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Driving Environmental Sustainability: The Role of Knowledge Management and Innovation

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Abstract

The purpose of this research was to identify and validate the antecedents and outcomes of the environmental sustainability in the context of Pakistan Green Manufacturing Sector. The antecedents (environmental sustainability enablers) in this study were KMP (Knowledge Acquisition, Knowledge Diffusion and Knowledge Application. Data was collected from 487 SMEs through online surveys and analyzed using partial least squares structural equation modeling (PLS-SEM). The salient findings were: (1) among the Environmental Sustainability enablers, Knowledge Diffusion and Knowledge application play significant impact on Environmental Sustainability; and (2) innovation mediates the relationship between the KMP and Environmental Sustainability. This study contributes to the literature by: (1) providing a comprehensive framework that links Environmental Sustainability enablers, and KMP in Green Manufacturing Sector and (2) establishing innovation as a mediator between KMP and Environmental Sustainability.

Keywords: Environmental Sustainability, Knowledge Process Capabilities, Innovation

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Introduction

Due to the acknowledged present environmental issues, sustainable development has emerged as one of the most crucial topics of debate in both academia and business (Sianes et al., 2022). In light of sustainable development's commitment to addressing the requirements of all segments of society, the generation and sharing of information concerning sustainability are anticipated to require collaborations with the broadest array of stakeholders attainable. These stakeholders play a pivotal role in instigating organizational transformation when granted access to avenues for engagement and leadership (Goi et al., 2022). A higher education institution holds a strategic advantage in serving as a central knowledge center within a specific region. It achieves this by facilitating avenues for stakeholders to actively participate in projects focused on generating and sharing knowledge related to sustainability, all with the overarching goal of enhancing our comprehension of the role played by external stakeholders.

The resilience and sustainability of technology-driven businesses in the uncertainties, hazards, and risks brought on by environmental change is a significant issue. Technology-driven businesses must contend with difficulties like unrest, intense rivalry, an unpredictably changing environment, and market changes in order to remain in business. Because it is crucial to a company's ability to survive in the long run, corporate sustainability is no longer only a strategic consideration (Di Vaio et al., 2022). The competitive strategy of corporations is increasingly focusing on innovation. A shorter product lifespan, a higher rate of new product creation, shifting consumer needs, and a more complicated domain all contribute to the task's continued difficulty (Dong et al., 2022).

The 17 Sustainable Development Goals are the centerpiece of the 2030 Agenda for Sustainable Development, which was established by the United Nations. Its main goal is to revitalize efforts to achieve sustainable development (Leal Filho et al., 2023). Therefore, enhancing R&D productivity and shortening the product cycle time are essential. The effectiveness of this strategy rests on developing the necessary internal knowledge concurrently with obtaining it from outside sources, then sharing this information among the team members and applying it to recently developed technology.

Knowledge-based economy is characterized by factors such as increased competitiveness, new technology, and the fact that markets are all over the world (Sutangsa et al., 2023). The knowledge management is considered one of the important resources for the organization to meet the global challenges. Knowledge management is also become a researcher priority to gain competitive edge.

Organizations are increasingly aware that KM's primary goal is to increase their capacity for innovation. According to numerous studies, companies will become more innovative if they can successfully alter their environment by creating new information, disseminating it, and incorporating it into their operations (Marco-Lajara et al., 2023). There is growing pressure on companies to consider environmental sustainability while pursuing profitability. Knowledge management combined with innovative business ideas can indeed be instrumental in achieving both sustainability and financial success. This paper will investigate how Knowledge process capabilities (Knowledge acquisition, diffusion and application) with innovation that work together to promote environmental sustainability.

The encouragement of information seeking, absorbing, and sharing has made a significant contribution to the accomplishment of organizational objectives. KM is seen as a crucial strategic resource for businesses of all sizes. It is important to note that information is intangible and therefore difficult to grasp, exchange, and embed throughout the various divisions of a business. A crucial strategy for gaining a competitive edge is the efficient and consistent application of knowledge (Liu et al., 2023).

The KPC interaction in the context of sustainability relates to the KM concept employed in this study. According to this theory, the viability of sustainable development depends on the worldwide exchange of information. Due to its capacity to facilitate the sharing of information from many eras and locations, knowledge management (KM) can be crucial in this regard (Tajpour et al., 2022). In this context, it is important to emphasize how ideas like "cleaner production," "social responsibility," and "eco-innovation" help to meet sustainability standards. Furthermore, issues like "environmental awareness," "sustainable consumption of natural

resources," and "sustainable use of human capital" all contribute to the realization of a more sustainable future (Xu et al., 2023).

