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The Interrelations Among the Project Team's Conduit Networks, Knowledge Network and its Performance

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Abstract—From the perspective of network, a project team's social capital consists of conduits network, and resource exchange network. Prior research intensively studies the effect of the structure of conduits network on the team's performance, assuming knowledge transfer is the causal mechanism linking conduits network to performance. This paper attempts to explore the interrelations between conduits network and knowledge network, and further distinguish the different influence between various conduit networks, and hypothesizes that a project team's knowledge network mediates the effect of various conduit networks on the team's performance. This research can enrich our knowledge of disparate influence of the various conduit networks on knowledge transfer, and imply some management practices to enhance the organization's social capital, and hence improve the organization's performance.

Keywords—PBO, conduit network, knowledge network, performance

I. INTRODUCTION

It has been generally realized that knowledge from one project is valuable and can be reused in other projects [1][2]. Many project based organizations (PBOs) have invested financial and human resources to implement IT-based knowledge repository in order to capture, store knowledge and facilitate knowledge transfer across projects. However, some empirical findings suggest that these knowledge repositories can hardly meet the investors' expectations. Mintzberg [3] indicate that people prefer to turn to other people rather than documents for information. More recently, the same tendency has been found even for people with ready access to the Internet and their firm's IT-based knowledge repository [4]. The limited use of IT-based strategies and the importance of social networks for cross-project knowledge transfer have also been found by others (e.g.[5]). It is then apparent that interpersonal relationship network plays a pivotal role in the knowledge transfer (e.g.[6]).

The research that focuses on interpersonal relationship is the study of social capital. Social capital includes both interpersonal relationships and the resources embedded in these

relationships[7]. Social capital is a productive resource, facilitating knowledge transfer and creation[8] and affecting the organization's competitive advantage and performance (e.g.[9]). Particularly important for strategy are social capital's unique features compared to other forms of capital in that social capital is neither as easily alienable from the firm as physical or financial capital nor as mobile as human capital[10].As such, to the extent the firm can influence its development and can appropriate its value, social capital may well prove to be the firm's most enduring source of advantage[10]. Group social capital was initiated and defined as the set of resources made available to a group through group members' social relationships within the social structure of the group itself, as well as in the broader formal and informal structure of the organization [11]. Group social capital is classified into two categories: social capital resource and social capital conduits [11]. Furthermore, from the perspective of network, the two categories of group social capital correspond to resource exchange network and conduits network respectively. In this paper, the resource exchange network refers particularly to knowledge network. There are some studies which examine the association between the structure of conduits network and performance. There are the studies on egocentric conduits network [7], and the works on bounded conduit network of project groups or within an organization [12], as well as the exploration on internal and external structure of groups' conduit networks [13]. These studies are built on the assumption that knowledge transfer is the causal mechanism linking network structure to performance[14]. In each instance, however, the path from conduits network structure to knowledge network characteristics was not examined. Thus, the present paper attempts to explore the interrelations between the project team's knowledge network and conduits network.

Traditionally network research has assumed that relationships can be appropriated for different purposes, and so it is unnecessary to distinguish between kinds of ties or specify content in networks[15]. Yet, the constructivist perspective calls into question the assumption of interchangeable relationships. It suggests that some relationships are likely to

be more helpful than others[16]. Till now, various types of relationships and its impact have been studied, such as strong ties and its facilitation for tacit knowledge transfer[6][14], weak ties and its benefit to nonredundant information diffusion[18], trust and its impact on knowledge transfer[17][19], energy and its influence on performance and knowledge transfer[20][21]. In accord with the different kinds of relationships, the project team's conduits network includes strong ties network, energy network and trust network. In order to identify the different effects of various kinds of conduits networks on knowledge network, this paper further explores the associations between strong ties network, energy network, trust network with knowledge network.

The paper is organized as follows. Section 2 discusses the proposed theoretical model; section 3 describes the research methods including data collection techniques, questionnaire and the independent, dependent, control variables; and section 4 summarises the preliminary study.

II. THEORETICAL MODEL

A. Strong Ties Network and Knowledge Network

Tie strength is a concept which characterises the closeness and the interaction frequency of a relationship between two parties and ranges from weak ties at one extreme to strong ties at the other[6][18]. There is evidence suggesting that strong ties lead to greater knowledge exchange [6]. Strong ties are more likely to expend effort to ensure that a knowledge seeker sufficiently understands and can put into use newly acquired knowledge [6]. In exploration of the interrelations between the strong ties and performance, Ingram and Roberts[22]describe how dense friendship networks affect the performance of Sydney hotels. Cummings and Cross[12]find that core-periphery and hierarchical project team structures are negatively associated with team's performance. Consistent with these findings, it is suggested that the interrelations between project team's strong ties network and its performance is mediated by its knowledge network. Stated formally:

HYPOTHESIS 1: the density/structural diversity of the project team's knowledge network mediates the effect of the density/structural diversity of this team's strong ties network on its performance.

