

FACTOR ANALYSIS OF DYNAMIC FACTOR MODEL OF ENTERPRISE DISTRIBUTED INNOVATION

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Abstract: With the continuous deepening of economic globalization, the innovation of science & technology also presents itself in globalization trend. Enterprises' distributed innovation is one of the manifestations of this trend. The practice of distributed innovation has been keeping ahead the development of its theory. Many multinational companies (MNCs) and large enterprises explore and practice distributed innovation actively besides their global production and operation. How to enhance the innovation dynamics is the key in the process of enterprise distributed innovation, and is also an important prerequisite for achieving distributed innovation effectively. This article introduces the concepts of enterprise distributed innovation and hypothesizes the dynamic factor of enterprise distributed innovation. The authors analyze, using factor analysis and SPSS, the data by questionnaire surveys from 184 large enterprises in China. Additionally, five common factors are obtained according to component matrix after rotation. At last, the authors establish the dynamic factor model of enterprise distributed innovation.

Key words: Factor analysis, SPSS, Dynamic factor model, Enterprise distributed innovation

1. INTRODUCTION

With the constant deepening of the development of the world economy, the competitive environment has undergone tremendous changes, increasingly fierce market competition and the unpredictability and volatility of market environment. Being confronted with business pressures (shorter product life cycles, more demanding customers, and providing efficient services and high-quality products to customers), enterprises have to continuously improve the innovation ability for adapting the demand of changing market and localization. How to improve the innovation ability of the enterprise? The distributed innovation is the development trend of the technology innovation under the background of economic globalization. In these distributed innovation system, the enterprises successively become the distributed R&D in order to short the development period of new product, reduce the development cost and improve the product quality and technology content. Upon transferring knowledge among the enterprises and taking good advantage of the partner's experience and special techniques, the different cooperative enterprises can easily and effectively achieve the resource sharing and superiority complementary, which is good for distributed innovation to meet the rapid and changeable market easily and timely.

However, how to enhance the innovation dynamic is the key in the process of enterprise distributed innovation, and is also an important prerequisite for achieving distributed innovation effectively. In many cases, companies do not operate technology innovation not because of lack of innovation capability, conditions or chance, but because of lack of innovation dynamics (Charles Carter, 1981). Therefore, in order to thoroughly change the unfavorable situation of weak innovation in China, we should carefully study the dynamic factor of distributed innovation, and strive to explore the effective ways to stimulate innovation activities of enterprise.

2. DISTRIBUTED INNOVATION.

2.1 Literature Review

Distributed innovation is the successful implementation of creative ideas, tasks, or procedures by employees in different geographic locations. DI can be inter-firm or intra-firm cooperation, but narrows down the definition to be specifically cooperation that is possible as a direct result of globalization and the changing face of the world economy towards a knowledge based economy (Cummings, Jonathon N 2005) .

Distributed Innovation is an emerging frame work for a novel method of new product/service development, where knowledge from within and outside the organization is shared in an evolutionary dialogue, which consistently produces high quality results (Alistair Bowden 2005)¹.

To exploit these opportunities faster, companies carry out their innovations by collaborating with outside partners, from whom they learn, transfer or in-source components of the new knowledge. This inter-organizational coordination has been referred to as distributed innovation (Coombs and Metcalfe 2000; Smith 2001).

Distributed innovation offers exciting possibilities for a firm to capitalize on the creativity of its partners and customers, the management of distributed innovation requires firms to re-examine the mechanisms they use to govern innovation. A new model for managing distributed innovation, the community of creation is a governance mechanism for managing innovation that lies between the hierarchy-based (closed) mechanism and the market-based (open) mechanism for innovation management (Mohambir Sawhney, Emauela Prandelli 2000).

Distributed innovation is innovation across a particular intranet within an organisation and even within key suppliers and strategic partners. This level of innovation is defined by all of the 'collaborative', 'project' and 'individual' innovation. A key feature of distributed innovation is that any individual within the intranet can search and 'surf' around the organisation looking at the innovation that to their own team or department. Senior manager can surf into particular individuals. The tools required for distributed innovation are in their infancy. A principal design feature will be that these tools must support 'structured collaboration', to allow any individual easily find the information they are looking for (David O'Sullivan 2003).

Globalization means Distributed Innovation, Distributed Innovation builds on clusters and the specialization of places as well as localized innovation and the capabilities that places develop as a result of high densities of Florida's "creative class." (Chris Kelly 2006).

