

TECHNOLOGICAL ADVANCEMENT: THE IMPACT OF EXTERNAL KNOWLEDGE SEARCH ON INNOVATION PERFORMANCE IN ENTERPRISES

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Abstract:

In today's globalized and highly competitive business environment, innovation is a driving force for economic growth and the lifeblood of enterprises. This holds especially true for technology-based companies facing complex market dynamics and escalating research costs. Navigating this environment requires timely access to external knowledge and resources to support innovation initiatives and overcome potential challenges.

This paper explores the concept of knowledge search from three distinct perspectives. Firstly, it entails organizations proactively seeking, identifying, and assimilating knowledge from external sources and diverse industries within an open environment. Secondly, it aligns with a learning-oriented view, viewing search as an inherent learning process aiding enterprises in developing new markets, technologies, and management insights to effectively respond to evolving environmental dynamics. Thirdly, knowledge search is seen as a narrow process focused solely on knowledge acquisition, without considering subsequent stages such as fusion and application.

By examining these perspectives, this study sheds light on the multifaceted nature of knowledge search and its critical role in fostering innovation and ensuring enterprise sustainability in the contemporary business landscape.

Keywords: innovation, knowledge search, technology-based enterprises, competitive environment, learning perspective.

Introduction

Innovation is an important force driving economic growth in a country and also the core of enterprises. Under the influence of the wave of economic globalization, the competition between enterprises is becoming increasingly fierce. However, with the increasing cost of research, the Market trend is complex and changeable, and the demand for innovation of enterprises is increasingly urgent, especially for technology-based enterprises. If there is a misjudgment of the current environment, it may lead to an innovation dilemma for the enterprise. To prevent such situations from happening, the enterprise can search for external knowledge and obtain the information needed for innovation from external resources, thereby solving the problems encountered during innovation.

There are three different perspectives on the understanding of knowledge search. Firstly, knowledge search refers to an organization that searches, identifies, and absorbs knowledge from external sources and different industries in an open environment^[1]; Secondly, guided by a learning perspective, search is

essentially a learning process that helps enterprises develop new markets, technologies, and management knowledge, thereby helping them respond to dynamic changes in the environment; Thirdly, knowledge search is limited to the acquisition stage and does not involve knowledge acquisition, fusion, application, etc.^[2].

Innovation performance is an important indicator and symbol for measuring an enterprise's innovation ability and competitiveness. It refers to the performance achieved by a company by creating new products or ideas through new thinking, inventions, and technologies^[3]. Yu Xiaomin^[4] proposed that the innovation performance of enterprises is manifested as the multiplier effect and efficiency effect of resource factors. Absorption ability refers to the ability of an enterprise to transform and develop acquired knowledge. The enterprise can digest the external knowledge acquired and combine it with internal resources, so that the two can be perfectly combined and applied to Product development. Innovation willingness refers to people's acceptance of new things, knowledge, and ideas, which is a subjective factor used to measure whether a company is willing to invest resources such as time, energy, and funds in innovative activities^[5]. For enterprises, innovation willingness not only enables them to seize opportunities but also actively create them. Especially in the current global economic integration environment, the higher the innovation willingness of enterprises, the more independent they will be in promoting innovation activities and improving innovation performance^[6].

In summary, this study will explore the impact mechanism of external knowledge search on innovation in technology-based enterprises from the perspective of external knowledge search, utilizing patent information of technology-based enterprises.

1. Research Assumptions and Conceptual Models

1.1 Knowledge search width and innovation performance

Knowledge search width refers to the breadth of external knowledge search. By conducting width search, enterprises can obtain more new knowledge, enrich their knowledge reserves, improve the integrity of the system in the enterprise knowledge system, and also help eliminate knowledge blind spots. Enterprises continuously stimulate their innovation capabilities through the integration, absorption, and application of knowledge^[7].

Many scholars believe that the relationship between external knowledge search and enterprise innovation is an inverted U-shaped relationship^[8]. These scholars believe that the learning ability of enterprises is limited, and while expanding the search scope, there is also a phenomenon of knowledge redundancy. If the search width is greater than the threshold, the cost for enterprises to integrate these knowledge will become greater, and the company's ability to learn and apply knowledge in the innovation process will also decrease, which will be detrimental to the improvement of the company's innovation performance.

