Social Network Structure and Performance of Improvement Teams

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Abstract: There is a kind of knowledge, possessed by groups, that is more than the aggregation of individual knowledge. Nahapiet and Ghoshal call it intellectual capital. How does social structure in a project team influence collective knowing capability?

In this study, several conclusions can be made. First, a project team with median centralization of power has a good evaluation. Second, team structure with fully connected cliques has a significant impact on group performance. It is also found that only consultative ties are related to knowledge exchange and combination, while friendship ties have nothing to do with the team's performance

Key words: Social Network Structure; Knowledge Creation; Social Capital.

Word Count: 6196

1 Social Capital and Intellectual Capital

The concept of intellectual capital has caught the attention of both managerial studies and business practices **[1]**. It is thought of as the main part of the key intangible assets for the long-term success of enterprises **[2]**. Social capital[1], or relational capital, without any doubt is an important component of intellectual capital **[1,3]**, since various pieces of evidence have shown its significant impact on firms' innovation performance **[4]**. However, the constructs and definition of social capital have remained debatable. Sometime, it refers only to a firm's external accesses to key resources **[4]**. In other instances, a firm's internal social relations are included **[5]**, but only attitudinal dimensions, such as employees' satisfaction, commitment and mutual trust are taken as their indicators in the causal map of innovation performance **[6]**. The structural dimension of social capital is seldom remembered, and this paper will bring the structural factors into intellectual capital studies.

How firms gain knowledge always stands in the center of intellectual capital studies. Spender **[7]** distinguished four kinds of knowledge: individual explicit, individual tacit, social explicit and social tacit. A social collectivity such as a group, team or organization can gain individual knowledge either through the learning of its members or by bringing in new recruits. Sometime, this gaining process needs good social relations as necessary lubricant. Granovetter **[8]** showed that tacit knowledge, which he refers to as a "clue," requires social relationships to be effectively distributed. A worker without good social networks can successfully learn explicit skills by reading manuals, but is unable to get the "clue" in doing a particular job, which ironically is often the most important factor in determining his or her job performance. Coleman **[9]** expressed a similar viewpoint in noting the vital role played by an individual's family and community social relations in the development of human capital. These thought-provoking studies remind us to pay attention to the function of social capital

[1] In the tradition of Intellectual Capital studies, social capital is often referred as relational capital.

in individual knowledge acquisition, especially in the case of individual tacit knowledge.

How does social collectivity develop group knowledge, especially social tacit knowledge? Social relations again play an important role. Group knowledge is created by means of exchange and combination **[10]**. Exchange is a social process, which allows the distribution of information and knowledge to group members. Then, group members brainstorm different ideas through the process of combination and create new knowledge. Nonaka and Takeuchi describe this social process in more detail. In their argument, a person documents his or her knowledge in the process of externalization, and then exchanges externalized knowledge through socialization. A group of members with different knowledge then get together to create new knowledge through the process of combination, and finally, group members learn the created knowledge via the internalization process. In these processes, few are individual activities, with most being related to group dynamics. Since creating intellectual capital, either gaining individual knowledge or innovating group knowledge, is mainly a social process, the issue of social capital is brought in..

1.1 Improvement Teams and Social Capital

The importance of social capital leads us to review its most commonly cited definition by Coleman **[11]**:

> *Social capital is defined by its function. It is not a single entity, but a variety of different entities having two characteristics in common: They all consist of some aspect of a social structure, and they facilitate certain actions of individuals who are within the structure (p. 302).*
>
> *…Social capital, in turn, is created when the relations among persons change in ways that facilitate action (p. 304).*

Briefly summarizing, social capital consists of two characteristics--social relations accompanied by some aspect within these relations, and the resulting cooperative actions that bring resources in. "Some aspect" can be referred to as goodwill **[5]** and trust **[12]**. In other words, the creation of intellectual capital needs a group of persons

with social relations. They keep goodwill toward other group members and are willing to share information and knowledge. This eventually facilitates cooperative actions to make exchange and combination possible.

