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Impact of knowledge management practices on green innovation and corporate sustainable development: A structural analysis

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ABSTRACT

The current study examines the role of knowledge management (KM) in green innovation and corporate sustainable development (CSD) activities. The researcher collected data from lower, middle and upper-level managers of small, medium and large-sized manufacturing and services firms located in Pakistan. The data was analysed through structural equation modelling (SEM) to investigate how KM processes, namely knowledge creation, acquisition, sharing and application, impact on green technology and green management innovation and environment, social and economic aspects of sustainability. As per the results, KM significantly impacts on green innovation and CSD activities. Green innovation also indicated significant positive impact on CSD. The dimensional analysis indicated that with the exception of knowledge creation and acquisition, which indicated an insignificant impact on social sustainability, all the paths indicated significant results. Moreover, KM is found as equally important for all sizes manufacturing and services firms.

1. Introduction

The preceding three decades have experienced a number of social, technological, and environmental changes, which have customized the operational environment of organizations (Cancino et al., 2018). One of those changes is the emergence of the internet, which has eliminated the geographical boundaries for businesses as well as for customers, and has resulted in globalization. In this era, customers can not only easily contact different suppliers around the world, but can also find the substitutes which fulfil their needs at a lower cost (Mardani et al., 2018); making the acquisition and sustaining of competitive advantage a real challenge for firms. Therefore, to fulfil customers' needs and to achieve the goal of sustainable development (SD), dynamic organizations adopt multiple strategies whose effectiveness in enhancing organizational performance is proven, such as knowledge management (KM) and total quality management (TQM).

Knowledge is an intangible asset and plays a critical role in the success or failure of any organization (Ooi, 2014). Dynamic organizations take it as an instrument, which enables them to enhance customer satisfaction (Attia and Salama, 2018) and successfully compete in the market (Mothe et al., 2017). During the last two decades, KM has received significant attention in the business world and has been acknowledged as a vital element in designing strategies, developing new products and services (Mardani et al., 2018), and managing the operational processes (Qasrawi et al., 2017). Effective KM enables the organization to become more innovative and effective (Yusr et al., 2017). For this reason, a number of organizations take KM as a strategic resource, which enables them to outperform their competitors (Bolisani and Bratianu, 2018).

Because of dwindling natural resources and increasing global warming, firms have started to experience a significant level of pressure from society (Albort-Morant et al., 2018) as well as from other stakeholders to abandon the practices causing environmental problems and adopt those that ensure SD (Davenport et al., 2018). According to Wijethilake (2017), SD has three indicators, namely environment, social, and economic sustainability. Environmental sustainability places emphasis on natural environment and resources, social sustainability relates to society and people, and economic sustainability focuses on the economic and financial aspects of firms (Guerrero-Villegas et al., 2018).

Green innovation is a concept which aims to facilitate firms to develop environment friendly products, so that SD objectives can be achieved (Xie et al., 2019). For this purpose, firms have to

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address not only technological innovation, but also administrative innovation (Li et al., 2018). Siva et al. (2016) and Qi et al. (2010) classified green innovation into two categories, namely green technology innovation (GTI) and green management innovation (GMI). GTI aims for integrating environmental knowledge with technology. Through GTI, firms introduce new or improve the existing products or processes that help to save raw material, energy and resources, and develop harmony between environment, economy and production processes (Fernando et al., 2019). In GMI, firms either restructure or adopt new management system which enables them to improve management and production processes which either eliminate, or reduces negative environmental effects (Qi et al., 2010).

Although a number of researchers have studied KM and SD from different perspectives; inadequate attention has been paid to exploring the role of KM in achieving SD, particularly with the help of green innovation (Lim et al., 2017). Mardani et al. (2018) and Davenport et al. (2018) also highlighted the need for enriching the limited literature on KM, green innovation and corporate sustainable development (CSD). There are even few studies that have used the multivariate statistical technique followed by structural equation modelling (SEM) to investigate the causal relationship between the variables in manufacturing as well as the services industries in Pakistan. To fill this gap, the current study analyses the multi-dimensional relationship between KM, green innovation and CSD and examines how KM processes impact on green innovation and CSD activities. Considering the significance of contextual factors, the researcher took organizational size and industry category as control variables.

According to Prajogo (2005), two noteworthy differences exist in the operational practices of manufacturing and services industries: first, the output of the manufacturing industry is tangible in comparison to the service industry, which is intangible and heterogeneous. Secondly, these two industries operate in two different systems; for example, the delivery and consumption process in the service industry occurs at the same time, which contradicts the manufacturing sector. The second control variable of the study is firm size. Firm size is taken as a control variable because, in comparison to small and medium-size firms, larger organizations have more resources. Similarly, larger firms may work differently to medium firms and this can explain the KM, green innovation and SD in a different manner. Firms with less than fifty employees are taken as small, those with fifty to two hundred employees are taken as medium, and those having more than two hundred employees are considered as large-sized firms. Ooi (2014) also followed similar technique in his study.

Considering the above discussion, the current study focuses on answering the following questions:

- What is the role of KM in green innovation and CSD?
- Do the contextual factors, such as organizational size and industry category, significantly impact on CSD activities?