There are five key action steps that companies and individuals must take to implement distributed innovation: Design processes to match the type of innovation required; Create structures to access and coordinate top global talent; Provide a share in the value created; Negotiate based on differing objectives, risk appetite, and power; Be open throughout the process (Ross Dawson 2003).

The knowledge-based view puts forward a specific mechanism through which distributed R&D leads to greater innovation success: multiple locations enable the firm to access a larger number of different knowledge sources outside of the organization than it could in a single location (Aija Leiponen, Constance E. Helfat 2006). Innovation is a distributed process that involves the collective efforts and the interaction of heterogeneous organizations. Each of those actors is specialized in specific activities, technologies and knowledge and innovation is the result of the combination and integration of their activities. Coordination is a key determinant for the viability of distributed innovation in that it stimulates complementarities across otherwise dispersed competences (Davide Consoli, Pier Paolo Patrucco 2007) .

2.2 Conception of Enterprise Distributed Innovation

Distributed innovation emerges because of globalization and information network, especially because of the global production and operation of large enterprises and transnational corporations. It is a continuation and development of technological innovation theory and practice, which obeys the general principles of the theory, but has its own characteristics. Distributed innovation of enterprises comes out under the background of globalization and information network, which is not only an inner innovation, but also an external innovation. Distributed innovation is an innovation which surpasses space and time, makes full use of communication, network and computer technology, and integrates the resources and knowledge in and out of the global enterprises quickly and dynamically.

3. DYNAMIC FACTOR OF DISTRIBUTED INNOVATION

3.1 Location Factor

"Location is everything" means that the physical location a firm chooses for its physical presence can make or break the future of the firm (Chris Kelly 2006). There are two distinct perspectives regarding the location of innovation activity. One general perspective emphasizes the benefits of distributed innovation, and derives primarily from the literatures on foreign direct investment and the knowledge-based view of the firm. The other general perspective emphasizes the costs of decentralization of innovation activity, and derives in part from the economics of transactions costs and agency (Aija Leiponen, Constance E. Helfat

2006) . For adapting to the complex market environment, producing products which more accurately reflect local market characteristics, and getting special interests of location, location factor is the key of dynamic factor of distributed innovation. Therefore, we develop hypothesize that location factor includes customers localization needs, opening new domestic/foreign markets and distribution of sub-plant/company.

3.2Technology Factor

Technology is the first productivity (Deng Xiaoping, 1988). Technology is the most active element in distributed innovation process. Technology always moves, develops and is applied in production continually under combined macro dynamic and micro dynamic, and becomes a strong driving force for enterprise innovation.

The new technology plays a strong role in promoting and stimulating enterprise innovation. The technological achievements, after transferring into products in the production process, usually obtains the higher monopoly profits, and helps enterprise achieve success and benefits in business and economy. Therefore, the new technologies constantly encourage enterprises to absorb new technological achievements for innovation. Although innovation is difficult, risky and costly, it is unprecedented from idea, R&D, production to the final market. Thus, it will provide a greater opportunity to enterprises by new products and new industries and impel innovation to face risk. It can be seen that the technology factor is the obvious dynamic factor of distributed innovation. In this paper, we suppose that the technology factor is composed of improving quality of goods or services and improving technology and manufacturing process.

3.3Market Factor

The market is the ultimate place for achieving technology innovation, while the market demand is not only the dynamic source, but also is the starting point for technology innovation activities. These market demands continuously change with the economy and social development, when the change reaches a certain degree and size, will directly impact on sales and incomes of products, and also provide new market opportunities and ideas for enterprises. Thus, the market forms the pull and motivation for innovation activities of enterprise. The market factor is the basic dynamic factor of distributed innovation. We hypothesize that the market factor includes increasing market share, opening new markets and rapid response.

3.4Profit Factor

The enhance anticipated remuneration (or cost saving) brought by innovation will attract enterprises to innovate. In the situation of the absence of external survival pressures, only when the anticipated remuneration from innovation is greater than benefits which can maintain the status quo, enterprise will have innovation impulse; the greater the expected returns are, the stronger the innovation dynamics are. It can be said that profits impel enterprise to innovation continuously. If enterprises have no way to obtain anticipated remuneration from innovation, potential consciousness of innovation will be diminished or even lost. The originator of innovation theory, J.A.Schumpeter pointed out that the reason why enterprises are willing to introduce new ideas and overcome old barriers, which must be risks, they hope to get their monopoly status and enjoy high profits in the maintenance period. Therefore, profit factor is the dynamic factor of distributed innovation. We suppose that profit factor includes Reducing R&D costs and production costs.

