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Empowering knowledge management in enhancing the performance of higher education institutions in the era of industrial revolution 4.0: A mediating role of innovation

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Abstract Education is the most important element of economic growth and development, Pakistan is full of resources, but improper use of resources leads to it being underdeveloped. Where appropriate education standards can help Pakistan overcome economic problems. Therefore, Pakistan has failed to establish new universities in the last two decades. On the other hand, the performance of the education sector of Pakistan is insignificant and nowhere exists in international rankings. Higher education institutions (HEIs) are progressively incorporating modern technologies and creative approaches to improve their performance in the context of Education 4.0. This study uses innovation as a mediating variable to examine the relationship between knowledge management (KM) and HEI performance. (KM), which includes the organized administration of an organization's knowledge resources, is essential for creating an atmosphere that supports ongoing education and development. Educational paradigms and operational efficiencies are being reshaped by innovation, which is defined by the application of technologies. This study aims to use knowledge management as a construct in enhancing HEIP, where innovation plays a contributing factor as a mediator. The unit of analysis was organization; therefore, the current study targeted 88 universities in Pakistan. The samples were selected via a stratified random sampling technique, and the data were analyzed via SMART PLS 4.0. The findings of the current study revealed that knowledge management in the era of Education 4.0 is a significant construct in enhancing HEIP. Similarly, the results of the mediation also revealed that innovation is a significant contributing factor to the progress of HIEIP. Furthermore, the research explores optimal methodologies and obstacles linked to the amalgamation of knowledge management and innovation, furnishing HEIs with an all-encompassing framework designed to prosper in the context of Education 4.0.

Keywords: education 4.0, organization's knowledge resources, optimal methodologies, unit of analysis

1. Introduction

The country's political, social, and economic development is based on education. Education can help in the development of countries in various forms, such as research and development, economic growth, and social growth (Abdelaty & Esmail, 2020). Since the Industrial Revolution (IR), education has been the most important component of economic development (Wiśniewska-Sałek, 2019).

With respect to IR 4.0 with education, four generations exist to understand IR 4.0 in an educational context, beginning with the beginning. The first generation, known as education 1.0, usually covers an informal teaching style, and the second generation, education 2.0, involves the training of people living in society. The basic goal of this revolution is to provide education to the maximum number of people living in society. In the third generation, education 3.0, the information technologies involved in the education structure, and the fourth generation, known as education 4.0, defines the two factors of innovation and change in an education paradigm shift. This stage is the era of artificial intelligence, and this era is also known as the future of education (Gueye & Exposito, 2020).

In the context of IR, education is the key component in any nation's growth; since 1947, Pakistan's education sector has been facing terrible situations compared with other countries; as a result, Pakistan is far behind in education rankings (Iqbal et al., 2023). However, higher education in Pakistan faces numerous challenges amid the prevailing global competitive landscape. The scrutiny of academic quality has intensified owing to the internationalization and globalization of HE, coupled with the impact of international rankings on these institutions (Awan, 2020).

Scholars frequently doubt the academic quality of Pakistani universities, drawing parallels with the challenges faced by their counterparts in other developing nations (Mastoi et al., 2019; Nisar, 2019). Researchers in Pakistan are particularly

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concerned with the outcomes of research, teaching, and other university-related pursuits. The three pivotal academic roles of teaching, research, and service, which are crucial for the fulfillment of university objectives, have been validated in prior studies (Iqbal et al., 2023).

Therefore, to overcome these educational challenges, Pakistan HEIs need a paradigm shift to Education 4.0, which is directly related to the Industrial Revolution 4.0 (Gueye & Exposito, 2020). Achieving alignment between Industry 4.0 and Education 4.0 supports a shift in the way that technological advancements are integrated into teaching and learning. Combining these two trends, the Education 4.0 paradigm is a collection of educational and technological advancements in education that support the use of both technology and humans to enhance and modify learning to better satisfy Industry 4.0 demands (Mian et al., 2020).

In integrating solutions to problems in the era of IR 4.0, knowledge management is a critical factor in enhancing performance (de Bem Machado et al., 2022). The landscape of HEIs has undergone a profound transformation, with research and the Industrial Revolution eclipsing the traditional teaching narrative, marking a significant shift (Ramjeawon & Rowley, 2018). Contemporary perceptions of HEIs depict them as entities that prioritize dynamic and innovative knowledge generation and dissemination (Sahibzada et al., 2020). In line with the literature, recent studies on KM also highlighted that KM with Industry 4.0 (Education 4.0) is very effective in enhancing performance (Cabeza-Pullés et al., 2020; Di Vaio et al., 2021).

