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The Effects of Knowledge Management and Organization Learning on the Organizational Innovation Performance of High-tech Enterprises in Shandong Province China

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Abstract
Knowledge Management (KM) aims to boost innovation and core competitiveness. Effective KM impacts product and service development through organizational learning (OL) and innovation (OI). China's high-tech industry relies heavily on foreign technology and lacks global competitiveness. Shandong Province, a key high-tech hub, exemplifies these issues. The purposes of this research were to measure the level of knowledge management, investigate the effect of knowledge management on the organizational innovation, and study the effect of knowledge management process impacts the performance of organizational innovation of high-tech enterprises in Shandong province China through the mediating roles of organizational learning. A quantitative research design was employed, utilizing a structured questionnaire survey distributed to 337 valid questionnaires were obtained, yielding a response rate of 84.25%. Data were analyzed using structural equation modeling (SEM) to test the hypothesized relationships and mediation effects. The results revealed (1) Knowledge management had positive effect on organization learning. (2) Organization learning had positive effect on organization innovation. (3) Knowledge management had positive effect on organization innovation. (4) Knowledge management had positive effect on organization innovation through the mediating role of organization learning. This study asserted the theoretical assumption with empirical data that knowledge management and organization learning assist in improving organization innovation in High-tech organization of developing countries.

Keywords: Knowledge Management, Organization Learning, Organizational Innovation Performance, High-tech Enterprises

1. Introduction

Organizations must adapt to an environment that is more complicated than ever before as the speed of innovation has increased in the last decades, shortening the life cycle of products and increasing the need for rapid changes within companies. (Wangcharoendate, Siewsamdangdet. and Sinchun, 2020). With the rapid development of the global economy, knowledge has become a key resource for enterprises to gain competitiveness. Knowledge management, as a new paradigm of enterprise management, aims to improve the innovation ability of enterprises and thus enhance their core competitiveness. In the era of the knowledge economy, the effective

management of knowledge has become a critical determinant of an enterprise's long-term competitiveness. Knowledge Management (KM) is recognized as a fundamental pillar of modern enterprise management, significantly influencing the development of products and services by fostering organizational learning and innovation (Ahmad et al.,2020). By systematically acquiring, sharing, and utilizing knowledge, organizations can enhance decision-making processes, improve operational efficiency, and sustain competitive advantages in dynamic market environments (Abbas et al.,2019).

Extensive scholarly research has established a robust relationship between KM and organizational innovation (OI) and between KM and organizational learning (OL). KM facilitates innovation by optimizing internal and external knowledge resources, enabling firms to generate and implement novel ideas, methods, and technologies. OL is a critical mechanism through which organizations develop new knowledge from collective experiences, enhancing capabilities and fostering continuous improvement. While prior studies have examined the mediating role of OL in the KM-OI nexus, the research has been conducted in developed economies (Karasneh, 2019). Little attention has been devoted to investigating these relationships in emerging economies, where challenges related to knowledge application and technological advancement remain pronounced (Li et al.,2021). This gap underscores the necessity of further empirical inquiry, particularly in high-tech sectors, where innovation is a key driver of sustainable growth.

China's high-tech industry has witnessed rapid expansion, supported by proactive government policies and substantial growth in enterprises, revenue generation, and profitability. In 2020, high-tech enterprises increased by 24% year-on-year, contributing significantly to the national economy (Hu et al.,2023). However, despite this remarkable growth, Chinese high-tech enterprises continue to face persistent challenges in technological innovation. The sector remains heavily reliant on foreign technology, exhibits relatively low innovation performance, and struggles to achieve global competitiveness (Kun,2022). Compared to developed economies, Chinese high-tech firms bear higher patent royalty costs, maintain lower profit margins, and depend extensively on imported equipment, constraining their ability to attain technological self-sufficiency and market leadership (Hu et al.,2023).

Shandong Province, a key high-tech industrial hub in China, exemplifies these challenges. While the province has experienced a steady increase in high-tech enterprises, its economic value-added ratio has consistently lagged behind the national average. Given that innovation performance is a crucial driver of high-tech enterprise development, understanding the role of KM in fostering innovation within this sector is of substantial theoretical and practical significance. Against this backdrop, this study examines the intricate relationships among KM, OL, and OI within China's high-tech industry, focusing on Shandong Province. By elucidating the mechanisms through which KM enhances innovation and strengthens competitiveness, this research aims to contribute to theoretical advancements and practical strategies for improving the technological innovation capabilities of Chinese high-tech enterprises.

The purposes of this research are (a) to measure the level of knowledge management process of high-tech enterprises in Shandong province in China. (b)to investigate the effect of knowledge management process on the organizational innovation of high-tech enterprises in Shandong province in China. (c) to study the effect of knowledge management process impacts

the performance of organizational innovation of high-tech enterprises in Shandong province China through the mediating roles of organizational learning.