B. Energy Network and Knowledge Network

Energy is associated with people's motivation and willingness to exert effort, and it is tightly linked to progress in organisations – initiatives that are described as having energy are usually the ones moving forward [20]. The ability of an individual to energise others is a determinant of individual and group success [21]. Energisers are more affective at motivating others, eliciting productive solutions, getting work done, and advancing their careers. Evidence shows that performance is closely connected to people's positions in the energy network, and those who energise others are much higher performance [20]. Individuals are willing to seek knowledge from energisers and avoid doing so from de-energisers [21]. Consistent with these findings, the following hypothesis is suggested:

HYPOTHESIS 2: the density/structural diversity of the project team's knowledge network mediates the effect of the

density/structural diversity of this team's energy network on its performance;

C. Trust Network and Knowledge Network

Trust is defined as "the willingness of a party to be vulnerable" [19]. The trust literature provides considerable evidence that trusting relationships lead to greater knowledge exchange: when trust exists, people are more willing to give useful knowledge [8] and listen to and absorb others' knowledge [19]. By reducing conflicts and the need to verify information, trust also makes knowledge transfer less costly [23]. These effects have been found at the individual and organisational levels of analysis in a variety of settings. Mayer, Davis, and Schoorman [19] identify benevolence-based trust and competence-based trust as two key trust dimensions. According to [19], benevolence-based trust is the extent to which a trustee is believed to want to do good to the trustor, aside from an egocentric profit motive; competence-based trust is the extent to which a trustee is believed to be highly competent in some area.

Trusting a knowledge source to be benevolent and competent should increase the chance that the knowledge receiver will learn from the interaction. When knowledge seekers ask for information, they become vulnerable to the benevolence of the knowledge source[24]. Benevolence-based trust likely shapes the extent to which knowledge seekers will be forthcoming about their lack of knowledge, even after seeking out the knowledge source, and so creates conditions for learning [17]. Trust in another's competence should also affect the perceived usefulness of knowledge received. Hence, the following hypotheses are suggested.

HYPOTHESIS 3: the density=structural diversity of the project team's knowledge network mediates the effect of the density=structural diversity of this team's competence-based trust network on its performance;

HYPOTHESIS 4: the density=structural diversity of the project team's knowledge network mediates the effect of the density=structural diversity of this team's benevolence-based trust network on its performance;

III. RESEARCH METHOD AND DESIGN

A. Data Collection Techniques

There are generally two techniques to collect network data [25]. One is sociometric techniques, which provide each respondent with a fixed contact roster and ask him or her to describe his or her relationship with every individual on the roster. A virtue of the sociometric approach is that it provides information on all interactions inside a network. The technique, however, can also introduce inaccuracies into network data. Defining an appropriate boundary around the network, the set of individuals who are interconnected, is critical [26]. To the extent that the network boundary varies from one person to the next, asking each respondent to report on connections that lie outside his or her frame of reference can be problematic. Individuals provide more accurate network data on that part of the network with which they are more familiar [27], but their assessment of network connections involving distant individuals is less accurate[28]. The other is egocentric

techniques. Each individual responds to a series of questions that generate names resulting in a roster of contacts. Next, the respondent describes the relationship with each cited contact. In some applications of egocentric techniques, respondents are asked to describe the relationships among their contacts. A virtue of the egocentric technique is that it asks an individual to report on that part of the network with which he or she is most familiar. Individual responses can be aggregated to describe the total network. A network can be constructed between different members of the firm based on their reported relationships with each other. A potential drawback of the technique is that it can miss important interactions that lie outside a respondent's frame of inference[14], but a high response rate can cover such shortage. In this research, we employed the egocentric technique to collect the network data. In order to elicit as many contactors as possible, in each question we reminded the respondent with the sentence "When you are listing the names, please list as many people as possible".

In order to control the social desirability bias, we made a confidentiality statement and research introduction as the preface of the questionnaire. We (1) stated the purpose of this study and that the data gathered was just for non-profit academic research, (2) promised that we would keep all individual responses completely confidential, (3) confirmed that our analysis would be restricted to an aggregate level that would prevent the identification of any individual or business unit, (4) provided the university ethics approval information, (5) arranged an online web-based questionnaire which was managed by the research team instead of the company.

