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Cross-Border Innovation, Knowledge Sharing and Breakthrough Innovation Blur Front-End Performance

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ABSTRACT
New product development (NPD) is an important manifestation of breakthrough innovation, and it is extremely important to strengthen the effective management of fuzzy front-end (FEE) as a key factor affecting new product development. Based on existing literature, this paper divides cross-border innovation into cross-border search and cross-border cooperation, and selects a sample of high-tech enterprises in Jiangsu, Guangdong and Shanghai to explore the influence of cross-border innovation and knowledge sharing on the performance of fuzzy front-end of breakthrough innovation of enterprises. It is found that: cross-border innovation has a significant positive impact on the fuzzy front-end performance of breakthrough innovation by promoting fuzzy front-end idea generation and product planning clarity; knowledge sharing, as a mediating variable, plays an important role in the fuzzy front-end performance of cross-border innovation and breakthrough innovation; cross-border search of technical knowledge and cross-border cooperation in cross-border innovation are particularly important for enterprises to achieve breakthrough innovation.
Keywords: *Cross-border innovation, knowledge sharing, breakthrough innovation, fuzzy front end*

1. INTRODUCTION

Breakthrough innovation as a breakthrough move in innovation-driven development, can drive the reengineering and reshaping of technological competition nodes, market patterns and industrial structures. As the main force of breakthrough innovation activities, high technology enterprises always maintain high investment in independent research and development. If the breakthrough innovation is successful, the profit return to the high-tech enterprises is huge[1]. However, breakthrough innovation's prospect is not clear, fuzzy front-end as the key process of new product development of breakthrough technology, its effective management is the key to improve the success of breakthrough innovation. The fuzzy front-end management includes creativity management and new product planning management. In the era of knowledge economy, the identification of innovation opportunities and the generation of breakthrough ideas are inseparable from knowledge and information transmission; and the development of new breakthrough products needs the synergy between internal and external enterprises and even within and outside the industry. Cross-border innovation as an innovation activity that breaks through its own boundaries greatly integrates internal and external innovation resources and expands information transmission channels such as technology and market. Knowledge sharing among suppliers, customers, competitors and enterprises reduces fuzzy front-end uncertainty to a certain extent[2]. However, the specific mechanism of cross-border innovation and knowledge sharing on the fuzzy front-end performance of breakthrough innovation is still unclear, and this paper conducts an in-depth study based on it.

2. THEORETICAL FOUNDATIONS AND RELATED ASSUMPTIONS

2.1. Breakthrough Innovation Blurs the Front End of the Context

In order to reduce the risk of breakthrough innovations, most enterprises usually adopt a gradual technological innovation mode, and ignore breakthrough technological innovation, which will bring the "innovation dilemma" to enterprises. In the rapid development of the enterprise stage, the traditional innovation theory is unable to sustain the innovation development of enterprises, especially the high-tech enterprises that rely heavily on technological innovation[3]. One of the key measures of breakthrough innovation capability which determines the position and competitiveness of high-tech firms in the market is the development of radically transformative new products with significant innovation gains. Fuzzy front-end (FFE) as an early stage in the new product development (NPD) process covers the period from idea generation to its approval or termination of development[4]. FFE is an important stage in the generation and selection of new and disruptive product development knowledge, concepts and ideas, and is the weakest link in the new product

development process, but it is the key stage to enhance the breakthrough innovation capability of high-tech enterprises. At this stage, enterprises can achieve great performance at low cost, most of the value of the new product is generated in the fuzzy front-end, the more mature the front-end innovation process, the better the performance of new product development, the fuzzy front-end determines the success of innovation or not[5]. If high-tech enterprises can timely and effectively "de-fuzzy" the fuzzy front-end stage, promote the breakthrough technological knowledge innovation characterized by knowledge transformation and knowledge spiral, make full use of internal and external innovation resources, and tap the potential market, they can greatly enhance the success rate of breakthrough innovation. The main work of the fuzzy front-end of breakthrough innovation is generally divided into two categories, one is idea generation, idea development and idea evaluation; the other is product and project planning, including the coordination with enterprise strategy and innovation strategy, Figure 1 depicts the process of breakthrough innovation, and highlights the fuzzy front-end related activities.

