A Diagnosis Framework for Identifying the Current Knowledge Sharing Activity Status in a Virtual Community of Practice

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Abstract: In accordance with Communities of Practice(CoP) becomes highlighted as an effective method for knowledge sharing in Knowledge Management(KM), CoP has been used in many organizations strategically. Therefore, the needs of diagnosing knowledge sharing activities in CoP have been increased. Previous researches about CoP strategies, which are usually suggesting general guidelines without diagnosis of current status, are not sufficient to diagnosing individual CoP. Furthermore, diagnosis methodologies are not connected to strategic direction or take too much time and effort to conduct regularly. The purpose of this paper is to develop sustainable diagnosis framework for identifying knowledge sharing activities in CoP using Social Network Analysis(SNA) and to suggest strategies for individual CoP based on proposed diagnosis framework. And the last, we applied proposed diagnosis framework to the industry case.

Keywords: Diagnosis framework, knowledge sharing, CoP, Social Network Analysis

I. Introduction

Knowledge is one of the most valuable resources for business organizations [31]. It helps to create and sustain a competitive advantage by applying collected knowledge to the production of goods and services [9]. The purpose of Knowledge Management (KM) is to maximize the utilization of knowledge and to gain an advantage relative to other competitors.

Communities of Practice (CoP) have been highlighted recently as one of the most effective methods to build effective KM [10]. A CoP is defined as an informal structure of groups that share a common work environment [4] [16]. By working together, members of a CoP share their concerns, problems or passion about specific topics to cultivate their knowledge and expertise [30]. CoP activities facilitate mutual trust among CoP members based on social capital; connections, relationships and common context [18] [24]. Consequently, knowledge sharing activities in a CoP, create and sustain a competitive advantage for an organization [9].

As the importance of CoP activities increase, organizations align their CoP activity with organizational strategy and as a consequence, the need to assess the current status of CoP is also increasing [21] [3]. Several research groups have suggested general guidelines for CoP (e.g., [19] [28] [15] [32]). These guidelines were proposed without assessing the current status of a CoP and are only useful when determining an organization's KM or CoP philosophy. Other researchers suggested a diagnosis framework. However, proposed frameworks were usually based on subjective methods. Also, guidelines are hard to apply at an individual CoP level since most research regarding CoP diagnosis was focused at the organization level, but actual activities are conducted at an individual CoP level. Some other researchers tried to use objective methods, such as SNA, but it takes too much time, costs too much to implement and has no strategic direction [6].

The first purpose of this paper is to develop a diagnosis framework to identify the current knowledge sharing activity status in a virtual CoP. The proposed framework should be conducted periodically and in an objective way. The second purpose of this paper is to derive knowledge sharing strategies based on the proposed diagnosis framework. The strategies should be suited to the activity of an individual CoP.

II. Literature Review

CoP diagnosis methodology and strategy General guidelines

Some researchers have suggested general guidelines for CoPs by identifying current CoP issues, e.g proposing future directions for linking CoP activity to an organization's performance [19], pinpointing executive level management issues [28], identifying the current key issues and proposing strategies [29], providing direction to solve potential problems in a CoP [15] and suggesting guidelines for online CoPs [32]. However, these guidelines are based on the philosophy or general issues of CoPs and not the status of individual or organization CoPs. From this point of view, some researchers have mentioned that a measurement of activity is needed [19].

Diagnosing CoP

McDermott [20] measured the impact of CoP in three dimensions. The first dimension is personal knowledge. By sharing ideas or helping each other, members of a CoP increase their personal knowledge and ability to solve problems. The second dimension is strength of relationship. Members of a CoP get to know who has certain knowledge, and as their level of interaction grows, trust and the comfort

of relationships increase. The third is access to information. Communities commission members to create tools, procedures or databases and increase members' access to the information already created by other members.

Verburg and Andriessen [26] introduced the Community Assessment Toolkit (CAT) as an assessment method. They assumed that mutual trust and a common identity are crucial factors to diagnosis the status of a knowledge sharing activity in a CoP. Based on this assumption, they proposed the use of a CAT with three parts: CAT-Members, CAT-Coordinator and CAT-Context. However, they did not suggest any strategic direction for its use.

Chu et al. [5] assessed organization performance using a non-additive fuzzy integral method. They identified four key dimensions which are locus of leadership, incentive mechanisms, member interaction and complementary assets. Each dimension had four criteria and was conducted in their proposed model. Final result of this model was a weighting and ranking for all 16 criteria.