3.5Resource Factor

With the deepening development of world economy's globalization, enterprise is no longer an isolated system, the barrier between enterprises are becoming more and more fuzzy. The ability of utilization and integration resources has become an important source of value creation. According to the theory of resources, the enterprise is composed of a serious of resources, the situation of resources owned by enterprises plays a leading role in enterprise innovation activities. Resources are the basic of innovation, risk-bearing and strategic decision for enterprise. In the process of enterprise innovation, because of lack of technology, human, knowledge resources, enterprises achieve resources sharing to remedy defect using external resources by the model of distributed

innovation. Thus, the resource factor is also the dynamic factor of distributed innovation. In this paper we hypothesize that the resource factor includes resource sharing and knowledge sharing.

3.6 Environment Factor

The last factor considered in our analysis is the environment. Nowadays, the environmental problems have become not only a general danger for human kind but also an economic subject when talking about new products and services. Large distances between manufacturing plants create new logistic processes which cost money and pollute the environment. In order to maintaining their survival and achieving further development, enterprises more and more attach great importance to environmental protection and take favorable measures to protect environment, such as increasing R&D investment, improving the environment of production and the process of usage. Therefore, the environmental factor including the index reducing environment impacts is the dynamic factors of distributed innovation.

4 SURVEY DESCRIPTION

In this section the concept of the survey on distributed innovation processes is briefly explained. The focus is on a brief description about data collection, data analysis and factor analysis using SPSS.

4.1 Data Collection

The questionnaire survey is one of the ways in empirical study. It collects the information and data to research object by written form with the subject strictly designed. The method need definite research goal, thus, the general arrangement, the content and the scale composition are decided by the different research purpose and theoretical framework(Wang Chongming. 1993).

The authenticity and validity of data is the premise and basis of mathematical statistics. This survey chose parts of enterprises in Suzhou Industrial Park and Wuhan Zhuankou Economic Department Zone for acquiring authentic and effective samples, because the economy of Suzhou and Wuhan city is more developed than other city, the distributed innovation of large enterprises is more active than others. Selected Industries include electrical and optical equipment, iron and steel, chemicals, machinery and equipment, household appliance, car and zero parts manufacturing and so on. On the one hand, because their technology updates quickly, their generation of products replaces fast, and they are typical representatives facing drastically competitive environment, they have more needs of innovation; on the other hand, these industries are the pillar industry in the high-tech industry, and also play a decisive role in the national economy. Therefore, it is realistic significance to research in these industries.

4.2 Data Analysis

Factor analysis is a procedure aimed at finding out the underlying structure or dimension of a set of data. Factor analysis is a statistical procedure used to uncover relationships among many variables. This allows numerous intercorrelated variables to be condensed into fewer dimensions, called factors(Peter tryfos. 2001, Andy field. 2005). According to the third chapter, the dynamic factor of distributed innovation is made of 14 indexes (Table 1).

Variable	Index	Explain
X1	Improving quality of goods or services	Technology Factor

X2	Increasing market share	Market Factor
X3	Opening new markets	Market Factor
X4	Reducing product costs	Profit Factor
X5	Reducing environment impacts	Environment Factor
X6	Customers' localization needs	Location Factor
X7	Rapid response in the market	Market Factor
X8	Resource sharing	Resource Factor
X9	Knowledge sharing	Resource Factor
X10	Risk sharing	Resource Factor
X11	Reducing R&D costs	Profit Factor
X12	Opening new domestic/ foreign markets	Location Factor
X13	Distribution of sub-plant/company	Location Factor
X14	Improving technology and manufacturing process	Technology Factor

Table1: Dynamic factor of distributed innovation

4.3 Factor Analysis Using SPSS

According to the principle that the eigenvalue is greater than 1, we extracted 5 principal components from 14 effect factors by principal component analysis, and the cumulative contribution of variance of those components is 57.808%. Table 2 is the rotated component (also called the rotated factor matrix in factor analysis) which is a matrix of the factor loading for each variable onto each factor. This matrix contains the same information as the component matrix in table 6 except that it is calculated after rotation. After rotation, the factor coefficient has been obvious to the polarization, this matrix is particularly significance for interpretation.

