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Network Structure and Creativity of Employees under HR Multi-model Form -Taking a company's software development team as an example

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Abstract：Taking an IT outsourcing company's project team as an example, by building team members' social networks and extracting their network characteristics, we can put employees' behavioral variables and social network variables into the same economic model to do variable regression analysis. The study found that employees' network structure characteristics have certain influence on employees' knowledge sharing and creativity, and employees' knowledge sharing partially mediated the network structure characteristics and creativity. Based on structure characteristics of the R&D networks, this paper explains the organizing, coordinating, communicating role of employees from the parent company in the IT outsourcing project team under HR multi-model. We also proposed measures and strategies to promote employees' creativity under HR multi-model.

Keywords: Software outsourcing, employee networks, creativity, HR multi-model

1. INTRODUCTION

Facing the fast-growing IT outsourcing market, software suppliers often use two models to implement large and medium - sized software outsourcing projects. One is to divide a project into parts which are then outsourced. Under this model, parent companies jointly implement the project with other software companies by signing contracts. This is an easy way, but the progress and quality of the project can hardly be controlled. Another model is to temporarily employ surplus R&D staff from other companies to form an R&D team according to the human resources plan. Under the second model, the entire IT industry can be regarded as a human resources pool, from which companies can obtain suitable human resources any time. Because project quality is relatively easy to control due to low cost, this model is widely used in IT outsourcing companies. However, human resources form of the parent company is transformed into a multi-model form from a single-model form under this model. That is to say, the parent company's software outsourcing project team may consist of staff from several software outsourcing suppliers. We are interested in the network structure and relationship among the members in the new team. This paper focuses on the impact of network structure on employees' creativity. Specifically, three questions are studied:

(1) What is the impact of employees' network structure characteristics on employees' creativity under HR multi-model?

(2) How does employees' knowledge sharing mediate employees' network structure and creativity?

(3) What are the project team's network characteristics and incentive policies under HR multi-model?

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2. LITERATURE REVIEW AND HYPOTHESES

In recent years, many scholars who study embeddedness theory focused on the impact of social structure and network on economic performance, trying to find the mechanism about how social networks influence performance. But results were controversial. For example, Granovetter [1] believed that the weak link as an information bridge is important to organizations. Burt [2], however, emphasized more on structure holes in the network, and found no relationship between the strength of relationship and the amount of network resources. Other scholars believed that the stronger the link between companies is, the more frequent information interchange will be, and consequently, more knowledge and resources can be acquired [3,4,5,6]. Among them, Jie Xuemei[7] conducted an empirical study and found characteristics of collaborative innovation networks have positive impact on firms' innovation performance, and knowledge absorptive capacity mediates the network characteristics and innovation performance.

So far, no agreement has been reached about the nature of organization innovation capability, although how to improve team work has been emphasized all the time [8]. Schepers[9] found that team cooperation can form team creativity through knowledge sharing. Ding [10] suggested that team creativity is the function of individual creativity, team structure, team climate and team leaders' ability. Luo[11] conducted an empirical research and found that employees' cognitive style has impact on their creativity, and employees' psychological innovative climate has positive impact on their creativity and performance. Peng [12] proposed network structure has effect on employees' knowledge sharing and performance.

In a given network, nodes in the center are more capable of acquiring information and knowledge through communication, they are often considered to have higher positions in the network [13,14]. The ability to acquire knowledge can provide various perspectives for individuals [15], which would further give individuals the confidence and judgment to take risks. Some empirical researches also supported the theory about centrality and risks cognition [15, 16]. Creativity may involve risk-taking not only in inventing innovative products, but also in proposing novel and effective solutions to existing problems. Based on the theory that creativity can be promoted by supporting risk-taking behavior, some scholars proposed that individual creativity can be improved by taking up the central position in a network. [17] We believe that the closer to the center an employee's position is, the more resources and opportunities of seeking help he or she can acquire, and consequently, his or her creativity can be promoted. Therefore, we propose the following hypothesis:

Hypothesis 1: Employees' network structure characteristics have impact on employees' creativity.

