Research on the Relationship among Knowledge Dissemination, Technological Innovation and Innovation Performance of Small and Medium-sized Sci-tech Enterprises

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Abstract

Based on the theory of knowledge management and organizational learning, taking small and medium-sized scientific and technological enterprises as the investigation object and taking "knowledge management-innovation performance of small and medium-sized scientific and technological enterprises" as the research thread, this paper discusses the intermediary between knowledge dissemination (KD) and innovation performance (IP), knowledge dissemination (KD) and technological innovation (TI), technological innovation (TI) and innovation performance (IP), and technological innovation (TI). In the form of questionnaire survey, using the data of 376 questionnaires, a series of data analysis and tests were carried out, including reliability and validity test, structural equation test, path analysis and so on. This study combines literature and theoretical analysis, introduces technological innovation as an intermediary variable, and establishes a conceptual model of the influence of knowledge dissemination on the innovation performance of small and medium-sized scientific and technological enterprises. The results show that KD has a significant impact on IP, KC and TA, KC and TA have a significant impact on IP, and KC and TA play an intermediary role between KD and IP. The research results are also enlightening to the senior managers of small and medium-sized scientific and technological enterprises and have made important contributions to open innovation and knowledge management.

Keywords: Knowledge dissemination; Technological innovation; Small and medium-sized scientific and technological enterprises; Innovation performance.

Introduction

In the economic society, small and medium-sized enterprises play an important role. Small and medium-sized scientific and technological enterprises with innovation as their mission and development as their survival characteristics are the most active and contributing groups in the innovation team of small and medium-sized enterprises, which are the social and economic development of the country. In the field of modern economic management research, the research on small and medium-sized scientific and technological enterprises has become an important content. (Matiusinaite,2015).

The important symbol of enterprise development is to improve innovation performance, and researchers believe that organizational learning is an important way to improve innovation performance. Organizational learning is conducive to the sustainable development of enterprises. An important stage of organizational learning is knowledge dissemination. The current era is the era of knowledge economy, and knowledge dissemination is conducive to promoting the innovation practice of enterprises and enhancing their competitive advantages,

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thus bringing considerable economic benefits (Chesbrough,2009). The purpose of learning is to apply and practice, and technological innovation is the demonstration of enterprise's application and practice of knowledge. Knowledge dissemination ability has become a major factor for enterprises to gain competitive advantage. Focusing on knowledge and learning, technological innovation can directly play an intermediary role in linking knowledge dissemination with enterprise performance.

Knowledge dissemination is a very effective way to organize learning. Many scholars at home and abroad have found that organizational learning has a positive and significant impact on enterprise innovation through research, but so far, few scholars have explored the mechanism of organizational learning on enterprise innovation from the perspective of knowledge dissemination.

Literature Review and Hypothesis Development

Based on the influence of knowledge dissemination on the innovation performance of small and medium-sized scientific and technological enterprises, this study analyzes the formation mechanism of spontaneous innovation motivation of small and medium-sized scientific and technological enterprises. By introducing technological innovation as an intermediary variable, this paper analyzes the communication mechanism of knowledge dissemination, and based on this communication mechanism, explores the chain intermediary role of compound variables in technological innovation process (knowledge creation and technology application) between knowledge dissemination and innovation performance (Reychav, 2010). At the same time, innovation climate is introduced as a moderating variable, and its contingency influence between knowledge dissemination and innovation performance is discussed. (LIN Hsiu-Fen et al., 2009). The details are as follows:

Knowledge dissemination and innovation performance

Knowledge dissemination is an important content of knowledge management, which is beneficial to both individual employees and enterprise organizations. The exchange and sharing of knowledge provide opportunities for individuals to learn from each other and cooperate with each other, which helps to spread knowledge within the organization and provide opportunities for those who need knowledge to acquire new knowledge, thus stimulating individuals' motivation to create knowledge and enhancing their innovation ability. (Tsai,2001) The core of creation is the creation of knowledge, the transformation and diffusion of explicit knowledge and tacit knowledge among different subjects promote the generation of new knowledge, and knowledge sharing is an indispensable link in the process of knowledge transformation and diffusion. (Nonaka et al. ,1994). The knowledge in the competitive environment is very important and thought that effective knowledge dissemination was the necessary way for enterprises to gain sustainable competitive advantage by improving innovation performance. (Rlubit,2001). Knowledge transfer is the central task of technical cooperation and alliance among individuals, and the level of individual innovation ability depends on the effectiveness of knowledge transfer within the alliance (Ren Ling, 2008).

Based on the above analysis, this paper puts forward the following assumptions:

H1: Knowledge dissemination promotes innovation performance.

2.2 Knowledge dissemination and technological innovation

Improving the core competitiveness of technological innovation is an important purpose for enterprises to organize learning (Jing Guangmin, 2020). Small and medium-sized scientific and technological enterprises are small and medium-sized economic entities (Fang Jianqi, 2020) that rely on a certain number of scientific and technological personnel, take the market as the guide, and provide high-tech or services as the main content. Technological innovation is the embodiment of knowledge dissemination obtained by small and medium-sized scientific and technological enterprises outside the organization, and it is also the embodiment of knowledge dissemination by enterprises inside the organization (Lee，2013). Divided into two dimensions: knowledge creation and technology application, this paper deeply analyzes the mechanism between knowledge dissemination and innovation performance of small and medium-sized scientific and technological enterprises. Through organizational learning, the innovation resources obtained from outside are integrated and utilized in the innovation process, thus promoting the improvement of technological innovation performance (Sun Yin et al., 2020).

Based on the above analysis, this paper puts forward the following assumptions:

H2: Knowledge dissemination is affecting scientific and technological innovation.

H2.1: Knowledge dissemination plays a positive role in knowledge creation.

H2.2: Knowledge dissemination plays a positive role in technology application.

Technological innovation and innovation performance of small and medium-sized scientific and technological enterprises

The theory of open innovation points out that technological innovation activities can play a positive role in promoting the growth and performance of enterprises. Technological innovation is a comprehensive result including the choice of invention, capital investment guarantee, organization establishment, making plans, recruiting workers and opening up markets (J. L. Enos,1962). Technological innovation refers to the first commercial transformation of new products, processes, systems, and services.

Chris Freeman (2016) mentioned that product innovation is an exploratory activity that starts with the idea of new products and ends with the sales and delivery of new products. It is the first commercial application of an invention and the subsequent stage of the invention (E.Mansfield, 1968). Technological innovation is the commercialization process of economic and social benefits generated by the research and development of new technological ideas or the combination of technologies into practical applications (Wu Guisheng，2002). All these show that technological innovation has a significant impact on the innovation performance of enterprises, and small and medium-sized science and technology enterprises make this impact more obvious because of their constant pursuit of technology, especially new technology (Dhara,2016).

H3: The innovation performance of small and medium-sized science and technology enterprises is being influenced by technological innovation.

H3.1: Knowledge creation is playing an active role in the innovation performance of small and medium-sized scientific and technological enterprises.

H3.2: The innovative performance of small and medium-sized scientific and technological enterprises is being positively influenced by the application of technology.

The mediating effect hypothesis

The innovation performance of small and medium-sized scientific and technological enterprises is mainly used to measure the R&D and innovation achievements of small and medium-sized scientific and technological enterprises, focusing on the measurement and investigation of the company's market innovation ability and product innovation ability (Xu Kaige, 2020). Scholars at home and abroad have studied the measurement of enterprise innovation performance. Innovation performance of enterprises is determined by innovation activities, which can be measured by R&D, patents and the number of new products (Cloodt et al, 2012). Innovation performance from three dimensions: innovation benefit, innovation efficiency and overall innovation performance. (Wagner,2016). Under the background that knowledge is the need of innovation, enterprises need to consider the impact of innovation input and output on enterprise innovation performance (Zhang Ming et al, 2019).

