI as larger organisations have more resources than medium-sized firms. KMP supports firms in building a culture of sustainable corporate performance and helping them make the competencies required for CGI. KMP has aided the growth of FI in the production of cost-effective goods (Chopra et al., 2021). As a result, KMP may be critical to obtaining CSP. Their liabilities and knowledge resources determine the ability of companies to innovate sustainably.

It is a common practice to use the terms innovation and knowledge interchangeably. Investigating GCI has been under research for the past two decades. The KMP anticipates research on its progress implemented in organisations of developing countries like China. The ever-developing autonomous nature of green innovation has led to several liable techniques for improved products and services originating under the CGI model of organisations (Mirzaie et al., 2019). Awareness of environmental impacts by production firms has increased due to progressive social media and globalisation; thus, organisations are now forced to fix their methodologies for clean and green production (Ch'ng et al., 2021). As one of the most populous countries, China is adversely impacting the global environment due to large-scale manufacturing corporations that have not yet implemented the proper KMP to achieve CGI. Manufacturing firms have attained sustainable development by shifting their strategies to KMP at the management level. Thus, the hour needs to represent organisational strategies from analyzing collected data through structural equation modelling (SEM), interlinking the KMP dimensions with SDPs' dimensions. Valuable insights will be provided to upgrade the manufacturing firms within China, still employing traditional data transfer and production strategies.

In recent years, the research attention has increasingly switched to the antecedents of corporate green innovation. The existing literature on the elements that drive green innovation is classified into organisational, institutional, and interpersonal. Even after a significant development in sustainable technologies, there are few studies on CGI to shift the work structures towards green development (Fernando et al., 2019). Management teams must interlink the development of KMP with SDG to achieve CGI at the organisational level in China's small and medium (SME) industries. A few research works of literature have been found linking the KMP with SDGs that will further enrich the goals of this study, incorporating green innovation through sustainable development within manufacturing sectors (Johnson et al., 2019). KMP aims to bring innovative and technological production processes at the organisational level to minimise its impacts on the environment. This study will fill the gaps in implementing manufacturing strategies based on sustainable development while reducing the utilisation of fossil fuel-based energy resources. A more comprehensive research study is required on KMP, SDGs, and the development of CGI. It will provide managers with a liable forum to exchange knowledge and interact with employees for organisational progress (Farza et al., 2021). Technologically advanced countries, such as China, frequently take practical actions and invest in fostering environmentally friendly technology through collaboration with other countries concerned about environmental issues and CGI objectives.

Manufacturing is one of the significant sectors in China, with an industrialised economy and a GDP of $16.642 trillion in 2021 (Nguyen et al., 2021). As per the reports, the Chinese economy's total exports were $2.25 trillion, and 94.3% of the overall exports are based on the manufacturing sector (D'Souza et al., 2020). Implementing KMP keeps immense benefits for the Chinese industrial sector, as significant manufacturing industries include Iron and Steel, Chemical production, Petroleum, Automobiles, Cement, Food Processing, Fertilisers, and Air Crafts. These aspects make China one of the world's largest manufacturing sectors, and the progress of sustainable processes in all sectors can bring clean and green development while following the SDGs to achieve CGI (Cheng et al., 2020). Organisations are equally aware of the importance of technology developments and following sustainable development goals to fulfil the high standards for international commerce and trade. Thus, the current study focuses on the impacts of the KMP on sustainable development to improve China's CGI and address the following questions:

- What is the effect of Knowledge management in achieving SDGs and CGI?
- What part do SDGs play in determining the relationship between KMP and green innovation?

These research questions have been experimentally examined to add to the literature on the interaction between KMP and CGI. Firstly, the suggested theoretical model will analyze the degree to which the knowledge management process impacts the SDGs and CGI at the organisational level from a knowledge-intensive point of view, employing structural equation modelling (SEM). Secondly, fundamental concepts of organisational SDGs will be determined affecting CGI—further, the given research study centres around SDG implementation in developing nations, such as China. The rest of the article is organised in the following manner: Section two covers the literature review. Section three and four determines the research methods and study findings with the discussion. The last section concludes the study with policy implications and limitations for future directions.

2. Theoretical framework and literature review

A production firm can achieve green development by undertaking organisational functions, processes, and operations by implementing KM. Developing a sustainable production plant and its constructs has become a hot topic for research studies while carrying out the SDGs at the organisational level. The focus of the study is to determine the influence of KMP on CGI at the executive level while following the SDGs. Development of robust psychological capital was provided by Çop et al. (2021) in the production firms based on the leader's capability to transform their functions for combating environmental issues. The interrelationship between transformational leadership, corporate green innovation, and the knowledge management process was investigated in a recent study (Li et al., 2020). They employed a variance-based structural modelling equation to process the data collected from surveys and questionnaires (Sun et al., 2022).