Knowledge sharing is a process of selective interaction in a specific environment [18]. Not only can individuals choose whom they share knowledge with, but they can decide what to share. Many scholars believe interaction is a necessary condition for knowledge sharing [19,20]. Interaction is based on interpersonal structures. Interpersonal structures unavoidably have cultural background, under which employees' knowledge sharing behavior has its own features. Tsai[21] proposed that social interaction among departments can remove organizational boundaries and make possible more opportunities for resources interchange. On individual level, compared with weak link, strong link is considered to be more beneficial to sharing sophisticated or deep knowledge. Extensive interaction enables team members to know each others' expertise, and consequently, enables them to find the right experts when in need of certain knowledge [20]. Ke[22] proved through empirical study that interactive intensity, trust and network density have positive impact on knowledge sharing. According to embeddedness theory, individual behavior is interrelated rather than isolated. The link among individuals provides channels for transferring information or resources. Network structure determines the chances and results of actors' behavior [23]. Therefore, we propose the following hypothesis:

Hypothesis 2: Employees' network structure characteristics have impact on employees' knowledge sharing.

Some scholars applied social network analysis to studying enterprises' innovation. For example, zhang[24]

found firms can effectively improve innovation performance by acquiring knowledge from relational embeddedness and structural embeddedness. Jiang[25]proposed human capital has direct impact on innovation performance. Jian[26] found the higher the trust level between companies is, the higher the level of knowledge sharing is, and consequently, a higher level of technological innovation performance can be expected. Peng[27] conducted an empirical study and found R&D staff's network characteristics and knowledge sharing behavior are significantly correlated with the company's innovation performance. However, there is little research on employees' creativity under software outsourcing companies' HR multi-model.

As technological content involved in products is increasing, many R&D projects can only be accomplished through collaboration among knowledge workers. Therefore, knowledge sharing and knowledge reconstruction within an organization are the key to promoting creativity and product innovation. Since the efficiency and effectiveness of knowledge sharing is related to employees' social networks, we propose the following hypothesis:

Hypothesis 3: Employees' knowledge sharing mediates employees' network structure characteristics and creativity.

3. RESEARCH DESIGN

The case used in this research is from a software supplier's outsourcing project, which is provided to a telecommunication company in China. The temporary R&D team of the project is made up of employees from four companies. 32 of them are from the parent company. The number of employees from the other three companies is 20, 8, 8 respectively. Under this HR multi-model, employees' communication skills, knowledge sharing and network structure are key to success of the project. This paper is based on the employees' social network and creativity in the temporary team.

3.1 Research model

In this research, we choose employees' creativity as dependent variable, employees' knowledge sharing and network structure characteristics as independent variables to test the impact of employees' behavior on creativity. Figure 1 illustrates the research model:
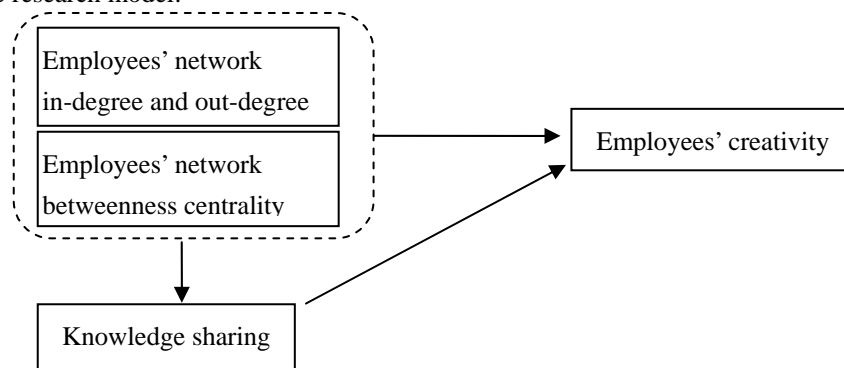

Figure 1.   Research model

Established constructs were adopted to measure the variables in the research model. Creativity was measured based on the scale proposed by Kirton[28], which was modified by introducing factors of Chinese working environment. Employees' knowledge sharing was measured by a framework which combined the measurement model of Zheng[29] and Yang[30]. We also used Granovetter's relationship measurement model to measure employees' relationships and Luo's[31](2010) network measurement model to measure employees' social networks.

We constructed six employees' social networks. Each network's in-degree, out-degree and betweenness

centrality were calculated. If a node receives many ties, it is often said to have high in-degree. That is, many other nodes seek direct ties to it, and this may indicate its importance. Nodes which have high out-degree are able to exchange with many other nodes. Therefore, they are often said to be influential nodes. Betweenness centrality views a node as being in a favored position if it falls on the paths between other pairs of nodes in the network. It serves as a bridge for other nodes to communicate. The more nodes depend on it to make connections with other nodes, the more power it has. We select betweenness centrality, in-degree and out-degree as independent variables.

3.2 Data process

Questionnaires were distributed and filled in anonymously. The data were further processed with reliability and validity analysis. The Cronbach's alpha coefficient of the two constructs (creativity, knowledge sharing) is 0.899, 0.924 respectively. KMO value of both two constructs are higher than 0.6, and the Barlett Test of Sphericity is significant, hence factor analysis is appropriate. Both constructs have good reliability and validity.