However, Zhang Zhixin and Liang Fu^[6] believe that with the progress of the times and the development of technology, the cost problem of knowledge search width has been greatly improved and solved. Moreover, the increasingly blurred organizational and industry boundaries make enterprise innovation more complex, and the knowledge that enterprises need to acquire is more extensive. Therefore, it is difficult to

have an inverted U-shaped curve relationship. Moreover, technology-based enterprises themselves have a foundation for innovation. Compared to other types of enterprises, technology-based enterprises have stronger innovation capabilities. Many technology-based enterprises have their own knowledge base, and they need to use external knowledge search to improve the knowledge base. Therefore, this article proposes hypothesis H1:

H1: There is a positive relationship between knowledge search width and enterprise innovation performance.

1.2 Knowledge search depth and innovation performance

The depth of knowledge search refers to the degree to which existing knowledge is integrated and utilized. The depth of knowledge search can help enterprises understand existing knowledge and better utilize it for innovation [5]. As the depth of knowledge search increases, enterprises have enhanced their ability to discern knowledge, effectively avoiding problems that arise in the process of applying knowledge. With the increase of knowledge search depth, it can also improve the proficiency of enterprises in knowledge application [8], deepen the understanding of related knowledge, and play a positive role in innovation, enhancing the innovation ability of enterprises.

Many scholars believe that when the depth of search exceeds a certain threshold, it will lead to the dilemma of core rigidity for enterprises, leading to a decline in innovation performance. However, Zhang Zhixin and Liang Fu^[6] believe that with the development of technology, the efficiency and degree of knowledge utilization and transformation of deep search have been greatly improved, which has a certain promoting effect on the innovation performance of enterprises. Moreover, the demand for innovation capability in technology-based enterprises is extremely strong, and many enterprises are far from reaching the critical point of theoretical search depth saturation. Therefore, the impact of knowledge search depth on the innovation performance of technology-based enterprises will not be an inverted Ushaped relationship. Therefore, this article proposes the hypothesis H2:

H2: There is a positive relationship between the depth of knowledge search and the innovation performance of enterprises.

1.3 The mediating role of absorptive capacity

Absorptive capacity is the process by which a company transforms and utilizes the acquired knowledge. As the width and depth of knowledge search increase, the channels and methods for enterprises to acquire knowledge will continue to increase. As the amount of knowledge searched increases, the internal knowledge processing mechanism of the enterprise will also become more mature, which can strengthen the absorption capacity of the enterprise^[9]. External knowledge search is the process of acquiring knowledge. Enterprises can only benefit from new knowledge by developing, learning, absorbing, and applying it to practical activities, thereby improving their innovation performance^[10]. Due to its stronger absorption capacity, it enables enterprises to deeply learn from limited resources and effectively digest them, thus enabling them to gain a competitive advantage. In addition, enterprises with strong absorption capacity can also efficiently apply the absorbed new knowledge to innovation, obtain technological

breakthroughs from new knowledge, and improve innovation performance^[11]. Therefore, this article proposes the hypothesis H3:

H3: Absorption ability plays a mediating role between external knowledge search and enterprise innovation performance.

1.4 The moderating effect of innovation willingness

Innovation willingness is a subjective factor that affects a company's innovation and is used to measure the company's acceptance of new things, knowledge, and ideas. The stronger an enterprise's willingness to innovate, the higher its ability to accept new things and knowledge. It is willing to explore new knowledge and optimize its own knowledge system, and has a more positive attitude towards innovation, which is beneficial for the enterprise to enhance its innovation ability^[12].

The stronger an enterprise's willingness to innovate, the more it can transform the acquired new knowledge into reality and achieve innovative results. Wang Juanru and Li Ping believe that the higher a company's willingness to innovate, the higher its adaptability and innovation ability. Therefore, enterprises with strong innovation willingness are prone to accepting new knowledge and have a strong ability to apply new knowledge to innovation, which will continuously improve the innovation ability of the enterprise. Therefore, this article proposes the hypothesis H4:

H4: Innovation willingness plays a moderating role between external knowledge search and innovation performance.