2.1. Resource-based view (RBV)

Various research studies have discussed internal industrial aspects of organisational growth in the past decade. Inner organisational strengths and weaknesses were widely described in strategic management based on RBV in response to their relationship with success and competitiveness (Molloy et al., 2011). The BRV theory can help organisations understand the best utilisation of available resources and techniques to increase production and logistics efficiency (Yusof et al., 2016). Organisations can attain a competitive edge over other businesses by accumulating various tangible and intangible productive resources. These practical resources include techniques, tools, skills, knowledge management, administrative effectiveness, information handling, organisational attributes, and facts that enable an organisation to develop and employ strategies for sustainable development (Yusof et al., 2016). These apparent resources have four main aspects valuable, rare, inimitable, and non-substitutable. According to (Andersén, 2021), RBV is inhibited from providing firm-level outcomes and indifferences the impacts of sustainable development goals (SDGs) on green innovation and the environment. Natural RBV, stated as NRBV was proposed by (Hart, 1995), further extends the implementation of RBV and makes organisations take steps to save the natural environment and resources.

The NRBV looks into how organisational resources might lead to significant benefits and beneficial environmental outcomes. By adopting an NRBV perspective, ecologists and environmental planners have claimed that sustainable development can be achieved through CGI and reduced emissions that deteriorate the environment

(Cheng et al., 2017). This process, however, is based on vital and appropriate organisational capabilities and resources (Sarkis et al., 2010). Optimisation and continuous improvement of manufacturing techniques can reduce production costs and emissions. organisational capacity to implement strategic productivity through KMP will provide substantial benefits and improved environmental development (Andersén, 2021). Similarly, the research study by (Grant, 1996) stated that resources of knowledge act as the driving force for financial development and enhance the knowledge-based performance of an organisation. Organisational capability is estimated by its competitiveness by integrating knowledge resources that add to reliable and green innovation development.

In the present evidence-based economy, the right strategy to achieve CGI is the implementation of KMP while following SDGs, as it can enhance national and corporate development by regenerating and redesigning natural resources (Awan et al., 2021). Implementing RBV theory provides the structure by which an organisation with improved KMP strategies and sustainable development can get a better chance to produce sustainable products and green energy. Available literature shows that employing the strategies of KMP through the SDPs help organisations to make green and innovative production with minimised effect on society and the outer environment.

2.2. Knowledge management process

Manufacturing organisations utilise 'knowledge' as a powerful tool to take advantage of other firms in improved competitive methodologies (Nonaka, 1994). Organisational knowledge is accumulated through effective interaction among top managers and social aspects of production firms stated as a set of arguable approaches that can be useful for corporate development. Ooi (2014) stated that 'organisational knowledge is taken as an abstract asset' and provides a cut-throat edge to organisations and individual firms due to its limitations. For organisations to develop corporate green innovation, the implementation of knowledge obtained from stakeholders such as consumers, suppliers, and institutes has been suggested in multiple research studies (Cui et al., 2021). In addition, proper KMP at the organisational level assists businesses in making deliberate decisions by collecting information and datasets from internal and external resources. Various aspects of KMP have been provided in literature research (Abbas & Sağsan, 2019). Based on the given research studies, a three-dimensional element of KMP is employed in this research report: knowledge dissemination (KD), knowledge acquisition (KA), and knowledge application (KAP).

One of the core components of KMP is 'knowledge acquisition'. Organisations implementing KA gain advanced knowledge for constant development in each sector (Shahzad, Qu, Ur Rehman, et al., 2020). This approach provides a developed utilisation of every resource according to the dynamic progress in today's business environment, such as customer care, organisational development, financial improvement, and improved product and service quality (Darroch, 2005). The involvement of administrative employees in knowledge concentration is fundamental to ensuring excellence in products and services (Song et al., 2020). Organisational objectives can be fully achieved through employee participation in knowledge sharing at all levels of an organisation (Awan et al., 2021).

Furthermore, corporations should put the information gathered from their customers and other stakeholders to excellent use and distribute it among staff members to improve the whole operations of the company to the finished product. Knowledge-driven businesses actively encourage employee participation in company issues and provide practical solutions (Cui et al., 2021). Proper knowledge acquisition, utilisation, and distribution management is required to attain the benefits mentioned earlier out of KMP to achieve CGI.

2.3. Sustainable development programs and CGI

The sustainable development process was initiated in the 1990s as a modern-day tactic for sustainable development related to social, environmental, and economic aspects. Sustainable development plans are followed in complex issues at different regional and sectoral levels with varying sustainable development initiatives (Tseng, 18). Social, economic, and environmental aspects are considered 'Tripple bottom line' (TBL) foundations affecting society (Elkington, 1998). This approach provides eco-friendly and green innovation technologies and strategies for organisations to generate eco-friendly products to reduce environmental degradation (Razzaq, Sharif, et al. 2021; Tseng et al., 2018; Xuefeng et al., 2022). Various factors, such as legal, ethical, and commercial, motivate an organisation to employ SDPs. This research study has three dimensions: SDP sustainable social practices (SOC) and sustainable environment operations (ENV).