This study will expand the inadequate literature on the relationship between KM, green innovation and CSD, and the findings will provide valuable insights to the managers of manufacturing and services industries in regard to how they can achieve their SD goals by benefiting from KM and green innovation. The remaining sections of this article discuss the theory and hypotheses, followed by research methodology, discussion and implications, and conclusion.

2. Theory and hypotheses

The current study uses the concepts of 'knowledge management theory' and 'theory of sustainable development' as its foundation.

2.1. Theory of KM

According to Bolisani and Bratianu (2018), knowledge is an abstract concept that is free from the tangible world, and has two forms, namely explicit knowledge and tacit knowledge. Explicit knowledge is any knowledge that can be codified, verbalized, transferred, and articulated. Usually, explicit knowledge is in written form, such as written reports, books, and manuals (Ooi, 2014). Tacit knowledge is hidden and unwritten knowledge, which exists in people's minds (Maravilhas and Martins, 2019). It is gained with experience and by involving with people. Since it is an unspoken and unwritten, as compared to explicit knowledge, tacit knowledge is difficult to transfer to other persons (Johnson et al., 2019). Considering the explicit and tacit forms of knowledge, Yang (2008) defined KM as the conversion of tacit knowledge into explicit knowledge which enables the transfer of knowledge within the firm without any obstacle.

The current study uses four dimensions of KM, namely knowledge creation, acquisition, sharing, and application. In view of Lee and Wong (2015), knowledge creation involves the creation of new notions and concepts by interacting with people through tacit and explicit knowledge. Considering the changing customer preferences and dynamic business environment, organizations have to acquire knowledge from employees, customers, and suppliers, so that they can continuously improve the quality of their products and services (Qasrawi et al., 2017). The acquisition of knowledge will also enable firms to capitalize on their strengths and review their weaknesses (Albort-Morant et al., 2018). The acquired knowledge must be shared with colleagues, particularly those in relevant departments (Jarrahi, 2018). Learning organizations encourage their employees to actively participate in different organizational issues. Employee participation not only enables the management to analyse problems from different perspectives, but also helps in proposing viable solutions. Finally, the acquired and shared knowledge must be applied in the relevant areas so that improvements in the processes can be made. Fig. 1 visualise the conceptual framework of the study.

2.2. Theory of SD

The roots of the theory of SD are linked with the "Brundtland Commission" report titled "Our Common Future", presented at the United Nations General Assembly in 1987 (UN, 1987). The report highlighted the issues pertaining to economic development and environmental stability, and defined SD as "the development which fulfils the present generation's needs without compromising future generation's ability to fulfils their needs". In 1992, Munasinghe added the third approach to SD, namely social sustainability (Munasinghe, 1992); hence, the overall aim of CSD is to achieve economic, social, and environmental sustainability by integrating all approaches in the decision making process. The concepts of SD also relate to a modern and multidisciplinary approach called the green theory which states that firms should focus on adopting green management strategies and capitalize on modern technology to develop environment-friendly products and services. In 1994, John Elkington coined the term Triple Bottom Line (TBL) for SD (Elkington, 2018). Later, some other researchers, such as Shahzad et al. (2019) and Hussain et al. (2018) also used this term for SD. The environmental approach of SD focuses on preserving the natural environment, ensuring clean water and air, least consumption of natural resources (particularly the non-renewable ones), the production of environment-friendly products, and the reduction of dangerous gases and liquid emissions (Lucas, 2019). The social

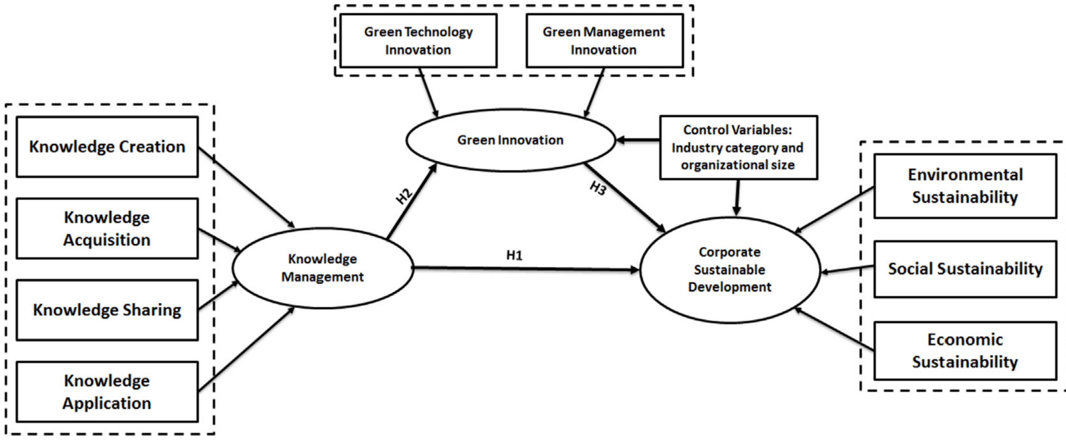

Fig. 1. Research model of KM, green innovation and CSD.

aspect of SD concentrates on enriching organizational relationship with human and society, and promotes human wellbeing by understanding their needs (Guerrero-Villegas et al., 2018). It also aims to promote social and cultural life and ensure social development, social equity, human and labour rights, social support and justice. The economic approach of organizational SD relates to maximizing profit by increasing sales and reducing operational costs.