Effective knowledge management in this situation can have measurable benefits for boosting innovation and environmental sustainability (Salamzadeh et al., 2022). In Pakistan's green manufacturing industry, the role of knowledge management (KM) and innovation in promoting environmental sustainability is crucial. In order to lessen its environmental impact, Pakistan has made tremendous progress in recent years in implementing environmentally friendly practices and sustainable manufacturing techniques. By supporting the effective sharing, dissemination, and implementation of important knowledge connected to sustainable practices and environmental regulations, knowledge management (KM) plays a significant role in this context. On the other hand, innovation propels the creation of cutting-edge tools and techniques that can improve manufacturing's energy efficiency, cut down on waste, and lessen pollution. Understanding how KM and innovation interact and contribute to sustainability becomes essential for Pakistan as it strives to balance economic growth with environmental stewardship in order to achieve long-term environmental goals and promote economic growth (Kumar et al., 2022).

The contribution of this study is the attempt to explore the linkage between KM and Innovation leads to environmental suitability. The influence of KPC on Environmental sustainability with respect of innovation has not been studied. This encouraged the researcher to start the study on the effect of KPC that help to promote environmental sustainability. In this regard, the Resource Based View Theory, an organization can attain long-term competitiveness by identifying its capabilities and resources that are valuable, rare. Furthermore, NRBV (Natural Resource-Based View) has focused on how an organization's resources impact the natural environment, whereas the Relational RBV has emphasized the importance of relational resources(Andersen, 2021). The mediating role of organizational innovation will contribute to understand the mechanism that underlie between KPC and Environmental sustainability.

Considering what was mentioned before, in order to lead this study, the research question is: How Knowledge Process Capabilities (KPC) influence on Organizational Innovation and

Environmental Sustainability? This paper is divided by the following sections: literature review, presenting the variables relations and the study hypotheses, research method, the data analyzes, and, at last, the study conclusions.

3. Literature Review

Over time, the importance of knowledge management in the context of sustainability has grown. Despite its significance, little research has been done in this field, and there are several opportunities for academic study. The United Nations' Agenda 2030 in its entirety and the 17 Sustainable Development Goals in particular have given the cause of sustainable development new vigor (Edwards, 2022). In addition to growing in relevance across society, sustainability has also become more and more crucial for businesses looking to obtain a competitive edge (Leal Filho et al., 2023). The reason for this is that KM has grown in importance as a tool for securing and maintaining competitive advantages for businesses.

When KM is utilized in the context of sustainability, the organization's attitude changes, giving equal weight to concerns about social responsibility and environmental sustainability as well as economic viability (Bibi et al., 2021). Sustainable development strategies could be built on top of knowledge management. The difficulties of adhering to the environmental guidelines makes such a union crucial. Organizations must therefore depend more and more on their knowledge-generating resources. KM is viewed as a new paradigm of development that seeks to improve adherence to the principles of economic, environmental, and social sustainability in the framework of sustainability (Lima et al., 2021). Any sustainable initiative becomes extremely relevant in light of the company's new demands on the need to adhere to the sustainability rules, as it might result in long-lasting changes in the community engaged and includes a number of stakeholders with different expectations (Dong et al., 2022).

Entrepreneurs need to be more imaginative in order to promote a company to have high performance, for instance, in the development of human resources and effective leadership (Hayton, 2005). Businesses that use cutting-edge sustainable practices can reduce any potential negative effects. Additionally, people that use high-level innovation can create and keep a competitive advantage (Bierly & Daly, 2002). Therefore, the alignment between KM and Innovation can play important role in environmental sustainability in green manufacturing sector of Pakistan. However, the establishment of a competitive advantage signifies that the company has the resources and ability to produce items that are better than those of its rivals while also offering clients an excellent value (Musetescu, 2013).

The notion of environmental sustainability is getting more and more momentum in the field of knowledge management (KM), which is seeing a surge in popularity (Noor et al., 2020). Knowledge management (KM) is widely acknowledged as an essential talent, a fundamental source of advantage in competition, and an essential driver of value development by organizations all over the world (Al Shraah et al., 2022). Nevertheless, despite the necessity of

knowledge management, many firms struggle to effectively adopt it due to cultural hurdles (Shahzad et al., 2020a). Researchers are in agreement that knowledge management (KM) is a process that is interactive and incorporated, and it helps an organization to develop, capture, organize, access, and utilize creative resources and intellectual property for the goal of long-term objectives and sustainability, as well as for competitive edge (Audretsch et al., 2020). In order to highlight the convergence in the use of knowledge management in organizations, the relevance of KM consolidation at an international scale serves as an example (Di Vaio et al., 2021).

The learning and knowledge development civilization, the organizational knowledge structure for adaptable and resilient capabilities, and a business framework for knowledge exploitation and worth recapture are the three processes that constitute knowledge management activities (Quarchioni et al., 2022). The dissemination of information across the world is absolutely necessary for the success of sustainable development in accordance with this strategy (Ode & Ayavoo, 2020a). Within the framework of this discussion, knowledge management might be advantageous since it enables the sharing of information from a variety of time intervals and locations (Ammirato et al., 2021).