Innovation performance needs to be combined with small and medium-sized science and technology enterprises (Zhang Shaojie，2004). Due to the development of product innovation, the frequency of design and modification is low; Due to the development of product innovation, the manufacturing cost of similar products is low; Due to the development of product innovation, the time for similar products to reach the market is shortened; Enterprise's product innovation plan is usually successful. (Harabi,1995). Based on the above analysis, this paper puts forward the hypothesis:

H4: Technological innovation plays an intermediary role in the relationship between knowledge dissemination and innovation performance of small and medium-sized scientific and technological enterprises.

H4.1: knowledge creation plays an intermediary role between knowledge dissemination and innovation performance of small and medium-sized scientific and technological enterprises.

H4.2: Technology application plays an intermediary role in the relationship between knowledge dissemination and innovation performance of small and medium-sized science and technology enterprises.

Research Method

In this study, the idea of empirical research is used to test the conceptual model and research hypothesis. Through pre-test, 100 questionnaires were distributed for the first time, thus ensuring the reliability, effectiveness and accuracy of the feedback obtained after the questionnaire was distributed. 505 questionnaires were distributed for the second time, and 376 questionnaires were recovered, with a recovery rate of 74.4%.

Then through the pre-test questionnaire collection, descriptive statistics and reliability and validity analysis, to ensure the correctness of the research design ideas. The test data are analyzed and processed by SPSS and AMOS software, and relevant conclusions are drawn.

Research Conceptual Framework

Construct a conceptual model of knowledge dissemination, technological innovation, and enterprise performance, according to the above analysis and assumptions, as shown in Figure 1.

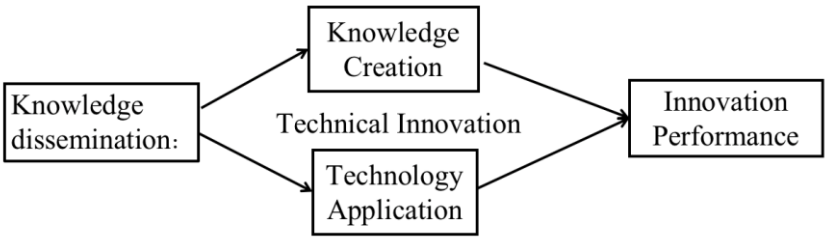

Figure 1: Research Conceptual Framework

Research Results

The question design of the questionnaire is divided into three parts: knowledge dissemination, technological innovation, and innovation performance. This research takes small and medium-sized scientific and technological enterprises as the research object, covering electronic information, software development, high-tech services, and other fields, ensuring that the samples are extensive, representative and explanatory. The research objects include not only business owners, but also middle and senior managers and grass-roots employees (GaoJian，2004).

Make statistics on the establishment time, enterprise nature, industry category, scale and the position of the respondents, as shown in Table 1.

Table 1 Statistics of relevant information of enterprises

position	classify	sample number	percentage
Time of enterprise establishment	Less than 5 years	58	15.43
	6-10 years	142	37.77
	11-15 years	120	31.91
	More than 15 years	fifty-six	14.89
Enterprise nature	state-owned enterprise	161	42.82
	Sino-foreign joint venture	65	17.29
	private enterprise	101	26.86
	foreign enterprise	34	9.04
	other	15	3.99
industry	electronic message	50	13.30
	Biomedical treatment	41	10.90

	software development	82	21.81
	High-tech service	109	28.99
	Information transmission industry	94	25.00
Scale	Small businesses (50-100 people)	177	47.07
	Medium-sized enterprises (100-500 people)	199	52.93
position	Business owner	four	1.06
	senior management staff	57	15.16
	middle management	99	26.33
	low level managers	172	45.74
	other	forty-four	11.70

From the perspective of enterprise age, these enterprises are in the young and middle age of innovation, and their samples can better reveal the relationship between the variables involved.