Consequently, scholars advocate for empirical research on the organizational factors that contribute to the implementation of KM in HEIs (Iqbal, 2021). Second, there is a notable gap in the empirical research examining the impact of KM on HEI performance, whether direct or indirect (Rehman & Iqbal, 2020). Earlier studies have demonstrated that the influence of KM on OP is often indirect, operating through mediating factors rather than having a direct effect (Iqbal et al., 2019).

According to certain academics, the impact of KM methods on OP is often indirect, with other mediating variables serving as conduits for transferring the influence of KM to OP (Haider et al., 2021; Sonia et al., 2020). However, the role of mediating variables and the mechanism through which they mediate the relationship between KM and OP remains largely unexplored in the literature (Samsiah et al., 2020). One research element suggests that KM establishes an innovative environment, thereby enabling firms to attain heightened performance (Koohang et al., 2017). To draw conclusions into the relationship between KM and OP, innovation should be considered in future research focusing on the relationship between KM and HEI performance (Li et al., 2023). Similarly, innovation in IR 4.0 is also an important contributor to enhancing performance (Aedi et al., 2022). In developing nations such as Pakistan, HEIs are an important contributor to driving economic and societal advancement. Consequently, when Education 4.0 is taken as a major element, very few researchers refer to Education 4.0 (Ishak & Mansor, 2020). Therefore, the current research aims to empirically test the interplay between KM, innovation 4.0, and HEI performance in Pakistan. The primary objective of this study is to address identified knowledge gaps and contribute many practical and theoretical insights to the literature.

2. Structure of the Study

The current study is systematically structured into various sections to facilitate a comprehensive exploration of its research objectives. Figure 1 shows the complete structure of the study.

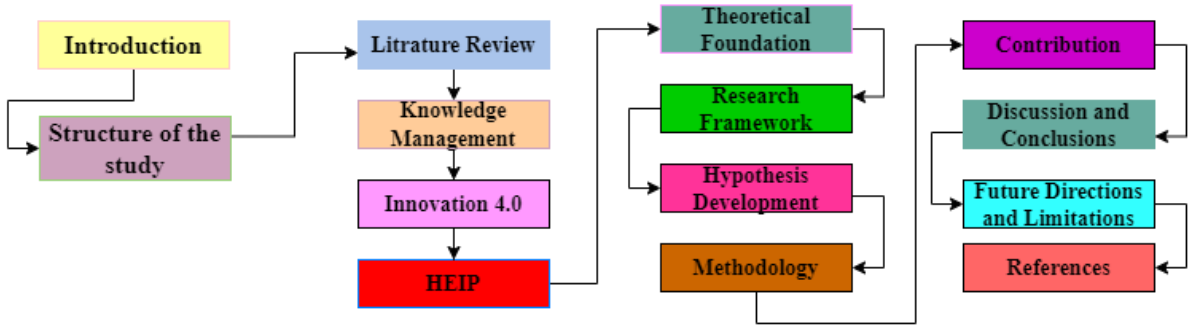

Figure 1 Organization of the study.

3. Literature Review

3.1. Knowledge Management

Knowledge management in the era of Industrial Revolution 4.0 was considered an important concept that also contributed to business development (Luo, 2024). KM also stresses how proper knowledge implications for resources benefit from acquisition, sharing, and application (de Bem Machado et al., 2022). The association between IR 4.0 and KM is very strong and helps organizations enhance performance (Ribeiro et al., 2022).

In the realm of KM, scholars have characterized it as a systematic series of actions, attributing significant importance to these processes in the context of organizational capabilities (Ishak & Mansor, 2020). The concept of KM in terms of knowledge capability helps organizations create, acquire, share, and utilize knowledge (Sonia et al., 2020). Although universities have extensively studied the sharing of knowledge, there is still some uncertainty surrounding the empirical evidence concerning how knowledge is acquired and applied in educational settings (de Bem Machado et al., 2022; Shah et al., 2018; Wiśniewska-Sałek, 2019).

Consequently, the present study aims to explore KM as a composite of acquisition, sharing, and application processes. The acquisition of knowledge is acknowledged as one of the most challenging and resource-intensive phases in KM, simultaneously being deemed the most crucial and foundational activity (Ahmad et al., 2017). Conversely, knowledge sharing is characterized as a set of beliefs, behaviors, cultural attributes, or network systems within an organization, encompassing the distribution and exchange of knowledge, skills, and experiences among individuals or different organizational departments (Gharakhani & Mousakhani, 2012).

Knowledge application, on the other hand, involves storing, retrieving, using, and contributing to knowledge. It is characterized as an effort to enhance OPs by applying and utilizing knowledge in the operations of businesses, products, and services (Rasheed & Guo, 2020). The application of knowledge spans operational, technological, and social dimensions (Shujahat et al., 2018), encompassing the utilization of knowledge in organizational activities, processes, and procedures to increase the production of goods and services that deliver value to stakeholders (Anwar et al., 2020).

