9

Study on Relationship Between Collaboration Network Characteristics and Academic Performance of Industry-University-Research Institute Collaboration in Yangtze River Delta,China

การศึกษาความสัมพันธ์ระหว่างคุณลักษณะเครือข่ายความร่วมมือกับ
ผลงานทางวิชาการที่เกิดจากความร่วมมือของ ภาคอุตสาหกรรม-
มหาวิทยาลัย-สถาบันวิจัย ในสามเหลี่ยมปากแม่น้ำแยงซี ประเทศจีน

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Abstract

Collaboration performance is an important index to measure the output of Industry- University-Research Institute collaboration. This study analyzes the characteristics of Industry- University-Research Institute collaboration network, collects questionnaire data, With the method of quantitative research on the relationship between the characteristics of Industry- University-Research Institute collaboration network and academic performance.

This study found that the four indicators of network characteristics of Industry-University- Research Institute collaboration : Center of Position, Connection Strength, Hetwork Size and Knowledge Distance have a significant positive impact on the academic performance of

9

Study on Relationship Between Collaboration Network Characteristics and Academic Performance of
Industry-University-Research Institute Collaboration in Yangtze River Delta, China
การศึกษาความสัมพันธ์ระหว่างคุณลักษณะเครือข่ายความร่วมมือกับผลงานทางวิชาการที่เกิดจากความร่วมมือของของ
ภาคอุตสาหกรรม-มหาวิทยาลัย-สถาบันวิจัย ในสามเหลี่ยมปากแม่น้ำแยงซี ประเทศจีน

223

the research teams participating in Industry-University-Research Institute collaboration.

Keywords : Academic Performance; Collaboration Network characteristics; Industry-University-Research Institute Collaboration

บทคัดย่อ

ผลที่ได้รับจากการทำงานร่วมกันเป็นตัวชี้วัดที่สำคัญในการวัดผลผลิตจากการทำงานร่วมกันของภาคอุตสาหกรรม-มหาวิทยาลัย-สถาบันวิจัย วัตถุประสงค์ของการวิจัยชิ้นนี้ เพื่อวิเคราะห์คุณลักษณะการทำงานร่วมกันของเครือข่ายภาคอุตสาหกรรม-มหาวิทยาลัย-สถาบันวิจัย การวิจัยนี้เป็นการวิจัยเชิงปริมาณ เก็บรวบรวมข้อมูลโดยใช้แบบสอบถาม ใช้การวิเคราะห์เชิงปริมาณ เพื่อการวิเคราะห์ความสัมพันธ์ระหว่างคุณลักษณะเครือข่ายของการทำงานร่วมกันของภาคอุตสาหกรรม-มหาวิทยาลัย-สถาบันวิจัย และผลการปฏิบัติงานด้านวิชาการ

ผลการศึกษา พบว่า ตัวชี้วัด 4 ประเภทของคุณลักษณะเครือข่ายของการทำงานร่วมกันของภาคอุตสาหกรรม-มหาวิทยาลัย-สถาบันวิจัย ได้แก่ ศูนย์กลางของตำแหน่งงาน ความเข้มแข็งของการเชื่อมต่อ ขนาดของเครือข่าย และระยะห่างของความรู้ มีผลกระทบเชิงบวกต่อผลการปฏิบัติงานด้านวิชาการของคณะทำงานวิจัยที่เข้าร่วมทำงานร่วมกันกับภาคอุตสาหกรรม-มหาวิทยาลัย-สถาบันวิจัยอย่างมีนัยสำคัญ

คำสำคัญ : ผลการปฏิบัติงานด้านวิชาการ; ลักษณะของเครือข่ายการทำงานร่วมกัน; การทำงานร่วมกันของภาคอุตสาหกรรม-มหาวิทยาลัย-สถาบันวิจัย

Introduction

With the increasingly close connection between science and technology and economy, the speed of knowledge transfer and utilization is accelerated. In reality, it is difficult for enterprises to achieve both the research and development of new products and

the promotion to the market. Therefore, more and more enterprises, universities and research institutions, based on trust, carry out complementary advantages and collaboration innovation through the exchange, transmission and sharing of knowledge and information resources, and Industry University Research Institute collaboration becomes a specific form of collaboration innovation (Haeussler, Colyvas, 2011).