Judging from the distribution of enterprise types, most enterprises in the survey sample have regarded innovation as their daily business activities, and they have rich experience in innovation, so people in enterprises can understand and answer the questions in the questionnaire more accurately. From the respondents, there are samples at all levels, and the samples are more universal.

Descriptive statistical analysis

Before testing the research hypothesis, this study first makes descriptive statistical analysis on the formal survey data of the survey items to judge whether the observed variables obey multivariate normal distribution, and then carries out subsequent relevant data analysis. In this study, descriptive statistical analysis was carried out on the mean, standard deviation, and skewness. The mean can reflect the average level of the whole sample data, the standard deviation measures the dispersion degree of the sample data, and the skewness coefficient is generally used to test the normal distribution of the sample data. (XuJie,2015). Among them, there are 10 items for knowledge dissemination, 3 indicators for knowledge creation, 5 indicators for technology utilization and 5 indicators for innovation performance. Descriptive statistics are shown in Table 2.

Table 2. Descriptive Statistics of Survey Items

Item	minimum value	maximum	average/mean value	standard deviation	Skewness coefficient
KD1	one	seven	4.190	1.500	-0.173
KD2	one	seven	4.110	1.524	-0.058
KD3	one	seven	4.240	1.528	-0.174
KD4	one	seven	4.220	1.549	-0.209
KD5	one	seven	4.510	1.393	-0.573
KD6	one	seven	4.440	1.496	-0.303
KD7	one	seven	4.920	1.367	-0.720
KD8	one	seven	4.960	1.289	-0.823
KD9	one	seven	4.430	1.475	-0.390
KD10	one	seven	4.840	1.415	-0.653
KC1	one	seven	5.240	1.341	-0.844
KC2	one	seven	5.010	1.365	-0.701
KC3	one	seven	5.180	1.344	-0.737
TA1	one	seven	4.920	1.343	-0.602
TA2	one	seven	5.150	1.335	-0.706
TA3	one	seven	5.070	1.314	-0.726
TA4	one	seven	4.790	1.429	-0.507
TA5	one	seven	5.000	1.181	-0.894
IP1	one	seven	4.300	1.449	-0.006
IP2	one	seven	4.580	1.486	-0.553
IP3	one	seven	4.700	1.483	-0.706
IP4	one	seven	4.150	1.635	-0.272
IP5	one	seven	4.490	1.547	-0.554

Knowledge dissemination (KD)，Knowledge creation (KC)，Technology Application (TA)，Innovation performance (IP)

As can be seen from Table 4.2, the overall average value of knowledge dissemination is low. In terms of technological innovation, knowledge creation is slightly higher than the average value of technology application, indicating that the effect of knowledge creation is better than technology application. For small and medium-sized science and technology enterprises, we should not only pay attention to knowledge creation, but also pay attention to the transformation and application of knowledge. The average innovation performance is between 4.1 and 4.7, indicating that the innovation performance of enterprises is at a medium level, and there is still much room for improvement in the future development process.

Structural validity test

The confirmatory factors were analyzed, and the results are shown in Table 3.

Table 3. Results of confirmatory factor analysis

variable	item	Estimate	CR	AVE
Knowledge dissemination （KD）	KD1	0.874	0.910	0.668
	KD2	0.798		
	KD3	0.789		
	KD4	0.819		
	KD5	0.871		
	KD6	0.831		
	KD7	0.875		
	KD8	0.807		
	KD9	0.760		
	KD10	0.810		
Knowledge creation （KC）	KC1	0.820	0.851	0.656
	KC2	0.823		
	KC3	0.786		
Technology Application（TA）	TA1	0.864	0.902	0.648
	TA2	0.831		
	TA3	0.793		
	TA4	0.807		
	TA5	0.724		
Innovation performance（IP）	IP1	0.788	0.897	0.635
	IP2	0.838		
	IP3	0.790		
	IP4	0.806		
	IP5	0.761		
	IA2	0.785		
	IA3	0.825		

From the analysis results in the above table, it can be seen that the standardized factor loads of observation variables are all greater than 0.7, CR is greater than 0.7, and AVE value is greater than 0.5, which indicates that the aggregation validity is good; The arithmetic square root of AVE is greater than the correlation coefficient between this dimension and other dimensions, which indicates that the discriminant validity of this dimension is good; It shows that it has good discrimination validity. To sum up, their internal items have good structural validity.