To eliminate environmental hazards, continuous climate deterioration, and enhanced global warming, everyone should take a proactive part in controlling industrial fragmentation for a sustainable and green ecological system. Organisations that have thoughtfully considered promoting environmental sustainability by lowering unfavourable outcomes from industrial procedures will also strengthen their economic and financial stability, according to the economic perspective of SDPs (Tecchio et al., 2017; Wang, 2020). Social aspects of SDP are linked with improving and ensuring the community's development, health and safety, improved communication, and equal opportunities for collective well-being. Organisational competitiveness can be enhanced while incorporating social, economic, and environmental practices with increased demand for sustainable development.

CGI is an internally driven concept and provides external responses. It contains the characteristics of novelty and value addition, emphasising the attributes of environmental progress and conservation of resources (Peruffo et al., 2019). Implementing sustainable and green practices at the organisational level provides a competitive advantage for CGI (Awan et al., 2021). CGI and innovative technologies thrive to eliminate environmental pollution by producing digital devices, services, and production procedures to reduce severe ecological effects. In addition, (Chen et al., 2006) stated that CGI is the fundamental driver for social and economic development in the long term. CGI also indicates the extent of green and sustainable development within an organisation in the past three years.

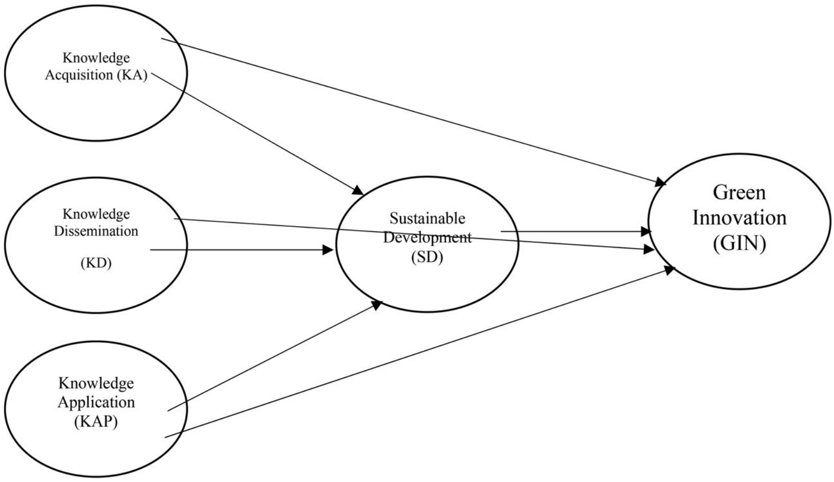

Figure 1. Conceptual framework.
Source: Authors estimations.

Abbas and Sağsan (2019) validated that corporate green innovation includes sustainable products and customers' green services. CGI developments tend to reduce natural resource utilisation, capitalise on sustainable resources, and reduce waste. Manufacturing firms, in particular, bring innovative ideas in product development, supply chain, processing, and consumption to acquire sustainable products that can diminish environmental deterioration. Peruffo et al. (2019) investigated the adoption of green development within several organisations for product and service improvement. CGI can be brought at the organisational level while following the SDPs that tend to improve products for colossal market potential. Furthermore, it is considered an essential factor to get clean and green development within organisations while positively impacting the environment (Figure. 1)

2.4. Hypothesis development

KA is mainly about discovering and acquiring the latest information utilised in organisational operations to boost performance at all levels (Darroch, 2005). It is employed to determine customer requirements and feedback regarding administrative services and products. Integrating a sustainable and green innovation agenda enhances the likelihood of communication and cooperation with stakeholders while utilising the latest technologies and adequate knowledge (Song et al., 2020). The research study has stated a positive interconnection between KA and sustainable environment activities (Cui et al., 2021). Some negative considerations have also been detected in the relationship between organisational development and KA; still, many research studies propose investment in green innovation and the environment for improved CGI (Mills & Smith, 2011). Lee et al. (2013) investigated the impacts of SDPs on green development and stated a positive correlation in corporate performance. Abbas and Sağsan (2019) proposed the implementation of knowledge obtained in production procedures to accomplish SDGs. Shahzad, Qu, Ur Rehman, et al. (2020) also acknowledged the importance of information absorption that enhances sustainable environmental practices. The given research study will highlight the critical role of knowledge utilisation and KA's impacts on sustainable development, especially in terms of a clean environment.

KD process collects, divides, and transfers information among organisational employees that improve production processes and develop sustainable products. It involves various aspects, including collecting and sharing information, knowledge sharing strategies, and compiling information for beneficial utilisation (Lee et al., 2013). Mills and Smith (2011) determined that knowledge sharing positive impacts the firm's performance. Previous research studies have shown that knowledge dissemination can provide social and economic cooperation for environmental sustainability by providing innovative solutions for production processes.

Organisations must employ advanced knowledge sharing methods among employees to achieve higher performance in production facilities (Song et al., 2020). It was stated that positive and sustainable changes could be attained in production facilities through knowledge sharing, innovation management, and green technology at the organisational level. In addition, (Jun et al., 2019) stated that knowledge sharing and dissemination positively enhance the sustainable CGI. Sharing important information and knowledge among all hierarchical levels and sub-divisions will strengthen the likelihood of sustainable development in terms of environmental variations.