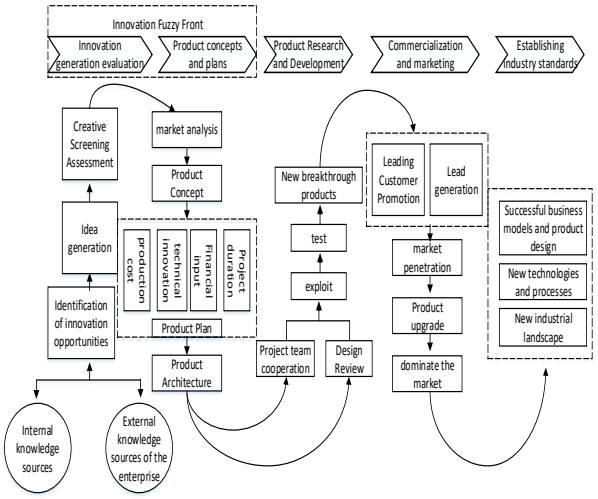

Figure 1 Breakthrough innovation process flow

2.2. Cross-border Innovation and Breakthrough Innovation Blurred Front-end

Cross-border innovation is an activity for enterprises to realize all-round and multi-level innovation by crossing organizational boundaries and industry boundaries, which is a comprehensive innovation from thinking to action. In this paper, it is believed that the focus of cross-border innovation lies in the search of resources needed by enterprises to carry out innovation across their own borders and the cooperation of different organizations, which is divided into cross-border search and cross-border cooperation from the content, including cross-border search of technical knowledge, cross-border search of market knowledge and cross-border search of social relations, and cross-border cooperation refers to horizontal homogeneous enterprises within the supply chain and vertical upstream and downstream enterprises of the two-tier cooperation.

Cross-border search of technical knowledge can help enterprises to quickly access a large number of different technical knowledge from the outside, which may bring more novel ideas to enterprises and create potential solutions. Cross-border search for market knowledge can provide an in-depth understanding of the potential needs of mainstream customers and the dynamics of competitors, which can help the enterprise to discover breakthrough innovative product concepts and gain a competitive advantage in the same field. Social relations include individuals and institutions that can provide a range of innovative resources such as capital, technology and human resources for cross-border innovation. Enterprises actively conduct cross-border search of social relations is conducive to restructuring or building social networks suitable for the development of enterprise innovation and achieving win-win [3]. Wang Liping and Chen Qingqing [5] argued that improving the ability of enterprises' cross-border cooperative behavior can timely access external political commitments and complementary resources to create favorable external conditions, and at the same time, it can feedback and correct internal deviations, forming an effective complementary mechanism to formal organizational structures and rules in uncertain environments, which is conducive to reducing uncertainty in the fuzzy front end of breakthrough innovation. Therefore, this paper proposes the following hypothesis:

H1: Cross-border innovation has a significant positive impact on the performance of the fuzzy front-end of breakthrough innovation.

H1a: Cross-border search for technical knowledge has a positive impact on the performance of the fuzzy front end of breakthrough innovations.

H1b: Cross-border search for market knowledge has a positive impact on the performance of the fuzzy front end of breakthrough innovations.

H1c: Social relationship cross-border search has a positive impact on the performance of the fuzzy front end of a breakthrough innovation.

H1d: Cross-border cooperation has a positive impact on the performance of the fuzzy front end of breakthrough innovations.

2.3. Cross-border Innovation and Knowledge Sharing

Knowledge sharing was first proposed by Teece in 1997, who argued that international transfer of technology can help firms accumulate valuable knowledge and promote technology diffusion, thereby reducing the technological gap between regions. Cross-border innovation breaks the traditional closed innovation model of firms and purposefully manages knowledge flows across organizational boundaries. On the one hand, through cross-border search for external knowledge transfer to internal

integration or exploratory learning, and on the other hand, through cross-border cooperation and sharing of internal valuable knowledge with external organizations to carry out diversified knowledge integration and innovation. It is conducive to enhancing inter-organizational knowledge flow and interactive communication, and promoting the production and sharing of new internal and external knowledge. Therefore, the following hypothesis is proposed.

H2: Cross-border innovation has a positive impact on knowledge sharing.