Hafeez and Alghatas [11] used discourse analysis to diagnosis CoP. Discourse analysis is a way of identifying categories and developing relationships between the exchanges, sequences and episodes of messages [25]. For all communications, they classified them based on the length of the message, nature of the discourse and types of reply. By using this analysis information, they found out who contributed most and what patterns of discussion were present in the CoP.

In short, the diagnosis frameworks that were introduced above have no strategic directions for use after their initial assessment. Some researchers also mentioned the importance of suggesting a strategic direction after conducting diagnosis [10] [9]. CoP is one of the most effective methods for KM and the activities of CoP should be aligned with an organization's strategy [21] [3].

Some research tried to connect a diagnosis framework with strategic guidelines. Bishop et al. [2] identified the critical factors of CoP based on factors suggested by Wenger et al. [30], Vestal and Lopez [27] and Lee and Neff [17]. They conducted interviews to extract which critical factors are suited to their CoP and the findings were as below:

- Consider CoP member requirements
- Establish both short and long-term CoP objectives
- Establish regular CoP meetings and events
- Provide specific time allocations for CoPs
- Facilitate regular communication of CoP work
- Consider the use of supporting technology

However, the proposed diagnosis framework is not a systematic method and it is hard to conduct annually due to the long working time and high cost involved. In addition, strategic guidelines cannot be applied to individual levels.

Gongla and Rizzuto [7] proposed an evolution model to diagnosis the current state of operations. They observed patterns evolving in the organization and summarized them into five stages; potential, building, engaged, active and adaptive. They developed strategies for people, processes and technology according to each stage. Also they also showed a couple of scenarios for each stage. However, the method depends on subjective judgment to determine the evolution state.

Ruuska and Vartiainen [23] identified five dimensions of CoP characteristics; formality, organizational boundaries, competence diversity, space and interaction. The CoP is distinguished whether the social structures of CoP are formal, quasi-informal or informal. Based on the statuses of CoP, they demonstrated a way to share knowledge and showed how to direct activity. The suggested model is easy to apply in a real case due to its simplicity. However, classification of CoP status, whether the CoP is formal, quasi-informal, or informal, relies on a subjective process.

III. Social Network Analysis

Limitations of previous research on diagnosing KM using SNA

Hong [14] identified a knowledge flow network among government organizations, non government organizations, government sponsored research centers and universities. He gathered relationship data based on the degrees of hyperlinks among these organizations. He conducted an in-degree centrality analysis and an out-degree centrality analysis. Unfortunately the diagnosis just showed basic SNA indexes and did not give any strategic direction, although the research still has some meaningful information.

Kim et al. [15] conducted SNA at individual and organization levels. They presented some basic indexes, such as link distance, maximum component percentage, clustering coefficient, network density and concentration coefficient. Using these indexes, they identified current knowledge sharing activities, and also conducted an analysis of knowledge brokers. Based on the major findings from the analysis, they derived seven propositions for future research. However they also did not suggest any strategic direction for guiding knowledge sharing activities.

Anklam [1] mapped the flow of knowledge between the group manager and other sub-unit members. The direction of knowledge sharing was captured using a yes or no questionnaire, e.g 'Am I receiving information from this person frequently or very frequently?' Using the data, the author constructed a personal and sub-unit level knowledge network and analyzed it to see whether the network was well connected or not. However, a diagnosis framework takes long time if a questionnaire is needed each time and the analysis of results would depend on the knowledge of the expert, because this kind of analysis is not systematic.

Cross et al. [6] applied SNA to understand the current status of a CoP . They identified five network viewing points: central connectors, brokers, peripheral players, fragmentation points and external connectivity. Along with the above, they suggested an assessment method based on network objectives; improve information flow and knowledge reuse, develop a sense-and respond capability,

drive planned and emergent innovation, nurture value-creating interactions and engage employees through CoP efforts. However, the purpose of using SNA in this research was mainly focused on visualizing the current action in CoP, even though they did identify the types of actors in the community. Subsequently, it would be hard to conduct diagnosis regularly in this fashion due to the long time needed to collect data.

Previous research about the diagnosis of knowledge sharing activities using SNA did not give a strategic direction for future knowledge sharing activities, and some research was not effective in collecting data even though some of the results of analysis were meaningful. This paper tries to overcome limitations of previous research by suggesting an effective way of collecting raw data, developing new indexes based on fundamental indexes and suggest a knowledge sharing strategy for an individual CoP.

IV. Methodology

The overall framework of this research is shown in Figure 1.