Based on questionnaires about employee relationships and our observation, we constructed 6 types of social networks. They are employees' discussion network, consulting network, help network, entertainment network, informal chatting network and personal counseling network. Using UCINET, we calculated the betweenness centrality, in-degree and out-degree to represent the unique position of each employee in the networks. In-degree of a node shows how many invitations the employee receives. Out-degree of a node shows the number of colleagues the employee contacts on his/her initiative. The two variables indicate an employee's activeness and popularity in a network. Betweenness centrality of a node demonstrates the extent to which the employee controls other employees' communication. The greater the value is, the greater influence the employee has on others' communication.

4. DISCUSSION BASED ON MODEL TEST

In order to test how employees' network structure influences individual creativity through knowledge sharing, we establish the following three models to test the impact of network structure on employees' creativity (y), and how employees' knowledge sharing behavior(M) mediates network structure characteristics and employees' creativity.

$$y = \sum_{i}^{n} \sum_{j}^{k} c_{ij} x_{ij} + \varepsilon_1 \ldots \ldots (1)$$

$$M = \sum_{i}^{n} \sum_{j}^{k} c_{ij} x_{ij} + \varepsilon_2 \ldots \ldots (2)$$

$$y = \sum_{i}^{n} \sum_{j}^{k} c_{ij} x_{ij} + bM + \varepsilon_3 \ldots \ldots (3)$$

In each equation above, X_{ij} represents employee j's structure characteristics in network i.

We utilize software to identify the variables which have significant impact on employees' creativity and knowledge sharing under this multiple independent variables situation. Automatic linear modeling in regression analysis in SPSS is employed here to gradually remove variables which have little impact on the dependent variable. The result is shown in Table1.

Table 1.   Parameter estimation for models

Independent variables	Model 1		Model 2		Model 3	
	coefficient	VIF	coefficient	VIF	coefficient	VIF
(Constant)	-.010		-.009		-.006	
Discussion network betweenness	.205*	1.098	-.037	1.098	.225**	1.099
Consulting network out-degree	-.425***	1.460	-.244*	1.460	-.297***	1.535
Entertainment network in-degree	-.374***	1.135	-.263**	1.135	-.236**	1.223
Personal counseling network out-degree	.335**	1.535	.488***	1.535	.079	1.833
Chatting network out-degree	-.605**	6.064	-.569**	6.064	-.306	6.476
Chatting network betweenness	.712**	6.605	.565*	6.605	.415*	7.010
Knowledge sharing					.525***	1.253
R	0.290		0.202		0.510	
F	4.088***		2.527**		8.783***	

According to Table1, employees' network structure characteristics have different impact on individual creativity in different networks. In help network, employees' network structure characteristics have little impact on creativity, which indicates knowledge workers are unwilling to seek help in a strange environment. Betweenness centrality in both chatting network and discussion network, out-degree in personal counseling network have positive impact on individual creativity. This suggests in chatting network and discussion network, employees trust people in betweenness positions and are willing to ask them to deliver information. Therefore, people in betweenness positions are able to select relevant information to improve their creativity. In R&D departments, employees can reduce pressure by seeking personal counseling. Their creativity can be boosted if they are under less pressure. Table1 also shows some network structure characteristics have negative impact on creativity. For example, in consulting network, employees who often ask colleagues for advice are weak in creativity. Similarly, employees who often chat with others or who are often invited for entertainment have poor creativity. Based on Model 1 in Table 1 and what we discuss above, Hypothesis 1 is supported.

Knowledge sharing is key to employees' collaborative innovation. Employees can improve mutual understanding through communication at work and form informal networks based on their preferences. According to Model 2 in Table 1, employees' knowledge sharing behavior is influenced by various network structure characteristics. Therefore, Hypothesis 2 is supported. Out-degree in personal counseling network, betweenness centrality in chatting network have positive impact on employees' knowledge sharing. The other variables have negative impact. This indicates in the temporary team, employees are unwilling to share knowledge. One of the important reasons is that employees don't know each other well. People from the same companies are often observed to be together.

Model 3 in Table 1 shows employees' some network structure characteristics have positive impact on employees' creativity. Employees with high betweenness centrality in discussion network and chatting network have strong creativity, while employees who often consult or are often invited for entertainment have poor creativity. People who often seek personal counseling also have strong creativity. Employees' knowledge sharing behavior partly or completely mediates employees' creativity. Specifically, knowledge sharing completely mediates the impact of out-degree on employees' creativity in personal counseling network and chatting network, and partly mediates the impact of betweenness centrality in discussion network and chatting network, out-degree in consulting network, in-degree in entertainment network on employees' creativity. Therefore, Hypothesis 3 is supported.

