ISSN 1816-6075 (Print), 1818-0523 (Online)
Journal of System and Management Sciences
Vol. 1 (2011) No. 3, pp.79-89

Social network analysis on knowledge sharing of scientific groups

Gao Lei[1], Guquan Xin[2]
[1]Automation College, Beijing Union University, China
[2]China Academy of Launch Vehicle Technology Systems Engineering Division, China
gaolei@buu.edu.cn, guquanxin@126.com

Abstract: Knowledge sharing and knowledge flows of scientific groups have become an important factor affecting the development of the groups. On account of the mutual communication and collaboration in scientific, academic and research paper field, an invisible relationship network has been formed among them --- knowledge sharing of scientific group network. Therefore, a good mastery of the network structure and characteristics of the scientific groups can be of some help in knowing where knowledge flows, how scientific information is exchanged among members. It can promote the communication and collaboration among members and the formation and development of scientific groups. The research applies SNA to study the strength relation, small groups and coreness to detect the problems in knowledge flow within groups with the help of quantitative description, measure knowledge network. SNA is used in the analysis of group knowledge network. And from the perspective of improved network structure, management strategies can be suggested to improve knowledge sharing ability in the scientific collaborative network.

Keywords: Scientific groups, Knowledge sharing, SNA

1. Introduction and Present Situation of the Problem

Multi-carrier technology based communication system has been widely used in Knowledge management plays the key role in the innovation of knowledge in scientific groups. Among the 10 challenges confronting knowledge management, knowledge sharing comes in the second. Kochikar believes that there are three aspects involved in knowledge sharing: content construction, technology construction and interpersonal construction. However, interpersonal construction hasn't gained enough attention in the research of knowledge

sharing. Knowledge sharing should cover two areas: socialization of invisible knowledge and internalization of explicit knowledge. Knowledge is not a simple information reallocation, but a process of interpersonal exchange of knowledge in specific environment. The study of knowledge sharing in scientific groups must be related to interaction among members: both the socialized process of knowledge flown to the whole group via individual exchange and the internalized process of knowledge absorbed via communication with other members.

With the development of social network theory, researchers began to pay attention to the study knowledge management in terms of group relation network(Borgatti, Everett, & Freeman,2002). It is shown in the research that the interpersonal relation network will affect the production and sharing of the knowledge of the group. And the social network is playing a significant role in the sharing of invisible knowledge. Social network(Sun & Qiu,2008) is where group members can acquire information, resources and social support to identify and make use of opportunities. It is composed of a series of social relations among connected behaviourists (nodes). Among these relations, the mode of the comparatively stable relations constitutes the social structure. Social network theory is the study of the relation structure between nodes as well as the behaviours of the nodes embedded in the network and the characteristics of the whole network. Social network analysis (SNA) has provided a measurable and visible method for the study of social network (Zaphiris & Chee,2009).

Science groups refer to the social organizations formed voluntarily by people who are interested in science and technology. Its management goal is to promote effectively the competence and innovation abilities of the group members. And the main function of science groups is the realization of effective flow of knowledge information in the science group(Cross & Prusak,2002). From the perspective of composing elements of the social network, science groups should be made up of scientific experts and the network should be one with the exchange of academic information resources as the main mutual relation. In social relations, It is mainly the calculation of relation matrix that can help work out relevant measure indication system. The calculation of the effect of strength ties, the analysis of small groups and the measurement of centrality can be used in the research of conflicts between groups and the exchange of knowledge and information

2. Methodology

The research is subjected to a 16-member typical university science group.

Among all the members, 3 were administrators and 13 were ordinary members. This group was founded in 2007 and it has s relatively steady organizational structure. All the members are familiar with each other and they have a very good cooperation with each other. They have undertaken many scientific research projects and are qualified as the subjects of the analysis of knowledge sharing network.

2.1 Questionnaires

According to the requirement of the research, a set of questionnaire sheets were designed. Participants answered all the questions and their answers can be used as data for the research(Zhang,2009). In the meanwhile, these answers can be used as the measurement of individual behaviours and attitudes. The questionnaires provide necessary personal information on group members (duties, special abilities, interests and hobbies), data on their familiarity degree with the knowledge sharing and knowledge flow process. These former data can be regarded as the foundation for the later research.