	Component				
	1	2	3	4	5
x1	-.067	.123	.367	.615	-.084
x2	.224	-.092	.720	.223	.070
x3	.039	.111	.686	-.087	-.073
x4	.128	.080	-.146	.675	.136
x5	-.057	-.065	.038	.054	.916
x6	.636	-.055	.248	-.233	-.023
x7	.251	.105	.498	-.378	.197
x8	.264	.371	.147	-.482	.002
x9	-.085	.827	.103	.003	-.101
x10	.110	.867	-.028	.022	.069
x11	.418	.195	-.193	-.367	.266
x12	.545	.370	.023	.227	-.166
x13	.767	-.044	.036	.091	-.139
x14	.641	.049	.188	-.081	.197

Table 2: Rotated Component Matrix

5. INTERPRETATION OF RESULTS

5.1 Interpretation

The analysis results show that the load value of X6 (Customers' localization needs), X12 (Opening new domestic/foreign markets), X13 (Distribution of sub-plant/company) and X14 (Improving technology and manufacturing process) in the common factor F1 is greater than others. Among them, X6, X12, X13 reflected the location distribution of enterprises, X14 represented the technology factor. Therefore, F1 is the common factor which reflected location and technology factor. The higher this factor gets the score, the stronger the enterprise need location factor of innovation dynamic.

In the common factor F2, the load value of X8 (Resource sharing), X9 (Knowledge sharing), X10 (Risk sharing) is greater than other variables. Therefore, F2 is the comprehensive reflection of 3 indexes, which represents resource factor.

The common factor F3 is composed of X2 (Increasing market share), X3 (Opening new markets) and X7 (Rapid response in the market) according to above principal, which depicts the market factor.

X1 (Improving quality of goods or services) and X4 (Reducing product costs) respectively represent the technology factor and the profit factor, meanwhile compose the market factor. The common factor F5 is only composed of X5 (Opening new markets) and X6 (Customers' localization needs) represent the location factor.

5.2 Results

According to the analysis of 51 variables, the dynamic factor model of enterprise distributed innovation, as shown in Figure 1, is established. The market factor, technology factor, resource factor and profit factor are the core factors of the dynamic factor model of enterprise distributed innovation.

In the whole process of distributed innovation, enterprises have a large number of exchanges and action relationship with these external environment, whereas, there are countless ties between these external environment and location. Because market, technology, resource and environment are different external environment, the location factor is the core factor of the location factor drives enterprise distributed innovation.

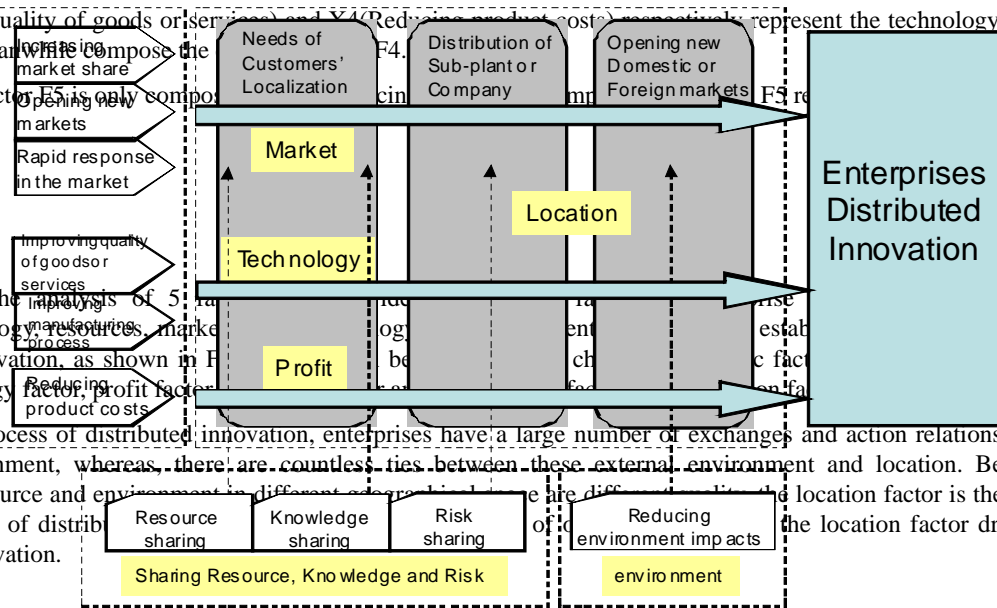


Figure 1: The dynamic factor model of enterprise distributed innovation

6. CONCLUSIONS

According to the dynamic factors model of enterprise distributed innovation, we can make sure that what kind of factor drive enterprise to distributed innovation, how about the relationship among them, how to act on distributed innovation, how to operate under the action of these factors. Furthermore, enterprises can consciously reform controlled factors to adapt to uncontrollable factors in order to enterprises distributed innovation continually.

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