3.2. Innovation

Technology is changing quickly, and this has an impact on education. Examples of these advancements include robotics, artificial intelligence, 5G, the Internet of Things, and others (Aedi, 2023). To better comprehend education, classroom management, organization, assessment, pedagogy, ethics, and professional development, among other topics, new and creative techniques and strategies have been presented (Gómez-Marín et al., 2022).

In the 4.0 IR, technology systems are developing at a rapid pace and influencing all spheres of human activity daily. Production went through rapid digitization throughout this era (Masood et al., 2024). IR has led to various advancements and innovations in nearly all fields, and the beginning of IR 4.0 brought many opportunities and challenges that can spur innovation and the creation of all higher education institutions (HEIs) (Li et al., 2023).

Innovation, within an organization, refers to its ability to implement “novel ideas, inventions, and discoveries, leading to the development of new products or services, managerial strategies, procedures, work methods, and technology” (Etzkowitz & Leydesdorff, 2000). It is recognized as one of the pivotal organizational elements, and innovation significantly influences the outcomes of organizations (Ahmed et al., 2020; Mardani et al., 2018).

Al-Hakim & Hassan, (2016) categorize innovation into three types: radical, incremental, and both technological and administrative. Researchers increasingly acknowledge the heightened importance of innovation for organizations in complex and dynamic corporate environments. The growing body of research underscores innovation as the most effective tool for organizational success, contributing to enhanced performance (Hwang et al., 2020; Migdadi, 2019). Consequently, innovation has emerged as a primary organizational strategy, playing a critical role in determining sustainability and competitiveness (Ghasemzadeh et al., 2019).

However, when its nature and traits are considered, innovation in HEIs may differ from that in commercial enterprises. Innovation in HEIs encompasses unique academic programs, curricula, teaching strategies, research initiatives, and other elements (Rehman & Iqbal, 2020). Reflecting these distinct characteristics, studies on innovation in the context of HEIs have focused predominantly on its apparent impact on OP (Elrehail et al., 2018).

3.3. Performance of Higher Education Institutions

The assessment of OP, regarded as a dependent variable within the realm of management, has been extensively explored to gauge the success of various entities. There is a growing emphasis on enhancing the operational efficiency of educational institutions (Yaakub & Mohamed, 2019). The OP serves as a key indicator of an organization's growth and development (Koohang et al., 2017). The existing body of literature indicates that financial metrics are commonly employed to evaluate the performance of HEIs; however, there is persistent apprehension regarding this approach (Feranecová & Krigovská, 2016). While some individuals place a premium on nonfinancial dimensions such as innovation, research, operations, and services, there remains a notable concern in this regard.

Pakistan perceives the performance of its universities, particularly in teaching and research, as significantly disappointing. This concern has been addressed in prior studies and the literature, explicitly highlighting the imperative need to fulfill the dual roles of teaching and research for performance enhancement (Iqbal et al., 2023). Similarly, another study highlighted the same issue: the evaluation of university performance in terms of teaching and research in Pakistan reveals a pronounced sense of dissatisfaction. The imperative to fulfill the multifaceted responsibilities of teaching, research, and services for enhanced performance has been underscored in earlier scholarly works (Murtaza & Hui, 2021).

Despite being a problematic area, the deficiency in research performance remains apparent in Pakistani universities (Ali et al., 2024). Researchers express the sentiment that university administration frequently falls short in terms of both teaching and research performance. Consequently, the present study addresses this gap by concentrating on teaching and research within HEIs.

4. Theoretical Foundation of the Study

This investigation primarily draws upon the theoretical underpinnings of the Gold et al., (2001) model on KM capability and the Grant, (1996) knowledge base view (KBV), which is prominently referenced in the literature on KM. KM is distinctive within two domains: knowledge infrastructure capabilities and knowledge process capabilities (Gold et al., 2001). The former encompasses pivotal facilitating elements, namely, structure, culture, and technology, whereas the latter consists of the intricacies of knowledge acquisition, sharing, and application (Iqbal et al., 2019). This conceptual framework of the KM suggests that this process not only autonomously impacts organizational effectiveness but also furnishes a competitive edge to the organization, thereby assisting in the augmentation and refinement of overall OP. This study proposes an integrated model to examine the relationships among knowledge management, innovation 4.0, and HEIP in Pakistan by combining these important theoretical perspectives.

5. Research Framework

Given the inadequacies identified in the literature, a conceptual framework based on knowledge-based view (KBV) theory is proposed. Through the KBV, universities can take advantage of their internal assets as organizations, particularly through the skillful application of knowledge management (KM), which can improve performance and provide them with a competitive advantage over other universities. A mediating variable (innovation), a dependent variable (HEIP), and an independent variable (KM) make up the research framework. Figure 2 below shows a graphic illustration of the conceptual framework.