KAP is the process of absorbing the already collected information to design and delivery finished products that can improve the overall operations of a production firm (Mills & Smith, 2011). It can also be stated as a reaction to data accumulation. One of the examples of KAP includes collecting data regarding clients' priorities and market trends to take action accordingly for improved organisational processes. It is a core component to generate corporate competitiveness that can enhance their performance in terms of sustainable environmental developments. KAP was essential in the research report (Darroch, 2005) for advanced performance and technological innovations. It is also a tactical resource for sustainable progress in the digital era of digitalisation.

KAP can also be implemented to enhance organisational knowledge and ability for product development. Knowledge application allows firms to implement sustainable manufacturing procedures through innovative, advanced, and improved manufacturing technologies (Awan et al., 2021). Research studies have provided that organisations can practice sustainable processes to achieve green development in CGI (Ding et al., 2019). Hence, the practical applications of knowledge management can provide sustainable solutions for organisational performance. In the current research, KAP is tied with SDPs, especially environmental sustainability.

In addition, sustainable economic practices (ECO) are composed of two views: financial performance and community development. Tseng et al. (2018) proposed that implementing reprocessing strategies for transportation assists in energy production and waste reduction, which adds to a sustainable environment. Literature on KMP implementation also suggested that CGI can be increased through technological advancement, ultimately reducing production costs (Abdul-Rashid et al., 2017). Corporate social responsibility (CSR) was also considered a significant aspect of CGI development. CGI can also positively impact the actions of concerned stakeholders, including NGOs and external communities. Improved profits of a production firm also add to the green innovation at the organisational level through sustainable products and services (Zhang, Wei, et al., 2020). This cooperation is not thoroughly related to CGI; thus, research will focus on these uncertain frameworks to determine the association of CGI with a sustainable economy.

Environmental considerations aid in transforming production methods to reduce severe impacts and industrial waste. To reduce consumption and deterioration, businesses should consider implementing environmental-friendly and innovative technologies that point to the effective utilisation of natural resources (Song et al., 2020). Literature research has recognised that organisations with existing policies of sustainable processes and environmental considerations can produce green and clean technologies (Huang & Li, 2017). According to (Shah & Soomro, 2021), implementing environmental strategies can proactively increase green development to impact the environment positively. Current studies have provided the benefits of environmental considerations that enhance sustainable development through competitive advantage (Zhang, Sun, et al., 2020). Environmental sustainability is the primary element of green innovation. Organisations have gained levels of green performance through environmental considerations under SDPs (Peruffo et al., 2019). Likewise, CGI has seen a tremendous rise in environmental sustainability. As a result, environmental issues must be mentioned in the organisational plan to bring clean and green innovation to businesses.

Another critical consideration in KMP and CGI interrelationships is the role of SDPs. Nidumolu et al. (2013) suggested that SDPs are fundamental for developing green innovation. For improved results in KMP implementation and CGI achievement, adequate organisational plans must be prepared to capitalise on the role of SDPs. organisational commitment at the organisational level can improve the association between KMP, SDPs, and CGI to promote green innovation and reduce environmental degradation. Integration of knowledge and sustainable development methodologies can provide long-term benefits for environmental progress (Davenport et al., 2019). Further research has provided and elaborated a positive correlation between CGI and KMP. Innovative KMP strategies need to be implemented for improved sustainability in manufacturing and production firms through moderate use of resources. Other research reports have established a direct linkage between various factors of green innovation and sustainable development (Chang, 2016). Nevertheless, there is not enough literature on the interlinkage of SDPs with CGI and KMP strategies. Hence, this study focus on the intermediary part of SDPs between CGI and KMP.

KMP enables organisations to impose green activities and innovative processes to remove the negative impacts of production on natural resources and the environment. Shakeel et al. (2020) also provided the interlinkage between organisational performance, green innovation, and sustainable performance in the production sector while reducing negative environmental impacts in China. In addition, proper organisational management through KMP strategies can bring sustainability to organisational performance and business operations. Hence, a strong bond is developed between KMP and CGI while following the sustainable development procedures. Important aspects considered in the research include knowledge acquisition, knowledge dissemination, and knowledge application to enhance sustainability in the production sector of China.

Organisations can also improve the processes and final products for customer satisfaction through KMP strategies. Knowledge sharing with other corporate businesses also benefits an organisation at all levels. It will also provide public services and liable natural resources with minimised utilisation of energy and fuels. It will provide business owners with solid and liable strategies for sustainable growth. The following hypotheses and research framework are under consideration based on the above discussion.

H1: Knowledge acquisition has a significant impact on green innovation practices.

H2: There is a significant impact of knowledge dissemination on green innovation practices

H3: Knowledge application has a significant impact on green innovation practices.

H4: Knowledge acquisition is significantly linked with sustainable development.

H5: Knowledge dissemination is significantly linked with sustainable development.