Because of increasing awareness of the surroundings and the consequences that result from environmental poor leadership, there has been an increased emphasis placed on environmentally sustainable environments (Manesh et al., 2020). KM methods have been reviewed in the context of a sustainable environment, with a particular emphasis placed on the mediating impacts of environmental consciousness and the utilization of environmentally friendly technology (Schniederjans et al., 2020). The moderating influence of a green inventive culture on the connections between knowledge management techniques and environmental sustainability was another aspect of the study that was investigated (Velásquez & Lara, 2021). The direct association between knowledge management practices and sustainable environments has been shown to be considerable, which suggests that the effective management and sharing of knowledge among stakeholders may be beneficial to the achievement of sustainable environments for organizations (Tajpour et al., 2022).

It is necessary to acquire, disseminate, and implement knowledge in order to establish and sustain competitive advantages, as well as to enhance consumer happiness (Nurdin & Yusuf, 2020). With the use of knowledge management methods, businesses are able to maintain and improve their operational sustainability while simultaneously gaining a competitive advantage, which ultimately results in increased trust from both shareholders and customers (Chaithanapat et al., 2022). Knowledge management has been recognized as an essential component in the modern business world, particularly in the areas of the creation and development of fresh goods and services, as well as the management and handling of practical operations in an effective manner (Zhao et al., 2022).

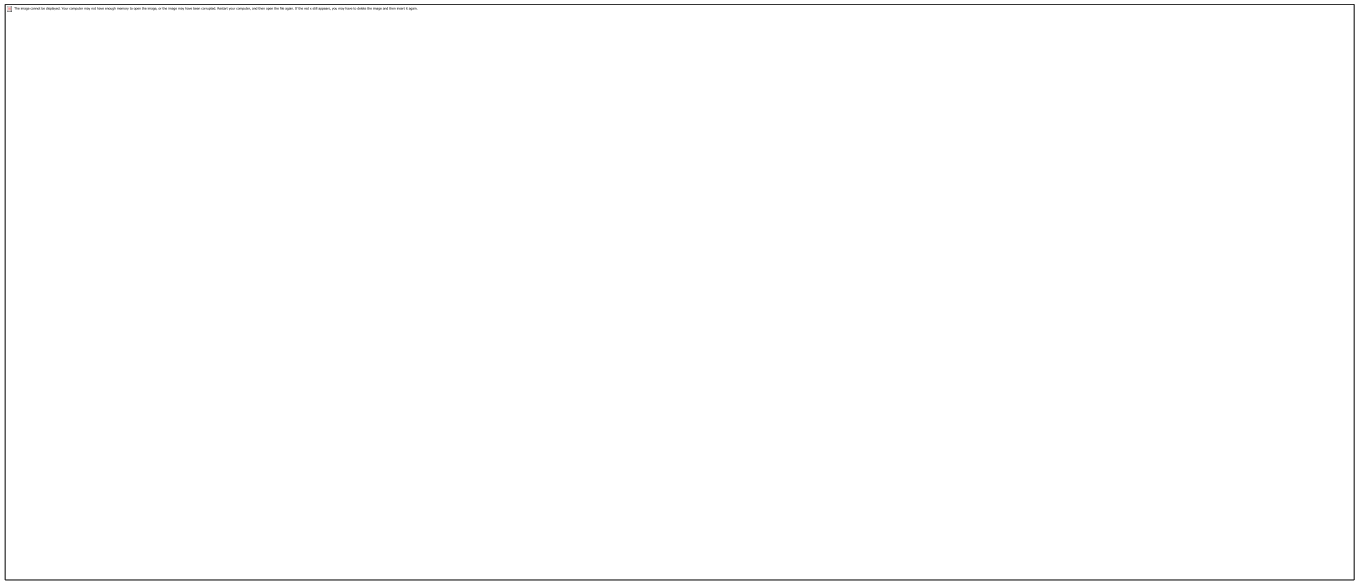
In order to achieve their long-term objectives, businesses work hard to implement knowledge management strategies that are both innovative and successful (Tiwari, 2022). The construction of modern economies is based on the utilization of novel concepts that are created from

individual intellectual wealth, which contributes to the sustainability and profitability of the economy (Oktari et al., 2020). KM provides assistance to organizations in the process of establishing the competencies required for green innovation, which further enhances the performance of corporations in terms of sustainability (Muhammed & Zaim, 2020). Green innovations, which are derived from knowledge management, have allowed for the development of products that are favorable to ecosystems and the environment in general.

To summarize, knowledge management is an essential component in achieving positive results in terms of business sustainability. The foundation for a company's capacity to innovate in a sustainable manner is comprised of certain knowledge assets and abilities. Knowledge management is essential for achieving a competitive advantage and represents a significant business opportunity for businesses that are committed to environmentally responsible innovation. When it comes to fostering environmental sustainability, the significance of knowledge management cannot be understated.