2.4. Knowledge Sharing and Breakthrough Innovation Fuzzy Front End

Knowledge sharing generates transferable knowledge resources, and an increase in knowledge sharing behavior facilitates the externalization of tacit knowledge and increases firm innovation performance. High-tech firms are typically knowledge-intensive, and knowledge (especially tacit knowledge) is a strategic resource and determinant for them to achieve breakthrough innovation.

In an open innovation environment, the higher the degree of external knowledge source sharing, the higher the efficiency of knowledge integration, application, and transformation, and thus the higher the success rate of breakthrough innovation opportunity identification; at the same time, the higher the degree of internal employee information knowledge sharing, the higher the efficiency of the externalization of individual tacit knowledge (creativity) into explicit knowledge (creative solutions). Cross-departmental communication and cooperation improves the flow and integration of diverse knowledge within the enterprise, and facilitates the generation of brand new concepts and ideas in product development. The hypothesis is as follows.

H3: Knowledge sharing has a significant positive impact on the performance of the fuzzy front end of breakthrough innovations.

H3a: External knowledge sharing has a positive effect on the performance of the fuzzy front end of breakthrough innovations.

H3b: Internal knowledge sharing has a positive effect on the performance of the fuzzy front end of breakthrough innovation.

Based on the above assumptions, the model of this study is developed as shown in Figure 2.

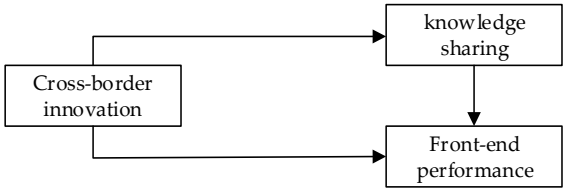

Figure 2 Research model

3. QUESTIONNAIRE DESIGN

3.1. Questionnaire design and data collection

The questionnaire survey usually adopts a Likert five-point scale, which is used in this paper, in which five represents a very good fit and one represents a very bad fit. In this paper, the data collection objects are high-tech enterprises with fast product update and more NPD projects, selected Jiangsu, Guangdong, Shanghai and other regions to carry out questionnaire survey, combined with online "questionnaire star" survey and two forms of field research, data collection period from September 2019 to February 2020. In order to improve the quality of the questionnaire survey, the respondents mainly consisted of middle and senior managers, technical directors, R&D managers and marketing managers of enterprises, covering a variety of fields such as biomedical, transportation, electronics and information. A total of 400 questionnaires were distributed, 270 questionnaires were returned and 50 invalid questionnaires were eliminated, making a total of 220 valid questionnaires with an effective return rate of 55%.

3.2. Reliability and Validity

The reliability of the variables was tested using SPSS19.0 software, and the sample reliability was expressed as Cronbach's value, which indicates high reliability when the value is greater than 0.8; if the CITC value is lower than 0.3; the corresponding question items were deleted. Among the variables selected for this study, all the variables have a Cronbach's value greater than 0.8, except for cross-border cooperation, which has a Cronbach's value greater than 0.75, and the scale reliability is good. Validity was tested using AMOS 18.0 for validation factor analysis (CFA) to obtain the standardized coefficients of each factor, and the standardized coefficients of each item were all greater than 0.6 and significant at the level of $p<0.001$, indicating that the questionnaire met the validity requirements and the measures were more interpretative of the corresponding variables. The average amount of extracted variance (AVE) values were all greater than 0.5, indicating high aggregation validity.

4. ANALYSIS OF RESULTS

In the high-tech enterprise breakthrough innovation fuzzy front-end management, enterprises across organizational and industry boundaries for cross-border search and cooperation, to promote the mutual sharing of knowledge based on different technical resource backgrounds, to promote the generation of breakthrough innovation ideas, creativity, etc., fuzzy front-end creative generation capacity to be improved; at the same time due to fuzzy front-end market, technology and other uncertainties to

reduce and different experiences within the enterprise Individual knowledge sharing, product development planning is clearer, and the success rate of breakthrough new product development is improved. In summary, the fuzzy front-end performance of breakthrough innovation of a company is greatly improved. Thus, according to the conceptual model of this paper, the structural equation is used to form Model 1, as shown in Figure 3.

