Design Engineering

ISSN: 0011-9342

Issue: 11 | Pages: 614 - 627

Research on the Dimension Structure and Measurement of Network Relationship Strength in Enterprise Network

Baohua Qi[1,2], Changqing Ding[1]

[1]Bussiness School of Hohai University, Nanjing, Jiangsu, China

[2]School of Society and Population, Nanjing University of Posts and Telecommunications, Nanjing, Jiangsu, China

Abstract:

Network relationship strength is an important variable of enterprise network. At present, many scholars at home and abroad have carried out relevant research on the component dimensions of network relationship strength. However, due to the different perspectives and emphases, there are also great differences in the division of its constituent dimensions. Therefore, it is necessary to conduct further in-depth research on the strength and dimensions of enterprise network relations, which will be the first in the study On the basis of defining the concept of enterprise network relationship strength, this paper uses content analysis method to initially establish the composition dimension of enterprise network relationship strength, and then uses questionnaire survey and factor analysis method to conduct further quantitative test on the survey data, and further support the research results proposed by content analysis method.

Keywords: *Enterprise network, Network relationshipstrength, Component dimension.*

I. INTRODUCTION

With the wide application of social network theory in the field of management, different scholars put forward different definitions of enterprise network, Brass. et.al considered that firm network is a long-term cooperative relationship between an organization and its customers, competitors, suppliers and other organizations [1]; Chen Shouming believes that the enterprise network is established by a group of independent and interrelated enterprises based on

ISSN: 0011-9342

Issue: 11 | Pages: 614 - 627

specialized division of labor and cooperation. It is a kind of long-term and directed organization consortium, which includes both inter enterprise and internal enterprise[2]. This paper holds that the enterprise network is a collection of various relationships established between the enterprise network and the related suppliers, customers, scientific research institutions and technical intermediary organizations, as well as with financial institutions, other enterprises and organizations, through formal or informal ways to obtain resources and reduce innovation risk. The main body of high-tech enterprise network includes the government, suppliers, upstream and downstream enterprises, financial institutions, scientific research institutions and intermediary institutions. Through various network relations, enterprises obtain various elements such as knowledge, technology, information, management and market, so as to improve the efficiency of enterprise innovation activities. A complete enterprise network includes not only the basic elements, but also the network nodes as well as the relationship connections caused by the relationship among network nodes, labor force, knowledge, technology and information in the network. The goal of enterprise network is to realize resource sharing, complementary advantages and collaborative innovation within the network. It includes joint venture, strategic alliance, enterprise consortium, outsourcing, joint R & D, long-term trading partner network, license agreement, reciprocal trade agreement, chain operation, enterprise cluster and virtual enterprise based on long-term joint venture, relationship contract, and some forms of manufacturing and outsourcing.

At present, many scholars have studied the component dimensions of network relationship strength from different perspectives, and have achieved certain research results; Granovetter proposed to define innovation performance from three dimensions of interaction frequency, intimacy and reciprocity; Marsden & Campbell proposed in 1990 to divide the strength of network relationship from four aspects: mutual trust, relationship duration, communication frequency and intimacy [3]; In 2004, Nooteboome & Gilsing divided the dimension of network relationship strength from interaction frequency, personal trust, reciprocity degree and sustainability [4] ; Wang Xiaojuan divides the dimension of network relationship strength from two aspects of experience exchange frequency and connection strength; Generally speaking, there is no consensus in the academic community on the dimension composition. Therefore, it is necessary to further study the composition dimension and measurement of enterprise network relationship strength on the basis of previous studies on the dimension of network relationship strength, so as to provide theoretical basis and guidance framework for enterprises to better manage network relationship.