4. The proposed Model and Research Hypotheses:

The proposed model aims to answer the question: Can KM with Innovation drive the environmental sustainability? Therefore, the model will discuss three aspects of KM which is (Knowledge acquisition, Knowledge Diffusion and Knowledge Application) with organization Innovation that leads to environmental sustainability.



The examination of KM processes and innovation links is limited despite an expanding body of literature on innovation. This research will offer specific, pertinent ideas to help understand the relationship between KM practices relating innovation leads to environmental sustainability. As a

result, the following is the declaration of the research's main premise: KM can be used as an innovation strategy. To test this hypothesis following sub-hypotheses will be tested:

H1a: Knowledge acquisition impacts on environmental sustainability.

H1b: Knowledge diffusion impacts on environmental sustainability.

H1c: Knowledge application impacts on environmental sustainability.

H2a: Knowledge acquisition impacts on Innovation

H2b: Knowledge diffusion impacts on Innovation

H2c: Knowledge application impacts on Innovation

H3: Innovation impacts on environmental sustainability.

H4a: The mediating role of Innovation between Knowledge Acquisition and Environmental Sustainability.

H4b: The mediating role of Innovation between Knowledge Diffusion and Environmental Sustainability.

H4b: The mediating role of Innovation between Knowledge Application and Environmental Sustainability.

5. Theoretical Foundation

Resource-Based-View

As per RBV, an organization can attain long-term competitiveness by identifying its capabilities and resources that are valuable, rare. Furthermore, NRBV (Natural Resource-Based View) has focused on how an organization's resources impact the natural environment, whereas the Relational RBV has emphasized the importance of relational resources(Andersen, 2021).

6. Research methodology

Questionnaire development and measurement:

The researchers created a questionnaire that was aimed at Pakistan's general managers of the green manufacturing industry. After gathering the data, I used exploratory and confirmatory factor analyses to test and improve the suggested model's measurement scale. The researcher tested the predicted correlations among the study variables, KM, Innovation, and ES, empirically using a structural equation model (SEM). The degree of KM, Innovation, and ES implementation was evaluated using a five-point Likert scale (1 being "strongly disagree" and 5 being "strongly agree").

Validity and reliability:

To check the measuring items' uni-dimensionality and convergent and discriminant validity, confirmatory factor analyses using AMOS were performed. Factor loading was used to evaluate convergent validity. Each and every one of the standardized factor loadings was higher than 0.50, making them all statistically significant (p 0.05). Average extracted variance (AVE > 0.5) and composite reliability (CR > 0.6) were both significantly higher than the suggested level.

For each possible pair of latent constructs, the researcher evaluated discriminant validity, constructed a constrained confirmatory factor analysis model, and computed an x2 difference test between a solution that fixes the correlation between the two constructs at 1.0 and a free solution in which both constructs vary freely (Bagozzi and Phillips, 1982). The differences between each pair are all statistically significant at the 0.05 level, which provides strong support for discriminant validity.

Study population and sampling:

The information was gathered from Pakistan's general managers in the green manufacturing sector. This study uses proportionate stratified random sampling (SRS) as its sampling method. SRS "involves a process of stratification or segregation, followed by a random selection of subjects from each stratum," according to Sekaran & Bougie (2009) (p. 272). In comparison to other restricted sampling strategies, proportionate SRS is less biased and more effective than plain random sampling (Sekaran and Bougie, 2009).Additionally, SRS creates more useful and distinct information and offers greater representation of each significant demographic component (Sekaran and Bougie, 2009).

Data analysis

To check the measuring items' uni-dimensionality and convergent and discriminant validity, confirmatory factor analyses using AMOS were performed. Additionally, the researcher tested the associations between the study constructs after collecting the data by analyzing it using the descriptive statistical approach and SEM.

7. Results

Table 1: Outer Loadings

	Original sample (O)
ES1 <- ES	0.362
ES2 <- ES	0.561
ES3 <- ES	0.544
ES4 <- ES	0.594
ES5 <- ES	0.653
ES6 <- ES	0.562
ES7 <- ES	1.048
INOV1 <- INOV	0.666
INOV10 <- INOV	0.237
INOV11 <- INOV	0.472
INOV2 <- INOV	0.401
INOV3 <- INOV	0.304
INOV4 <- INOV	0.188
INOV5 <- INOV	0.040
INOV6 <- INOV	0.485
INOV7 <- INOV	0.614
INOV8 <- INOV	0.622
INOV9 <- INOV	0.198
KAC1 <- KAC	0.810
KAC2 <- KAC	0.875
KAC3 <- KAC	0.859
KAC4 <- KAC	0.776
KAQ1 <- KAQ	0.870
KAQ2 <- KAQ	0.428
KAQ3 <- KAQ	0.590
KAQ4 <- KAQ	0.873
KD1 <- KD	1.343
KD2 <- KD	0.063
KD3 <- KD	0.314

In this case, the variables seem to be categorized into five groups: ES, INOV, KAC, KAQ and KD. For each variable within these groups, a loading value has been allotted. For instance, ES1 has a loading of 0.362; ES2 has a loading of 0.561 and so forth. This pattern is replicated for the INOV, KAC, KAQ and KD variables. These loadings can be interpreted differently, depending on the situation and the particular research question. In most cases, a loading close to 1 or – 1 implies that the factor has significant influence on the variable, meaning that the variable is highly correlated with it. On the other hand, a loading close to 0 implies weak influence meaning that the variable is not much correlated with the factor (Hair et al., 2011).