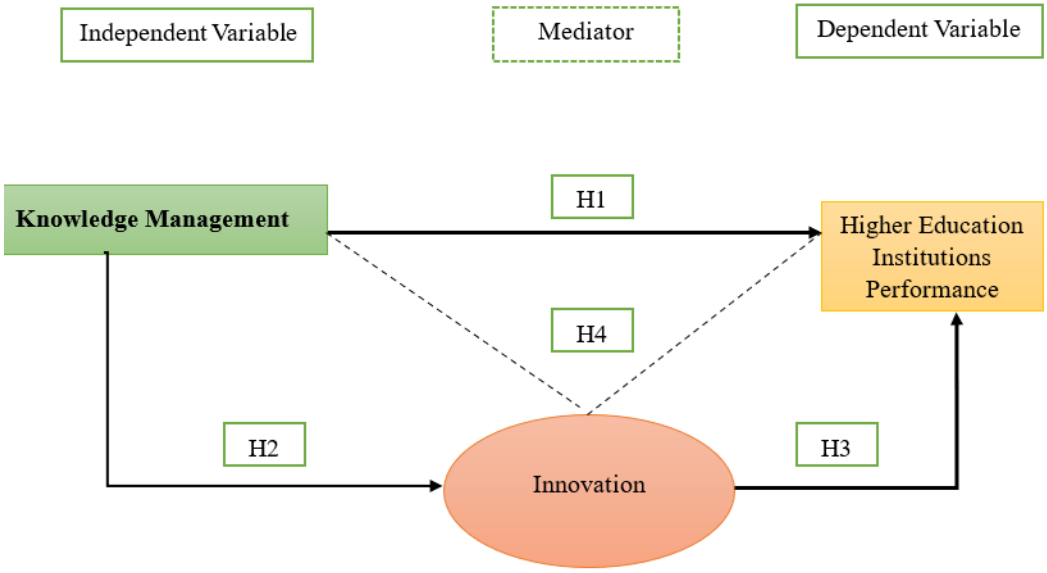

Figure 2 Research Framework.

6. Hypothesis development

6.1. Performance of KM and Higher Education Institutions

Within the ever-evolving realm of business, where enterprises continually confront swift environmental shifts, knowledge has arisen as an important asset in maintaining competitive advantage and safeguarding organizational prosperity (Shahzad et al., 2016; Shannak et al., 2017). This recognition extends to HEIs, particularly research universities, where KM assumes equal importance because of its potential, and it significantly enhances their overall performance (Shannak et al., 2017).

Nonetheless, the knowledge-based view (KBV) proposed by Grant, (1996), the proficient administration of knowledge-based resources and the efficacious execution of KM are imperative for achieving heightened OP (Mazhar & Akhtar, 2016). For example, activities such as acquiring, sharing, and applying knowledge not only increase overall performance but also increase productivity and profitability through the cultivation of inventive concepts and the infusion of novelty into products and services (Chiu & Chen, 2016; Iqbal et al., 2019; Shannak et al., 2017). Specifically, the facilitation of knowledge sharing emerges

as a catalyst for enhancing research performance within university contexts (Al-Kurdi et al., 2018). Many recent investigations have revealed a noteworthy, positive, and direct correlation between KM processes and OP (Chiu & Chen, 2016; Iqbal et al., 2019; Ngha et al., 2016; Shahzad et al., 2016). In light of these findings, the following hypothesis is posited:

H1: There is a positive direct effect between KM and HEIP.

6.2. KM, Innovation 4.0, and HEIs performance

The impact of the KBV theory in current studies demonstrates a steady and universally favorable correlation between KM, innovation capability, and effectiveness [58], [60]. The innovation capacity of an organization is closely linked to its competencies and expertise, which are obtained not only from internal reservoirs but also through engagements with external counterparts (Obeidat et al., 2016). Likewise, the implementation of KM, such as knowledge acquisition and application, has been linked to enhanced innovation and performance (Huang & Li, 2009; Inkinen, 2016).

A substantial body of empirical studies has consistently demonstrated the favorable influence of KM processes on innovation (Al-Hakim & Hassan, 2016; Darroch, 2005; Obeidat et al., 2016). Moreover, innovation emerges as a crucial element driving organizational effectiveness, and various research outcomes underscore the noteworthy beneficial impacts of KM on innovation (Li et al., 2023; Wang et al., 2016). In the context of the correlation between innovation and OP. “Innovation is a crucial enabler, innovation plays a vital role in attaining OP and maintaining a competitive advantage in a swiftly evolving and intricate business milieu” (Ruiz, 2013). Empirical investigations extensively accentuate how innovation acts as a catalyst for enhanced organizational effectiveness.