In recent years, the collaboration between industry, university and research institute has been transformed from a "point-to-point" mode to a collaboration network model composed of multiple enterprises, universities and research institutions (Adegbesan JA and Higgins MJ, 2011). Collaboration innovation performance is an important index to measure the out put of the Industry-University-Research Institute collaboration Network,. The basic characteristics of the network are closely related to the innovation performance.

Industry-University-Research Institute collaboration has become the most important external environment for scientific research teams. It is also worth paying attention to and studying the influence of research teams on their own academic performance while enhancing the innovation performance of enterprises and promoting economic development in the collaboration of industry, university and research.

The significance of research perspective. This study makes up for the deficiency of existing researches in analyzing the influence mechanism and action path of Industry-University-Research Institute collaboration network on organizational performance from the perspective of academic teams, and expands the theoretical research on Industry-University-Research Institute collaboration.

9

Study on Relationship Between Collaboration Network Characteristics and Academic Performance of
Industry-University-Research Institute Collaboration in Yangtze River Delta, China   225
การศึกษาความสัมพันธ์ระหว่างคุณลักษณะเครือข่ายความร่วมมือกับผลงานทางวิชาการที่เกิดจากความร่วมมือของ
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Literature Review

The structure of inter-organization network, the relationship network embedded by individuals, and the formation and maintenance of the relationship between organizations and individuals are all issues of concern in social network research.

Social Network Theory holds that individual actors are all in a Social Network, and the interaction between individuals forms an interactive Network, and the structure and relationship of the Network and other characteristics of the Network will have an important impact on individual actors.

Existing studies have carried out adequate studies on the model, interaction behavior and effect of Industry-University-Research Institute collaboration, Scholars mainly discussed the linear interaction model of Industry-University-Research Institute. (Aguiar-Díaz I and Díaz-Díaz NL, 2015)

Scholars believe that collaboration network is characterized by multi-dimensional and multi-level structure. Scholars uses the structural dimension and the cognitive dimension to explain the structure of the collaboration network between enterprises. The cognitive dimension is used to measure the "intangible" structural characteristics of the network nodes in terms of knowledge, technology and other cognitive levels, while the structural dimension is used to measure the "tangible" network relationship structure between the network nodes.

In contrast, relevant studies on the impact of Industry-University-Research Institute collaboration on academic performance of academic research institutions are still not rich enough, and there are still great differences in research findings on this topic (Laursen

9

K, 2011). Most existing literature directly analyze the influence relationship between "collaboration network-performance", and there are still many differences on the direction and degree of the influence of collaboration network on organizational performance.

Therefore, it remains to be further studied and tested whether the existing research findings of collaboration network between basic enterprises are applicable to the situation of Industry-University-Research Institute collaboration network. In view of this, this paper, from the perspective of the connection strength between the academic teams and the enterprise and the knowledge distance between the two sides, explores the influence mechanism of the strong connection relationship established by the two sides and the knowledge distance on the academic performance of the academic teams, and provides some ideas and references for solving the existing research disputes.

Research objectives and Conceptual Framework

The objective of this study is to focus on the relationship between organizations in the Industry-University-Research Institute collaboration network, Influence of Industry-University-Research Institute collaboration network on academic performance of academic teams.

This study takes the research teams embedded in the Industry-University-Research Institute collaboration network as the research samples, and centering on the core objective of "the influence of collaboration network on academic performance", constructs the research model of "collaboration network-academic performance", and puts forward relevant hypotheses (Jones O and Macpherson A, 2016). The Conceptual Framework and the relationship between

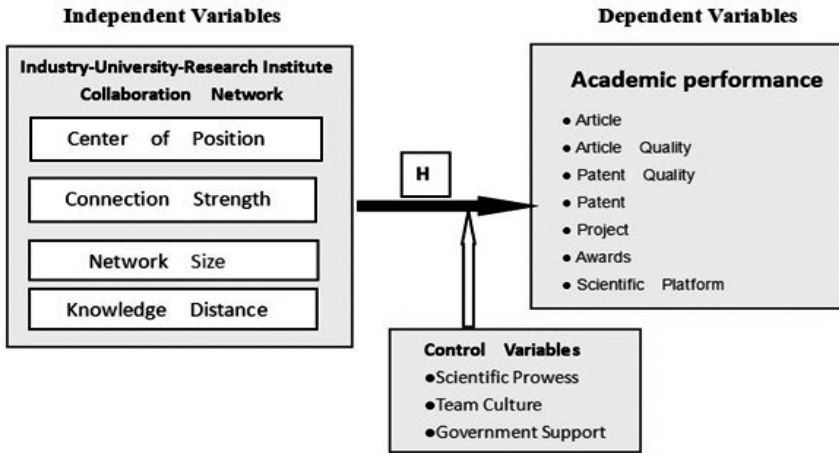dependent variables and independent variables are shown in the figure below.