Such social networks can be created intentionally. Coleman asserted that there are six forms of social capital, three of them based on mutual interactions among individuals and three on collective actions **[11]**. The former include obligations and expectations, information potential, and norms and authority relations; the latter consist of norms and effective sanctions, appropriable social organizations, and intentional organizations (pp. 310-313). These elements can create a positive social environment in which people trust each other, share resources, and cultivate chances for knowledge exchange and combination. Intentional organization is one of the main forms of social capital in Coleman's definition, and also an important mechanism for most firms in the creation of group knowledge. A team or department organized for the purpose of creating knowledge is exactly such a social network. For example, R&D departments with special professional tasks can be the institutionalized social networks required in order to improve professional knowledge. Project teams for the purpose of continuous improvement, in brief improvement teams in the following paper, are another common means of pursuing specific goals within matrix or network forms of organization, and their goals are more or less involved with knowledge creation **[13,14]**. Following this line of thought, Nahapiet and Ghoshal **[15]** provided us with a good theoretical framework for analyzing social capital in teams.

1.2 The Structural Dimension of Social Capital

Most previous studies of macro-level social capital **[16]** focus on goodwill in social relations **[17-19]**. Since the analytical subjects are individuals in their models, individual attitudes towards other members and shared norms in the group become their main concerns. However, the structure of these social relations is basically ruled out of their explanatory models. Likewise, Nahapiet and Ghoshal **[15]** analyze what they call cognitive and relational dimensions of social capital, which mainly concern

shared values and mutual trust in social relations among a group of people. However, in addition to these cognitive and relational aspects of social capital, they also propose a structural dimension to our research agenda, in which network configuration definitely is an important factor for creating intellectual capital. As they **[15]** put it:

> *Ties provide the channels for information transmission, but the overall configuration of these ties constitutes an important facet of social capital that may impact the development of intellectual capital. For example, three properties of network structure—density, connectivity, and hierarchy—are all features associated with flexibility and ease of information exchange through their impact on the level of contact or the accessibility they provide to network members (p. 252).*

This argument inspires many followers to investigate the network configuration of a R&D team, and tries to explain team performance by structural factors in their researches. Sparrowe, Linden, Wayne and Kraimer **[20]** lead the study of this sort. They deployed a whole-network questionnaire to survey 38 groups in several organizational settings. Their concerns were mainly related to two things; the first was the influence of an individual's centrality position in advice networks and hindrance networks on his or her job performance. The second concern was the correlation of group density and group centralization of advice networks to the group's performance. Regarding the second concern, their analytical results show that group centralization in advice networks is positively related to group performance, but the density of those networks doesn't illustrate significant impacts. Two network configurations are included in the research of Sparrowe et, al.. Network density indicates the average level of consultative relations built among group members. Group centralization measures the extent to which interactions are concentrated in a small number of individuals or distributed equally to all group members. The former structural indicator is the mean of network ties owned by each member, while the latter is the variance of network ties owned by each one.

This paper will follow the above line of thought to examine the impacts of

network structure on an improvement team’s performance. However, something new is included. First, Sparrowe et, al. think that the indicators of network structure should be linearly correlated to a team's knowledge creation. If network density is not only taken as the mean level of ties owned by group members, but also as an instrument of diffusion of innovation, this paper finds that it should be curve-linearly related to diffusive effects. By the same token, when group centrality is not only taken as the variance of ties among group members, but also as an indication of power centralization, its correlation to team performance should not be linear, either; rather, it is curve-linear, too. In addition, the effect of cliques in a group has never been taken into consideration in the past. However, cliques hinder information sharing and cooperative actions. This damage is especially serious in Chinese cultural settings, since the political struggle among cliques is always a big problem of Chinese bureaucracies. This leads us to review social network theory; so relevant structural factors can be explored theoretically.

2 Network Structure and Team Performance--A Social Network Perspective

2.1 Network Density

In the research of Sparrowe et, al., density is assumed linearly correlated to team performance. However, this assumption fails to pass their test. On the contrary, Krackhardt in his computer simulation of "organizational viscosity" **[21]** proposes a non-linear relationship between density and knowledge diffusion.