2.2 Observation

This research applies census method to collect information about group members' routine activities and behaviours as well as their connection. Materials can be gathered through observations and further interviews and nodes (group members) and lines (relations of knowledge sharing and knowledge flow) can be calculated through division tables of the duties within the group, the name list of the members and photos of group activities.

2.3 Social Network Analysis

Social network analysis is used to build the model of social relations, find out the social relations among behaviourists within the groups, and describe the social relation structure. These relations include the information exchange, knowledge sharing and degrees of trust among members. The use of graph theory tools can make it possible to visualize the interactive relation mode among group members and the social structure, thus providing a wide range of network variables to evaluate the new mode of social group development from the social aspects. The research mainly uses ties strength, small group analysis, centrality and structure hole as the indicators of measurement.

3. Analysis of Knowledge Sharing Network in Science Groups

3.1 Analysis of Strength Ties in the Knowledge Sharing Network in Science Groups

American sociologist M.S. Granovetter put forward the strength ties theory in 1973. According to his theory, strong ties involve the determination of knowledge sharing relations and its strong ties. Strong ties refer to the link existing because of communication and contact between members, between member and groups and between groups. According to the contact frequency, the dependence degree of emotion, the familiarity degree and times of mutual exchange, he defines the interpersonal relations as weak relations and strong relations. Strong relations are frequent and strong in time and emotion devotion and density (members trust each other). Whereas, weak relations refer to the relations which are scarce and isolated. Strong relations have enormous advantages in knowledge sharing: strong relations mean that there more chances of direct contact among nodes so that members can keep good communication which can benefit high-quality information and knowledge sharing. In particular, as far as "invisible degree" knowledge is concerned, trust, coordination and deeper between understanding between group members are the precondition of effective sharing and can only be produced in the network with strong relations. In the meantime, strong relations are favourable for the chronological maintenance of knowledge exchange activities. It makes groups members experience more and benefit more in knowledge sharing. Also it can influence their future activities, thus ensuring a better communication result.

The analysis of strong relations in knowledge sharing network within science groups makes it possible to draw the strong relations structure graph of knowledge sharing in science groups. The greater the degree of knowledge sharing among members is, the wider the lines will be. For example, the width of the lines between No. 1 and No. 7, between No. 12 and No. 2 indicates that these members have frequent and strong knowledge flow between them. Therefore, the strong relations in the knowledge sharing network of the whole science group show that these members are familiar with each other and have similar knowledge structure, experience and backgrounds. They are willing to trust each other and cooperate with each other. So conveying complex knowledge can ensure the stability of knowledge sharing network structure of the science group. But the strong relations between some members are exclusive and these members refuse to receive the knowledge outside the small groups they form. And they never produce any resources and information. All the resources and information added are old. As shown in Figure 1, a triangle-structure is formed among No. 12, 14, and 16. This structure is highly closed and steady. It's easy for them to form fixed knowledge acquisition patterns in the process of knowledge sharing, which is not good for the reception of new

information and new knowledge. It may be related to the remarkable difference between research areas and interests. On the other hand, it can also be seen that in the knowledge sharing network of the science group, weak relations help build up some kind of bridge between members so that a diversity of resources can be exchanged. For example, there is a weak relation between No. 9 and No. 12. No.12 is Block 1 and No. 9 is Block 2. The weak relation between them ensures the complete online knowledge sharing process.