2. Review of Related Literature

Knowledge management and Organization Learning

Knowledge management (KM) and organizational learning (OL) are crucial concepts in organizational development that complement and reinforce each other. Knowledge management emphasizes the effective use and transfer of knowledge resources, while organizational learning focuses on the creation and sharing of knowledge within the organization, thereby increasing its adaptability and competitiveness (Grant, 2021). KM enables knowledge sharing and dissemination. Organizational learning (OL) has been regarded as one of the strategic means of archiving long-term organizational success (Hsu & Lin, 2008; Hsu & Lamb, 2020). Organizational learning is seen as a dynamic process based on knowledge. Which implies moving among the different levels of action, going from the individual to the group level, and then to the organizational level and back again (Huber,2019).

Organizational learning (OL) is crucial for long-term organizational success in the face of rapid change and uncertainty. Traditional measuring tools like learning curves and experience curves are incomplete. OL is a complex multidimensional construct encompassing managerial commitment, systems perspective, openness, experimentation, and knowledge transfer. Businesses must continuously learn to maintain competitiveness in an uncertain environment. Organizational learning is a dynamic process based on knowledge acquisition and dissemination within an organization. To satisfy consumers' demands, organizations must develop personal or group learning abilities through effective KM processes (Huber, 2019). Knowledge is the antecedent and base of OL, moving from individual to group and organizational levels. Then is reasonable to assumed the hypothesis here that:

H1: Knowledge management has positive effect on organization learning

Organization Learning and Organization Innovation

Huber (1991) and Dixon (1992) cited in Soontornwiwattana (2022) suggested approaches according to which organizations acquire knowledge, interpret it from distributors to receivers, and lastly store it as organizational knowledge. OL was born. Rue1 et al. (2021) suggested that the true value of organizational learning is in the constant development and application of new knowledge to produce value, and they see it as a process-based approach to resource acquisition. Organizational learning is a critical component in fostering organizational innovation, which involves the application of new ideas, processes, products, or services within a firm, thereby enhancing its overall performance. Organizational innovation is positively influenced by learning, as higher levels of learning orientation leaded to greater firm innovativeness in managers. Learning processes are seen as drivers of innovation processes within firms. Organizational learning is considered a means to improve performance, which at the same time confirms the validity of its conceptual connotations (Volberda et al., 2021). Jimenez-Jimenez and Sanz-Valle (2011) confirmed that the positive impact of organizational learning on performance and innovation in the context of Spanish organizations. The organization learning is critical to driving innovation (Gold et al., 2021; Guisado-González et al., 2017). Organizational innovation is described as the use of new ideas within the organization, whether

they are expressed in goods, processes, management, or marketing systems. Abbas et al. (2019) found a link between organizational learning and technological innovation. Organizational learning is closely related to organizational innovation (Abbas et al., 2019; Ben Zaied et al., 2015). Then is reasonable to assumed the hypothesis here that:

H2: Organization learning has positive effect on organization innovation

Knowledge Management and Organization Innovation

Wang and Ahmed (2004) identified organizational innovation through extensive literature and validated a 20-item measurement construct using FAME Database. The five dimensions tested were product, market, process, behavioral, and strategic innovation. In organizations the effective KM practices would be able to capable the innovative behavior among employees through generate and transfer of knowledge (Liao et al., 2023). The study compared results in Taiwan, highlighting the need for empirical research on effective knowledge management (Ruel et al., 2020). Innovation is closely linked to effective knowledge management (KM), as it positively impacts performance and innovation (Liao et al., 2023).

The link between knowledge management (KM) and organizational innovation is a key research area in organizational and management science(Kun,2022). Knowledge management (KM) plays an important role in driving organizational innovation (Cui et al., 2005; Grant, 2021). Knowledge management enables businesses to more efficiently acquire, produce, exchange, and utilize knowledge resources, hence increasing organizational innovation (Kushwaha & Rao, 2016). Knowledge transformation theory highlights the link between knowledge exchange and innovation. The relationship between KM and organizational innovation, research has made some progress and provided important theoretical and practical insights for organizations to enhance their innovation capabilities and competitive advantages (Ruel et al., 2020; Volberda et al., 2021). The relationship between KM and innovation is well-documented, with studies indicating a close relationship (Volberda et al., 2021).

KM is a method that dynamically holds the knowledge and influence to create value and effectiveness of the firm (Gold et al, 2021). Managing knowledge helps to communicate and exchange the knowledge in innovation process and increase performance by developing new vision and capability (Kushwaha & Rao, 2016). Therefore, in innovation process it is difficult to manage knowledge, so this study focusses on knowledge capture and sharing as a part of KM for the creation of innovation capability in an organization. Then is reasonable to assumed the hypothesis here that:

H3: Knowledge management has positive effect on organization innovation

Mediating Role of Organization Leaning in the Relationship between Knowledge Management and Organization Innovation

Knowledge management emphasizes knowledge (Liao et al., 2023). Organizational learning emphasizes the behavior of learners and the learning process, and the value of knowledge management is reflected in the fact that it is an important source of competitive advantage (Volberda et al., 2021). The goal of knowledge management is knowledge innovation, and the ultimate goal is to form the core competitiveness of the enterprise and improve the ability of the organization. Knowledge management, as a management concept and method, is carried out by the organization (Ruel et al., 2020). Organizational innovation is the foundation and guarantee for the implementation of knowledge management, and

organizational innovation based on knowledge management is a prerequisite for the success of knowledge management (Grant, 2021). The knowledge management system identifies and acquires external knowledge related to the organization's strategic development direction, which is conducive to the organization's active response to changes in the external environment (Kun,2022). The storage and sharing of knowledge by a knowledge management system promotes the reconfiguration of information, technology, and knowledge already existing within the organization, triggers innovation (Liao et al., 2023), develops or improves products, services, and processes, enhances core competitiveness, and creates competitive advantages.