H6: Knowledge application is significantly linked with sustainable development.

H7: sustainable development is significantly linked with green innovation.

H8: There is a significant mediating effect of sustainable development between KA and GIN.

H9: There is a significant mediating effect of sustainable development between KD and GIN.

H10: There is a significant mediating effect of sustainable development between KAP and GIN.

Figure 1 presents the conceptual framework of this study.

3. Research methods

Current research applies a five-point Likert scale to measure the items as extracted from the existing body of literature. More specifically, the knowledge acquisition, dissemination, and application items were extracted from Abbas and Sağsan (2019) and Shahzad, Qu, Ur Rehman, et al. (2020). Knowledge acquisition is measured through five items ranging from KA1-KA5, whereas knowledge dissemination is measured through four items entitled KD1-KD4. Finally, the items for KAP ranged from KAP1-KAP3, respectively. Moreover, sustainable development (SD) practices have been measured through five items ranging from SD1 to SD5, as observed by Saunila et al. (2018). Finally, our study considers green innovation as a primary dependent variable, for which four items were taken from Song et al. (2021). After finalising the study scale, a questionnaire was developed, and an online survey was created to collect the data from the targeted companies. Initially, 567 questionnaires were collected from respondents working in Small and Medium enterprises in China. However, a

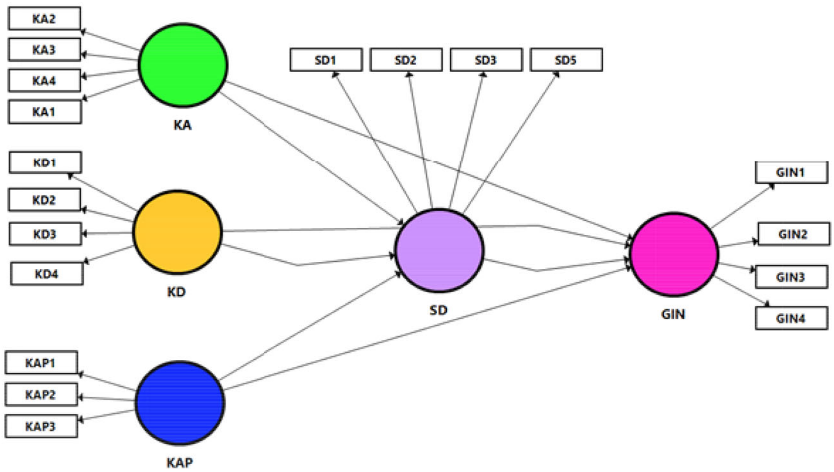

Figure 2. Layout of the measurement and structural model of the study.
Source: Authors estimations.

valid response of 364 questionnaires was finally considered for data analysis through Smart PLS. The analysis section covers both the measurement and structural model assessment. The former considers reliability and validity, discriminant validity, and convergent validity. It later covers the path coefficients and relative *p*-values for justifying the direct and indirect relationship between the latent constructs. Figure 2 provides a layout for the measurement and structural model of the study.

4. Results and discussion

Initially, this research examines the reliability and validity of the latent constructs named green innovation, knowledge acquisition, knowledge discrimination, knowledge application, and sustainable development practices among the targeted companies working in the Chinese economy. The findings in Table 1 confirm the reliability findings through Cronbach's alpha. The results report that all the latent constructs show the alpha score above 0.70 (threshold level), hence no issue for the reliability findings. Furthermore, the composite reliability output for all study variables is above 0.70, providing a similar argument to Cronbach's alpha. Finally, the average variance extracted helps justify the amount of variance as explained by the relative construct relative to measurement error. Hair et al. (2010) state that the AVE value for the relative latent variables should be above 0.50 to claim that constructs have convergent validity. As per Table 2, the AVE for all the latent constructs is above 0.50, confirming the convergent validity.

After reliability and validity analysis, the measurement model considers the discriminant validity of the latent variables. Three major approaches, entitled Fornell-Larcker criterion, loadings and cross-loadings, and HTMT ratio are applied. Henseler et al. (2015) claim that Fornell-Larcker is a contemporary approach to examining the model's discriminant validity for which the square root of AVE is considered. More specifically, the values in the diagonal series in Table 3 reflect that the square root of

Table 1. Construct reliability and validity.

Constructs	Cronbach's Alpha	rho_A	Composite Reliability	AVE
GIN	0.888	0.901	0.922	0.748
KA	0.850	0.867	0.899	0.691
KAP	0.834	1.095	0.892	0.734
KD	0.790	0.855	0.859	0.607
SD	0.873	0.879	0.913	0.726

GIN: green innovation, KA; knowledge acquisition, KAP; knowledge application, KD; knowledge dissemination; SD; sustainable development.
Source: Authors estimations.

Table 2. Fornell-Larcker criterion.