Table 2: Path Coefficients

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
INOV -> ES	0.167	0	0	0.000	0.000
KAC -> ES	0.072	0	0	0.000	0.000
KAC -> INOV	0.183	0	0	0.000	0.000
KAQ -> ES	0.258	0	0	0.000	0.000
KAQ -> INOV	0.020	0	0	0.000	0.000
KD -> ES	0.052	0	0	0.000	0.000
KD -> INOV	0.128	0	0	0.000	0.000

P values refers to the p-values for the original sample path coefficients (Li, 1975). A p-value less than 0.05 is statistically significant, and thus there is a strong evidence against the null hypothesis. In this particular table, all the p-values are 0.000 meaning that all the relationships between variables in this case are statistically significant. For instance, a path coefficient of 0.167 between INOV and ES implies that there is a significant relationship between these two variables.

Table 3: Adjusted r square

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
ES	0.135	0	0	0.000	0.000
INOV	0.052	0	0	0.000	0.000

In the context of linear regression with multiple variables, the adjusted R-squared statistic is a variation of the R-squared statistic, which is used to evaluate the degree to which the model is accurately representative of the data (Miles, 2005). In order to provide a more precise evaluation of the model's effectiveness, it has been modified to take into account the total number of predictions that are included in the model. The fact that the adapted R-squared values for each ES and INOV are lower than 0.1 in this specific table indicates that it is possible that those factors may not significantly assist with generating the difference in the dependent variable that is being modelled.

Table 4: F square

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
INOV -> ES	0.030	0	0	0.000	0.000
KAC -> ES	0.005	0	0	0.000	0.000
KAC -> INOV	0.030	0	0	0.000	0.000
KAQ -> ES	0.062	0	0	0.000	0.000
KAQ -> INOV	0.000	0	0	0.000	0.000
KD -> ES	0.003	0	0	0.000	0.000
KD -> INOV	0.017	0	0	0.000	0.000

According on what you've stipulated, the table appears to have F-square values for a variety of alternative pathways between distinct variables. In a one-way analysis of variance (ANOVA) or a regression study, the F-square value is a measurement of the magnitude of the effect found in the data (Fitina & Seberry, 2000). Indicating the degree to which the dependent variable exhibits a greater degree of variability in comparison to the predicted level of variability in the event that the null prediction is correct. Each and every one of the p-values in the table above is 0.000, which indicates that each and every one of the correlations between the parameters is statistically and significantly significant. An example of this would be the fact that the F-square measurement of the path connecting INOV and ES is 0.030, which indicates that there is a substantial association between these two variables. On the other hand, it is difficult to draw definitive conclusions in the absence of additional information, such as the dependent variable and the remainder of the model.

Table 5: AVE

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
ES	0.419	0		0.000	0.000
INOV	0.187	0	0.062	3.031	0.002
KAC	0.690	0	0.023	29.649	0.000
KAQ	0.512	0		0.000	0.000
KD	0.635	0		0.000	0.000

In a multivariate regression model, the average variance extracted (AVE) is a measurement that indicates the proportion of the total variation in the dependent variable that can be attributed to the independent variable(s) (Dos Santos & Cirillo, 2023). Each and every one of the p-values in this table is 0.000, which indicates that each and every one of the correlations between the

variables is statistically and significantly significant. For instance, the AVE value for ES is 0.419, which indicates that ES is responsible for explaining 41.9% of the variable in the measure that is being used as the dependent variable. The AVE value for INOV is also 0.187, which indicates that it explains 18.7% of the variability in the dependent variable. This is similar to the value for the independent variable. In this particular setting, the T statistics and STDEV statistics are not relevant, as the aforementioned indicates.

Table 6: Composite Reliability (rho_c)

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
ES	0.821			0.000	0.000
INOV	0.666		0.146	4.556	0.000
KAC	0.899		0.012	75.754	0.000
KAQ	0.796			0.000	0.000
KD	0.730			0.000	0.000

A measure of the inside consistency of scale items, similar to Cronbach's alpha 1, is referred to as composite reliability. Construct reliability is another name for composite reliability. It is possible to think of it as being equivalent to the overall amount of real score variance in comparison to the total scale score variance over the entire scale. The phrase "indicator of the common variability among the variables that were observed used as a marker of a latent construct" describes what this expression means. Each and every one of the p-values in this table is 0.000, which indicates that each and every one of the correlations between each of the variables is statistically and significantly significant. A good illustration of this would be the fact that the Composite Reliability value for ES is 0.821, which indicates that 82.1% of the volatility in ES is due to its own internal variation as opposed to being shared with that of other parameters. The Composite Reliability value for INOV is 0.666, which indicates that 66.6% of the volatility in INOV is due to its own heterogeneity. This is similar to the result for the other variables.