From Liao and Wu (2010) who studied the system perspective of knowledge management, organizational learning, and organizational innovation, it was founded that organizational learning is the mediating variable between knowledge management and organizational innovation. Just like a system, knowledge management is an important input, and organizational learning is a key process, then organizational innovation is a critical output. Liao et al. (2023) suggested organization learning as a key indicator of an organization's effectiveness and capacity for innovation and expansion. Then is reasonable to assumed the hypothesis here that:

H4: Knowledge management has positive effect on organization innovation through the mediating role of organization learning

Therefore, this study developed a model that aligns with the research objectives and assumptions. The model in consideration is seen in Figure 1.

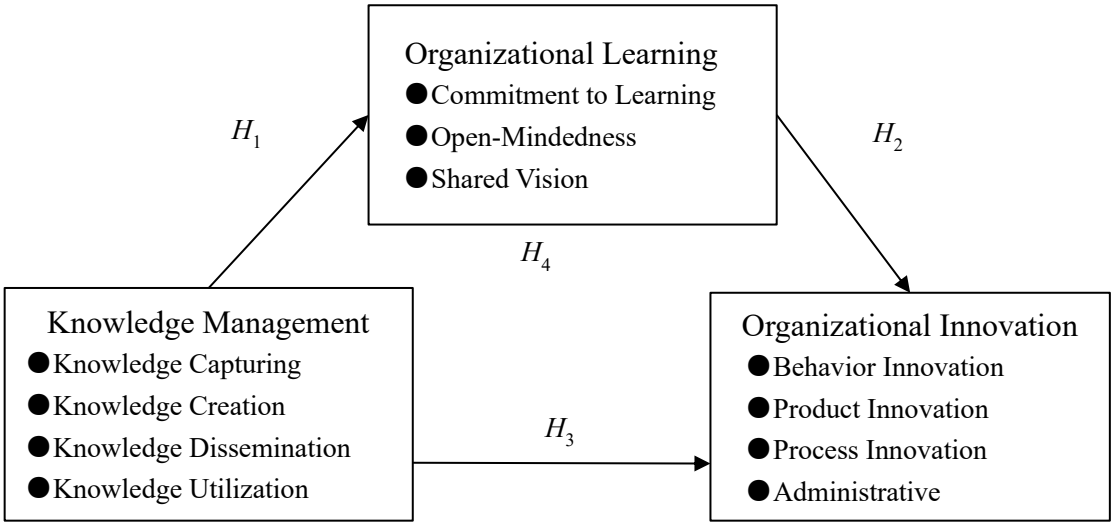

Figure1: Research framework

3. Methods

Population and Sample

China's high-tech enterprises include the new generation of information technology manufacturing enterprises, new energy and new materials enterprises, high-end equipment enterprises, artificial intelligence enterprises. Among them, the economic added value of high-tech enterprises is the measurement index of the development of each type of enterprises by the Chinese government. The high-tech industry in Shandong Province develops rapidly, and

the economic added value of high-tech enterprises continues to grow, and has become an important development object of Shandong Province. There are 23,556 CEOs of high-tech enterprises in Shandong Province (http://tjj.shandong.gov.cn/). Among them, there are 7,677 CEOs in new-generation information technology manufacturing companies, 6,181 CEOs in new energy and new materials companies, 4,833 CEOs in high-end equipment companies, and 4,865 CEOs in artificial intelligence companies.

The study aimed to study the influence of knowledge management and organizational learning on the organizational innovation performance of high-tech enterprises in Shandong Province. The main research object was high-tech enterprises in Shandong Province. According to Yamane (1973), the sample size was recommended at 379 samples at Yamane's reliability of 95% (f=±5%). This sample size could also respond to the appropriated size for SEM analysis. This samples were retrieved from four categories of high-tech enterprises in Shandong, with a total population of 23,556 and a sample size of 379. The basic qualification requirements for participants were: (1) they must be managers of enterprises in the list of high-tech enterprises in Shandong Province published on the Shandong Provincial government website, (2) they must have experience at the management level for more than one year, (3) have a good English level, and (4) be able to read and understand the basic content of the English questionnaire.

The stratified proportional random sampling was employed for sample extraction to ensure representativeness. The population was stratified into four groups: New-Generation Information Technology Manufacturing Enterprises, New Energy and New Material Enterprises, High-End Equipment Enterprises, and Artificial Intelligence Enterprises. The sample size for each category is proportionally allocated based on the number of enterprises in the population, with adjustments made to meet research requirements. Specifically, New-Generation Information Technology Manufacturing (NGITM) enterprises accounted for 7,677 firms, gave a sample of 124; New Energy and New Material enterprises include 6,181 firms, gave a sample of 99; High-End Equipment enterprises comprise 4,833 firms, gave a sample of 78; and Artificial Intelligence enterprises consist of 4,865 firms, gave a sample of 78.