2.3. KM and CSD

KM is a process through which organizations ensure that their employees have the right information in the right format at the right time (Ooi, 2014). Khodadadi and Feizi (2015) stated two aspects of KM, namely people management and information management. The people management aspect deals with tacit knowledge concerning abilities and skills, while information management deals with explicit knowledge and supports firms in becoming more competitive and creative. In the knowledge-based society, the relationship between KM and SD has become particularly important as, according to Maravilhas and Martins (2019), knowledge is the main driving force for individual, organizational, and national development. Breznik (2018) said that organizations that base their operations on knowledge are not only more innovative, but are also capable of exploring new directions of sustainability.

To counter the negative impact of organizations' operations on the natural environment, the United Nations Global Compact (UNGC) has urged all businesses, particularly those in manufacturing, to follow environment-friendly processes and benefit from the latest technologies so that resources can be utilized in efficient manners (UNGC, 2018). KM, particularly knowledge sharing and research and development (R&D) activities are the fundamental tools which enable firms to develop new technologies (Habib et al., 2019). Dynamic organizations use such technologies to develop new or improve the existing products and processes, so that organizational performance can be enhanced not only from economic perspectives, but also from environmental and social perspectives (Stanovcic et al., 2015).

In the context of sustainability, KM is primarily responsible for creating and using knowledge resources in a sustainable manner by taking into account the social, environmental, and economic aspects (Lim et al., 2017). The learning organization place emphasis on combining KM strategies with overall organizational strategies so that sustainability can be achieved in all aspects (Davenport et al., 2018). Shahzad et al. (2019) said that organizational knowledge absorptive capacity has a significant impact on their environmental performance. For this reason, KM, with the help of knowledge workers, can strengthen the sustainability of firms. Although a number of researchers, such as Breznik (2018), Brix (2017) and Yusr et al. (2017) have highlighted the importance of KM with respect to general innovation and organizational performance, limited attention has been given to the role of KM in CSD. Therefore, the first principal hypothesis of the study is:

H1. KM significantly impacts on CSD

2.4. Green innovation

Green innovation is a mean through which firms eliminates or minimizes the negative impact of their operations on the environment (Fernando et al., 2019). It is the invention in products, processes, technologies and management structures which aims to protect the natural environment (Li et al., 2017) by minimizing the resources consumption, controlling waste and pollution (Rossiter and Smith, 2018). GTI incorporates environmental science with technology to improve existing or invent new products or processes and curb the harmful impact of business operations (Butt, 2016). Xie et al. (2019) further divided GTI into green process and green product innovation. The aim of green process innovation is to bring improvements in production processes through which raw material is converted into a useable product (Albort-Morant et al., 2016). Such improvements aim for minimizing the natural resources consumption, capitalisation of renewable resources and minimizing the waste (Rossiter and Smith, 2018). Green product innovation focuses on modifying existing products design or develops new products which use renewable or non-toxic material in the production process, so that not only energy efficiency can be achieved, but disposal impact on the environment can also be reduced (Zhang et al., 2019).

GMI is the firms' adoption of new management structure, system and strategies through which they aim for improving production processes (Li et al., 2018). Such improvements enable firms to gain economic benefits and ensure minimization of environment hazardous activities (Siva et al., 2016). Firms can achieve GMI goals by implementing management policies and systems related to the environment (Qi et al., 2012), such as ISO 14001. According to Albort-Morant et al. (2016), firms pioneering GTI and GMI have a tendency to enjoy a number of competitive advantages, such as customer trust, loyalty and enhanced profitability.

KM has central importance in the innovation processes as it provides a foundation for research and analysis activities (Sesay et al., 2018). Breznik (2018) analysed the impact of KM on organizational innovation and concluded that it triggers firm's innovation activities. A number of managers believe that innovation activities mediate the relationship between organizational social sustainability and organizational performance (Guerrero-Villegas et al., 2018). However, according to Li et al. (2018), to promote green innovation, the government should encourage, facilitate and support firms to innovate, as it will enable them to produce high-quality goods and services while consuming the least amount of natural resources. Considering the above discussion on KM, green innovation and CSD, the following hypotheses are proposed:

H2. KM significantly impacts on green innovation

H3. Green innovation significantly impacts on CSD

To understand this relationship in detail, the study explores the dimensional relationship between the KM, green innovation and CSD and proposes the sub-hypotheses.