This theoretical perspective implies the role of innovation as a mediator in the relationship between KM and OP, as highlighted in prior studies. For example, the KA and KAP not only improve an organization's decision-making and learning capabilities but also contribute to increased efficiency and effectiveness (Chiu & Chen, 2016; Obeidat et al., 2016). In one study, innovation was found to have a partially mediating effect on the relationship between KM and OP in an investigation of the telecom industry of Iraq (Al-Hakim & Hassan, 2016). Similarly, a significant mediating effect of innovation empirically tested the relationship between KM and the organization performance setting (Iqbal et al., 2019).

Within the context of a research university, the following hypotheses are proposed:

H2: There is a positive direct relationship between KM and innovation

H3: There is a positive direct relationship between innovation and HEIP.

H4: There is a mediating effect of innovation between KM and HEIP.

7. Materials and Methods

7.1. Unit of Analysis, Population, Sample, and Data Collection Procedure

The research employed a quantitative survey methodology. Universities served as the primary units of analysis, and the respondents included vice-chancellors, deans, directors, heads of departments, and others. To determine the sample size, a power analysis was conducted; this power analysis identified the sample size as well as significant statistical results. G*power software was used to identify the sample size with parameters such as effect size (0.15), alpha error probability (0.05), power (0.80), and predictors (2). Table 3 of the parameters show that a sample size of 68 universities is appropriate for the current study, where actual data collected from the sources are 88, which is justifiable with respect to the sample size.

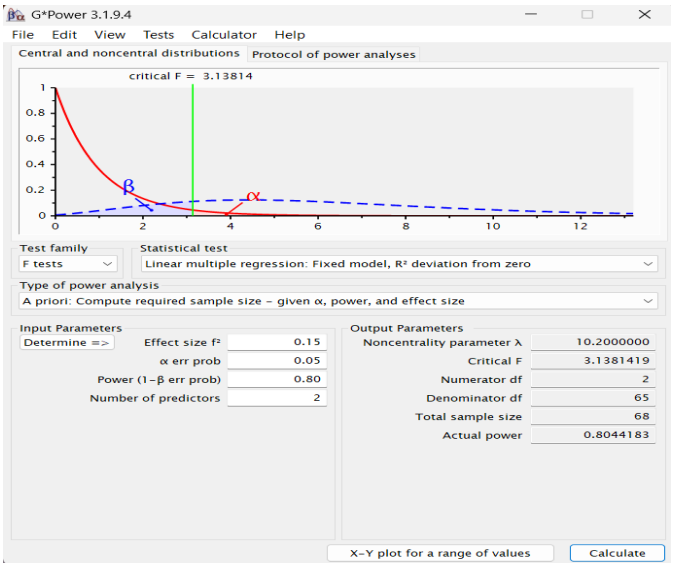

Figure 3 Recommended sample size by G* Power.

The importance of G* power is vital in design studies (Perugini et al., 2018). The G* power estimates the probability and power of an experiment and computes significant statistical results, confirming that the method supports quality and satisfactory standards (Ksenija & Berislav, 2013). All universities in the public and private sectors received self-administered questionnaires via a stratified random sample technique. Researchers can obtain data from various subgroups via stratified random sampling, which is acknowledged for its accuracy and affordability (Lynn, 2019). A self-administered questionnaire was administered both physically and online. The actual sample size for the current study calculated through power analysis was 68, but the researcher collected data from 88 universities for more generalized results.

7.2. Measures

In the present study, all 37 measurements were adapted from preexisting research. Some slight modifications were applied to better align them with the context of a university setting. External experts were approached for the facial validity of the modified scale items. After their confirmation and recommendations, scale items were integrated into the research instrument. The "five-point Likert scale", which serves as the instrument's basis, uses a "1" to represent "strongly disagree" and a "5" to represent "strongly agree." Table 1 provides an in-depth description of the measurement tools used. The demographic details are provided in Table 2, which shows that 46 (52.3%) public sector universities participate, and 42 (47.7%) private sector universities participate. The maximum participation from provinces comes from Punjab (46, 52.3%), KPK (18, 20.5%), Sindh (14, 15.9%) and Islamabad (10, 11.4%). Similarly, in terms of gender, the maximum number of participants was 66 (75%), and the number of female participants was 22 (25%). However, as per the designation, the number of VCs involved is 2 (2.3%), 32 (36.4%), 39 (44.3%), 9 (10.2%) and 6 (6.8%) from Deans, HODs, respectively.

Table 1 Measurement instrument sources.