The research team identified a list of eligible enterprises by referring to publicly available government statistical data, industry association directories, and third-party databases. The enterprises registered in Shandong Province and belong to the aforementioned industries. After randomly selecting enterprises within each stratum, the research team contacted the enterprise executives through telephone calls, emails, and on-site visits. Upon obtaining consent, structured questionnaires were distributed via email to ensure the breadth and validity of data collection. For enterprises that could not be contacted initially, multiple rounds of follow-up were conducted. After questionnaire recovery, the data were screened to eliminate invalid samples.

Measurement

The classic scale of Brief & Motowidlo (1986) is highly authoritative and widely applied in the field of knowledge management, ensuring the theoretical rigor and scientific nature of the measurement tools. Brief & Motowidlo's scale covers four key dimensions of knowledge management: (1) knowledge capturing, (2) knowledge creation, (3) knowledge dissemination, (4) knowledge utilization, these dimensions comprehensively reflect the core process of

knowledge management. It can effectively evaluate the actual situation of knowledge management in enterprises. This scale comprehensively reflects the key processes to achieve knowledge management within enterprises. The theoretical foundation for selecting this scale is robust, enabling a systematic assessment of enterprises' knowledge management practices at various stages. The scale applies to technology-intensive enterprises. By measuring these dimensions, the research can gain an in-depth understanding of high-tech enterprises, effectively facilitating the acquisition and utilization of knowledge resources, and promoting the enhancement of organizational innovation capabilities.

Levitt & J.G. (1988) 's organizational learning Scale is selected as a framework for revising definition, component, and measurement items of organization learning. This scale is based on the classical theory of organizational learning and emphasizes three key aspects of the organizational learning process: commitment to learning; open-mindedness; shared vision. These dimensions underscore the attitudes and cultural factors of organizational members during the learning process, accentuating the propelling role of the internal organizational environment in knowledge absorption, sharing, and innovation. The rationale for selecting these three dimensions lies in their possession of a solid theoretical underpinning their alignment with the core driving forces that foster continuous innovation within the high-tech enterprise context. The organizational innovation performance scale of Kordova et al. (2022) was selected as a frame when exploring literature related to the impact of knowledge management and organizational learning on the organizational innovation performance of high-tech enterprises in Shandong Province.

This scale was divided into behavior innovation, product innovation, process innovation, administrative. This scale comprehensively encapsulates multiple facets of an organization's innovation activities, paying attention not only to specific product and process transformations but also emphasizing changes in innovation culture and management approaches. The rationale for selecting this scale stems from its capability to fully capture the diversity and complexity of innovation outcomes in high-tech enterprises. Moreover, the latest theoretical advancements render it more congruent with the realities of the contemporary innovation landscape. By utilizing this scale, the research can precisely measure the impact of knowledge management and organizational learning on organizational innovation performance, thereby enhancing the scientific rigor and practical guiding significance of the research conclusions. The study was designed as a 5-point Likert scale to measure the CEOs of high-tech enterprises in Shandong Province's attitudes toward these items. 5 = Strongly agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly disagree.

4. Results and Discussion

The study highlights the demographic profile of managers in Shandong’s high-tech enterprises. Female managers dominate (61.1%). Most are middle-aged, with 42.7% aged 36-45. Bachelor’s degree holders make up 34.7%, while 53.4% have other educational backgrounds, reflecting diverse talent needs. In terms of experience, 33.8% have over 10 years, and 27.9% have 3 years or less. Overall, the workforce is experienced, well-educated, and primarily middle-aged, aligning with industry demands. For details, see Table1.

Table1: Sample feature description

Variable	Options	Frequency	Percent
Gender	Male	131	38.9
	Female	206	61.1
Age	18-25	19	5.6
	26-35	103	30.6
	36-45	144	42.7
	Above 45	71	21.1
Education	Bachelor Degree	117	34.7
	Master Degree	23	6.8
	Ph.D. Degree	17	5.0
	Others	180	53.4
Experience	Less Than/Or Equal To 3 Years	94	27.9
	Between 4-5Years	66	19.6
	Between 6-10	63	18.7
	10 Years and Over	114	33.8
	Total	**337**	**100.0**

Reliability Analysis

The data presents the reliability analysis results for various variables and dimensions. The study employs Cronbach's Alpha coefficient as a measure of internal consistency. A Cronbach's Alpha value closer to 1 indicates a higher correlation among the measurement items within a dimension, suggesting better reliability. All dimensions' exhibit Cronbach's Alpha values exceeding 0.79, attesting to the overall high internal consistency of the scale. Knowledge acquisition (0.874), learning commitment (0.873), and process innovation (0.873) demonstrate the highest reliability, signifying strong internal correlations among their respective measurement items. While knowledge utilization (0.795) and product innovation (0.799) exhibit slightly lower Alpha values, they remain within an acceptable range. The high reliability of this scale underscores its ability to consistently and reliably reflect the corresponding concepts with precision. As shown in Table 2.