Design Engineering

ISSN: 0011-9342

Issue: 11 | Pages: 614 - 627

II. THE ORETICAL DEVELOPMENT OF THE STRENGTH OF ENTERPRISE NETWORK RELATIONSHIP

As for the definition of enterprise network, Foss thinks that enterprise network is a persistent and stable relationship pattern among specific enterprises[5]. Gomes-casserser thinks that the enterprise network is a collection of independent enterprises connected by cooperation protocol[6].However, Gulati describes the enterprise network from the perspective of function, and believes that the enterprise network is a voluntary arrangement for the exchange of resources, joint development of products, sharing of technology and services between enterprises[7]. Brass. et.al considered that the enterprise network is a long-term cooperative relationship between an organization and its customers, competitors, suppliers and other organizations. The strength of network relationship refers to the closeness of the relationship among the main bodies in the enterprise network. It is an important feature of the relationship dimension of the enterprise network, which is multidimensional and complex, at present, scholars at home and abroad have divided the dimensions of network relationship strength in various forms from different research perspectives, but they have not reached a generally accepted conclusion. In the research on the dimension of innovation network relationship strength, Granoveter proposed for the first time that emotional network relationship strength has four dimensions: closeness, reciprocity, communication time between nodes and familiarity[8]. Marsden used intimacy, mutual trust, relationship duration and communication frequency to study the relationship strength of innovation network[9]. Burt, in his research on the component dimensions of network relationship strength, advocates the following aspects: personal trust, persistence, interaction frequency, mutual understanding, special investment scope and formal control. Six aspects are the dimension characteristics of network relationship strength[10]. Nooteboom used six dimensions to measure the strength of network relationship: persistence, interaction frequency, mutual understanding, personal trust, special investment scope and formal control[11]. On the basis of previous studies, Chen Guangxue subdivided the strength of network relationship into the interaction frequency, duration, number of exchanges and reciprocity between enterprises and suppliers, customers and competitors[12]; six dimensions of solution, personal trust, special investment scope and formal control were used to measure the strength of network relationship. Based on the analysis of the relationship strength of knowledge chain, Wu Shaobo uses the dimensions of trust, interaction frequency and asset specialization to study the strength of network relationship. At present, there is no general consensus on the component dimensions of network relationship strength, and it is necessary to conduct further in-depth research.

Design Engineering

ISSN: 0011-9342

Issue: 11 | Pages: 614 - 627

TABLEI.Representative views on the dimension division of network relationship strength

SERIAL NUMBER	AUTHOR	AGE	COMPONENT DIMENSION
1	Granoveter	1973	Closeness, reciprocity, communication time and familiarity
2	Burt	1992	Closeness, reciprocity, communication time and familiarity, personal trust, persistence, interaction frequency, mutual understanding, special investment scope and formal control
3	Wu Shaobo and Gu Xin	2008	Interaction frequency, trust, resource interdependence and asset specialization [13]
4	Zhao Tiantian	2014	Contact time, resources input, scope of cooperation and exchange, reciprocity [14]
5	Zhang Xiarong	2015	nteraction duration, intimacy, mutual trust and reciprocity
6	Du Xian	2018	Reciprocal exchange, interaction frequency, input resources, cooperation and exchange scope [15]

It seems that there are different views on the dimension division of network relationship strength, but from the perspective of research context, the strength of enterprise network relationship will inevitably go through the process of continuous accumulation and change. In the initial stage of cooperation, the attitude and behavior of both parties are more cautious and rational at the beginning. With the increase of communication and cooperation between the two sides, the cooperation results are fixed in some form, which shows the increase of relationship strength Strong. In order to study the influence mechanism of relationship strength on innovation performance, this paper further studies the structural dimension of network relationship strength based on literature review.

III. RESEARCH DESIGN

In this paper, a general scale development method is adopted to propose the component dimensions of network relationship strength through literature review and interview, and a

ISSN: 0011-9342

Issue: 11 | Pages: 614 - 627

hypothesis scale to be verified is formed. After data collection, spss22.0 and Amos24.0 were used to verify the scale.

3.1 Interview and Dimension Development

3.1.1Enterprise Interview

Interview research method is a commonly used research method in sociological research. Through on-the-spot interviews with investigators, this paper truly understands the respondents' understanding and attitude towards the strength of network relations, and then determines the preliminary interview results according to the interview results and expert consultation. All the interviewees in this paper are mainly the middle-level and above managers, project leaders and senior executives of enterprises. From 2017 to 2018, we interviewed 29 middle-level managers and 16 senior executives of 17 science and technology enterprises in Nanjing through alumni resources. Each interview lasted about 30 to 50 minutes. The interview group recorded and recorded the interview process, and took star interview registration outline to sort out the interview process.