2.4.1. *Knowledge creation*

Knowledge creation is the result of interaction between knowledge and the act of knowing, which is done through action, practice, and interacting with people (Maravilhas and Martins, 2019). It is crucial for firms to allocate adequate resources for creating new knowledge as it will enhance their innovation capabilities and development of new technologies (Habib et al., 2019), which ultimately will facilitate firms to achieve sustainability (UNGC, 2018). Dynamic firms facilitate knowledge creation environment by encouraging their employees to share their knowledge (Jarrahi, 2018), provide a system, such as an infrastructure and information, which enables them to practice the creation of new knowledge, and offer financial and non-financial rewards to employees who introduce new ideas or solutions (Chatzoudes et al., 2015). Knowledge-intensive organizations aim to achieve the efficient utilization of resources and tend to follow environment-friendly processes (Albort-Morant et al., 2018). Such organizations not only encourage and facilitate the process of green product development, but also constantly consider the impact of their operations on the environment (Tseng, 2014). Hence, the following hypotheses can be proposed:

H4a. Knowledge creation activities significantly impact on corporate environmental sustainability

H4b. Knowledge creation activities significantly impact on corporate social sustainability

H4c. Knowledge creation activities significantly impact on corporate economic sustainability

H4d. Knowledge creation activities significantly impact on green technology innovation

H4e. Knowledge creation activities significantly impact on green management innovation

2.4.2. *Knowledge acquisition*

Knowledge acquisition refers to organizational activities to acquire, extract, and organize knowledge from different sources (Attia and Salama, 2018). According to Qasrawi et al. (2017), the majority of employees acquire knowledge from internal sources, such as team members and other colleagues. This indicates that the more employees are familiar with each other, the greater the probability that their productivity will be enhanced. The acquisition of knowledge from external sources refers to knowledge acquired from customers, competitors, suppliers, partners, and experts (Mothe et al., 2017). The aim of knowledge acquisition is to understand customers' needs and their experience with organizational products and services. By doing so, organizations make relevant changes so that customers' satisfaction can be achieved, leading to enhanced economic sustainability (Wijethilake, 2017). According to Shahzad et al. (2019), an organization's ability to acquire and absorb knowledge positively impacts on its financial performance. Similarly, Sztangret (2017) stated that to achieve SD goals, firms must utilize acquired knowledge in their operations. Hence, the following hypotheses can be proposed:

H4f. Knowledge acquisition activities significantly impact on organizational environmental sustainability

H4g. Knowledge acquisition activities significantly impact on organizational social sustainability

H4h. Knowledge acquisition activities significantly impact on organizational economic sustainability

H4i. Knowledge acquisition activities significantly impact on green technology innovation

H4j. Knowledge acquisition activities significantly impact on green management innovation

2.4.3. *Knowledge sharing*

Knowledge sharing is the process through which explicit or tacit knowledge is communicated to an individual or group of people (Jarrahi, 2018). It is a popular mean of social interaction in organizations, which enables workers to solve problems in a creative manner (Attia and Salama, 2018) and provides excellent support for designing strategies, making decisions and building a learning environment (Bolisani and Bratianu, 2018). Knowledge sharing significantly enhances workers' explicit and tacit knowledge, resulting in reduced errors and mistakes, and improved operational and economic sustainability (Maravilhas and Martins, 2019). Dynamic firms take knowledge sharing as their social responsibility and regularly participate in social awareness programs (Khodadadi and Feizi, 2015). To promote collective innovation and a win-win culture, learning organizations make their experimental results' public so that other organizations can use such information for creative purposes (Al-Busaidi and Olfman, 2017). A number of organizations share the details of their manufacturing processes to ensure transparency in their operations and gain customer trust (Lucas, 2019). Therefore, the following hypotheses are proposed;

H4k. Knowledge sharing activities significantly impact on organizational environmental sustainability

H4l. Knowledge sharing activities significantly impact on organizational social sustainability

H4m. Knowledge sharing activities significantly impact on organizational economic sustainability

H4n. Knowledge sharing activities significantly impact on green technology innovation

H4o. Knowledge sharing activities significantly impact on green management innovation

2.4.4. Knowledge application

Knowledge application is the use or integration of acquired knowledge in designing or delivering organizational products and services (Mothe et al., 2017). It is also considered as firms' timely response to operational changes through technology and strategy and the ability to benefit from them to design new products and services (Barão et al., 2017). The application of knowledge is also a principal source for creating new core competencies for organizations and enhancing their economic performance (Mulhim, 2017). By applying knowledge, firms can uncover new processes that can significantly improve their performance. Considering the stakeholders' interest, dynamic organizations follow environment-friendly practices and integrate existing and new knowledge in research and development activities to introduce new processes and technologies (Albort-Morant et al., 2018). This enables firms to produce high-quality products by consuming the least amount of resources, which will not only benefit the environment, but also the organization itself (Mardani et al., 2018). Hence, the following hypotheses are proposed:

H4p. Knowledge application activities significantly impact on organizational environmental sustainability

H4q. Knowledge application activities significantly impact on organizational social sustainability

H4r. Knowledge application activities significantly impact on organizational economic sustainability

H4s. Knowledge application activities significantly impact on green technology innovation

H4t. Knowledge application activities significantly impact on green management innovation

3. Research methodology

3.1. Target population and sampling procedure

The target population of the current study is the manufacturing and services firms registered on the Securities and Exchange Commission of Pakistan (SECP) and having ISO 14001 certificate. The SECP database is the most comprehensive and largest catalogue of different businesses in Pakistan. Using a non-probability convenience sampling technique, the researcher collected data from five major business cities in Pakistan, namely Lahore, Karachi, Islamabad, Sialkot and Faisalabad. The researcher approached the junior, middle, and senior managers of these firms through personal visits as well as through electronic means (such as e-mail) and requested them to evaluate the performance of their organization with respect to KM, green innovation and CSD activities on a five-point Likert scale. The data was only collected from management staff as they possess accurate and up to date information not only about the organizational policies, but also about the practices. Moreover, managers are also responsible for sharing and implementing organizational policies within their departments. The data was collected between May 2018 and August 2018 through the non-probability convenience sampling technique. Out of 302 useable responses, 99 responses were generated from small, 135 from medium and 68 from large-sized organizations. Furthermore, 172 respondents were male and 124 were female; 9 respondents preferred not to disclose their gender. The detailed demographic information of the respondents is given in Table 1.