Most previous studies have long considered the diffusion of innovations to be a social process **[22]**. Following the thought of these studies, Krackhardt **[21]** designed an experiment to simulate this social process of diffusion. Given some reasonable behavioral assumptions, his experimental results show that a very small number of innovation adopters may take over a large organization under some network structural

conditions. However, to the contrast of traditional viewpoints that a dense group can be beneficial to innovation diffusion, Krackhardt illustrates that "innovative adoptions are enhanced by the organization's viscosity, that is, the lack of free movement and exchange of ideas and people throughout the organization" (p. 177). In his simulation, five groups are embedded in the network of an organization. Only one mother site is full of innovation adopters, while most of the others in the organization are still non-adopters. The rate at which individuals are allowed to migrate from one group to another group will be controlled by a parameter（v）--a rate indicating the degree of organizational viscosity. The simulation results make Krackhardt conclude：

> *The degree of viscosity from one group to another has two threshold values v-poly and v-critical, where 0< v-poly< v-critical<1. If v is below v-poly, then the result will be poly-stable, with the mother site dominated by adopters and other sites dominated by non-adopters. If v is above v-poly but below v-critical, then all sites will become dominated by adopters. But, if v increases beyond the v-critical value, then the adopters will lose out to the non-adopters in equilibrium. (p.194)*

In other words, very tight or loose social networks are not all suitable to diffuse new knowledge. A tight network makes the small number of innovation adopters easily influenced by the majority of non-adopters. A very loose network does not provide enough interactive opportunities to diffuse new innovations. So a social network with median viscosity is a good environment, nourishing the diffusion of new knowledge. Although viscosity indicates the relations among groups in an organization, Krackhardt's theory could be extended to individuals in a group, and group density can be used to measure viscosity. Since knowledge diffusion is crucial to the exchange process in an improvement team, the viscosity argument therefore reaches the first hypothesis:

Hypothesis I: An improvement team with a median high-density network has a good performance.

2.2 Group Centrality

Common wisdom points out that authoritarianism makes group members stop expressing their own opinions, and blocks the process of exchange. So empowerment is the right philosophy for managing an improvement team **[23]**. This wisdom has been supported by some empirical studies **[20]**, which have shown that the centralization of power is a proven hindrance to knowledge sharing. Similar observation can be found in Chinese organizational studies, too. In Chinese firms, authoritarian leadership leads to distrust among employees and obedience to the leader's viewpoints, so different views are erased and combination becomes impossible **[24]**.

On the other hand, is a team with highly decentralized power good for group performance? It is reasonable to assume that a group without leadership goes nowhere and achieves nothing. Following this thought, Ibarra examines the impact of power on the diffusion of innovations **[25]**. Her results suggest that centrality was important for administrative innovation roles, and official positions and power centrality were indistinguishable in their effects on technical innovation roles. Although this research employs the viewpoint of individual centrality, rather than group centrality, to investigate the diffusion of innovations, it offers an important finding： "…*the centrality in the organization had influence to the diffusion of innovations, and organization power played an important role*." In other words, a certain degree of power from the leader is still necessary for creating administrative and technical innovation.

Combining the researches of Ibarra and Sparrowe et, al., it can be concluded that over or less centralization of power is not good for diffusion of knowledge. These previous researches make it necessary to test the influence of the group centralization on an improvement team's performance. This provides us with the second hypothesis:

Hypothesis II: An improvement team with median centralization of power has a

good performance.