Figure 1 Conceptual Framework

Research hypothesis

H : There is a significant correlation between the Industry-University-Research Institute collaboration network and academic performance of academic teams.

Sub H1-There is a significant correlation between the Center of Position in the Industry-University-Research Institute collaboration network and academic performance.

Sub H2-There is a significant correlation between the connection strength in the Industry-University-Research Institute collaboration network and academic performance.

Sub H3-There is a significant correlation between network size in the Industry-University-Research Institute collaboration network and academic performance.

Sub H4-There is a significant correlation between knowledge distance in the Industry-University-Research Institute collaboration network and academic performance.

Research Methodology

This study Mixed Research Method, qualitative and quantitative Research. The initial questionnaire was designed. Questionnaires were issued to collect survey data. Software programs were used to conduct reliability and validity analysis to verify the scientific rationality of the data. Software programs were used to verify the research hypotheses and theoretical models through regression analysis.

On the premise of fully grasping and understanding the connotation of network indicators used in the social network analysis method, relevant measurement items are summarized by referring to the research of others, and the Likert scale is used to describe the characteristics of network structure.

The data of each sample are restricted to the Yangtze River delta region. The person who fills in the questionnaire must be the leader of a scientific research team with experience of Industry-University-Research Institute collaboration in the Yangtze River Delta.

During sampling, the snowball sampling method was used. The researchers first asked the heads of some of the research teams to provide other team leaders as suitable respondents, and so on, snow balling from small to large. Through these leaders of scientific research teams, the questionnaires were accurately distributed by taking advantage of opportunities such as Industry-University-Research Institute collaboration meetings, industry or academic alliances.

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Industry-University-Research Institute Collaboration in Yangtze River Delta, China
การศึกษาความสัมพันธ์ระหว่างคุณลักษณะเครือข่ายความร่วมมือกับผลงานทางวิชาการที่เกิดจากความร่วมมือของ
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229

In this study, 430 questionnaires were sent out and 420 questionnaires were collected. Obviously unqualified questionnaires were excluded, including incomplete questionnaires, people who did not participate in the collaboration of production, university and research, and questionnaire filling was obviously random. A total of 27 unqualified questionnaires were excluded through the above measures. In the end, 393 valid questionnaires were obtained.

Empirical Analysis Results and Discussion

Descriptive Analysis : The number of samples investigated in this study is 393, among which 208 are from universities and 185 are from scientific research institutes, with a relatively balanced distribution. Majority of established time of academic teams less than 5 years were 125 teams, accounted for 31.81 percent, followed by 5–10 years were 108 teams, accounted for 27.48 percent, 10–15 years were 93 teams, accounted for 23.66 percent, 15–20 years were 43 teams, accounted for 10.94, and more than 20 years were 24 teams, accounted for 6.11 percent respectively. In the academic teams that participated in the survey, there are 170 teams working on applied research, accounted for 43.26 percent, there are 138 teams working on basic research, accounted for 35.11 percent, there are 80 teams working on experimental development research, accounted for 20.36 percent.

Reliability analysis Results : Through software analysis that the corresponding item of dependent and independent variables and CITC all values are higher than 0.7, and the independent variables Cronbach α coefficient value is 0.972, the Cronbach α coefficient of the dependent variable is 0.962, all the Cronbach α coefficient

value is greater than 0.9, and reflect the use of questionnaire has high reliability, research data reliability level is good, the quality of data reliability is high, Further analysis is possible.

Validity analysis Results : This study carried out validity analysis on 16 items of independent variables, and the results of independent variable validity analysis are shown in the following table.