Table 1
Demographic of respondents.

Particulars	Description	Value	Percentage
Total received responses	Small organizations	99	42.72%
	Medium organization	135	34.77%
	Large organization	68	22.52%
Job Position	Lower management	154	50.99%
	Middle management	111	36.75%
	Upper management	37	12.25%
Industry type	Manufacturing	131	43.38%
	Services	171	56.62%
Gender	Male	172	56.95%
	Female	124	41.06%
	Prefer not to disclose	6	1.99%
Years of Experience	Up to 5 years	63	20.86%
	6–10 years	127	42.05%
	11–15 years	79	26.16%
	More than 15	33	10.93%

3.2. The measurement instrument

The researcher divided the instrument into four sections. The first section contained the demographic information of the respondents. The second section contained twenty-two items pertaining to the four processes of KM, namely knowledge creation, acquisition, sharing and application. Knowledge creation and acquisition were measured through five items for each dimension; while knowledge sharing and application were measured through six items for each dimension. The items for this section were taken from Lee and Wong (2015), Wang et al. (2008), and Darroch (2003). The third section contained fifteen items related to three dimensions of SD, namely environment, social, and economic sustainability, and each dimension was measured through five items. This section's items were taken from Bansal (2005) and Turker (2009). The fourth section contained eight items related to two dimensions of green innovation, namely GTI and GMI and items were taken from Wong (2013) and Kam-sing Wong (2012). To ensure the reliability and validity of the adopted items within the Pakistan context, a pilot test was conducted and 32 responses were collected from firms located in Lahore. The results indicated the internal consistency of constructs with values of 0.79–0.93, which sufficiently fulfils the 0.7 value requirement of Hair et al. (2010). Hence, the researcher initiated the comprehensive survey.

3.3. Data analysis and results

To examine the relationship between KM, green innovation and CSD, the researcher followed the SEM technique, as it has the strength to build the hierarchy of latent construct, as well as to remove the biasing effect caused by measurement errors (Prajogo and Cooper, 2010). To analyse the collected data, the researcher used SPSS v.23 and AMOS v.23. According to Lee et al. (2010), to perform multivariate analysis, followed by SEM, researchers should ensure the adequacy of the sample, non-existence of multicollinearity and common method bias (CMB). Hoelter (1983) recommended a minimum sample size of 200 for factor analysis. As the current study has a sample of 302 respondents, it fulfils Hoelter's minimum sample size criteria. The multicollinearity was assessed through the variance inflation factor (VIF), which indicated a value of 2.249, representing the non-existence of multicollinearity. As per Podsakoff et al. (2012), CMB influences the results if single factor represents more than 50% of the whole variance. The researcher performed Harman's single factor test to analyse CMB. The result for single factor contribution indicated a value of 38.91%, which is well below the 50% threshold value, and represents the non-existence of CMB in the data.

3.4. Analysis of measurement and structural model

The researcher performed confirmatory factor analysis (CFA) to examine the measurement model. According to Hinkin (1998), CFA ensures the validity and unidimensionality of the measurement model. The reliability of the measurement was evaluated through Cronbach's alpha and indicated a value of 0.901. This fully complied with the minimum 0.8 value suggested by Peterson (1994) and indicated adequate reliability. The researcher examined the validity through the convergent and discriminant validity test. Awang (2012) and Hair et al. (2010) suggested that convergent validity can be analysed through factors loading. According to Awang, the ideal loading for already established items is above 0.6. Moreover, according to Molina et al. (2007), the lowest value of average variance extracted (AVE) for all the constructs should be higher than 0.5. The result of convergent validity indicated items loading higher than 0.6 and AVE value for all the constructs higher than 0.5. The details of items loading along with AVE values and composite reliability are given in Table 2. The discriminant validity was assessed by Fornell and Larcker's (1981) approach. According to them, the value of a construct's variance with its indicators should be higher than other constructs. Moreover, if the square root values of AVE indicate higher correlation among the pair indicators, it also indicates discriminant validity. Hair et al. (2010) suggested that the values of correlation among the predictor variable's pair should be less than 0.9. The detailed results are given in Table 3, which fully comply with the Fornell and Larcker (1981) and Hair et al. (2010) criteria for discriminant validity.