In order to carry out the interview effectively, an interview outline was designed before the interview activity. On the basis of listening to the experts' opinions, the interview outline was preliminarily revised to form the final interview outline. Generally speaking, there are semi-structured interview and unstructured interview. Generally, there is no outline for unstructured interview, which mainly depends on the interviewers to obtain the interview information. This paper is mainly semi-structured interview. You have the interview outline in advance, and carry out the interview on the basis of the interview outline, and record the whole process for convenience of sorting out. On the basis of literature review, the interview outline designed by us mainly involves three types of issues, namely, enterprise innovation, enterprise network relationship and enterprise network management, with a total of 10 topics. In the interview, the interview outline was modified and adjusted in detail according to the actual situation.

TABLEII.Code table of interview coding sentences

Design Engineering

ISSN: 0011-9342

Issue: 11 | Pages: 614 - 627

SERIAL NUMBER	DIMENSION	CODING STATEMENT
1	Interaction frequency	We have frequent business contacts with our partner companies. In addition to the formal cooperative relationship, many business personnel will have a good private relationship. We often have regular cooperation and exchanges with our partner companies and put forward suggestions.
2	Degree of trust	We and our partners have more trust in each other; we have been able to keep our promises for a long time; we are willing to share problems and visions with each other; we and our innovation partners trust each other to keep their promises.
3	Resource dependence	We have complementary resources such as capital, technology, equipment and market between us and our partners; we obtain resources such as technology and equipment from each other in cooperation; termination or replacement of partners is a loss to both parties。

In the research, this paper adopts a three person coding scheme. First of all, the data is analyzed and the three people are allowed to carry out open coding on the basis of reading the manuscript. On the basis of reading relevant materials, key stem is created and identified. On this basis, the proposed similar stems are classified into one category, representing different network relationship components. Finally, the coding results of three coders are compared, and those with more than two coders are recognized as recognition.For the content of inconsistent classification, if the content reached consensus after discussion continues to be classified, otherwise deleted, the coding result contains 35 valid sentences. According to the coding reliability research proposed by BOS in 1999, when the classification consistency coefficient is greater than 0.8, the coding result is consistent, and the coding coefficient greater than 0.9 indicates that the consistency is very good The number is 0.90, greater than 0.8, indicating that the reliability is good.When there are different opinions on the specific stem and content, the consensus is reached through discussion, so that the code sentence preparation reflects the meaning of the dimension, which indicates that this study has high validity.

3.1.2 Questionnaire Survey and Data Collection

On the basis of interview and content analysis questionnaire, we initially developed a three-dimensional measurement questionnaire of enterprise network relationship strength for further verification. We used the questionnaire survey method to test and verify the preliminary enterprise network relationship strength research questionnaire. n the distribution of questions,

Design Engineering

ISSN: 0011-9342

Issue: 11 | Pages: 614 - 627

we distributed 290 questionnaires to some industrial parks in Nanjing, Nantong and Taizhou by means of interview, e-mail and entrustment. Through questionnaire survey, SPSS statistical analysis software and confirmatory factor analysis method were used to analyze the survey results. A total of 255 questionnaires were collected in this survey, of which 193 were valid to valid, and the effective rate was 68.93%.

TABLEIII. Statistics of enterprise nature, industry and age

FEATURES	CLASSIFICATION	NUMBER OF QUESTIONNAIRES	PROPORTIONOF QUESTIONNAIRES
NATURE OF ENTERPRISE	state-owned en terprise	35	18.13%
	Collective enterprises	22	11.40%
	private enterprise	146	75.65%
TRADE	Telecommunications and value-added services	35	18.13%
	Information electronic and photoelectric equipment	22	11.40%
	Software	53	27.4%
	internet	47	24.35%
	Information technology service industry	36	18.65%
ENTERPRISE AGE	Less than 3 years	62	32.12%
	3-5 years	75	38.86%
	More than 5 years	56	29.02%

3.1.3 Internal Consistency Test of the Questionnaire on the Strength of Enterprise Network Relationship

At present, cronbach'a coefficient is often used to test the internal consistency and reliability of the questionnaire. Cronbach'a above 0.7 indicates that the reliability level of the measurement items is high, and cronbach'a greater than 0.7 is regarded as the standard for the reliability of the questionnaire. The analysis results are as follows:

Design Engineering

ISSN: 0011-9342

Issue: 11 | Pages: 614 - 627

TABLE IV.Internal consistency test

ITEM	CORRECTED TOTAL	CRONBACH'A VALUE
a1	.682	.860
a2	.605	.864
a3	.593	.865
a4	.593	.865
a5	.074	.887
a6	.542	.868
a7	.493	.870
a8	.617	.865
a9	.560	.867
a10	.645	.862
a11	.567	.867
a12	.556	.867
a13	.608	.842
a14	.365	.875

According to the calculation, the value of cronbach'a composed of 14 scales is 0.876, which meets the requirement of consistency. From the cronbach'a coefficient of a single item, the coefficient of A5 item will increase. If this item is deleted, the overall cronbach'a coefficient should be deleted, and the consistency test should be conducted after deleting A5 item. The cronbach'a coefficient technology of 13 items is 0.887, and A5 item is deleted. After that, the overall cronbach'a coefficient increased again, and the overall cronbach'a was 0.887, greater than 0.7, indicating that the consistency test met the requirements, and exploratory analysis could be carried out. It can be seen from TABLE IV that the three measurement indicators have a high level of internal consistency, so the measurement indicators are suitable for quantitative analysis.

3.2 Exploratory Factor Analysis

In the exploratory factor analysis of the measurement results, the common principal component analysis method is used to extract the common factors whose eigenvalues are greater than 1. In the process of using the principal component analysis method, we should pay

ISSN: 0011-9342

Issue: 11 | Pages: 614 - 627

attention to the contribution rate of the equation of the principal component, and the variance contribution rate of the principal component reflects the contribution of the factor to the research objective. The contribution rate can measure and explain the factors and research questions. It is generally considered that the variance contribution rate greater than 40% meets the measurement requirements.

After deletion, the 12 items of network relationship strength measurement are retained. After rotation by principal component analysis, common factors with eigenvalues greater than 1 are extracted. The first common factor contains 4 items, and the second common factor contains 4 items. After verification, the factors of 12 items are all above 0.5, as shown inTABLEV.

TABLE VExploratory factor analysis of measurement of enterprise network relationship strength

ITEM	COMMON FACTOR 1	COMMON FACTOR 2	COMMON FACTOR 3
a1	0.262	0.270	0.786
a2	0.384	0.108	0.657
a3	0.102	0.324	0.752
a4	0.185	0.119	0.852
a6	0.096	0.827	0.206
a7	0.159	0.813	0.063
a8	0.196	0.678	0.208
a9	0.162	0.679	0.290
a10	0.761	0.281	0.210
a11	0.732	0.233	0.155
a12	0.814	0.062	0.187
a13	0.826	0.088	0.230

Design Engineering

ISSN: 0011-9342

Issue: 11 | Pages: 614 - 627

Common factor 1 variance contribution rate was 23.518%, common factor 2 variance contribution rate was 23.442%, common factor 3 variance contribution rate was 22.265%, cumulative variance contribution rate was 69.225%, indicating that the three dimensions are suitable for the measurement of network relationship strength.

3.3 Confirmatory Factor Analysis

In the development and research of a certain concept dimension, exploratory factor analysis is generally used to verify the factors, but in order to ensure that the obtained factor structure can reflect the characteristics of the scale to the greatest extent and provide support for theoretical research. In this paper, Amos data analysis software is used to conduct confirmatory factor analysis on the measurement factors of the network relationship strength of high-tech enterprises. The parameters of the hypothetical model are estimated with the data of sample fitting, and the covariance matrix is constructed according to the parameter estimation. If the elements in the residual matrix are close to 0, it indicates that the models fit well.

In this paper, Amos22.0 statistical software is used for confirmatory factor analysis of 24 measurement indicators. The factor load of each potential variable is above the significance level, and the measurement error is positive, which shows that the theoretical model fully meets the fitting standard. As shown in TABLEVI, from the overall fitting situation, the value of X^2 is 93.096, and the degree of freedom DF. = 50. From the point of view of P = 0.000 < 0.05, it shows that the fitting effect is good. In addition, the RMSEA value is 0.072, which meets the reference value lower than 0.1; the CFI value is 0.966, which meets the reference value greater than 0.900; the GFI value is 0.929, which is also greater than the reference value. On the whole, the dimension structure of network relationship strength is effective, and the measurement scale used has reliability and validity.