Constructs	No. of items	Source
KM	22	(Ngoc-tan et al., 2019)
Innovation	05	(Qassas & Areıqat, 2020)
Organization Performance of HEI's	10	(Iqbal et al., 2023)

Table 2 Demographics of the study participants.

Items	Frequencies	Percentage
Sector		
Public sector	46	52.3
Private sector	42	47.7
Province		
Punjab	46	52.3
Sindh	14	15.9
Islamabad	10	11.4
KPK	18	20.5
Gender		
Male	66	75
Female	22	25
Designation		
VC	2	2.3
Deans	32	36.4
HOD	39	44.3
Director	9	10.2
Other	6	6.8

7.3. Data Analysis Process

The present study follows a quantitative cross-sectional research design, employing Smart PLS-4 for data analysis (Hair et al., 2017). The analysis was conducted via the (SMART PLS) SE modeling technique. PLS is recognized as a promising analysis tool that is particularly suitable for academic disciplines such as business and social sciences research. Its utility extends to effectively handling small sample sizes and nonnormal data, making it a valuable choice for a diverse range of research applications (Hair et al., 2017).

The Smart PLS analysis is based on two different phases: one phase is measurement model specification, and the second phase is structural model evaluation (Moscato, 2023). During the measurement model specification, emphasis is placed on ensuring that only the constructs exhibiting robust factor loading, convergent validity, composite reliability (CR), and discriminant validity are integrated into the structural model. The subsequent stage, structural model evaluation, is designed to scrutinize path coefficients and assess their significance via the bootstrapping technique (Ringle et al., 2018). In the context of mediation analysis, the approach outlined by Baron & Kenny, (1986) was adopted, recognized for its rigor in testing mediating effects, and deemed particularly suitable for use in conjunction with the PLS-SEM technique (Hair et al., 2017).

8. Data Analysis and Results

8.1. Measurement Model Assessment

To ensure the validity and reliability of the constructs, the measurement model was assessed by the standards provided by Roebianto et al. (2023) during the early stage. The model contains 37 items to be tested, and during the analysis, items with minimum or low factor loadings were systematically removed (Waseem & Yusoff, 2024). The iterative process continued until all factor loadings reached or approached the suggested threshold of 0.50. However, in adherence with the guidelines set by Agus Purwanto & Yuli Sudargini, (2021), caution was exercised to retain items of theoretical importance, ensuring that their removal did not disproportionately impact the average variance extracted (AVE) and composite reliability (CR). Consequently, the final measurement model comprised 31 items. As shown in Table 3, all factor loadings surpassed 0.50. Similarly, convergent validity and reliability were confirmed by the AVE and CR for every construct that either matched or surpassed the recommended standards of 0.50 and 0.70, respectively. Additionally, as indicated in Table 4, discriminant validity was substantiated by the criteria proposed by Fornell and Larcker, (1981). The comprehensive outcomes of the confirmatory factor analysis affirm that the model is apt for structural evaluation.

Table 3 Reliability and convergent validity.

Constructs	Items	Loading	Cronbach's Alpha	AVE	CR
KM	KM2	0.669	0.962	0.642	0.966
	KM3	0.700			
	KM4	0.718			
	KM5	0.696			
	KM6	0.702			
	KM7	0.890			
	KM8	0.882			
	KM9	0.839			
	KM10	0.809			
	KM11	0.836			
	KM12	0.828			
	KM13	0.851			
	KM14	0.856			
	KM15	0.830			
	KM16	0.829			
	KM17	0.831			
Innovation	INNO1	0.877	0.889	0.692	0.918
	INNO2	0.827			
	INNO3	0.854			
	INNO4	0.776			
	INNO5	0.824			
Organization Performance of HEI's	OP1	0.853	0.957	0.722	0.963
	OP2	0.882			
	OP3	0.849			
	OP4	0.842			
	OP5	0.841			
	OP6	0.866			
	OP7	0.835			
	OP8	0.815			
	OP9	0.835			
	OP10	0.875			

Table 4 Discriminant Validity (Fornell– Larcker Criterion).

	HEIP	INNO	KM
HEIP	0.849		
INNO	0.630	0.832	
KM	0.436	0.385	0.801

8.2. Assessment of the structural model

Following figure 4 shows the mandatory the mandatory assessment of the measurement model, the second stage involved the analysis of the structural model. The testing of hypotheses was performed in various steps. Phase one tested the direct relationships between KM and HEI performance (HEIP). In phase two, the direct impacts of knowledge management

(KM) on innovation were investigated. The third phase looks at how innovation directly affects HEIP. Using 500 resamples of the bootstrap resampling method, the direct pathways and standard error estimates were calculated via the methodology of Ringle et al. (2018). Additionally, p > 1.64 was used to examine the directional hypotheses of the current study.