2.3 Disconnected Cliques and Bridges

Granovetter **[26]**, in his theory on "the strength of weak ties," compared the strength of social ties in two communities near Boston. One was a West End Italian community in which there were many strong ties among its members; the other, a Charlestown neighborhood, was characterized by weak ties. When the city government sought to implement an urban renewal plan, the former community proved unable to take collective action against it, while the latter successfully mobilized to defend their interests **[27]**. Granovetter observed that a social network composed mainly of strong ties is generally full of small-sized groups; this segmented the West End community into many small cliques. Without weak ties as bridges to bind these small cliques together, the West End community failed to find a common leader to organize effective collective action. Given that cooperation is crucial to the performance of improvement teams, it follows that those teams composed of disconnected cliques will find it difficult to exchange knowledge effectively. This argument leads us to the third hypothesis:

Hypothesis III: An improvement team containing disconnected small groups has a poor performance.

Burt has also made similar observation **[28]**. He further extended Granovetter's theory on the strength of weak ties to devise his now famous "structural hole" argument. This argument states that a player reaps benefits from a structural hole when he or she has two groups of non-redundant contacts. In other words, if two disconnected cliques have no bridges between them except this focal player, he or she enjoys the advantage of mediating resource exchange. By utilizing this opportunity to mediate, the bridge person enables originally segregated groups to interact with each other.

To summarize, Granovetter's theory suggests that a group made up of segmented cliques will be unable to take effective cooperative actions, while Burt's argument

implies that a segmented network can be fully connected by the presence of bridges. If bridges are established to connect these cliques with one another, the resulting network structure will enhance team performance.

This leads to the fourth hypothesis:

Hypothesis IV: When small groups in an improvement team have bridges to connect other team members, the team's performance will be improved.

3 Research Methods

3.1 Data Collection

Everest Textile Co. is one of the most successful textile firms based in Taiwan. In 1997, it was listed in the top 10 textile firms in Taiwan, and ranked as No. 126 in the global textile industry. At the end of 1998, a reengineering movement was promoted by the company, which could therefore catch up to the pace of e-business. In its reengineering design, a large part of company resources will eventually be allocated to project teams instead of functional departments. These project teams will take the responsibility of improving the company's business processes, products and productive procedures. They are named after QCDS teams—Q is quality improvement, C is cost control, D is quick delivery, and S means satisfactory service. The concept of QCDS comes from two sources. One is the concept of network organization, and the reengineering movement tried to change Everest's organizational structure from a bureaucracy to a matrix form. The other is the concept of "continuous improvement", by which QCDS teams are designed as a copy of QC teams, but the former is the team of office workers for improving quality, cost, delivery and service, while the latter is the team of blue-collar workers for improving production.

Throughout the year of 1998, all the office workers in the company were encouraged to organize QCDS teams in order to propose improvement plans. Proposals came from three sources. First, an individual could propose his or her idea

to organize a team. Second, a departmental meeting might discuss possible improvement plans and organize its members as a team. Third, the company might find a problem and assign the improvement job to the relevant department. Brainstorming was the most important job in these teams. Every Monday, there was a fixed period of time for the meeting of QCDS teams. Every month, a committee of QCDS movement held a meeting, in which teams presented their plans and got evaluation from high-ranking officers. Project teams needed to execute their final suggestions and reported whether their ideas could be successful in instigating improvements.

All project teams were required to complete all their proposals within three months, after that the team could be dismissed. Eventually, there was a conference of QCDS teams once every three months. In the conference, the performance of teams was evaluated. There was a criterion for high-ranking officers to make an evaluation—a percentage of score was given to the record of brainstorming meetings, and the other to the quality of plans proposed by the team and presentation in the conferences. The winner of the competition received a cash reward. In addition to the monetary reward, the results of projects were also taken into account during the participants' yearly performance evaluation.

During the period of 1998/10/02 to 1998/12/02, there were 193 teams formed, in which each had 4 to 10 members, and the average was about seven. Most teams were composed of 6 or 7 people. These teams were good samples for this research, since their main job was to make improvement proposals and their performance directly impacted the company's knowledge creation. The focus of my research is on the impact of social network structure on team performance. The dependent variable of this research is therefore the evaluation of the team's proposal. There are three grades for these QCDS teams--A, B and C. Grade A is best, while grade C is worst. This research randomly samples one-third of the teams in each grade. Then a whole-network questionnaire was distributed to each member of the chosen team. In total, 56 teams were surveyed, and 50 surveys were returned as shown in Table 1.