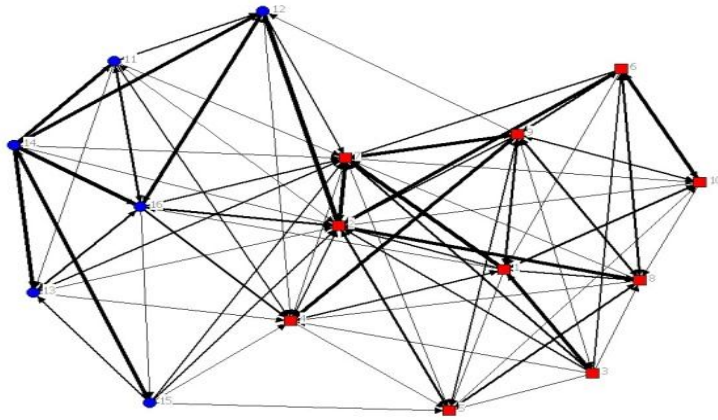

Fig. 1: Graph of Strength Ties Structure of Knowledge Sharing in Science Group

According to the research, it can be clearly seen that in terms of strong relations, nodes are directly connected to each other and at the same time the connection is close. As a result, this kind of network can support any knowledge sharing with a high degree of "invisible degree" knowledge. Based on the features of knowledge, the analysis of knowledge sharing and the theory of "invisible degree" knowledge, there is a strong tie among nodes and it needs a large amount of time and a large amount of coordination cost. On the contrary, it is more efficient to maintain the weak relations among nodes. Therefore, the increase of strong relations seldom leads to the increase of value. While the increase of weak relations will surely brings about the rise in the new value. That's to say, it is the weak relations that are the important channel to acquire new resources. And it is the weak relations that preserve the integrity of the knowledge sharing network in the whole science group. It reveals that the relationship among members is just a weak relation due to the difference in duties and abilities of the members in the group, which indicates that the communication within the group is not enough and there is a lack of measures to stimulate the interpersonal communication of the invisible knowledge sharing.

3.2 Analysis Of Small Groups in the Knowledge Sharing of Science Groups

The analysis of small groups should start from the influence of the intimacy degree among group members on the network. Some members have a relatively direct, frequent or active relationship with each other and they form a subgroup. This is called "condensation subgroup" in SNA and it is a pointer of the whole structure in the network. There is plenty of direct, face-to-face communication among subgroup members so their interaction is very active. Their recognition of familiarity with other group members helps them cultivate more common emotions, which leads to mutual acceptance and recognition. The analysis is of great significance in the study of knowledge sharing in science groups. Its appearance comes from the inner strong relations of the small group and the existence of structure holes. The application of social community graphs can let us further our study in the characteristics of the different layers in the science groups, such as the distribution of small groups in the science group. From it, we can find whom members are often connected in the same group, then a tree structure analysis diagram of small groups in the knowledge sharing of science groups can be drawn as follows.

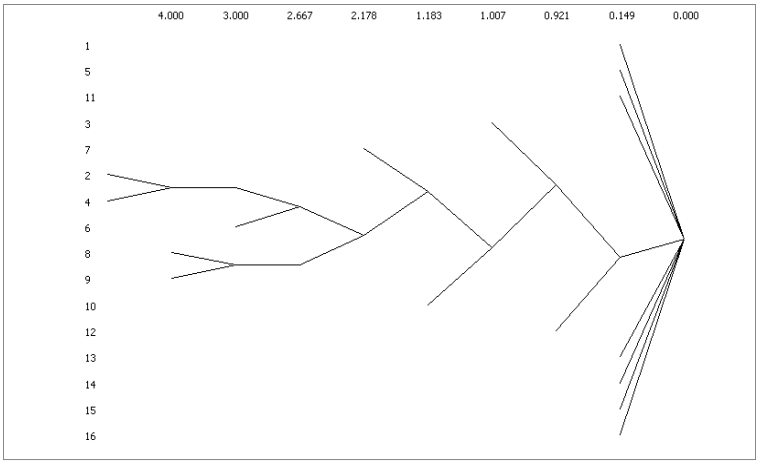

Fig. 2: Tree Structure Analysis Diagram of Small Groups in the Knowledge Sharing of Science Groups

From Figure 2, it can be seen that the group members with better control of knowledge flow can join different small groups. There is a tendency that the number of members acting as "bridge" in exchanging knowledge within the science group is on the decline with the biggest on the left side of the chart. And the number of isolated members is growing. It's quite clear that knowledge is flowing in the small group of the science group, but not at random or evenly. No. 2 and 4 have the most resources in the knowledge sharing network and No.1, 5, 11, 13, 14, 15, 16 are usually at the edge of the knowledge sharing network. So they receive the least resources. According to the analysis, it can be found that

small groups may affect not only the relations among the group members, but also the effective operation and development of the group (in that they can be the positive power and the negative power at the same time). In closely related small groups, either gathered formally or voluntarily, there is a strong similarity among the group members. And the strong connection contributes to the most appropriate environment where knowledge sharing and innovation can take place.