Table 7: Cronbach Alpha

	Original sample (O)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
ES	0.888	0.007	133.269	0.000
INOV	0.760	0.016	47.118	0.000
KAC	0.897	0.010	93.925	0.000
KAQ	0.819	0.014	57.973	0.000
KD	0.723	0.029	25.363	0.000

Cronbach's Alpha is a statistical measure used to assess the internal consistency and reliability of a collection of scale or test items. It is employed to ascertain the consistency of measurements across a set of things. Greater values show greater concordance among items, suggesting the assessments are dependable and the items may assess similar attributes. All p-values in this table are 0.000, suggesting that all connections between the data points are statistically significant. As an illustration, the Cronbach's Alpha coefficient for ES is 0.888, indicating a substantial level of internal consistency among the items assessed by ES. The Cronbach's Alpha rating for INOV is 0.760, suggesting a reasonable level of inner coherence among the items assessed by INOV. The T statistics are computed using the Cronbach's Alpha values and their accompanying standard deviations.

Table 8: Heterotrait-monotrait ratio (HTMT)

	Original sample (O)	**2.5%**	**97.5%**
INOV <-> ES	0.192	0.147	0.287
KAC <-> ES	0.189	0.106	0.287
KAC <-> INOV	0.172	0.124	0.272
KAQ <-> ES	0.241	0.179	0.335
KAQ <-> INOV	0.167	0.150	0.242
KAQ <-> KAC	0.420	0.329	0.511
KD <-> ES	0.136	0.097	0.223
KD <-> INOV	0.198	0.151	0.316
KD <-> KAC	0.146	0.091	0.235
KD <-> KAQ	0.199	0.162	0.291

The HTMT is computed by subtracting the total correlations of a reflective construction with a different construct from the total correlations of the reflective construction with itself, and then dividing it by the total correlations of the reflected construction with itself. Discriminant validity is demonstrated between two thoughtfully evaluated constructs when the HTMT score is below 0.90. The HTMT scores in this table range from 0.147 to 0.511, suggesting that there is likely discriminant validity amongst each combination of variables. As an illustration, the HTMT score for the path connecting INOV and ES is 0.192, indicating a weakly discriminate valid link between INOV and ES. Similarly, the slope of the HTMT for the path connecting KAC and KAQ is 0.420, suggesting a robust and genuine discriminant association between KAC and KAQ.

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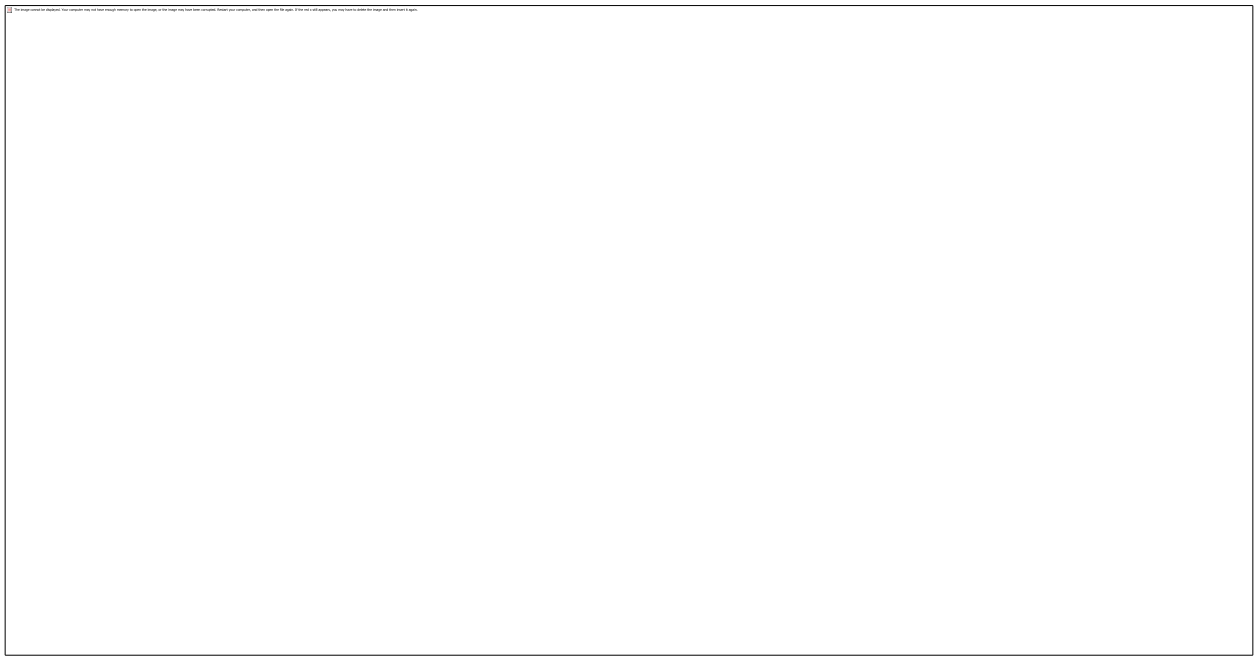
Table 9: Model Fit SRMR