In order to identify the relationship between network structure characteristics and creativity in different

networks, SPSS is utilized to calculate employees' network characteristics and behavior in each company. Results are shown in Table 2.

Table2.   Structure characteristics in different networks

Source	Item	Creativity	Knowledge sharing	Discussion network betweenness	Consulting network out-degree	Entertainment network in-degree	Personal counseling network out-degree	Chatting network out-degree	Chatting network betweenness
Parent Company	Mean	-0.073	0.129	-0.055	0.225	0.205	0.133	0.028	0.139
	SD.	1.050	0.968	0.653	1.329	1.319	1.096	0.847	0.898
Outsourcing Company A	Mean	-0.227	-0.517	0.275	0.011	-0.177	0.096	0.231	0.047
	SD	1.036	1.078	1.490	0.510	0.638	1.013	1.469	1.452
Outsourcing Company B	Mean	0.194	0.408	0.018	-0.229	0.263	-0.010	-0.206	-0.339
	SD	1.003	0.979	1.113	0.452	0.488	0.909	0.250	0.153
Outsourcing Company C	Mean	0.655	0.383	-0.443	-0.753	-0.604	-0.631	-0.470	-0.303
	SD	-0.073	0.129	-0.055	0.225	0.205	0.133	0.028	0.139

According to Table 2, in discussion network, employees from outsourcing companies have high betweenness centrality. They are managed by employees from the parent company, who are coordinators in the team. Since employees from the parent company are not familiar with the specialties of employees from other companies, they need some employees from the outsourcing companies to help to coordinate with R&D work. Those employees with high betweenness centrality are core members in outsourcing companies, who have strong R&D ability and are trusted by their colleagues. In chatting network, employees from the parent company have the highest betweenness centrality. They play the role of liaisons and coordinators, and are responsible for improving mutual understanding among employees and boosting the team's creativity. Consulting network is an important channel for employees to report their work. Employees' out-degree in the network shows the extent to which they contact other team members. According to Table 2, employees from the parent company have the highest out-degree in consulting network, which indicates they are the organizers and managers of the project. Employees who are fond of entertainment are often invited out for various activities, so their input into R&D work may be affected. Employees' personal counseling network reflects their emotional communication. People who have high out-degree in this network often confide or complain. But they are also willing to share knowledge. Their creativity is delivered through knowledge sharing. Table 2 also shows that employees from the parent company have the highest average out-degree in personal counseling network. Employees from other companies tend to control their personal counseling behavior due to the lack of mutual understanding. Combining Table 1 and Table 2, we find that employees who often seek personal counseling have high creativity. They are also willing to share knowledge.

Based on the discussion above, we propose that employees' mutual trust and mutual assistance could be promoted by improving employees' network structure. Betweenness centrality is an important variable to employees' mutual trust. In chatting network and discussion network, employees with high betweenness centrality are not only the liaisons, but also the information deliverers among employees in the team. As they are in the betweenness positions in the two networks, they are highly creative. Therefore, the parent company is supposed to pay more attention to these employees and let them pass positive energy. Meanwhile, employees from the parent company should listen to ideas of employees from outsourcing companies as often as possible and take various chances to improve the relationship with them so as to make good use of their knowledge and creativity and boost knowledge sharing within the R&D team.

The HR multi-model is based on R&D cost and employees' knowledge. Software companies may have

different positions due to different business demand. The core problem of integrating R&D human resources and implementing software development projects is how to select R&D employees and form an efficient R&D team. According to our case, different types of employees' networks have impact on individual creativity. Therefore, under HR multi-model, in order to stimulate employees' creativity, the company responsible for R&D team-building should arrange an appropriate gender ratio, encourage communication among employees from different companies in various ways, hold some activities which are aimed at improving employees' mutual trust, and award employees according to the progress and quality of their work.

5. CONCLUSION

Taking an IT outsourcing company's project team as the case, this paper studied the impact of employees' social network characteristics on employees' creativity under HR multi-model. We found that under this model, employees' creativity is influenced by various employees' network characteristics, and employees' knowledge sharing mediates employees' network characteristics and creativity. We proposed some strategies or methods on how to improve employees' knowledge sharing and creativity. When building a temporary team, the parent company must attach much importance to the running-in period, during which employees' network structure can be improved, their mutual trust can be strengthened, and their creativity can be promoted.

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