3.3 Centrality Analysis of Knowledge Sharing among Science Group Members

Centrality is one of the most important and most frequently used concept tools in analyzing social network. It defines the measure concept of centralized location of group members in the social network. Also it reflects the location and merit difference of behaviourists in the social network structure. Centrality is often used to measure who is the core member in the group and this member, sociologically speaking, is the one with the highest status in the social group. He or she is also the most powerful member in the group in terms of …. The member with the highest centrality is usually in the key position in the group. The analysis of centrality in the science group can give us some ideas that the positions of members in the same knowledge sharing network are different. Some of them are in the center while others are at the edge. Therefore, there is a large gap between in social layers such as resources and information they own. In the centrality analysis chart of knowledge flow among members in science groups (Fig. 3), No.2 has the highest reception point (7,000) showing that the member has obtained the largest amount of knowledge information while in the whole knowledge sharing process, No.1 member has the highest emission point (8,000) meaning that the amount of information emitted by this member is the largest.

	1 OutDegree	2 InDegree	3 NrmOutDeg	4 NrmInDeg
1	8.000	1.000	53.333	6.667
14	5.000	1.000	33.333	6.667
13	5.000	2.000	33.333	13.333
8	4.000	4.000	26.667	26.667
3	4.000	1.000	26.667	6.667
2	4.000	7.000	26.667	46.667
7	4.000	5.000	26.667	33.333
9	4.000	4.000	26.667	26.667
11	3.000	5.000	20.000	33.333
12	2.000	3.000	13.333	20.000
10	2.000	1.000	13.333	6.667
6	1.000	1.000	6.667	6.667
15	1.000	2.000	6.667	13.333
4	0.000	4.000	0.000	26.667
5	0.000	3.000	0.000	20.000
16	0.000	3.000	0.000	20.000

Fig. 3: Centrality Analysis Chart of Knowledge Flow Among Members in Science Groups

Thus, a finding can be made: when a member has the highest centrality score, this member must have the core resources of the whole group (knowledge points, innovation and core technology). Other members of the same group will have huge dependence on this member. According to Fig. 3, we can know where each member of the same science group is in the whole science group knowledge sharing network. It needs coordination to make the most of the efficiency of knowledge network. And some actions should be taken to encourage those edge members to get involved into the knowledge sharing network.

3.4 Monopoly in Knowledge of Science Group and its "Cave-Bridge"

Knowledge sharing is not only related to the strength ties between members but also related to the position of members in the network. Burt suggested the concept of "structural hole" in 1992 --- if two members related to one member are not directly related in the same network, this very member is in the position of "structural hole." Structural hole is the symbol of benefit of a network position: when one member of the science group is in the position of the structural hole when he or she is setting up an interpersonal relationship with other members, this member has the chance of getting access to two kinds of information flow. If he or she can go beyond the structural hole, he can benefit from the advantages coming from the richness of information.

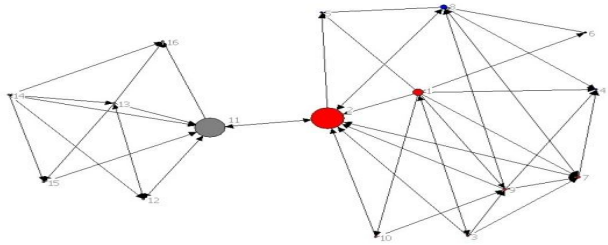

Fig. 4: "Block-Cutpoint" Relation Graph of Knowledge Sharing Network in Science Groups