Structural Equation Fit Test

In this study, knowledge dissemination is the independent variable and innovation performance is the dependent variable, and a structural equation model is constructed. Structural equation model includes independent variable-knowledge dissemination, intermediate variable-knowledge creation, technology application, and dependent variable-innovation performance. First, the overall fitness of the model is tested to judge the matching degree between the formal survey data and the model. The test results are shown in Table 4, and most indicators meet the standards. Therefore, this research model can be used for subsequent related data analysis.

Table 4 Test results of structural equation model fitting degree

Reference index	evaluation criterion	statistical values	Model adaptation judgment
x^2/df	1-3	2.291	Y
AGFI	> 0.8, the closer to 1, the higher the fitness.	0.871	Y
GFI	>0.8, the closer to 1, the higher the fitness.	0.897	Y
TLI	> 0.9, the closer to 1, the higher the fitness.	0.944	Y
NFI	>0.9, the closer to 1, the higher the fitness.	0.916	Y
CFI	> 0.9, the closer to 1, the higher the fitness.	0.951	Y
RMSEA	< 0.08	0.059	Y

Path analysis

In this study, the maximum likelihood method is used to estimate the regression coefficients. As shown in Table 5, the standard errors S.E. of the path coefficients are all positive and there is no abnormal large phenomenon, corresponding to the critical value. The absolute values of C.R. are all greater than 1.96, indicating that the regression coefficient values are significantly different at the level of 0.05. The criteria for the significance test of path coefficient are when the critical ratio is greater than 1.96, it is significant at the level of P less than 0.05; When the critical ratio is greater than 2.58, it is significant at the level of P less than 0.01.

Table 5. Test of Path Coefficient and Hypothetical Results

Path	Estimate	S.E.	C.R.	P	**Hypothesis**
KD→KC	0.140	0.053	2.219	0.026	H2.1 is accepted
KD→TA	0.164	0.055	2.644	0.008	H2.2is accepted
KD→IP	0.145	0.047	2.670	0.008	H1 is accepted
KC→IP	0.331	0.058	5.805	***	H3.1 is accepted
TA→IP	0.308	0.051	5.859	***	H3.1 is accepted

Note: * * * means significant at the level of 0.01.

According to the test results of fitting index in the above table, the fitting index of the model basically meets the standard, so the path analysis and hypothesis test between variables can be carried out.

The intermediary role of technological innovation test

According to the suggestion of Preacher and Hayes, Bootstrap method is used to test the mediation effect. Compared with other methods, Bootstrap method does not need normal distribution and other assumptions, which makes up for the weakness of step-by-step test method and has good statistical effect. The model fitting method used in this study is the maximum likelihood method, and the nonparametric percentage Bootstrap is corrected by deviation and the Bias-corrected test method is used, and the sampling is repeated for 2000 times under the condition of 95% confidence interval. According to the criterion of mediation

effect proposed by Wen Zhonglin et al. (2004), if the value interval of the variable in the 95% confidence interval does not include 0, it indicates that the mediation effect is significant. The intermediary effect is analyzed, and the specific results are shown in Table 6.

Table 6. Test results of intermediary effect

Path	Estimate	Lower	Upper	P	**Hypothesis**
Total					
Direct:KD→IP	0.145	0.004	0.285	0.039	
Indirect:KD→KC→IP	0.046	0.007	0.099	0.021	H4.1 is accepted
Indirect:KD→TA→IP	0.051	0.010	0.104	0.013	H4.2 is accepted

According to the above results, the results of H4.1 and H4.2 are valid.