Constructs	GIN	KA	KAP	KD	SD
GIN	0.865				
KA	−0.185	0.831			
KAP	0.301	−0.022	0.857		
KD	0.465	−0.172	0.078	0.779	
SD	0.325	−0.772	0.050	0.158	0.852

GIN: green innovation, KA; knowledge acquisition, KAP; knowledge application, KD; knowledge dissemination; SD; sustainable development.
Source: Authors estimations.

Table 3. Loadings and cross-loadings.

Items	GIN	KA	KAP	KD	SD
GIN1	**0.828**	−0.139	0.368	0.358	0.242
GIN2	**0.873**	−0.132	0.372	0.485	0.252
GIN3	**0.887**	−0.150	0.183	0.378	0.283
GIN4	**0.870**	−0.205	0.164	0.392	0.330
KA1	−0.131	**0.744**	−0.076	−0.163	−0.536
KA2	−0.186	**0.854**	0.002	−0.165	−0.640
KA3	−0.170	**0.889**	−0.042	−0.139	−0.759
KA4	−0.122	**0.831**	0.042	−0.111	−0.606
KAP1	0.227	−0.051	**0.933**	0.071	0.059
KAP2	0.259	0.000	**0.863**	0.058	0.024
KAP3	0.344	0.032	**0.767**	0.070	0.028
KD1	0.371	−0.151	0.143	**0.677**	0.076
KD2	0.352	−0.135	0.024	**0.854**	0.145
KD3	0.388	−0.148	0.004	**0.835**	0.158
KD4	0.369	−0.108	0.173	**0.736**	0.077
SD1	0.267	−0.579	0.022	0.137	**0.781**
SD2	0.304	−0.687	0.022	0.160	**0.851**
SD3	0.268	−0.715	0.039	0.121	**0.912**
SD5	0.268	−0.641	0.089	0.122	**0.858**

GIN: green innovation, KA; knowledge acquisition, KAP; knowledge application, KD; knowledge dissemination; SD; sustainable development.
Source: Authors estimations.

Table 4. Heterotrait-Monotrait ratio (HTMT).

Constructs	GIN	KA	KAP	KD	SD
GIN	–				
KA	0.206	–			
KAP	0.385	0.068	–		
KD	0.567	0.214	0.152	–	
SD	0.364	0.887	0.054	0.176	–

GIN: green innovation, KA; knowledge acquisition, KAP; knowledge application, KD; knowledge dissemination; SD; sustainable development.
Source: Authors estimations.

Table 5. VIF for the study items.

Items	VIF	Items	VIF
GIN1	2.260	KD1	1.638
GIN2	2.736	KD2	2.000
GIN3	2.679	KD3	1.745
GIN4	2.252	KD4	1.660
KA2	2.126	SD1	1.776
KA3	2.433	SD2	2.082
KA4	2.104	SD3	3.653
KAP1	2.052	SD5	2.935
KAP2	2.522	KA1	1.589
KAP3	1.730	Mean VIF=	2.09

GIN: green innovation, KA; knowledge acquisition, KAP; knowledge application, KD; knowledge dissemination; SD; sustainable development.
Source: Authors estimations.

AVE is greater than the off-diagonal values, which proves the existence of discriminant validity between the latent constructs.

The second measurement for assessing the discriminant validity is entitled loadings and cross-loadings, for which findings are presented in Table 4. The results show that the loadings for each latent construct, such as GIN, KA, KAP, KD, and SD are higher than the cross-loadings in Table 3. More specifically, the loadings for GIN are recorded as 0.828, 0.873, 0.887, 0.870, whereas the loadings for the key items of KA, KAP, KD, SD, and GIN are recorded as 0.744, 0.854, 0.889, 0.831, 0.933, 0.863, 0.767, 0.674, 0.854, 0.835, 0.736, 0.781, 0.851, 0.912, and 0.858, respectively. Therefore, the second criteria for investigating the discriminant validity of the measurement model are valid enough.

The third criterion to examine the discriminant validity is the HTMT ratio, for which findings are presented in Table 4. Hair et al. (2021) claim that the HTMT ratio between the latent construct should be lower than 0.90. It means that between the two latent constructs if the HTMT ratio is less than 0.90, it indicates the existence of discriminant validity between both. The results confirm that none of the HTMT ratios between two latent variables is higher than 0.90; therefore, discriminant validity is present.

Finally, the collinearity diagnostic has been performed by checking the variance inflation factor (VIF) for the selected items of the study variables. Table 5 reports that all of the selected items for the study variables show a VIF score of below 5 (threshold level), reflecting no multicollinearity in the model. Similarly, the Mean VIF is 2.09 also confirms that the study model is valid regarding the no-presence of higher interdependency between the latent constructs.

The assessment of the measurement model provides enough evidence to move on for the structural model assessment, for which initially explained variation in green innovation and sustainable development has been provided. In Table 6, the R-square for green innovation is 10.5%, with an adjusted score of 10.3%. However, sustainable development reflects an explanatory power of 59.8%, showing a reasonable variation in the primary mediating variable of interest.

For initially applying the mediating effect of sustainable development, the direct association between explanatory and outcome variables has been examined. The findings in Table 7 reflect that knowledge acquisition shows a positively significant

Table 6. R2 and adjusted R2 of the model.