Table2: Reliability Table for Each Variable and Dimension

Dimension	Number of items	Cronbach's Alpha
Knowledge Capturing	4	0.874
Knowledge Creation	4	0.848
Knowledge Dissemination	4	0.823
Knowledge Utilization	3	0.795
Commitment To Learning	5	0.873
Open-Mindedness	4	0.866
Shared Vision	4	0.849
Behavior Innovation	4	0.854
Product Innovation	3	0.799
Process Innovation	4	0.873
Administrative	4	0.870

Validity Analysis

Confirmatory factor analysis (CFA) is used to confirm that the measurement instruments utilized accurately represent the ideas or variables included in the study and to see if the built measurement model fits the data. As tests for convergent and discriminant validity, the measurement indicators in the confirmatory factor analysis procedure include path coefficients, composite reliability (CR), and average variance extracted (AVE). The validity and composite reliability are indicated by an AVE value of at least 0.5 (Hair et al., 2010) and a CR of 0.7 (Fornell & Larcker, 1981).

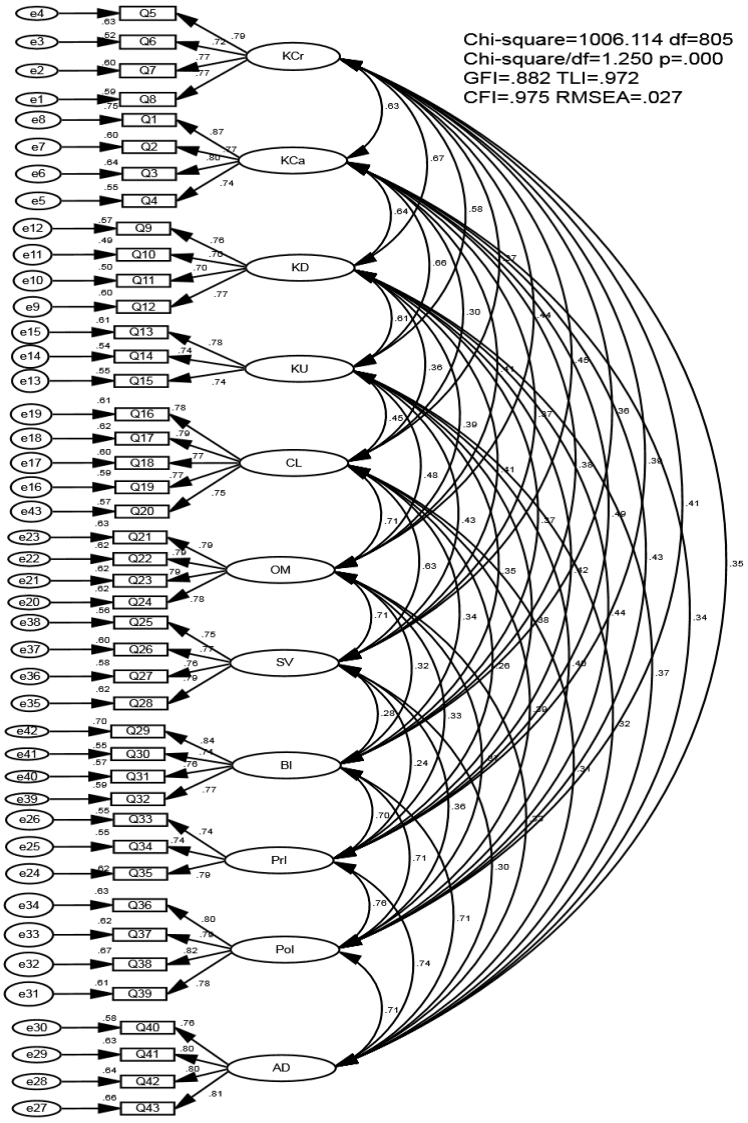

Figure 1: Confirmatory Factor Analysis Final Model

AVE and CR are indicators for assessing the convergent validity and reliability of the model. All dimensions' exhibit AVE values ranging from 0.540 to 0.637, surpassing the standard threshold of 0.5. This signifies that each latent variable effectively explains the variance of its measurement items, demonstrating robust convergent validity. The CR values lie between 0.796 and 0.881, far exceeding the acceptable level of 0.7, indicating a high degree of internal consistency among the measurement items and the strong reliability of the measurement

instrument. In summary, the convergent validity and reliability of the model meet academic standards, validating the soundness and reliability of the measurement structure.

Related Analysis

The square root of the AVE for all variables exceeds their respective correlation coefficients with other variables. The square root of the AVE for knowledge capture stands at 0.798, while its highest correlation coefficient with knowledge creation is merely 0.551, indicating good discriminant validity among the variables. The correlations between variables range from 0.2 to 0.6 and are all statistically significant ($p < 0.01$). The dimensions of knowledge management are highly correlated with each other. Specifically, the correlation coefficient between knowledge creation and knowledge dissemination is 0.568, and that between knowledge dissemination and knowledge utilization is 0.498, suggesting a close relationship between the circulation and application of knowledge within the organization. There is a strong correlation between learning commitment, open-mindedness, and shared vision. The correlation coefficient between learning commitment and open-mindedness is 0.614. The innovative dimensions, including behavioral innovation, product innovation, process innovation, and administrative innovation, are also closely interconnected. Notably, the correlation coefficient between product innovation and process innovation is 0.630. These data support the mutually reinforcing relationship among knowledge management, learning orientation, and innovation. As shown in Table 3.