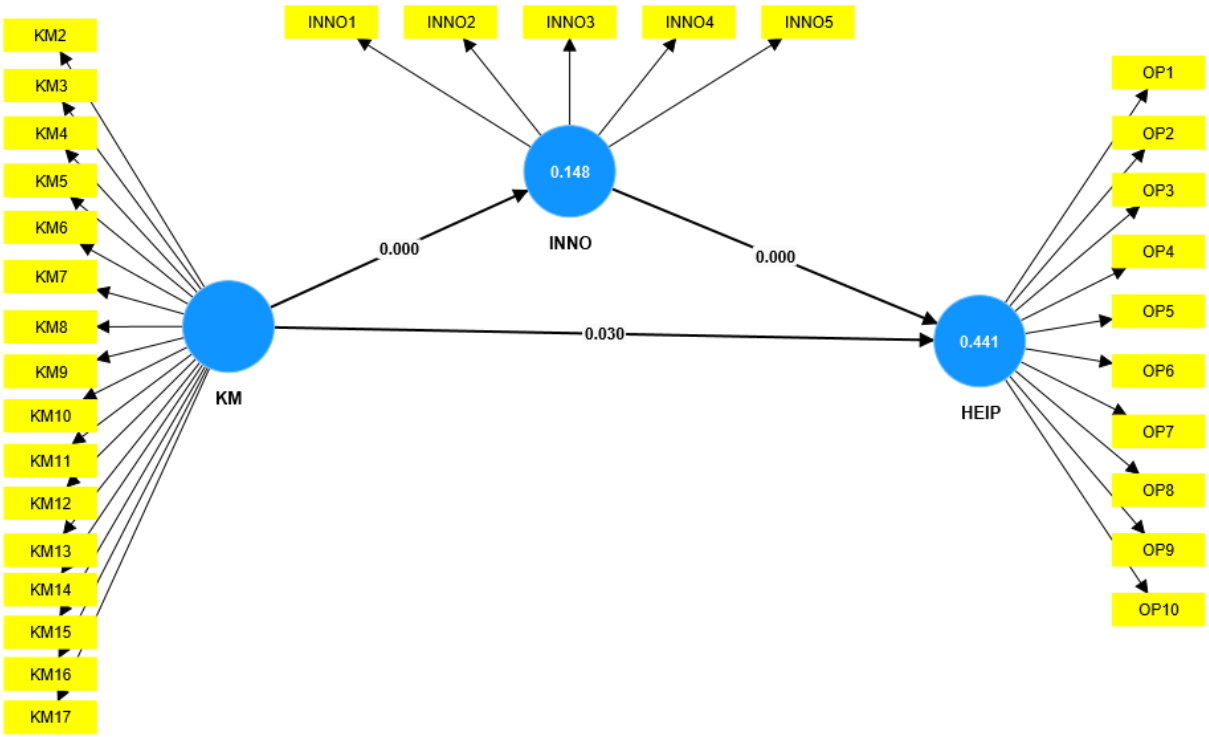

Figure 4 Assessment of the structural model.

The test results for the proposed hypotheses regarding direct and indirect relationships are outlined in Table 5. According to Table 5, the direct effect of KM on HEIP (β = 0.227, p ≤ 0.030) and innovation (β = 0.385, p ≤ 0.001) has a positive significant direct effect. These findings support H1 and H2. Similarly, innovation in HEIP (β = 0.543, p ≤ 0.001) also has a significant direct effect that supports H3.

Table 5 Path coefficient and structural model results.

Hyp.	Relationship	β	SE	t value	Sig.	Decision
H1	KM → HEIP	0.227	0.094	1.889	0.030	Supported
H2	KM → INNO	0.385	0.120	3.941	0.001	Supported
H3	INNO → HEIP	0.543	0.098	5.799	0.001	Supported
H4	KM→ INNO → HEIP	0.209	0.066	3.160	0.001	Supported

Similarly, the mediation of innovation is described via the concept of (Baron & Kenny, 1986), and p values are obtained by bootstrapping with 500 resamples, following the approach of Ringle et al. (2018) to check the indirect effect. The results from the analysis revealed a significant indirect effect of KM on HEIP through the mediation of innovation (β = 0.209, p ≤ 0.001). This finding provides substantial support for H4.

9. Discussion, conclusion, and practical implications

The primary objective of the current study was to scrutinize the direct influence of KM on HEIP, along with exploring innovation as a mediator between KM and HEIP within universities. The hypothesized relationships were subjected to rigorous testing via partial least squares structural equation modeling (PLS-SEM). The outcomes of this research make significant contributions to the literature in multiple aspects. During the initial phase of the investigation, all direct impacts were thoroughly examined. The present study revealed that the proficient execution of KM makes a substantial contribution to HEIP. This finding underscores that the adept implementation of KM within research universities has the potential to increase the efficiency of both teaching and research endeavors. Additionally, these findings lend support to the equivalence in the applicability of the knowledge-based view within HEIs.