Items	R Square	R-Square Adjusted
GIN	0.105	0.103
SD	0.598	0.595

GIN: green innovation, KA; knowledge acquisition, KAP; knowledge application, KD; knowledge dissemination; SD; sustainable development.
Source: Authors estimations.

Table 7. Direct relationship.

Direction	Original Sample (O)	SD	T-statistics	*p*-values
KA -> GIN	0.103	0.047	2.19	0.027
KD -> GIN	0.330	0.047	7.02	0.000
KAP -> GIN	0.305	0.045	6.78	0.000

GIN: green innovation, KA; knowledge acquisition, KAP; knowledge application, KD; knowledge dissemination; SD; sustainable development.
Source: Authors estimations.

influence on green innovation among the selected companies in the Chinese economy. More specifically, the coefficient for the direct impact of KA on GIN is reflected through 0.103 with a standard deviation of 0.047, followed by a T-score of 2.19. It reflects that more knowledge acquisition among the selected firms may lead to more green innovations and vice versa. Abbas and Sağsan (2019) have explored the association between knowledge practices in knowledge acquisition and green innovation with green orientation. Their findings confirm knowledge acquisition's positive and significant role in determining green innovation. Similarly, Awan et al. (2021) investigate the trends in green product and process innovation as determined through knowledge acquisition and environmental investment for manufacturing firms. The findings confirm that knowledge activities have a more significant influence on the green product innovation comparatively to green process innovation. Therefore, our study accepts H1 for the significant and positive impact of KA on green innovation.

In addition, KD reflects a change of 0.330 in green innovation among the selected companies in China, as shown in Table 7. It implies that more knowledge dissemination among the Chinese economy's small and medium enterprises leads to more green innovation, which confirms the productive ecological outcomes (beta = 0.330, SD = 0.047, T-score = 7.02, *p*-value = 0.000). The mechanism behind green innovation through more dissemination reflects that such organisations are more concerned with acquiring knowledge and its dissemination. Furthermore, Table 7 confirms that knowledge dissemination is more powerful towards green innovation, with a highly significant and positive coefficient among all three dimensions of the knowledge management process. Shahzad, Qu, Zafar, et al. (2020) examine the influence of knowledge management practices (acquisition, dissemination, and application) on green innovation for the manufacturing firms working in Pakistan. Their findings confirm the existence of a significantly positive nexus between knowledge sharing/dissemination and green innovation in manufacturing firms. Therefore, current research also considers the direct and significant association between knowledge dissemination and green innovation.

The third coefficient in Table 7 reflects the significant and positive relationship between knowledge application and green innovation (beta = 0.305, standard

Table 8. After mediation.

Directions	Original Sample (O)	SD	T-value	*p*-value
KA -> GIN	0.012	0.058	0.210	Insignificant
KA -> SD	0.771	0.038	20.29	Significant
KAP -> GIN	0.186	0.125	1.49	Insignificant
KAP -> SD	0.039	0.015	2.60	Significant
KD -> GIN	0.210	0.199	1.06	Insignificant
KD -> SD	0.150	0.012	12.50	significant
SD -> GIN	0.302	0.054	7.44	Significant

GIN: green innovation, KA; knowledge acquisition, KAP; knowledge application, KD; knowledge dissemination; SD; sustainable development.
Source: Authors estimations.

Table 9. Total effect and VAF.

Effects	Path	Path coefficient	Indirect effect	Standard deviation	Total effect	VAF	t values	*p*-value	Decision
Direct without mediator	KA -> GIN(IV1 > DV1)	0.103	Not applicable				2.19	**	Accepted
Indirect with mediator	KA -> GIN(IV1toDV1)	0.012	Not applicable		0.24	95.09	2.53	***	significant
	KA -> SD(IV1toM1)	0.771	0.232842	0.092					
	SD -> GIN(M1toDV1)	0.302							
Direct without mediator	KD-> GIN(IV2 > DV1)	0.330	Not applicable				9.25	***	Accepted
Indirect with mediator	KD -> GIN(IV2toDVI)	0.211	Not applicable		0.66	68.17	6.85	***	Accepted
	KD -> SD(IV2toM1)	0.150	0.452	0.066					
	SD -> GIN(M1toDV1)	0.302							
Direct without mediator	KAP -> GIN(IV3toDV)	0.305	Not applicable				2.22	**	Accepted
Indirect with mediator	KAP -> GIN(IV3toDV)	0.186	Not applicable		0.52	64.705	4.94	***	accepted
	KAP -> SD(IV3toM)	0.039	0.341	0.069					
	SD -> GIN(M1toDV1)	0.302							

Source: Authors estimations.

deviation = 0.045, T-value = 6.78, and *p*-value= 0.000). This positive and significant relationship implies that, like other dimensions of the knowledge management process, more application of acquired and disseminated knowledge, the application of knowledge is also providing some fruitful results in the form of more green innovation and vice versa. In the existing literature, Shahzad, Qu, Ur Rehman, et al. (2020) justify the argument that more application of the knowledge in the national manufacturing firms of Pakistan is leading towards more green innovation and, finally green sustainable performance. Shahzad et al. (2021) also support the direct association between knowledge management components and green innovation. Based on the above discussion and empirical findings, it is inferred that KAP and GNI are significantly associated.