Insert Table 1 about here

In the beginning of 1999, the data from the sampled teams was collected. The questionnaire surveyed the relationships among team members before the teams were formed. If a team had more than 20% missing or invalid data, the whole team's data was not included. Eventually, 43 teams had valid data. Because there was only one valid sample in grade A, and this number was too low to have convincing analytical results, only grade B and C were used for the hypothesis testing. Finally, only 42 teams, including 16 B-grade teams and 26 C-grade teams, are included in my analysis.

3.2 Questionnaire and Measurement

Two types of social ties are surveyed--consultation and friendship ties. In organizational settings, Krackhardt and Hanson **[29]** categorize social networks into three kinds, including information, consultation and trust networks. Furthermore, Krackhardt in his theory of "strength of strong ties" points out that the network of "philos" (friendship network) provides a base for mutual trust by which friendship facilitates cooperative behaviors **[30]**. Very similar classification is also evident in Brass and Burkhardt's work, which suggested a category of three social networks--communication, workflow and friendship networks. Since knowledge creation is through a process of knowledge exchange and combination and such exchanges are mainly about job-related knowledge, the social relations associated with workflow, i.e. advice ties, are therefore surveyed. Regarding knowledge combination in a team, since mutual trust and cooperative behaviors are necessary in the process of brainstorming, friendship networks are also related to knowledge creation. Three relational questions are asked. Two of them are related to advice ties--"When you encounter difficulty in your routine job, from whom do you ask for help before the project team is formed?" and "When you encounter difficulty in your routine job, who will actively help you before the project team is formed?" Another

concerns friendship ties, that is "With whom do you have your social activities in off-duty time before the project team is formed?"

Three network structural factors need to be measured-- network density, group centrality and cliques. The purpose of measuring network density is to indicate the group's viscosity, and the measurement of standardized network density is:

$$\triangle = \frac{L}{g(g-1)}$$

L is the number of arcs in a directed graph, and g is the number of nodes in the social network. The standardized density of the two advice networks is computed first for each project team, and then average the two figures to get a single index of viscosity. There is only one question about friendship networks, so a single index can be computed directly from the formula of density. Since the hypothesis is that a team with median high density will perform better, all project teams are divided into three equal sections—high, median and low density groups. It will be examined whether the median one is better than the other two.

As stated above, the concept of group centrality measures the degree of centralization of power. Group centralization is the variance of importance owned by each group member. When the variance is low, no group member is more important than others. We first need to compute individual centrality $C_A(n_j)$ for each member of a team. The formula of in-degree centrality is:

$$C_A(n_j) = \sum_i x_{ij}/(g-1)$$

Where x_{ij} is 0 or 1, indicating whether employee i recognizes the relation with employee j; g is network size.

Then the formula of group centrality is listed below.

$$C_A = \sum_{i=1}[C_A(n^*) - C_A(n_j)] / \max \sum_{i=1}[C_A(n^*) - C_A(n_j)]$$

Where $C_A(n^*)$ is the highest one of individual centrality in the team. By the same token, the two measures of two advice networks are averaged to get the final index. Since too centralized or too decentralized groups are not beneficial to team performance, all teams are equally divided into three categories.

The first step to compute cliques in a team is to make a directed graph symmetric. A clique is mainly built from strong ties. The simple way to measure a strong tie is the mutual recognition of relation by both sides **[26]**. So the one-direction ties (that is, A chooses B, but B does not choose A, or vice versa) in a team are erased, and only strong ties are left. Then the definition of 2-plex is employed to find cliques in each network. That is, each node in a k-member subgroup has at least k-2 relations with other subgroup members **[31]**. However, in the case of cliques with only three members, a more restricted definition of cliques is used--1-plex. In other words, every person in these cliques connects the other two clique members. At the same time, each network composed by strong ties is also plotted, that checks whether there are bridges making its cliques fully connected with other members. Since most teams are small-sized, cliques in these teams are generally also very small--most are 3-member groups and some have 4 persons.