TABLE VI.Fitting of network relationship strength measurement model

Fitting statistics	measurement model	reference value
X^2	93.096	>0
Df	50	>0
X^2/df	1.862	<3
NFI	0.931	>0.90
CFI	0.966	>0.90

Design Engineering

ISSN: 0011-9342

Issue: 11 | Pages: 614 - 627

RMSEA	0.067	<0.08
GFI	0.929	>0.90

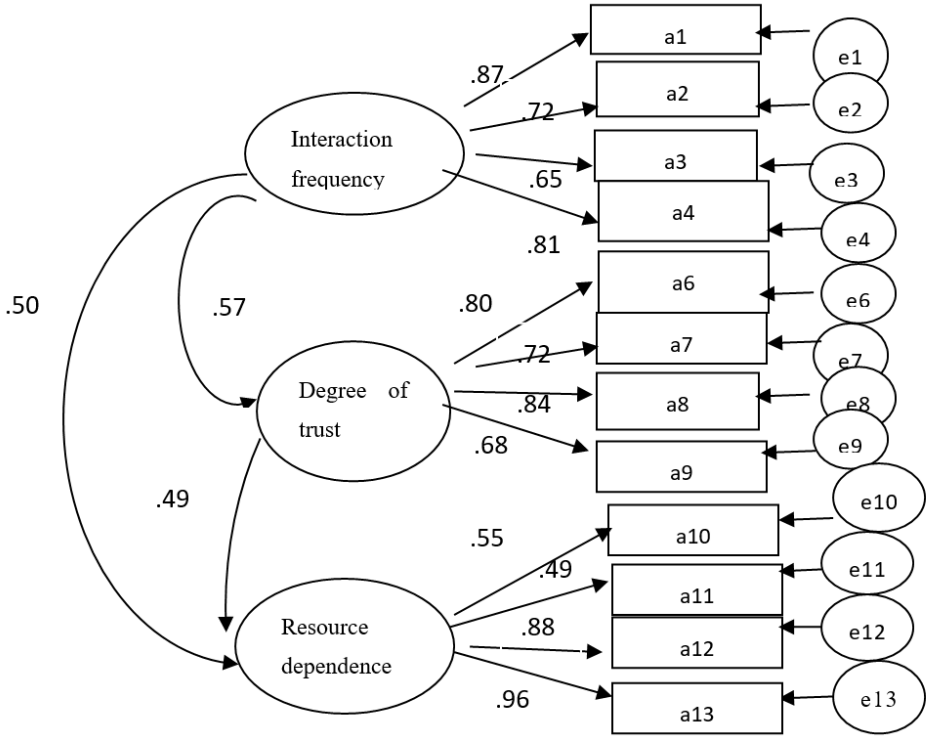

Fig1: Confirmatory factor analysis of measurement items of enterprise network relationship strength

IV. EMPIRICAL RESULTS ANALYSIS

Through principal component analysis and confirmatory factor analysis of the preliminary questionnaire, after deleting A5 items in the original questionnaire, the measurement items of each dimension fit well. The final measurement table of enterprise network relationship strength has three dimensions: interaction frequency, trust degree and resource dependence, and each dimension contains four items, as shown in TABLEVII

TABLE VII.Measurement table of each dimension of enterprise network relationship strength