2. Research Design

2.1 Data sources and acquisition methods

The website for data acquisition this time is the patent retrieval and analysis system, incompat database and Guotaian database in the patent module query service of the China National Intellectual Property Administration website. Based on the principle of data accessibility, this article selects enterprises in industries such as medicine, biology, electronics, computer, communication, etc., and filters out the corresponding patent information in the system, adds it to the batch download library in the system, and finally exports it as an Excel file.

This data obtained patent information from 645 companies within the range of January 1, 2020 to March 1, 2022, totaling 64563 pieces of data. The obtained data consists of 10 fields, including title (Chinese), applicant, application number, application date, IPC main classification, IPC, cited patent, cited patent, cited number, and cited number.

2.2 Variable measurement

This article refers to the measurement method of Sun Yaowu, Qin Yu, and He Shizhong^[13], using the number of patent applications to measure the innovation performance of enterprises. Patents are one of the main output results of innovation activities carried out by enterprises, and innovation performance is an important manifestation of the achievements made by enterprises in innovation activities. For external knowledge search, this article uses the citation rate of new knowledge in the current year by the enterprise to measure the search breadth, and the average number of repeated citations of patents by the enterprise

to measure the search depth. This article uses the measurement method proposed by Liu Yongsong, Wang Wannan, and Shi Junran^[11] to measure absorptive capacity through the R&D intensity of a company, which refers to the proportion of R&D expenditure to operating revenue. Innovation willingness refers to the willingness of enterprises to innovate, strengthen innovation activities, and increase innovation investment. The growth in the number of patent applications can reflect the output of innovation activities by enterprises. This article measures the innovation willingness of enterprises by measuring the growth rate of the number of patent applications.

3. Empirical research

3.1 Hypothesis verification

When conducting hypothesis testing, I used linear regression algorithms and multiple linear regression algorithms to study the relationship between a dependent variable and multiple independent variables. The model results of studying the impact of external knowledge search width on innovation performance show that the F-value is 4.529e+05 ($p < 0.01$), indicating that the model is meaningful. The standardization coefficient of external knowledge search width is 4.8008, indicating that hypothesis H1: there is a positive relationship between knowledge search width and enterprise innovation performance, which is supported. In the study of the impact of external knowledge search depth on innovation performance, the F-value is 2.879e+05 ($p < 0.01$), indicating that the model is meaningful. The results of the model show that the standardization coefficient of external knowledge search depth is 48.2824, indicating that hypothesis H2: there is a positive relationship between knowledge search depth and enterprise innovation performance, which is supported. Table 1 shows the results of the model.

Table 1. Model Results

Innovation performance	R	F	Coef	P
External knowledge search width	0.875	4.529e+05	4.8008	P<0.01
External knowledge search depth	0.817	2.879e+05	48.2824	P<0.01

Mediating variables refer to variables that partially mediate the relationship between two other variables. This article adopts the Bootstrap test method, which is a repeated sampling method from the sample. The coefficients of the independent variable and the intermediate variable, as well as the coefficient product of the intermediate variable and the dependent variable, are sorted by numerical value. Based on the confidence interval of the coefficient product at the 95% statistical level, it can be determined whether the coefficient product is significantly different from 0.

The study found that the 95% confidence interval range of the Mesomeric effect of external knowledge search width, innovation performance and absorptive capacity [-0.021830084958851532, 0.012260449933522849] was significant. The 95% confidence interval range of the Mesomeric effect of external knowledge search depth, innovation performance and absorptive capacity [0.018719672340694, 0.03333219775342091] is significant. So it is assumed that H3: absorptive capacity plays a mediating role

between external knowledge search and enterprise innovation performance. The absorptive capacity plays a mediating role between external knowledge search and innovation performance. Table 2 shows the results of the Bootstrap test.

Table 2. Bootstrap Test Results

Variable	P	Confidence interval	Mesomeric effect value
Search width, Innovation performance, Absorption capacity	P<0.01	[-0.021830084958851532, -0.012260449933522849]	-0.01696750932119554
Search depth, Innovation performance, Absorption capacity	P<0.01	[0.018719672340694, 0.03333219775342091]	0.0259297466294652

When calculating the moderating effect, regression analysis should be conducted on the dependent variable, independent variable, moderating variable, and the interaction term between the independent variable and the moderating variable. The moderating effect should be tested by checking whether the coefficients of the interaction term regression are significant.