Discussion

By combing the literature and summarizing the concepts, this paper puts forward a conceptual model of the influence of knowledge dissemination on enterprise performance, which provides a theoretical explanation for the internal mechanism of sustainable development of small and medium-sized scientific and technological enterprises (Zhangbo, 2020). The empirical results show that there is a positive correlation between knowledge dissemination and enterprise performance (Hsu, 2007). There is a positive relationship between knowledge dissemination and technological innovation; Technological innovation plays an intermediary role between knowledge dissemination and enterprise performance. Knowledge dissemination will prompt managers to think about the current situation, guide enterprise reform, and then promote technological innovation (Baker and Sinkula，1999).

According to the literature review, the author understands that the existing research on knowledge dissemination is more concerned with obtaining higher profits through it (Quigley, et al., 2007), but the research on how to improve the sustainable development of enterprises, especially small and medium-sized science and technology enterprises, by relying on knowledge dissemination is not clear (Szulanski, 2000).

From the perspective of knowledge management, the intermediary role of technological innovation between knowledge dissemination and enterprise performance is identified, and the path of knowledge dissemination affecting the performance of manufacturing enterprises is studied. (Lai, 2014). Although the existing research has provided the influence of technological innovation on enterprise performance, it is more about the direct relationship between the two and has not gone deep into the study of internal influence mechanism and path (Palvalin, 2015). This study analyzes that under the current economic environment and market environment, enterprises will actively use the newly acquired knowledge to affect their performance through technological innovation. (HongXiaonan, 2015). Knowledge dissemination can enable employees to acquire new knowledge at a relatively low-cost level, and enterprises should choose active measures to continuously improve their knowledge dissemination ability in the development process (Aladwani, 2002).

Implications and Recommendations

Give full play to the role of knowledge dissemination and technological innovation. For small and medium-sized scientific and technological enterprises, it is necessary to spread knowledge outside the organization with the help of external forces, learn from each other's strong points, and spread knowledge inside the organization and innovate on their own. Innovation performance of enterprises in different regions is also different, but the influence of knowledge dissemination on technological innovation, innovation performance and technological innovation on promoting knowledge dissemination and influencing innovation performance is positive and significant, so it is necessary to play the linkage role of knowledge dissemination and technological innovation in small and medium-sized scientific and technological enterprises.

Improve the knowledge dissemination model. For small and medium-sized scientific and technological enterprises, they should not only use external forces, but also establish their own internal knowledge management process and improve the knowledge dissemination model. Enterprise managers should pay attention to the law of knowledge dissemination within enterprises, improve the efficiency of knowledge dissemination, shorten the time of knowledge dissemination, and expand the effect of knowledge dissemination by promoting the enthusiasm of knowledge communicators and learners, screening the disseminated knowledge in time, paying attention to the value of knowledge and improving the environment of knowledge dissemination.

Limitations and Future Research

Although the objectivity and scientific of the research are ensured as much as possible in this study, there are still some shortcomings. First, this study tries to discuss the influence mechanism of knowledge dissemination on the innovation performance of small and medium-sized scientific and technological enterprises, but this study only finds one of the intermediary variables-technological innovation from the perspective of knowledge application. In future studies, more research perspectives will be introduced to further improve the relationship model between knowledge dissemination and enterprise performance, making it more explanatory. Second, cross-sectional data is used in this study, which has some defects in the relationship between verification results and cannot reflect the dynamic influence process of knowledge dissemination, technological innovation, and enterprise performance. We can consider using longitudinal research methods to further analyze the above quantitative relationship in future research. Finally, the current research only distinguishes technological innovation from two dimensions, and future research can further subdivide variables, distinguish variables from multiple dimensions, and introduce more control variables to deeply analyze the theoretical framework of this paper.

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