Table 8 provides the findings after adding sustainable development as a mediator in the relationship between exogenous variables named knowledge management dimensions and green innovations. The results show that the direct association between independent variables and green innovation is positive but insignificant with the addition of sustainable development. It indicates that sustainable development is a mediator in defining the linkage between the KM dimension and green innovations. In this regard, the relationship between KA -> SD, KAP -> SD, KD -> SD, and SD -> GIN is significant, and their relative T-value is above the threshold level of 1.96. In this regard, it is confirmed that current findings have provided significant evidence for the mediating effect of sustainable development between KM dimensions and GIN.

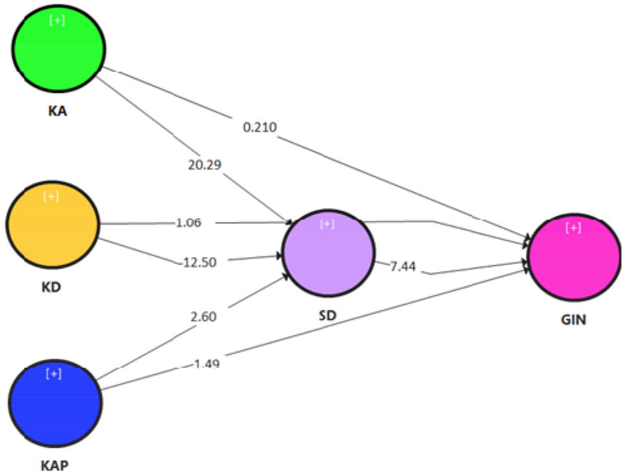

Figure 3. Structural model output.
Source: Authors estimations.

Table 9 reflects the total effect and variance findings while focussing on sustainable development practices as a key mediator. The findings reflect that the total effect of the mediating role of sustainable development on the relationship between KA and GIN is 0.24, whereas the total VAF is 95.09%. For this reason, it is quite essential to examine the strength of mediating effect, which can be justified through VAF as expressed by (Hair et al., 2021). The study findings reflect that 95.09 of the effect of knowledge acquisition on green innovation is explained through sustainable development. As the score of VAF is above 0.80%, this mediating effect will be accepted as complete mediation. Moreover, Table 9 shows that the total effect of sustainable development as a mediator between the second dependent variable (KD) and green innovation practices is 0.66. Furthermore, the VAF in this case is observed as 68.17. Since the value is less than 0.80 but in the range of 0.20–0.80, thus, a partial mediation effect is endorsed. The relationship between the third independent and dependent variables is mediated through sustainable development with VAF 64.70 and confirms partial mediation. In this way, it is inferred that sustainable development practices play a significant mediating role. Figure 3 visualises the structural model output for the bird-eye view.

5. Conclusion and recommendations

Due to increasing environmental pressure, it has become obligatory for both public and private organisations to integrate sustainable development practices and processes. Therefore, this study targets the green innovation practices specifically in the SMEs of the Chinese economy while taking into account the knowledge management dimensions entitled knowledge acquisition, knowledge dissemination, and knowledge application as major explanatory variables. Furthermore, sustainable development practices have been added to the model to examine its mediating effect on the association between KM dimensions and green innovation. All three dimensions of knowledge management reflect a significant and direct impact on green innovation practices. Moreover, the structural equation modelling reflects a significant mediating effect of sustainable development between knowledge acquisition and green innovation, knowledge dissemination and green innovation, and knowledge application and green innovation, respectively. Manifestly, a complete mediation exists between knowledge acquisition and green innovation through sustainable development, whereas partial mediation between knowledge dissemination and green innovation and knowledge application and green innovation.

A range of theoretical and empirical contributions are linked to this research. For example, considering the resource-based view as a theoretical underpinning, several research hypotheses are tested and justified while considering green innovation as a competitive tool to achieve a cutting edge in the marketplace. At the same time, current research provides a good theoretical and empirical understanding regarding sustainable development practices in promoting the positive link between knowledge management (organisational resource) and green innovation (a tool for achieving competitive advantage). Meanwhile, applying sustainable development practices would help achieve the long-term success of the selected companies. Effective measures should be taken to improve human development, knowledge accruing, and sharing to invest and adopt green technologies in production processes. Likewise, the knowledge management process needs to be integrated with sustainable development, the firm's innovation capabilities, and operational processes.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This study is funded by National Statistical Science Research Project (2022LY067); Philosophy and Social Science Foundation of Zhejiang Province in the form of a grant awarded to Lidi Xu (No. 19NDJC405YBM); and Humanity and Social Science Youth Foundation of Ministry of Education of China, "A Study on the Evaluation of Pragmatic Functions of Discourse Markers in Spoken English".

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