Network size is often included in an explanatory model of team performance as a control **[32]**. However, in my samples, most teams are composed of 6 to 7 members. The network size was invariant, so this variable was not a significant factor in my case.

3.3 Theoretical Model

Since there are not enough cases in Grade A, so only two categories, B and C, are put into the model. For analyzing this categorical data, a logistical model is used as follows:

$$\mathbf{Y} = \alpha + \beta_1\mathbf{X}_1 + \beta_2\mathbf{X}_2 + \beta_3\mathbf{X}_3 + \beta_4\mathbf{X}_4 + \gamma_1\mathbf{Z}_1 + \gamma_2\mathbf{Z}_2 + \gamma_3\mathbf{Z}_3 + \gamma_4\mathbf{Z}_4 + \varepsilon$$

Y is the log function of probability of performance of improvement teams--Log {Pr（P）/ Pr（1-P）}, where P is the probability for a team to achieve Grade B.

$\mathbf{X}_1$ is the variable representing medium density in the advice network. The value of the group's density from 0.097 to 0.233 are coded as "1", while others are "0".

$\mathbf{X}_2$ is the medium group centralization in the advice network, and the value of the

group's centralization from 0.04 to 0.083 is defined as "1", while others are "0".

$\mathbf{X_3}$ is the variable indicating a group with disconnected cliques in the advice network. "1" means having cliques, and "0" means no cliques.

$\mathbf{X_4}$ represents a team with cliques but also fully connected in the advice network. "1" means a fully connected group, and "0" means the inverse.

$\mathbf{Z_1}$ is medium density in the friendship network. The value of the group's density from 0.095 to 0.267 is defined as "1", while others are "0". That is, the middle one-third are coded as "1".

$\mathbf{Z_2}$ is medium group centralization in the friendship network, and the value of group's centralization from 0.034 to 0.08 is "1", while others are "0". By the same token, the middle one-third are "1".

$\mathbf{Z_3}$ is a group with disconnected cliques in the friendship network.

$\mathbf{Z_4}$ represents a team with cliques but also fully connected in the friendship network.

ε is the random item.

4 Analytical Results

Insert Table 2 about here

As shown in Table 2, model 1 presents the analytical results of regressing team performance on social structure in the advice network. The medium group in density was not significantly better than the other two categories. Tight or loose groups haven't been found to be worse in the diffusion of new ideas. The medium category of group centrality is proven to be a significant factor in improving team performance. In other words, groups with centralized authority or without leadership are not all good for encouraging motivation to brainstorm. A team with disconnected cliques is not shown to be worse than those teams with other structures. However, team performance indeed gets improved when its cliques have bridges to connect other members. Holes and bridges do impact the results of knowledge creation. A fully

connected group shows better performance than those with holes.

Model 2 shows the impact of structural factors in the friendship network. Since no group with cliques is fully connected, this variable is not included in my model. Unfortunately, no independent variables significantly impact team performance. It seems that the friendship ties are not related to knowledge exchange and combination. Model 3 regresses team performance on all the structural factors in both advice and friendship networks. As illustrated in Model 1 and Model 2, only teams with medium group centrality and fully connection in the advice network is significantly better than others.

Several conclusions can be made from the above analytical results. First, hypothesis I is basically falsified, since group density is not an influential factor affecting the performance of the improvement teams. A possible reason for this result is that knowledge diffusion in these small teams may not be a decisive factor for team performance. In a team composed by only 6 to 7 persons, everybody has the chance to distribute his ideas face-to-face, so structural barriers of diffusion may not exist. The key for success in such small teams is not the ability to diffuse but the willingness to exchange. How to stimulate and control brainstorming therefore comes to the center of the future discussion.

Second, hypothesis II is basically verified, but some modifications are still needed. In my analysis, the middle section of group centrality is a significant positive factor. In other words, centralization of power is not good, but a group without leadership also shows poor performance. This result implies that absolute power in a team will discourage active knowledge exchange, but some leadership is still necessary for stimulating innovation motivation and controlling brainstorming meetings effectively.