Table 1   Number of load families and validity analysis

Independent Variable	Number of load families				
	Item	Factor 1	Factor 2	Factor 3	Factor 4
Center of Position	A1	0.789	0.36	0.275	0.253
	A2	0.8	0.323	0.32	0.242
	A3	0.76	0.37	0.341	0.264
	A4	0.793	0.344	0.336	0.255
Associative Strength	B1	0.369	0.741	0.271	0.277
	B2	0.392	0.755	0.305	0.295
	B3	0.395	0.729	0.329	0.301
	B4	0.342	0.77	0.316	0.317
Network Size	C1	0.38	0.261	0.739	0.319
	C2	0.335	0.328	0.749	0.342
	C3	0.356	0.281	0.757	0.345
	C4	0.28	0.349	0.754	0.325

Table 1   Number of load families and validity analysis

Independent Variable	Number of load families				
	Item	Factor 1	Factor 2	Factor 3	Factor 4
Knowledge Distance	D1	0.222	0.237	0.206	0.834
	D2	0.197	0.278	0.274	0.828
	D3	0.257	0.187	0.301	0.836
	D4	0.192	0.242	0.259	0.846
Variance interpretation rate%		23.018%	20.846%	20.662%	24.069%
Cumulative variance interpretation rate%		24.069%	47.087%	67.932%	88.594%
KMO	0.943				
Bartlett	8552.106				
Degrees of Freedom	120				
P value	0.000				

Note : *P Value ≤ 0.05; **P Value ≤ 0.01; N = 393
Source : Respondent's questionnaire

As can be seen from the above table, first of all, KMO value is 0.943, greater than 0.6, Bartlett test value is 8552.106, and the significance probability P value of sphericity test is 0.000 (P<0.05), which means that the data has validity and meets the prerequisite requirements of factor analysis, indicating that it is suitable for factor analysis. In addition, the cumulative variance explanation rates were 88.594%, which meant that the information content of the research item could be effectively extracted. The factor loading coefficients

are all greater than the threshold value 0.5, indicating that there is a corresponding relationship between the option and the factor, which also indicates that more than half of the variance can be explained by the underlying variable. From this, it can be inferred that the four factors extracted conform to the above Settings of the structural characteristics of Industry-University-Research Institute collaboration network, namely, position centrality, connection strength, network size and knowledge distance, and conform to the theoretical hypothesis.

Regression analysis Results : In order to verify the theoretical model and hypothesis established, six regression models were set through regression analysis to verify the impact of Industry-University-Research Institute collaboration network on the academic performance of research teams. First, put the control variables into the regression model, such as Model 1 Then, the four dimensions of independent variables (position centrality, connection strength, network size and knowledge distance) were respectively put into the regression model to verify the hypothesis proposed above; Model 2 the influence of position centrality on academic performance; Model 3 influence of connection strength on academic performance; Model 4 influence of network size on academic performance; Model 5 influence of knowledge distance on academic performance. Finally, all variables are put into the regression model to verify the robustness, such as Model 6 The regression results were analyzed as follows.

Table 2 Six regression models analysis

Variable	Model1	Model2	Model 3	Model 4	Model5	Model6
			Academic performance			
Control Variable						
Team research strength	0.11	0.047	0.053	0.057	0.029	0.013
Teaminnovation atmosphere	0.182*	0.11*	0.065	0.017	0.049	0.015
Government Support	0.325**	0.029	0.08	0.114*	0.145**	0.013
Independent Variable						
CenterofPosition		0.669**				0.23
ConnectionStrength			0.673**			0.159
NetworkSize				0.683**		0.108
Knowledge Distance					0.724**	0.478
R^2	0.332	0.613	0.63	0.638	0.721	0.805
F	64.419**	153.628**	165.025**	170.642**	251.044**	226.433**

Note : *P Value ≤ 0.05; **P Value ≤ 0.01; N = 393
Source : Respondent's questionnaire

Model 1 : The regression results were showed that F = 64.419, the three control variables of research institutions of academic teams in the Industry-University-Research Institute collaboration in the interpretation of the academic performance level of 33.2 percent (R^2=0.332)

Model 2 : Compared with model 1, model 2 significantly increased the explanatory power of academic performance achieved by the academic teamsof academic research institutions in collaboration with enterprises by 28.1 percent. The regression coefficient of position centrality of dimension A of the independent variable is 0.669 (t=16.786, P=0.000<0.01), which means that the

position centrality of dimension A of the independent variable has A significant positive impact on the academic performance of the dependent variable. So subhypothesis 1 is confirmed.