Similarly, this study reinforces the significance of KM within HEIs, aligning with the emphasis highlighted by (Ramjeawon & Rowley, 2018). Moreover, it validates and reinforces the findings of (Rehman et al., 2019), who carried out research in an academic setting and concluded that there is a significant positive and direct correlation between KM procedures and HEIP.

In conclusion, the findings of the current study provide crucial empirical insights into the relationships among KM, innovation 4.0 as a mediator and HEIP. The results indicate a significant and positive effect, highlighting that KM is an important factor contributing to the performance of universities. These findings align with recent research conducted by(Garcia-Perez et al., 2020; Ongus et al., 2016; Rehman & Iqbal, 2020; Sonia et al., 2020) within the corporate sector. Similarly, the present study's results reveal a significant positive and indirect impact of KM on HE HEIP through innovation. According to the study of Wang et al. (2016), innovation is connected primarily to OPs through the knowledge-sharing process. However, the empirical findings of this study suggest that KM, as a comprehensive concept, can foster innovation, consequently leading to enhanced performance. In conclusion, this study makes a valuable contribution to the KM literature by emphasizing the crucial role of KM within the realm of HEIs. Furthermore, the findings underscore that KM stands as a significant driver in augmenting the performance of HEIP.

These results offer valuable insights for practitioners and policymakers in HEIs, as they formulate strategic plans and cultivate a supportive culture and conducive working environment for their employees (Muqadas et al., 2017). For example, it is imperative for management and leaders to possess a comprehensive understanding of the role of KM within their organization and to communicate this knowledge effectively to their colleagues. This insight underscores the importance of KM as a fundamental requirement for enhancing both OP and individual performance (Sonia et al., 2020). Effective KM in educational organizations, particularly universities, necessitates proper strategic planning and a well-organized team with sufficient funding support. The knowledge culture within educational institutions is typically founded on elements such as openness, trust, and effective communication (Javed et al., 2020). Moreover, while past research has extensively explored the relationship between KM and HEIP (Haider et al., 2021; Rehman et al., 2019), the mediating role of innovation in this relationship has been comparatively underemphasized. The current study endeavors to bridge this gap, effectively contributing insights to the knowledge base view literature. This study elucidates how KM can aid educational institutions in enhancing university performance by introducing the mediating factor of innovation. Thus, the findings from the present study exemplify how KM functions as a pivotal driver in HEIs, fostering innovation and ultimately influencing OP.

10. Contribution

The outcomes of this study are poised to exert a substantial impact on research endeavors, offering valuable insights for problem resolution and strategic planning within universities. The study's contribution extends to shedding light on critical issues associated with research, teaching, and services in HEIs. Through this research, potential solutions to the formidable challenges confronting Pakistani universities in the realms of teaching and research can be identified. Moreover, this study proposes future directions for emerging nations, such as Pakistan. By underscoring the significance of KM as an independent variable and innovation as a mediating variable in enhancing the OP of HEIs, the current study aligns with its objectives. The findings are anticipated to be important factors in the formulation of strategies and planning initiatives.

11. Future directions and limitations

While contributing to the knowledge-based view, the current study acknowledges a few limitations that offer opportunities for future researchers. Primarily, the study is confined to the context of Pakistani HEIs, encompassing both public and private entities. Future researchers can consider replicating the same theoretical model in other developing countries, as the findings of the current study may not necessarily generalize the issues faced by other nations. Additionally, the study's focus on the overall impact of KM on HEIs opens avenues for future researchers to delve into specific dimensions such as knowledge acquisition, knowledge sharing, and knowledge application as primary constructs in the HEI context. Furthermore, the measurement of OP in HEIs in the current study focused on teaching performance and research performance; therefore, future researchers could explore alternative measures such as university–industry linkages, service performance, research rankings, and university rankings. Finally, the current study concentrated on the overall mediating effect of innovation with KM and HEIP, and future research could investigate specific facets or mechanisms within the innovation process. In future studies, researchers can explore individual KM dimensions separately, considering the mediating effect of innovation. Additionally, while the current study analyzed the KM construct at a higher order, future research could employ second-order data analysis to scrutinize KM and its specific dimensions with the mediator, innovation, and the dependent variable, the OP of HEIs. This nuanced approach may provide a more detailed understanding of the intricate relationships within the studied constructs.

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Ethical considerations

In this survey-based research, we ensured informed consent, confidentiality, and minimized harm, while adhering to ethical guidelines. This approach safeguards participant rights and enhances the integrity of our findings.

Conflict of Interest

The authors declare no conflicts of interest.

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