B. Questionnaire

1) *Strong ties*: The tie strength was measured as the average of emotional closeness and communication frequency [7]. Both emotional closeness and communication frequency questions were adopted from [14], and then were adapted in accord with the feedback from the pilot test. The respondents were asked to "list the name of the person you communicated regularly in the last three months on the project and non-project related issues" on a seven-point scale (1=once every 3 months or less; 2=once every 2 months; 3=once every month; 4=2-3 times a month; 5=once a week; 6=2-3 times a week; 7=daily). The respondents are also asked to "list the name of the person, with whom you maintain a close relationship in the last three months" on a five-point scale (1=more than distant; 2=somewhat close; 3=close; 4=very close; 5=especially close).

2) *Energy Ties*: Question about energy ties was adopted from [21] and then was adjusted according to the feedback from the pilot test. The subjects were asked to "list the name of the person, who affects your energy (namely your motivation and willingness to exert effort) when you interact with this person in the past three months. How does this person typically affect your energy level?" on a seven-point scale (1=very weakly; 2=weakly; 3=somewhat weakly; 4=just so so; 5=somewhat strongly; 6=strongly; 7=very strongly).

3) *Trust*: The competence-based trust questions were adopted from [17], and then adjusted according to the feedback from the pilot test. The respondents were asked to "list the name of the person, who I believe approaches his or her job

with professionalism and dedication above the normal level of expectation." and "list the name of the person, whose competence and preparation I trust given his or her track record." The benevolence-based trust questions were adopted from Mayer and Davis [29]. The respondents were asked to "list the name of the person, who is very concerned about my welfare." and "list the name of the person, who will go out of his/her way to help me."

4) *Knowledge Transfer*: The knowledge transfer question was adopted from[30]. The respondents were asked to "list the name of the people, to whom you turned for knowledge on work-related topics in the past three months".

C. Dependent Variables

Project teams were rated by senior managers who have supervised these projects. Seven dimensions of team performance were adopted from Cummings and Cross [12], they are: (1) teamwork, (2) clearly defined problem selection, (3) appropriateness of method used to solve problem, (4) innovativeness of remedies used to solve problem, (5) quality of impact from results, (6) institutionalization of solution, and (7) clarity of presentation. In addition, the project performance was also measured, which includes quality of the completed project, perception and satisfaction of the outcome. In the analysis, we will report results for team performance and project performance.

D. Independent Variables

1) *Network Density*: Density of a team's network is the sum of the connections in the group divided by the total possible sum of connections among all the members in the team[31].

2) *Network Structural Diversity*: We use Newman's[32] assortativity coefficient to measure the structural diversity of a project team's network. The assortativity coefficient is calculated as Equation (1).

$$r = \frac{\sum_{j,k} j^k (e_{jk} - q_j q_k)}{\sigma_q^2} \quad (1)$$

$$q_k = \frac{(k+1)P_{k+1}}{z} \quad (2)$$

In (1), e_{jk} is the fraction of connections that link an individual who has j friends to an individual who has k friends. σ_q is the standard deviation of the distribution of the excess degree q_k . q_k is distributed according to (2), where p_k is the probability that a randomly chosen individual will have k friends and $z = \sum_k k p_k$ is the mean number of friends in the

network. The value of r lies in the range of $-1 \leq r \leq 1$ [32]. When r is less than zero the network is disassortative, namely individuals with more friends tend to connect to those with less friends, vice versa. In this case, the network is more structurally diverse and when r is greater than zero, assortative

mixing occurs, that is individuals with more friends tend to connect to those with more friends, individuals with less friends tend to connect to those with less friends, in this case the network is less structurally diverse.

E. Control Variables

The project control variables are project duration, project team size and budget.

IV. CONCLUSION

This paper attempts to examine the interrelations between the project team's various conduit networks and knowledge network, and hypothesizes that the project team's knowledge network mediates the effect of strong ties network, energy network, competence-based trust network and benevolence-based network and the team's performance. This paper introduced the data-collection techniques and the measures to control common method bias, and described the questionnaire and dependent variables, independent variables and control variables. Currently we are collecting the data, the research results will be conveyed in the future paper. The research results will bridge a gap between the conduit networks and knowledge network, and enrich the knowledge of the disparate effect of the various conduit networks on knowledge transfer, and some management practices can also be implied to construct and improve some certain conduit network in order to optimize the knowledge network, and subsequently enhance the organization's performance.

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