Kaynak (2003) recommended seven indicators that determine the goodness of fit of a measurement model, namely chi-square to degree of freedom (χ^2/df), goodness of fit index (GFI), adjusted goodness of fit index (AGFI), normative fit index (NFI), comparative fit index (CFI), root mean square error of approximation (RMSEA) and standardized root mean squared residual (SRMR). The researcher also included the Tucker-Lewis index (TLI) so that the measurement and structural model's fitness could further be ensured. The results indicated that for the measurement model, the χ^2/df value is 1.099, which fulfils Bagozzi and Yi's (1988) requirement of less than 3. The value of RMSEA is 0.026, which fully complied with the maximum value of 0.08 recommended by Browne and Cudeck (1992). Moreover, the SRMR value was 0.0443, which also fulfilled the 0.1 cut-off requirement by Hu and Bentler (1998). Finally, the values of NFI, AGFI, GFI, CFI and TLI are also above the ideal value of 0.9 recommended by Bagozzi and Yi (1988), Bentler and Bonett (1980), and Bollen (1986). The analysis of the structural model indicated χ^2/df value of 1.166. The RMSEA value is 0.033 and SRMR value is 0.0342 which complied with the maximum values of 0.08 and 0.1 recommended by Browne and Cudeck (1992) and Hu and Bentler (1998), respectively. Finally, the values of CFI, GFI, NFI, AGFI and TLI were also above the value of 0.9 recommended by Bagozzi and Yi (1988) and Bentler and Bonett (1980). Considering these results, it can confidently be said that both the measurement and structural models perfectly fit the collected data. The details of the measurement and structural models are given in Table 4.

Table 3
Constructs' discriminant validity.

Construct	KC	KA	KS	KAP	ENS	SS	ECS	GTI	GMI
KC	***0.770***								
KA	0.583	***0.788***							
KS	0.524	0.489	***0.797***						
KAP	0.458	0.502	0.582	***0.813***					
ENS	0.621	0.531	0.452	0.442	***0.844***				
SS	0.485	0.456	0.485	0.492	0.532	***0.801***			
ECS	0.573	0.459	0.573	0.538	0.485	0.531	***0.805***		
GTI	0.582	0.499	0.613	0.583	0.611	0.483	0.522	***0.812***	
GMI	0.592	0.576	0.499	0.552	0.538	0.521	0.485	0.573	***0.832***

KC= Knowledge Creation, KA= Knowledge Acquisition, KS= Knowledge Sharing, KAP= Knowledge Application, ENS = Environmental Sustainability, SS= Social Sustainability, ECS = Economic Sustainability; GTI = Innovation Performance; Bold and italic values are AVE square root value for each construct.

3.5. Testing of hypotheses

The researcher analysed the formulated hypotheses using SEM. The value of the statistical significance of each structural parameter facilitated the validation of path hypotheses. The results indicated that KM has a significant impact on CSD with $\beta = 0.251$ and $p = 0.016$. Moreover, KM has also indicated a significant positive impact on green innovation with $\beta = 0.263$ and $p = 0.008$. Likewise, green innovation has also demonstrated a significant impact on CSD with $\beta = 0.291$ and $p = 0.002$. Hence, the hypotheses H1, H2 and H3 are accepted. The analysis of sub-hypotheses indicated that all the path coefficient, with the exception of H4b, H4e and H4g, explained statistically significant results and are accepted. The details of principal and sub-hypotheses can be seen in Table 5 given in appendix.

4. Discussion and implications

The current study examines the multidimensional relationship between KM, green innovation and CSD. The empirical results indicate that KM has a significant positive impact on CSD. This relates to Chen et al.,' (2015) finding who identified the similar association between knowledge sharing and CSD. This also supports the work of Lutchen (2018) which stated that

Table 2
Reliability and validity of the instrument.

Construct	Items	Factor Loading Ranges	Composite Reliability [a]	AVE [b]
Knowledge Creation	5	0.732–0.923	0.815	0.593
Knowledge Acquisition	5	0.706–0.914	0.899	0.621
Knowledge Sharing	6	0.698–0.942	0.913	0.636
Knowledge Application	6	0.724–0.895	0.879	0.661
Environmental Sustainability	5	0.711–0.883	0.823	0.712
Social Sustainability	5	0.719–0.921	0.819	0.642
Economic Sustainability	4	0.821–0.945	0.853	0.648
Green Technology Innovation	4	0.713–0.911	0.867	0.659
Green Management Innovation	4	0.771–0.898	0.831	0.692

[a] Composite reliability value should be ≥ 0.7 (Molina et al., 2007).
[b] Average variance extracted (AVE) value should be ≥ 0.5 (Molina et al., 2007).

Table 4
Model fit measures.

The goodness of fit measures	CMIN/DF	NFI	GFI	AGFI	CFI	TLI	RMSEA	SRMR
Recommended value	≤ 3[a]	≥ 0.9[b]	≥ 0.9[b]	≥ 0.9[b]	≥ 0.9[b]	≥ 0.9[b]	≤ 0.08[c]	≤ 0.08[d]
Measurement model	1.099	0.926	0.917	0.902	0.948	0.953	0.026	0.0443
Structural model	1.166	0.951	0.976	0.964	0.958	0.961	0.033	0.0342

[a] (Bagozzi and Yi, 1988).
[b] (Bagozzi and Yi, 1988; Bentler and Bonett, 1980; Bollen, 1986).
[c] (Browne and Cudeck, 1992).
[d] (Hu and Bentler, 1998).

organizational collaboration with respect to knowledge enhances their economic performance. This significant result indicates that the sampled firms in Pakistan are efficiently using their knowledge resources and their management is demonstrating strong commitment with KM and motivating their employees to create, acquire, share and apply knowledge in their operation to achieve SD objectives.