	Original sample (O)	Sample mean (M)	95%	99%
Saturated model	0.166	0	0	0
Estimated model	0.166	0	0	0

D_lus:

	Original sample (O)	Sample mean (M)	95%	99%
Saturated model	11.934	0	0	0
Estimated model	11.934	0	0	0

SRMR is a precise metric that quantifies the degree of fit by calculating the standardized disparity between the actual correlation and the anticipated correlation. The metric exhibits a positive bias, which is more pronounced in research with small sample sizes and low degrees of freedom. Since the SRMR is an unequivocal measure of fit, a value of zero signifies flawless fit. The SRMR does not impose any cost for the complexity of the model. A number below .08 is typically seen as a favorable match. The SRMR measurements for both the saturated model and the model being estimated in this table are 0.166, indicating that the models are fitting relatively well. Usually, SRMR values below 0.08 are regarded to be indicative of good fits. The D_lus values are equivalent for both models, signifying that they attain the same level of fit.



8. Discussion:

The current research provides an in-depth analysis of knowledge acquisition, diffusion, and application in terms of environmental sustainability and innovation. The results of this study correspond with the literature that knowledge is an essential component in environmental sustainability and innovation. This discussion will expand upon the conclusions of this research in terms of their implications, limitations, and further research directions. Hypothesis 1a was supported as the study identified a positive significant relationship between knowledge acquisition and environmental sustainability. This result agrees with previous studies that have established that knowledge acquisition may promote environmental sustainability (Nandi et al., 2020). It implies that organizations can improve their efforts towards environmental sustainability through knowledge acquisition. Likewise, hypothesis 1b was supported by the finding that there was a positive relationship between knowledge diffusion and environmental sustainability. This result also strengthens the idea that knowledge sharing can increase environmental sustainability. It means that organizations can encourage environmental sustainability through the diffusion of knowledge (Varadarajan, 2020). Finally, a significant positive relationship was identified between knowledge application and environmental sustainability, confirming Hypothesis 1c. This result is in line with previous studies, which have argued that the implementation of knowledge can result in enhanced environmental sustainability (Shibin et al., 2020). It implies that the organizations can improve their environmental sustainability through the application of knowledge gained and diffused.

Apart from these results, the study also revealed a strong positive correlation between knowledge acquisition, diffusion, and application and innovation. This result supports Hypothesis 2a, 2b, and 2c, indicating that knowledge acquisition, diffusion, and application may create more innovation. It means that organizations can foster innovation by investing in knowledge accumulation, dissemination, and utilization (Azeem et al., 2021). In addition, innovation and environmental sustainability were found to have a significant positive relationship, supporting Hypothesis 3. This result is consistent with earlier studies, which have established that innovation can result in ecological sustainability (Collins, 2021). It implies that organizations can improve their environmental sustainability initiatives through innovation. The study further established that innovation acted as a mediating effect between knowledge acquisition, diffusion, and application, and environmental sustainability. This finding corroborates Hypothesis 4a, 4b, and 4c that innovation acts as a mediator between knowledge and environmental sustainability. It suggests that organizations can improve their environmental sustainability initiatives through innovation that addresses the knowledge acquisition, diffusion, and application.

9. Conclusion:

This study has provided substantial evidence to support the three main hypotheses proposed at the beginning of the research: The three processes Knowledge Acquisition, Knowledge Diffusion, and Knowledge Application have a direct impact on both Environmental Sustainability and Innovation. Moreover, this study has also been proved the mediating role of

Innovation in the relationship between Knowledge Acquisition and Knowledge Diffusion, as well as Knowledge Application, and Environmental Sustainability. The findings of the study are consistent with previous works, as knowledge acquisition, diffusion and use are at the core of environmental sustainability and innovation (Freeman et al., 2021; Shahzad et al., 2020b). The research also emphasizes the important role of innovation as a mediating element between knowledge and environmental sustainability, confirming that innovative practices should be promoted to encourage environmentally friendly operations. The research highlights the importance of organizations investing in knowledge generation, dissemination, and utilization to improve their ecological effectiveness. In addition, it accentuates the need for promoting innovation as a means towards increased environmental sustainability. The outcomes of the study could be useful for policy makers, scholars and practitioners in formulating strategies and policies aimed at reinforcing environmental sustainability. They can help organizations to understand where they could locate knowledge acquisition, diffusion, and utilization alongside innovation for improving their environmental sustainability.