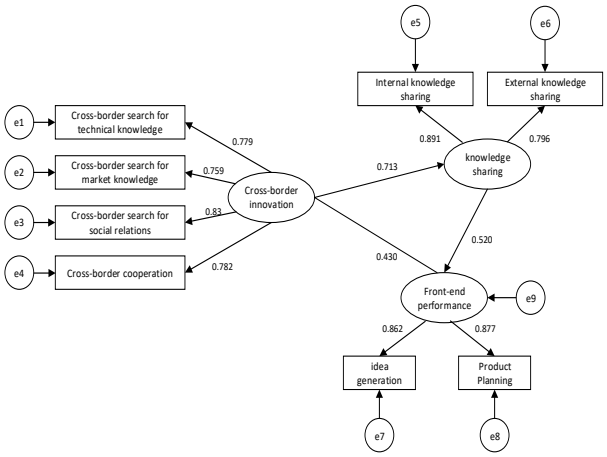

Figure 3 A fuzzy front-end performance model

(1) Analysis of the impact of cross-border innovation on the fuzzy front-end performance of breakthrough innovation of enterprises. In Cross-border innovation, cross-border search of technical knowledge (path coefficient 0.799), cross-border search of market knowledge (path coefficient 0.759), cross-border search of social relations (path coefficient 0.83), and cross-border cooperation (path coefficient 0.782) all have great influence in the cross-border innovation index. High-tech firms that perform better in cross-border innovation in the questionnaire have more efficient access to internal and external creative knowledge and better resources for research and development of breakthrough new products. The path coefficient of the influence of cross-border innovation on the fuzzy front-end performance of breakthrough innovation is 0.430, which indicates that cross-border innovation can to some extent improve the fuzzy front-end performance of its breakthrough innovation, and has an important role in promoting fuzzy front-end management, which is one of the key factors for enterprises to achieve breakthrough innovation.

(2) Analysis of the impact of cross-border innovation on enterprise knowledge sharing. Cross-border innovation can promote the introduction of external expertise and advanced ideas, while commercializing internal knowledge, technology and innovation through external diffusion channels, breaking the closed innovation model, and promoting the production and sharing of new knowledge within and outside the enterprise. The path coefficient of the impact of cross-border innovation on knowledge sharing is 0.713, which indicates that cross-border innovation has a significant impact on corporate knowledge sharing. 80% of the enterprises in the questionnaire that perform better in cross-border cooperation have more knowledge exchange within teams and between departments and better internal information systems; 75% of the enterprises that perform better in cross-border search are more active in communicating with external R&D institutions and competitors before new product development.

(3) Analysis of the impact of knowledge sharing on the fuzzy front-end performance of breakthrough innovation. The path coefficient of the influence of knowledge sharing on the performance of breakthrough innovation fuzzy front-end is 0.520, which indicates that knowledge sharing has a significant influence on the generation of breakthrough ideas and new product planning of the enterprise's fuzzy front-end.

5. CONCLUSIONS AND INSIGHTS

In order to promote high-tech enterprises to effectively manage the fuzzy front end of breakthrough innovation and improve the success rate of breakthrough new product development, this paper puts forward the following management inspiration: First, pay attention to cross-border innovation and break the closed mode of acquiring innovation value; in addition, they should actively conduct cross-border search and cross-border cooperation with external innovation agencies, supply chain enterprises, etc., to form breakthrough innovation technology and business networks, enhance knowledge flow and communication between organizations, improve knowledge field activity, and promote breakthrough innovation knowledge generation. Secondly, we focus on knowledge sharing and build a heterogeneous knowledge sharing mechanism for the participating subjects. The internal knowledge sharing mechanism should start from the organization, improve the ability of managers to establish organizational relationships, and vigorously improve the internal diversified knowledge flow, integration and innovation; the external knowledge sharing mechanism should start from the perspective of win-win cooperation, and adopt formal or informal knowledge sharing mechanisms. Thirdly, we focus on front-end management and improve the screening and evaluation mechanism of breakthrough ideas. The success of the process from the generation of breakthrough ideas to the development of new products is highly related to the judgment or research of ideas at the initial stage, and improving the screening mechanism of breakthrough ideas can greatly improve the implementation effect of FFE and the front-end performance of breakthrough innovation fuzzy.

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