Results

The CMIN/DF value is 1.240, lower than the threshold of 3, suggesting a good model fit. With GFI = 0.878 and AGFI = 0.864, both exceeding 0.8, the model fit is deemed acceptable. RMSEA = 0.027, less than 0.08, further supports the rationality of the model. The IFI, NFI, TLI, and CFI all surpass 0.95, fulfilling the criteria for an excellent fit, indicating a stable model structure with strong explanatory power. All indices meet the requirements, demonstrating a good model fit.

Table3: Pearson Correlation Analysis

Variables	√AVE	KCa	KCr	KD	KU	CL	OM	SV	BI	PrI	PoI	AD
KCa	0.798	0.798										
KCr	0.764	.551**	0.764									
KD	0.735	.549**	.568**	0.735								
KU	0.752	.548**	.478**	.498**	0.752							
CL	0.773	.263**	.315**	.306**	.369**	0.773						
OM	0.788	.368**	.376**	.330**	.394**	.614**	0.788					

SV	0.768	.320**	.377**	.344**	.350**	.549**	.607**	0.768				
BI	0.777	.335**	.302**	.314**	.289**	.297**	.273**	.235**	0.777			
PrI	0.771	.417**	.320**	.332**	.306**	.218**	.273**	.205**	.576**	0.771		
PoI	0.797	.362**	.348**	.375**	.324**	.316**	.317**	.308**	.616**	.630**	0.797	
AD	0.785	.320**	.307**	.320**	.291**	.268**	.282**	.253**	.600**	.605**	.594**	0.785

NOTE: * p<0.05 ** p<0.01 *** p<0.001. KCa is knowledge capturing. KCr is knowledge creation. KD is knowledge dissemination. KU is knowledge utilization. CL is commitment to learning. OM is open-mindedness. SV is shared vision.BI is behaviour innovation. PrI is product innovation. PoI is process innovation. AD is administrative

Table5: Results of Structural Equation Modeling

Path Relationship			Estimate	S.E.	C.R.	P
OL	<---	KM	0.607	0.092	7.713	***
OI	<---	KM	0.477	0.090	5.394	***
OI	<---	OL	0.165	0.069	2.098	0.036

NOTE: * p<0.05 ** p<0.01 *** p<0.001, KM is knowledge management. OL is organizational learning. OI is organizational innovation.

The results of the Structural Equation Modeling (SEM) for direct effect verification reveal the path analysis outcomes among Knowledge Management (KM), Organizational Learning (OL), and Organizational Innovation (OI). The research findings encompass path estimates, standard errors (S.E.), critical ratios (C.R.), and significance levels (P-values), which are utilized to validate the causal relationships and their significance among variables. The path estimate for the influence of KM on OL is 0.607, with a C.R. of 7.713 and a significant P-value ($p < 0.001$). This indicates a significant positive impact of KM on OL. The path estimate for the influence of KM on OI is 0.477, with a C.R. of 5.394 and a significant P-value ($p < 0.001$). This demonstrates a significant positive effect of KM on OI, highlighting its active role in driving corporate innovation. The path estimate for the influence of OL on OI is 0.165, with a C.R. of 2.098 and a significant P-value of 0.036 ($p < 0.05$). This suggests a significant positive contribution of OL to OI.

Table 6: Results of Internal Control Indirect Effects Tests

Path	Effect	S.E.	p-value (probability value)	Bias Corrected（95%）		%
				LLCI	ULCI	
KM ---> OI Direct Effect	0.477	0.076	***	0.318	0.685	82.7%
KM ---> OL ---> OI Indirect Effect	0.100	0.050	*	0.005	0.204	17.3%
KM ---> OI Total Effect	0.577	0.048	***	0.477	0.666	100%

NOTE: * p<0.05 ** p<0.01 *** p<0.001 KM is knowledge management. OL is organizational learning. OI is organizational innovation.

The study examined the direct effect of Knowledge Management (KM) on Organizational Innovation (OI), the indirect effect through Organizational Learning (OL), and the total effect. The aim was to analyze whether OL plays a significant mediating role between KM and OI, as well as the distribution of effects between them.