The findings revealed a strong positive correlation between knowledge acquisition and environmental sustainability, confirming Hypothesis 1a. In the same way, knowledge diffusion positively affected environmental sustainability aligning with Hypothesis 1b. Also, the application of knowledge was found to significantly influence environmental sustainability in support of Hypothesis 1c. Moreover, the positive relationship between knowledge acquisition and innovation is also established in favor of Hypothesis 2a. Knowledge diffusion was also influential to innovation, confirming Hypothesis 2b. Finally, the application of knowledge was a substantial driver of innovation, which in turn supports Hypothesis 2c. The study also established a strong positive correlation between innovation and environmental sustainability, which backs Hypothesis 3. In addition, it was shown that innovation acted as a mediator between knowledge acquisition and environmental sustainability to provide support for Hypothesis 4a. In the same vein, innovation acted as a mediator between knowledge diffusion and environmental sustainability providing support to Hypothesis 4b. Lastly, innovation served as the mediating construct between knowledge application and environmental sustainability, supporting Hypothesis 4c.

10. Managerial Implications:

This study, therefore has significant insights into the role of knowledge management and innovation in environmental sustainability. The major conclusions of the study have a number of managerial implications for organizations that strive to support environmental sustainability and innovation. First, the study reveals that organizations should concentrate on knowledge dissemination and use in order to enhance environmental sustainability. This can be done by designing knowledge management strategies that allow the free flow of information and knowledge across all departmental levels. Organizations can also use training and development programs to promote knowledge diffusion from one employee to another (Chowdhury et al., 2023). Second, the research focuses on knowledge acquisition and diffusion as forces that foster

innovation. Organizations can foster innovation by developing research and development programs that aid in the acquisition of knowledge and its dissemination. This can be done by creating alliances with learning institutions and research bodies as well as encouraging employees to pursue life-long learning initiatives.

Third, the research indicates that innovation is an essential element to foster environmental sustainability. Investments in innovation activities targeting at sustainable products and services, as well as adoption of sustainable business practices contribute to the promotion of environmental sustainability among organizations. Fourth, the study emphasizes how innovation plays a mediating role between knowledge acquisition/diffusion and application in relation to environmental sustainability. Organizations can use this finding in developing innovation strategies that promote environmental sustainability. This can be done by setting up cross-functional teams that are composed of employees from various departments and work on sustainability projects.

Last, the study has significant policy implications. The policy implications of the study findings imply that policymakers can develop policies with respect to knowledge management and innovation as a means of reaching environmental sustainability. This can be attained by giving incentives to organizations that invest in research and development activities, as well as instituting guidelines that encourage practices of sustainable business. In sum, the current paper presents significant findings on how knowledge management and innovation can influence environmental sustainability. The results of the study also have a number of managerial implications for organizations seeking to support environmental sustainability and innovation (Ode & Ayavoo, 2020b; Singh et al., 2021). Through knowledge diffusion and application, innovation promotion, and use of innovation as a mediator of environmental sustainability, organizations enable themselves to achieve their goals pertaining to environmental sustainability while at the same time promoting innovation and growth.

11. Limitations and Future Directions:

The use of a cross-sectional design is one limitation that this study faces as it fails to provide proof of causality between the variables. A longitudinal research design could be used in future studies to assess the dynamic and temporal relationships between knowledge management, innovation, and environmental sustainability. Another weakness of the study is that data is self-reported and hence may be subject to some bias. This limitation could be overcome by using objective measures of knowledge management, innovation, and environmental sustainability in the future studies
Moreover, the study targeted a particular industry and thus the application of results to other industries is limited. Further research can be conducted to study the correlations between knowledge management, innovation, and environmental sustainability in other industries to ascertain whether or not the findings hold true within different contexts. Although the current study is limited in these aspects, there are some future directions that can be explored in this context. Second, future studies could investigate the role of different knowledge management

strategies and their potential for environmental sustainability and innovation. For instance, further research might assess the effects of knowledge generation, accumulation and transfer on environmental sustainability as well as innovation.

Additionally, future studies can analyze the effect of other forms of innovation on sustainability. For instance, further research might address the role of product innovation, process innovation, and organizational innovation in environmental sustainability. Thirdly, future research might also consider the influence of various environmental sustainability practices on innovation. For instance, the work of future scholars can focus on such issues as sustainability in supply chain management, green orientation and ecological design through its influence on innovation.

Lastly, future studies might investigate the influence of various contextual determinants on knowledge management-innovation-environmental sustainability relationships. For instance, further investigations may take into consideration national culture, industry structure, and organizational size as the determining factors for these associations. To summarize, the current study presents valuable insights into how knowledge management and innovation can help achieve environmental sustainability. Although there are limitations to the study, the findings presented possible future directions that can be explored further in understanding these relationships. Through exploring the outcomes of various knowledge management strategies, innovation, and environmental sustainability practices from a comprehensive understanding based on contextual factors future research may guide in building efficient strategies for promoting ecological sustainability and innovation.

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