The analysis of KM impact on green innovation indicated significant results, indicating the ability of KM to trigger the environmental innovation activities. This finding is similar to Yusr et al. (2017) study that KM significantly enhances organizations product innovation capabilities. KM provides opportunities to workers to collaborate and share their knowledge. Through collaboration, workers can have access to external information requiring intensive R&D activities. They can capitalize on their peers' experience in their operations to develop environment-friendly technology. The result also indicates that green innovation has a significant positive impact on CSD. This finding is similar to Yu and Huo (2019) and Xie et al. (2019) studies that green innovation positively impacts on organizational financial performance. Green innovation act as a catalyst to invent new technologies and processes which enable firms to become environment-friendly and also achieve economic sustainability. It has critical importance in developing countries, like Pakistan, where the natural environment has substantially been damaged due to poor industrial operations and waste management. In the recent years, the government of Pakistan has taken valuable measures and made a huge investment to promote green business operations by developing green technology and related innovation. The result indicates that the sampled firms are adequately capitalizing on green innovation to achieve SD.

The dimensional level analysis indicated a significant impact of knowledge creation on environmental and economic sustainability and GMI. This confirms Albort-Morant et al. (2018) statement that KM strengthens the organization ability to utilize the natural resources in efficient manners and become an environment-friendly organization. Knowledge creation facilitates the innovation process, which enables firms to produce high quality of products and services, at lower cost, by consuming the least amount of natural resources. This not only enables organizations to achieve environmental sustainability, but also to enhance their customers' satisfaction and loyalty, leading to economic sustainability. The analysis of knowledge creation activities indicated an insignificant impact on organizational social sustainability and GMI. This result contradicts with Brix (2017) study which indicated a positive association between organizational knowledge creation activities, their learning, and social performance. This shows that the sampled firms are not giving adequate time and resources to create new knowledge which can significantly benefit society with respect to social development. Hence, the management of sampled firms should reconsider their policies with respect to knowledge creation and social sustainability activities.

The analysis of knowledge acquisition indicated a significant positive impact on the environment and economic sustainability, and GTI and GMI of sampled organizations. It relates to Sztangret (2017) study that knowledge acquisition significantly enhances organizational capabilities to improve environmental and financial performance. This result demonstrates that studied organizations emphasize knowledge acquisition and utilize it for improving their product and services quality, which is enabling them to achieve economic sustainability. These organizations are also adequately utilizing the acquired knowledge for social development programs. However, insignificant relationship has been found between knowledge acquisition and social sustainability which contracts to Shahzad et al. (2019) findings, and indicates that most of the studied organizations are not giving adequate attention to acquiring knowledge about how to improve their social contribution and become a leading socially responsible organization.

Knowledge sharing has indicated a significant positive impact on all SD practices. This result supports Habib et al. (2019) finding that knowledge sharing significantly increase workers' innovation capabilities and organizational financial performance. The result demonstrated that the sampled firms concentrate on knowledge sharing within and outside their organizations. Dynamic organizations regularly provide training to their employees and encourage them to acquire and share knowledge. The workers of such organizations consider knowledge sharing as their social responsibility, and such organizations enjoy more loyalty and customers' satisfaction. The results of knowledge application also indicated a significant impact on all SD practices. This relates to Kopnina (2015) study which stated that training, learning, and application of knowledge has significant importance in organizational SD. The results indicate that the sampled organizations place a strong emphasis on the application of knowledge to achieve sustainability.

The contextual analysis indicated an insignificant relationship between organizational size and CSD, environmental and economic sustainability and GTI and GMI. This means that KM is equally important for all sizes firms to achieve economic and environmental sustainability. It also indicates that firm size does not play a significant role in organizational capabilities for GTI and GMI. However, significant result for GI and social sustainability means that the level of firms' participation in social development programs and GI capabilities varies according to their firm size. The analysis of industry type impact on the relationship between KM and CSD, social and economic sustainability and GMI indicated insignificant result, which means that manufacturing, as well as service industries, can reap similar benefits from KM to achieve economic and social sustainability. However, the significant result of industry type with GI, environmental sustainability and GTI indicated that the level of importance of these areas varies from industry to industry. As per the author view, manufacturing industries need to pay more attention to KM processes to achieve GTI and environmental sustainability since they consume more natural resources to produce their products.

4.1. Research implications

The current research provides a number of implications to manufacturing and services industries. Firstly, it highlights the relationship between KM and CSD, and explains how KM processes facilitate organizations to achieve SD goals. The study suggests that to achieve SD, organizations should ensure the implementation of all KM processes. Secondly, the current study highlights the important role of green innovation which facilitates organizations to achieve SD through KM. Through green innovation, firms introduce new technologies which enable their workers to produce high quality and environment-friendly products and services leading to economic and environmental sustainability. The current study also provides confidence to the managers of small and medium-size firms that they can reap similar benefits from KM as being enjoyed by large firms for achieving CSD.