Third, hypothesis III is falsified, since disconnected cliques fail to demonstrate negative influence on collective activities. That means a group with cliques disconnected to other members does not show worse performance than a group without cliques. An interpretation of this result may be that those groups without cliques are also not fully connected, so effective collective actions to achieve the

team’s goal cannot be formed, either. On the contrary, hypothesis IV passes the test, since team structure with fully connected cliques has a significant impact on the dependent variable. This result illustrates that full connection is an important factor for group performance, and disconnected components, either cliques or individuals, are not only unable to contribute their efforts but also likely to cause conflicts with others.

5 Discussion

5.1 Interpretations for Conclusions

One contribution of this paper is that power distribution is taken into the explanatory model of an improvement team's performance, and finds the median degree of centralization very helpful. In the past, power centralization, or strong leadership, was conceptualized as a positive factor for team performance in the early study of group structure and process **[33]**. But according to Sparrowe, Linden, Wayne and Kraimer’s testing results **[20]**, group centrality is slightly negatively related to the performance of project teams. They explain that strong leadership is good for a team with a simple task, but power centralization may not be helpful for complex tasks like knowledge sharing and brainstorming. On the contrary, Ibarra **[25]** argues that some leadership is still helpful for innovation roles. This paper finds that both of the two arguments are partially right. Although distribution of power encourages more interactions and exchanges, a group composed by all equal members may not organize the process of knowledge creation effectively. Some leadership is still helpful.

The second contribution of this paper is that clique-analysis is brought into the studies of knowledge creation. It is found that a fully connected clique is helpful for the whole team's performance. My interpretation of this finding is that, in a fully connected network, a clique may turn out to be a core group, which leads collective actions. This interpretation parallels the finding about power centralization. A network

with the structure of this sort generally has median high group centrality, since several core members all have high individual centrality, rather than only one "autocrat" has high centrality. A core clique in a team can establish teamwork spirit, which initiates exchange and cooperation actions, and effectively controls the process of knowledge creation. Their bridges connected to other non-core-members help glue the whole team as an integrated one. Other members can also participate in and contribute to the whole team's performance.

In Hypothesis III, a disconnected clique excludes other members' participation, so a team with structure of this sort should have poor performance. However, the test fails to find evidence to support this argument. A possible interpretation is that those teams without cliques are not dense enough to fully connect all group members, thus many isolated team members can't participate in the knowledge creation process, either. Clique analysis is especially important for the studies of Chinese organizational behaviors, since Chinese managers tend to organize their own "Chin-Shins" (confidant subordinates) as ruling groups. As a result, clique conflicts are often seen in Chinese firms **[34,35]**. Information is also easily blocked due to the selfish interests of cliques. Therefore, clique analysis should be taken into account of the knowledge sharing process.

We also find that only consultative ties are related to the process of knowledge exchange and combination, while friendship ties have nothing to do with the improvement of a team's performance. It is not surprising to acknowledge that job-related discussion relations in routine workflow are very helpful for exchanging job-related knowledge. However, the later finding shows that privacy-talk cannot improve cooperative relations in knowledge exchange. In general, the resources that friendship ties provide are emotional support and informal influence **[29,30,36]**. It seems that these resources do not contribute much to the process of knowledge creation in a small-sized team.

5.2 Limitations

There were several limitations affecting this paper. First, like many researches of team performance, this study has only 42 units of data, not large enough to make the estimates of the model's parameters stable. As a result, my conclusions are sensitive to the sources of data, and any causal inference from these conclusions should be very cautious.

Second, since my data numbers are small, this prevents us from building a complex model, which will make the degree of freedom even lower. This paper therefore employed a simple strategy to measure the median high group centrality and density—the median one-third represents a dummy variable. In future studies, it would be better to develop a more complex measurement of curve-linear correlation when the sample size is large.