According to the analysis, the p-value of the interaction term regression coefficient is $p < 0.05$, and the interaction term coefficient is significant, indicating that innovation willingness plays a moderating role between external knowledge search and innovation performance. Table 3 illustrates the results of the regulatory effect. Hypothesis H4: The moderating effect of innovation willingness between external knowledge search and innovation performance is supported.

Table 3. Test results of regulatory effect

Variable	R	P	F	Coef
Innovation performance, Search width, Innovation willingness	0.886	P<0.05	1.681e+05	0.711
Innovation performance, Search depth, Innovation willingness	0.839	P<0.01	1.122e+05	-31.2020

3.2 Result Analysis and Discussion

3.2.1 Discussion on the Impact of External Knowledge Search on Innovation Performance

According to the research results, external knowledge search has a positive impact on the innovation performance of enterprises. This conclusion is consistent with the research of scholars such as Zhou

Aijun^[14], Zhang Zhixin, and Liang Fu^[6]. The existing knowledge base of an enterprise is limited and cannot contain all knowledge. By searching for external knowledge, one can not only obtain newly generated knowledge from the outside world, improve their own knowledge system, but also sort out the content of the existing knowledge base and mine out knowledge that can be used for innovation activities.

3.2.2 Discussion on the mediating effect of absorption capacity

The absorption ability based on the bootstrap test has a mediating effect on the impact of external knowledge search on innovation performance. This indicates that broader and deeper external knowledge search enables enterprises to establish more connections with the outside world, making it easier for enterprises to acquire more knowledge. Through continuous collection and absorption of knowledge, the experience of the enterprise has been enriched, promoting communication with the outside world and the digestion and understanding of knowledge, thereby improving the absorption capacity of the enterprise.

3.2.3 Discussion on the moderating effect of innovation willingness

According to data analysis, the moderating effect of innovation willingness on external knowledge search and innovation performance is supported. According to the regression coefficient, it is found that there is a significant positive relationship between innovation willingness and innovation performance of enterprises, indicating that the higher the innovation willingness of enterprises, the better their innovation results, and the more favorable it is for the improvement of innovation performance of enterprises. Some scholars believe that the willingness of enterprises to innovate can be replaced by individual willingness. Therefore, in order to enhance the willingness to innovate, companies need to create a good innovation environment, encourage employees to actively participate in innovation, and use individuals to drive the whole, thereby improving the innovation performance of the company.

4. Research Conclusion

This paper starts from the theory and literature, obtains data through incopat database, Guotai'an database and China National Intellectual Property Administration website, stores the obtained data in HDFS, and then conducts data pre-processing, variable measurement, hypothesis verification and other contents through data reading, finally draws conclusions, and analyzes and discusses the conclusions. This article mainly studies the width and depth of external knowledge search, absorption ability, innovation willingness, and innovation performance. Through the research and analysis of this article, the following conclusions are drawn.

External knowledge search has a positive impact on innovation performance. This article studies existing literature and collected data, dividing external knowledge search into knowledge search depth and search width. Enterprises obtain knowledge through external knowledge search, stimulate their creativity, establish new innovative thinking or models, and improve their innovation performance.

The absorptive capacity plays a mediating role between external knowledge search and enterprise innovation performance. Absorption ability refers to the ability of a company to transform and develop acquired knowledge, search width refers to the breadth of knowledge obtained through external sources, and search width refers to the degree to which a company mines internal knowledge. The mediating effect

of absorptive capacity between external knowledge search and enterprise innovation performance indicates that enterprises are adept at integrating, developing, and utilizing knowledge, which can be utilized to improve innovation performance.

The willingness to innovate plays a moderating role between external knowledge search and innovation performance. Innovation willingness is a subjective factor that affects enterprise innovation, which is the degree to which a company is willing to accept new knowledge and innovate. According to analysis, innovation willingness plays a moderating role between external knowledge search and innovation performance. Moreover, when a company has a high level of innovation willingness, the innovation performance of the enterprise is higher.

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