The current study also has multiple theoretical implications. Firstly, this research enriches the limited literature on the relationship between KM, CSD and green innovation. Using multivariate statistical technique, followed by SEM, the study examines the inadequately studied multidimensional relationship between KM and CSD based on KM theory and SD theory, and explains how KM facilitates SD activities in small, medium and large size manufacturing and service firms in Pakistan. Secondly, it highlights the important role of green innovation in the relationship between KM and SD, and has earlier never been studied. This study also highlights the importance of implementing all four dimensions of KM to enhance green innovation capabilities and achieving CSD goals.

4.2. Research limitations

The current study also has few limitations. The researcher collected data only from lower, middle and senior managers, and ignored operational staff; however, their opinion can give valuable insights. Hence, in future, researchers should include them to further explore the topic. Secondly, the data was collected by inviting the managers to operationalize the research instrument by considering their organizational activities; hence, the collected data is based on managers' perception, which may have caused bias. Although, the author has examined the reliability, the impact of biases cannot be completely ruled out. Hence, in future, along with managers' perception, researchers should use the hard data of the organizations, such as annual financial reports. The data for the current study was collected from firms located in Lahore, Karachi, Islamabad, Faisalabad and Sialkot cities in Pakistan. The researchers recommend expanding the region of the study by including other cities and countries.

5. Conclusion

The present research used the concepts of the theory of KM and the theory of SD to analyse the multidimensional relationship between KM, green innovation and CSD. Using four KM practices, namely knowledge creation, acquisition, sharing and application, and three SD practices, namely environment, social and economic sustainability, the researcher investigated how KM processes impact on green innovation and CSD practices. As per the results, KM has a significant impact on organizational green innovation and CSD performance, and green innovation has a significant impact on CSD. Moreover, with exception of knowledge creation which indicated insignificant impact on social sustainability and GMI, and knowledge acquisition which indicated the insignificant impact on social sustainability, all KM dimensions indicated a significant impact on green innovation and CSD of manufacturing and services firms in Pakistan.

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Conflicts of interest

The researcher declares no conflict of interest.

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Appendix

Table 5
Results of hypothesis testing

Hypothesis	Constructs	Estimate	Critical ratio	p-Value	Decision
H1	KM → CSD	0.251	2.211	0.016*	Supported
H2	KM → GI	0.263	2.244	0.008*	Supported
H3	GI → CSD	0.322	2.912	0.002*	Supported
H4a	KC → ENS	0.358	3.647	0.002*	Supported
H4b	KC → SOS	0.051	1.013	0.056	Not supported
H4c	KC → ECS	0.275	2.013	0.005*	Supported
H4d	KC → GTI	0.269	2.007	0.007*	Supported
H4e	KC → GMI	0.105	0.184	0.058	Not supported
H4f	KAC → ENS	0.189	1.709	0.035*	Supported
H4g	KAC → SOS	0.116	0.143	0.072	Not supported
H4h	KAC → ECS	0.219	2.154	0.009*	Supported
H4i	KAC → GTI	0.171	1.141	0.039*	Supported
H4j	KAC → GMI	0.253	2.260	0.011*	Supported
H4k	KS → ENS	0.197	2.213	0.021*	Supported
H4l	KS → SOS	0.213	1.994	0.041*	Supported
H4m	KS → ECS	0.218	2.221	0.016*	Supported
H4n	KS → GTI	0.231	2.204	0.022*	Supported
H4o	KS → GMI	0.198	2.041	0.032*	Supported
H4p	KAP → ENS	0.178	1.879	0.039*	Supported
H4q	KAP → SOS	0.168	1.135	0.044*	Supported
H4r	KAP → ECS	0.247	2.254	0.010*	Supported
H4s	KAP → GTI	0.171	1.142	0.049*	Supported
H4t	KAP → GMI	0.220	2.023	0.028*	Supported
Control Variables					
Firm size	FS → CSD	0.039	2.023	0.053	Not significant
	FS → GI	0.157	1583	0.042*	Significant
	FS → ENS	0.157	1583	0.082	Not significant
	FS → SOS	0.179	2.324	0.032*	Significant
	FS → ECS	0.028	0.466	0.583	Not significant
	FS → GTI	0.186	1.788	0.066	Not significant
	FS → GMI	0.184	1.921	0.059	Not significant
Industry type	Ind-Typ → CSD	0.038	0.384	0.593	Not significant
	Ind-Typ → GI	0.144	1.921	0.039*	Significant
	Ind. Typ → ENS	0.138	1.684	0.033*	Significant
	Ind. Typ → SOS	0.063	0.583	0.523	Not significant
	Ind. Typ → ECS	0.064	1.022	0.635	Not significant
	Ind. Typ → GTI	0.186	1.788	0.036*	Significant
	Ind. Typ → GMI	0.164	1.921	0.059	Not significant

*$p \leq 0.05$; **$p \leq 0.01$; KM = knowledge management; CSD = corporate sustainable development; KC = knowledge creation; KAC = knowledge acquisition; KS = knowledge sharing; KAP = knowledge application; ENS = environmental sustainability; SOS = social sustainability; ECS = economic sustainability; GI = green innovation; FS = firm size; Ind. Typ = industry type; GTI = green technology innovation; GMI = green management innovation.

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