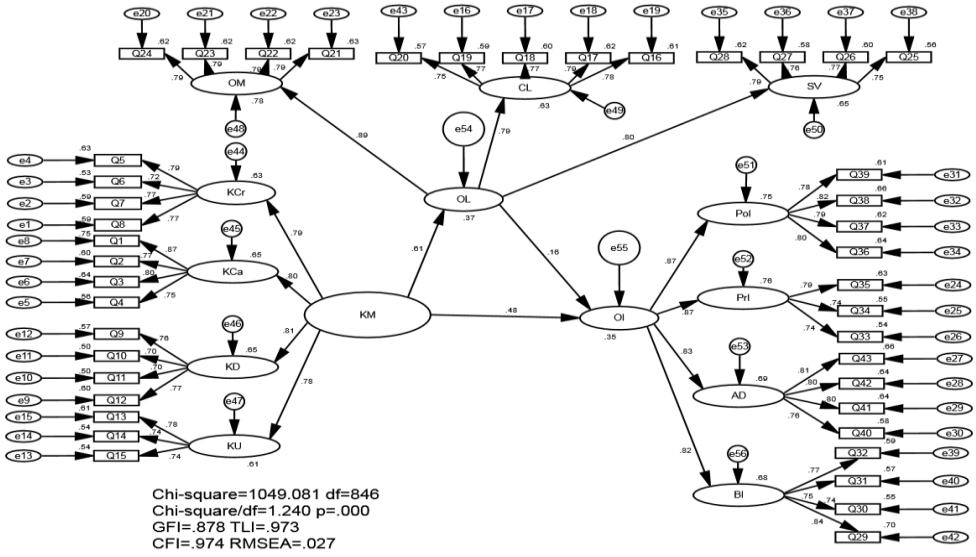

Figure 2: The Modified Structural Equation Model

The direct effect of KM on OI was found to be 0.477, with a significant p-value (p<0.001) and a 95% confidence interval of [0.318, 0.685], excluding zero. This indicates a significant positive direct impact of KM on OI, accounting for 82.7% of the total effect. The indirect effect of KM on OI through OL was 0.100, with a significant p-value (p<0.05) and a 95% confidence interval of [0.005, 0.204], also excluding zero. This demonstrates that OL plays a significant mediating role between KM and OI, with the indirect effect accounting for 17.3% of the total effect. KM can indirectly promote corporate innovation activities by enhancing OL, reinforcing its positive effect on OI. The total effect of KM on OI was 0.577, with a significant p-value (p<0.001) and a 95% confidence interval of [0.477, 0.666]. This data shows that the overall

impact of KM on OI is significant and stable. From the perspective of effect decomposition, the direct effect constitutes the portion of the total effect, while the indirect effect, although in proportion, remains significant.

5. Conclusion and Recommendations

This study substantiates the causal interrelations among Knowledge Management (KM), Organizational Learning (OL), and Organizational Innovation (OI), with a particular focus on the mediating role of Organizational Learning. The findings elucidate that KM exerts a profound positive influence on both OL and OI (Hsu & Lamb, 2020). While KM's direct impact on OI is paramount, the mediating effect of OL is equally noteworthy (Kun,2022). This research achieved its 3 objectives by (a) assessing the level of knowledge management process of high-tech enterprises in Shandong province in China. The mean scores for Knowledge Management (KM), Organizational Learning (OL), and Organizational Innovation (OI) are all positive, indicating generally favorable perceptions in the surveyed high-tech enterprises. KM has a mean of 3.54 with a standard deviation of 0.77, reflecting agreement with KM practices. OL has a slightly higher mean of 3.68 and a standard deviation of 0.78, suggesting strong agreement with organizational learning principles. OI has a mean of 3.63 and a standard deviation of 0.81, indicating positive views on innovation within the organizations. While the mean scores are consistently high across the components, the standard deviations show moderate variability, indicating some differences in responses, especially for certain items like Product Innovation and Shared Vision. (b) investigating the effect of knowledge management process on the organizational innovation of high-tech enterprises in Shandong province in China by conducting hypothesis test. The results revealed the positive effect of the relationship.

H1: Knowledge management has a positive effect on organizational learning.

The effect of knowledge management process on the organizational innovation of high-tech enterprises in Shandong province in China. The path coefficient from KM to OL stands at 0.607, signifying that effective management of knowledge acquisition, dissemination, and application significantly facilitates the enhancement of organizational learning (Gold et al., 2021).

H2: Organizational learning significantly enhances organizational innovation.

The path coefficient from OL to organizational innovation (OI) is 0.165 (CR = 2.098, p = 0.036), which is statistically significant at the 0.05 level. This suggests that OL contributes positively to innovation outcomes. Serving as a mechanism for knowledge transformation and capability accumulation, OL enables employees to learn and assimilate new knowledge with heightened efficiency in the presence of a robust KM system (Abbas et al., 2019). Such internal knowledge exchange and experience aggregation fortify organizational adaptability and innovative capabilities.

H3: Knowledge management directly and positively influences organizational innovation

The direct effect of KM on OI is empirically validated, with a path coefficient of 0.477 and statistical significance. This suggests that KM directly propels innovative endeavors, possibly through the efficient integration of knowledge resources, thereby accelerating the translation of new knowledge into innovation. A systematic approach to KM elevates the

success rate of technological innovations and fosters managerial and business model innovations via cross-departmental knowledge flow (Liao et al., 2023).

(c) investigating the effect of knowledge management process impacts the performance of organizational innovation of high-tech enterprises in Shandong province China through the mediating roles of organizational learning by testing the hypothesis. The result also confirmed the mediating role of organizational learning.

H4: Organizational learning partially mediates the relationship between knowledge management and organizational innovation.

The effect of knowledge management process impacts the performance of organizational innovation of high-tech enterprises in Shandong province China through the mediating roles of organizational learning. Furthermore, OL is found to mediate the relationship between KM and OI. Although its indirect effect (0.100) is smaller than the direct effect. KM propels innovation directly and indirectly augments innovative capacity by fostering OL. Enhanced internal knowledge exchange and learning capabilities empower employees to comprehend market demands, technological advancements, and industry trends, laying a robust knowledge foundation for innovation (Ruel et al., 2020; Volberda et al., 2021). Consequently, while fortifying KM, enterprises should prioritize fostering OL to unleash KM's innovative potential (Volberda et al., 2021).