Third, the sample size of A-grade teams is small, and it was especially unfortunate, that there was only one team without many invalid values in the four samples. As a result, A-grade teams were not included into the statistical analysis. However, a comparison was still made. In the A-grade team, the group centrality of advice network is 0.089, which ranks it nearly among the groups with median-high centrality. In addition, the team is almost fully connected. The advice network structure of the A-grade team shows similar evidence with the above-stated conclusions made from the explanatory model.

5.3 Implications for Future Research Agenda

This paper, built up from Sparrowe, Linden and Kraimer's work **[20]**, develops a more detailed measurement of network structure. However, the structural dimension is only part of the constructs of internal social capital. Many previous studies have included some other constructs, such as social ties, mutual trust **[5]**, shared vision **[19]**, and citizenship behaviors **[11,37]**. In organizational studies, Napiet and Ghoshal **[15]** propose a rather complete list, including structural, cognitive and relational

dimensions as elements of social capital. Whether a behavioral dimension should be included or not? **[17]** Is shared vision only an antecedent variable of mutual trust, rather than a part of social capital itself? The constructs of internal social capital are still debatable, and a complete measurement should be put into future research agendas.

Since knowledge has been the engine for economic growth **[38,39]** and organizational success in the Information Society **[40,41]**, intangible assets are now a major part of organizational wealth, especially for those in service and R&D industries. Intellectual Capital studies, on the one hand, provide the measurement of intangible assets, including operational processes, intellectual properties, service and production innovations and customer relations **[1]**, so that the real value of a firm can be evaluated effectively. On the other hand, a causal map of intellectual capital can provide the insight for a firm to invest the right assets and design correct strategies **[42]**. However, most causal models of intellectual capital take only human capital and external social capital into account **[4,43]**. This paper again illustrates the importance of the structural dimension of internal social capital, and proclaims the need to design a causal model of intellectual capital including internal social capital. What will a complete model, including both internal and external social capital and human capital, be like? Is internal social capital a factor, a mediator or a moderator? Building such a model posts a great challenge to intellectual capital studies. This paper is only an introduction to an area that is still waiting for further exploration, so I do not try to generalize the causal mechanisms between improvement teams' performance and social network structure at this moment. Since a whole network analysis needs close bound units from which to collect data, my data cannot be considered as a random sample. Even though the unit presented in this paper may be a typical Chinese large-sized private-owned bureaucratic firm, it should be cautious to generalize my conclusions to all Chinese companies. In addition, the sampled teams are all small-sized groups, in which information barriers are rare. So some of the hypotheses about information diffusion are not important to improvement teams of this sort. If my

data has many large groups to be surveyed, the analytical results may have some difference. It is necessary to collect more data from various work settings before the generalized conclusions can be made.

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Table 1: The Sampling Results

Grade	Original groups	Sampling groups	Collect-back groups	Valid data
Grade C	112 units	112 * 1/3 = 38	29 units	26 units
Grade B	70 units	70 * 1/3 = 24	18 units	16units
Grade A	11 units	11 * 1/3 = 4	3 units	1 units

Table 2: The Analytical Results of Regressing Team Performance on Social Structural Factors.

	Model 1	**Model 2**	**Model 3**
Intercept	-2.2182 （0.0346）	-0.5181 （0.4043）	-2.0992 （0.0786）
Medium density in the advice network	-0.1948 （0.8014）		-0.2380 （0.7762）
Medium group centrality in the advice network	1.9473 （0.0255）**		1.9848 （0.0270）**
A group with disconnected cliques in the advice network	0.5441 （0.5222）		0.8246 （0.3762）
A group with connected cliques in the advice network	3.0043 （0.055）*		2.8565 （0.0737）*
Medium density in the friendship network		0.3266 （0.6655）	0.1647 （0.8669）
Medium group centrality in the friendship network		0.2412 （0.7477）	0.2640 （0.7919）
A group with disconnected cliques in the friendship network		-0.4245 （0.5211）	-0.7837 （0.3514）
Likelihood Ratio	45.939	54.877	44.913

n=42

*p<0.1 , **p<0.05