According to the "block-cutpoint" analysis of the knowledge sharing relations among members of the science group, it can be found out that No. 2 and No. 11 are in the position of "block-cutpoint" (No. 11 – 16 are in block 1, and No. 1 – 10 are in block 2). The analysis shows that compared with other members of the group, No. 2 and No. 11 are related more members and are in a more preferable position. They have better advantages in dealing with different relationships. As a result, it is more likely for these two members to have more knowledge resources. The management goal of the science group is the effective promotion of the competence and innovation of the whole science group. Its main function is that it can realize the effective flow f information in the group so that members can communicate with each other mutually and willingly. Therefore, the active role of No. 2 and No. 11 as the bridge can make members easily exchange information with each other and they can share their knowledge, thus improve their innovative ability. If there is change or break-up of the "block-cutpoint" relationship, it will be consuming in both cost and time to reconstruct the "block-cutpoint" relationship. If there is some change in the position of No.11 in this science group, then No. 12 – 16 will break away from the whole knowledge sharing network. So it is necessary to pay attention to the appearance of the "block-cutpoint" relationship and the effect of the structural hole.

4. Conclusions

According to the different analysis indicators based on social network theory, the following management strategies can be provided as far as the knowledge sharing network in the science group is concerned:

Reform the structure of science groups. In order to realize the knowledge sharing, a new flat structure should be established. The traditional "vertical-layer" style should be switched into the new "horizontal-link" style. In this way, a number of layers can be cancelled and the smooth communication between

different levels can be ensured. And it is easier for members to communicate face to face and exchange information. In science groups with high density, members have many opportunities to communicate with each other and they can exchange and transfer their knowledge. Every member can have the chance to acquire technical knowledge and to ensure the acquisition, sharing and actual use of knowledge;

Stress the use and training of key members if the science groups. The key members of the science groups refer to the central figures and the important figures of the knowledge sharing network. It is necessary to guide the key members of the groups to carry out a goal-oriented study and communication. The ways in which other members communicate with each other should be optimized and the wide spread of their knowledge should be encouraged. Only in this way can the breakdown of the communication of knowledge within the science group and the loss of knowledge resources of the science group be avoided;

The key members of the science group serving as the "bridge" in the knowledge sharing network are the activators in the accelerating flow of knowledge in the network. Their communication with other members can to a great extent promote the knowledge sharing among the groups. It is strongly recommended to make the most of their communicative skills and manners. The knowledge management of science groups should be based on the difference of strength ties and network structure of the inner knowledge communication network. Certain measures should be taken to promote the effective communication of knowledge in the network according to the difference in obstacles and conditions of knowledge sharing. Small groups do exist in every science group and attention should be paid to members' positions and guidance should be given to them to encourage the transformation towards the "bridge" or a stronger relationship(Wenger, 2004).

Therefore, the construction and maintenance of knowledge sharing network must be complemented. Whether a science group can develop a knowledge network suitable for the development of the science group will have a direct influence on its exploitation and application of knowledge resources. Also it will affect the cultivation of abilities in knowledge innovation and competence. A good and scientific organization and management of knowledge exchange network within science groups will be of great help in establishing a good environment for the good organization and a good atmosphere for the knowledge communication and sharing. Then, the exchange of knowledge and reconstruction of knowledge will be influenced for the better innovation and

better application.

References

Borgatti, S. P., Everett, M. G. & Freeman, L. C.(2002). *Ucinet6 for Windows:Software for Social Network Analysis*.Harvard:Analysis Technologies.

Cross, R. & Prusak, L.(2002).The People Who Make Organization go or Stop.*Harvard Business Review,*7, 104-112.

Sun, W. J. & Qiu, H. M.(2008).A social network analysis on Blogospheres. *International Conference on Management Science and Engineering*, Long Beach, CA, USA,1769-1773.

Zaphiris, P. & Chee S. A.(2009). Introduction to Social Network analysis. *Human-Computer Interaction INTERACT 2009. 12th IFIP TC 13 International Conference* , Uppsala, Sweden,940-941.

Zhang, M. X.(2009). Exploring adolescent peer relationships online and offline: an empirical and social network analysis. *2009 WRI International Conference on Communications and Mobile Computing*,Yunnan, China,268-272.

Wenger, E.(2004).Knowledge management as a doughnut : Shaping your Knowledge strategy through communities of practice .*Ivey Business Journal* , 68,1-8.