The total effect of KM on OI amounts to 0.577, underscoring its pivotal role as a key driver of innovation, acting through both direct and indirect channels to bolster organizational innovative capabilities. Direct effects account for 82.7%, highlighting KM's inherent potency in driving innovation. Despite OL's relatively modest mediating role, it nonetheless amplifies this impact (Guisado-González et al., 2017). Therefore, when formulating innovation strategies, enterprises must emphasize KM system development and nurture OL to ensure the effective transformation of knowledge into innovative outcomes. This study corroborates KM's centrality in corporate innovation and underscores the significance of OL as a mediating variable (Gold et al, 2021). To maximize KM's innovation-driving effects, enterprises should, alongside optimizing KM systems, actively cultivate a learning organization ethos to enhance knowledge absorption and application efficiency.

The managerial insights from this study revolve around optimizing the Knowledge Management (KM) system to enhance Organizational Learning (OL) capabilities, ultimately elevating the level of Organizational Innovation (OI). The research findings reveal that knowledge management has a significant direct impact on organizational innovation, while also exerting an indirect influence through organizational learning. Consequently, managers should adopt comprehensive strategies in practice to maximize the innovation-driving role of knowledge management.

The study revealed the direct effect of knowledge management on organizational innovation accounted for as much as 82.7%. This indicates that enterprises can directly propel the generation of innovative outcomes through systematic knowledge acquisition, sharing, and application. Therefore, managers ought to bolster the enterprise's knowledge infrastructure. They should establish knowledge repositories, optimize internal knowledge flow mechanisms, and encourage cross-departmental collaboration to facilitate the creation and effective

utilization of new knowledge. Additionally, digital tools (such as artificial intelligence and big data analytics) should be adopted to enhance the efficiency of knowledge management, enabling enterprises to swiftly identify market trends and technological changes and make corresponding innovative decisions (Hsu & Lamb, 2020).

However, the research findings indicated that organizational learning played a significant mediating role between knowledge management and organizational innovation performance, the proportion of its mediating effect was merely 17.3%, suggesting a relatively limited impact. This phenomenon stems from the bottleneck of insufficient absorptive capacity in the organizational learning process of high-tech enterprises in Shandong Province. According to the absorptive capacity theory, enterprises must identify, acquire, and apply external knowledge to effectively facilitate the internalization of knowledge and the generation of innovative outcomes. Some high-tech enterprises rely heavily on external technologies, and their internal learning-transformation mechanisms are not yet well established. As a result, the mediating role of organizational learning as a bridge between knowledge management and innovation is constrained. Enterprises should establish an efficient knowledge management system to directly foster innovative activities.

Organizational learning is a crucial intermediary through which knowledge management influences innovation, and cannot be overlooked as an innovation driver. Thus, enterprises need to cultivate a learning organization culture to strengthen the indirect promotional effect of knowledge management on innovation. Managers can adopt various measures, such as establishing internal training systems, encouraging employee participation in industry seminars and cross-disciplinary learning, and facilitating experience sharing within the enterprise (Huber, 2019). Managers should also stimulate employees' learning enthusiasm through incentive mechanisms (e.g., knowledge contribution rewards, innovation competitions), and cultivate their problem-solving abilities to improve the efficiency of knowledge absorption and transformation.

This study offers several practical contributions for high-tech enterprises in emerging economies, particularly in Shandong Province, China. It provides a structured framework that enterprises can adopt to assess and improve their knowledge management (KM) practices by focusing on four key dimensions: knowledge capturing, creation, dissemination, and utilization. Managers can develop internal knowledge repositories, encourage interdepartmental knowledge exchange, and utilize digital tools (e.g., data analytics and AI-based platforms) to enhance knowledge flow across the organization.

Enterprises should regard knowledge management, organizational learning, and innovation capability building as integrated management objectives, rather than advancing them in isolation. When formulating innovation strategies, enterprises should focus on R&D investment and technological upgrades, while concurrently optimizing the knowledge management system and promoting internal and external learning exchanges. Managers should also pay attention to the enterprise's organizational structure and culture, making them more open and inclusive to facilitate knowledge sharing and collaborative innovation (Liao et al., 2023). The findings suggest that fostering organizational learning (OL)-through mechanisms such as internal training programs, learning communities, and shared vision initiatives - can

significantly amplify innovation performance. Enterprises should incorporate learning goals into performance appraisals and provide incentives for continuous learning and knowledge sharing among employees. By confirming the mediating role of OL, the study recommends that firms treat KM and OL as integrated strategic systems rather than isolated functions. Practical implementation may include establishing cross-functional innovation teams, adopting collaborative platforms (e.g., enterprise social networks), and institutionalizing knowledge-to-innovation pipelines. These practices improve innovation capabilities and enhance organizational adaptability and competitive advantage in dynamic markets. The managerial insights from this study indicate that to sustain innovation in a fiercely competitive environment, enterprises must attach great importance to knowledge management, complemented by the driving force of organizational learning. Systematic knowledge management, continuous organizational learning, and an innovation-oriented corporate culture can maximize the value of knowledge resources, enhance innovation capabilities, and secure a leading position in market competition (Ruel et al., 2020; Volberda et al., 2021).

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