Design Engineering

ISSN: 0011-9342

Issue: 11 | Pages: 614 - 627

VARIABLE	MEASUREMENT ITEMS	NUMBER	SOURCE
INTERACTION FREQUENCY	We often cooperate with our innovation partners on innovation activities or business processes	a1	Xie Hongming, Zhang Xiarong, Cai Ning, pan Songting, Liu Xueyuan, dangjianbing
	We have a lot of communication with our partners on cooperative projects and innovation activities	a2	
	We will discuss and make decisions with innovation partners on major decisions of innovation projects	a3	
	We have frequent informal and open communication with our partners	a4	
DEGREE OF TRUST	We can keep our promise or contract in cooperation with our innovation partners	a6	
	We and our innovation partners believe that performance is effectively monitored and the cost of default is high	a7	
	If we can't cooperate, both sides think it's a loss	a8	
	We are willing to share issues and vision with our innovation partners	a9	
RESOURCE DEPENDENCE	We have complementary resources with our major innovation partners	a10	
	We can effectively obtain the support of technical equipment and R & D personnel from our partners	a11	
	We can effectively acquire the management experience, marketing or sales skills of our partners	a12	
	It is very difficult to terminate or replace the current cooperative relationship, which will bring great opportunity cost loss to enterprises	a13	

V. CONCLUSION AND PROSPECT

ISSN: 0011-9342

Issue: 11 | Pages: 614 - 627

On the basis of theoretical analysis and literature review of network relationship strength, this paper uses interview method and content analysis method to summarize the component dimensions of enterprise network relationship strength, and on this basis, initially designs the measurement items of enterprise network relationship strength, and uses questionnaire survey method, exploratory factor analysis and confirmatory factor analysis to test the composition dimension of network relationship strength After quantitative verification, this paper divides the enterprise network relationship strength into three dimensions: interaction frequency, trust degree and resource dependence degree, and 12 items of enterprise network relationship strength measurement scale.

The main conclusions are as follows: (1) the strength of enterprise network relationship is composed of three dimensions: interaction frequency, trust degree and resource dependence. (2) Different from previous sociological studies, the degree of trust between enterprises can objectively reflect the strength of the partnership between enterprises in China. (3) The three-dimensional measurement model developed in this paper is more comprehensive for evaluating the strength of enterprise innovation network relationship. It provides a reference index framework for the relationship between enterprise maintenance and innovation partners, and lays a foundation for enterprises to better understand the impact of network relationship strength on enterprise technological innovation and competitive advantage.

REFERENCES

[1]BrassDJ,GalaskiewiczJ,Grenve HR, etal (2004) Taking stock of networks and organizations: A multilevel perspective.Academy of Management Journal47(6):796-817

[2] Chen Shouming (2003) Operation mode of Enterprise Cluster: a network model and an example. Southern economy 12: 38-40

[3]NooteboomB,VanhaberbekeW,DuystersG,GilsingV, Van den Oord (2005) Optimal cognitive distance and absorptive capaeity.Academy of Management Proeeedings, L1-L6

[4]Foss (1996) Kowledge-based Approach to the Theory of the Firm:Some Critical Comments.Organization Science 7:470-476

[5]Gomes-Casseres (1994) Groups Vsrs Groups:How Aliance Network Compete.Harvard Business Review 72: 62-74

[6]Gulati R (1999) Network location and learning: the influence of network resources and firm capabilities on alliance formation. Strategic Management Journal 20(5): 397-420

ISSN: 0011-9342

Issue: 11 | Pages: 614 - 627

[7]Brass DJ, GalaskiewiczJ, Grenve HR, et al (2004) Taking stock of networks and organizations: A multilevel perspective.Academy of Management Journal47(6):796-817.

[8]Granovetter (1973) The Strength of weak ties.American Journal of Sociology 78:1360-1380

[9]Marsden (1992) Network Data and Measurement.Annual Review of Sociology16

[10]BurtR (1992) StrueturalHoles:thesoeialstruetureofeomPetition.Cambridge. Harvard University Press: 88-198

[11]NooteboomBTrust (2002) Forms,foundations, functions, failures and figures. Cheltenham:Edward Elgar Press

[12] Chen Xueguang (2008) Research on the relationship between network capability innovation network and innovation performance.Zhejiang University

[13] Wu Shaobo, Gu Xin (2008) Research on the relationship strength of cooperation between knowledge chainorganizations. Science of science and management of science and technology 2: 113-118

[14] Zhao Tiantian (2013) Research on the influence of the strength of industry university research cooperation network on the technological innovation ability of enterprises.Harbin Institute of Technology

[15] Du Xian (2017) Research on the influence mechanism of manufacturing enterprise innovation network relationship strength on innovation performance. Harbin Engineering University