Model 3 : The regression coefficient of the connection strength of dimension B of the independent variable is 0.673 (t=17.670, P=0.000<0.01), which means that the connection strength of dimension B of the independent variable will have a significant positive impact on the academic performance of the dependent variable. So subhypothesis 2 is confirmed.

Model 4 : Coefficient of the size of the independent variable C dimension network is 0.683 (t=18.09, P=0.000<0.01), which means that the size of the independent variable C dimension network will have a significant positive impact on the academic performance of the dependent variable. So subhypothesis 3 is confirmed.

Model 5 : Coefficient of the d-dimensional knowledge distance of the independent variable is 0.724 (t=23.283, P=0.000<0.01), which means that the d-dimensional knowledge distance of the independent variable will have a significant positive impact on the academic performance of the dependent variable. So subhypothesis 4 is confirmed.

Model 6 : The regression results showed that the value F was 226.433, the regression equation was significant, and the value R squared was 0.805, which means that all variables and control variables of network structure explained the difference of academic performance achieved by the academic teams and enterprises in total, and the explanatory power increased by 47.3 percent. So, hypothesis is confirmed : Industry-University-Research Institute collabora- tion network will have a significant positive impact on the academic performance of academic teams.

9

Study on Relationship Between Collaboration Network Characteristics and Academic Performance of
Industry-University-Research Institute Collaboration in Yangtze River Delta, China   235
การศึกษาความสัมพันธ์ระหว่างคุณลักษณะเครือข่ายความร่วมมือกับผลงานทางวิชาการที่เกิดจากความร่วมมือของ
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Discussion

The position centrality of the research team has a significant positive effect on its academic performance. This indicates that with the increasing centrality of the position of the research team in the network, it is helpful for the research team to obtain various innovative resources from the network, which is conducive to the development of basic research activities and the improvement of academic performance (Zhang Y and Chen Kand Zhu G, 2016).

The strength of the connection between the research team and the enterprise has a significant positive effect on academic performance, the closer the connection between the organizations, the more conducive to promoting the establishment of the trust mechanism between the two sides, reducing the coordination, communication and transaction costs, and thus conducive to the transfer of innovation resources and the improvement of performance.

The size of the Industry-University-Research Institute collaboration network has a significant positive effect on the academic performance of the research team. When the network size is too small, the network resources provided to the research team are very limited, which is not conducive to the research team to carry out academic research to improve academic performance; When the network scale gradually increases, it indicates that the more resources it can provide, the higher the value of the resources it can provide, which is conducive to the scientific research team to carry out academic research and improve academic performance.

Research team and the enterprise the gap between the knowledge of a significant positive impact on academic performance, research team and the enterprise as "intellectual potential difference" between each other, is advantageous to the scientific research team

from the network access and integration of resources, to improve the performance becomes particularly important (Dornbusch F, 2015).

Conclusions and Recommendation

This study confirms that the four variables of the Industry-University-Research Institute collaboration network, namely, the position centrality of the academic teams, the connection strength between the academic teams and the enterprise, the scale of the network, and the knowledge distance between the academic teams and the industry, all have a significant impact on the academic performance of the academic teams in the process of participating in the Industry-University-Research Institute collaboration.

This study confirms that the embedding of innovative organizations or teams into the network is conducive to the integration and utilization of innovative resources, thus improving organizational performance. Obviously, how to effectively manage and configure the network relationship with other organizations is the key to achieve good team performance.

For the research team, in the process of participating in the collaboration between industry, university and research, it is necessary to make full use of the network relationship with the industry to serve the organization and create conditions for the construction of superior disciplines and the improvement of academic performance (ParuchuriS, 2010). Research team necessary to give full consideration to the knowledge and ability structure of the other party when selecting the partner, so as to ensure that the two parties have an appropriate "knowledge potential difference", so that they can smoothly acquire complementary knowledge to improve their academic performance.

Study on Relationship Between Collaboration Network Characteristics and Academic Performance of
Industry-University-Research Institute Collaboration in Yangtze River Delta, China
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ภาคอุตสาหกรรม-มหาวิทยาลัย-สถาบันวิจัย ในสามเหลี่ยมปากแม่น้ำแยงซี ประเทศจีน

237

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