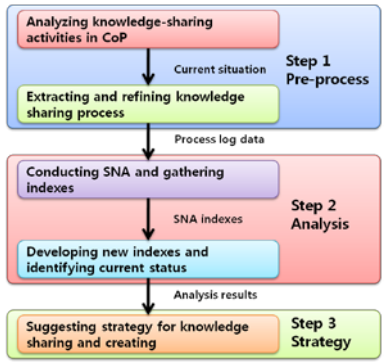

Figure 1 CoP diagnosis method

The main task of the pre-process is to understand the methodology of knowledge sharing and to build a relationship matrix as input data for the SNA. The analysis stage conducts a SNA and develops new indexes for CoP diagnosis. The strategy stage suggests strategies for future knowledge sharing activities.

Pre-process

In CoP activities, peoples share knowledge while they are solving problems, discussing certain topics and giving comments on the opinions of other members. This knowledge sharing process has two components; knowledge propagating and knowledge receiving process [13].

Knowledge propagating is the dissemination of personal ideas, techniques or know-how. Thr main difference in knowledge propagation between CoPs and Knowledge Management Systems (KMS) is whether the knowledge receiving process provides a sufficient service or not. For KMS, the knowledge receiving process is not just an important step, but rather it is a key operation because the knowledge propagator can upload knowledge on a KMS database and it may be used by many potentially unspecified persons. However, for a CoP, the interaction is even more important than in a KMS because without the knowledge receiving process, a person who disseminates knowledge cannot even be called a 'knowledge propagator'.

Knowledge receiving is an active and spontaneous process to acquire knowledge by a knowledge receiver. The knowledge receiver may search for certain knowledge, or look for knowledge experts to ask for certain knowledge. The CoP activity makes it easier to find knowledge experts and brings customized answers.

In a CoP activity, a knowledge propagator can be a knowledge receiver depending on the conditions, and a knowledge receiver can also be a knowledge propagator.

A conceptual framework showing knowledge sharing activity in a CoP is shown in Figure 2.

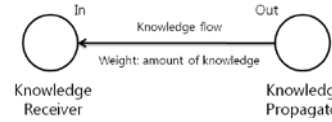

Figure 2 Knowledge sharing activity in CoP

The pattern of knowledge sharing is different between conventional CoPs and virtual CoPs. Conventional CoPs usually operate using offline activities, such as face-to-face meetings, discussions and conferences. Telecommunication and e-mail can also be used as a support activity. A conventional CoP's face-to-face activities are effective in understanding other people's knowledge and in building social capital among CoP members [18] [24]. However, the number of offline meetings can be limited and it is hard to overcome geographical dispersion.

Virtual CoP, which is an online based CoP, can be introduced to overcome the pitfalls of conventional CoP. CoP members can share knowledge without time and geographical barriers. But, virtual CoP activity may not work very well until a high level of trust has been built up among CoP members. To build trust, a virtual CoP system also uses offline meetings. The strengths of virtual CoPs are as below [22].

- High degrees of collegiality
- Generous sharing of time and resources
- Interactive and progressive problem solving
- Breakdown of previous geographical and hierarchical barriers

A knowledge sharing matrix can constructed based on an understanding of knowledge sharing activity in a CoP. Knowledge propagators are recorded in columns, and knowledge receivers are recorded in rows. If a CoP has n members, then the matrix size will be n^2, and all the spaces should be filled. This characteristic makes it necessary to spend a lot of time to collect all the data.

The methods used to collect knowledge sharing data include questionnaires, interviews and data logs. Questionnaires and interviews are the most reliable, but they take too much time to collect, and it is hard to use annually [12]. A Data log, for

a virtual CoP, can be used to create a knowledge sharing matrix. The data does need to be refined because of reliability problems.

Analysis

By using a knowledge sharing matrix for input data, basic indexes can be generated by SNA. Some of the basic indexes are explained below:

- Node type
  - Transmitter: a node which has only an out-flow
  - Receiver: a node which has only a in-flow
  - Carrier: a node which has only one connected in-flow and only one out-flow except from the in-flow node
  - Ordinary: a node which has a mixed in- and out-flow
  - Isolate: a node which is not connected to other nodes
- Network density: This is an indicator for the general level of connectedness of the graph. It is calculated based on the proportion of connected edge to all possible edges. If the network is a complete graph, the network density will be 1, and if the network is not connected at all, then the network density will be 0.

Network Density= (# of connected edge)/(n(n-1)/2) (1)

Using these basic indexes, member types can be developed; balanced player, egoistic propagator, egoistic receiver and knowledge isolator. Two dimensions are needed to determine the types of member; existence of knowledge receiving and knowledge propagating. The types of member are shown below and in Figure 3.

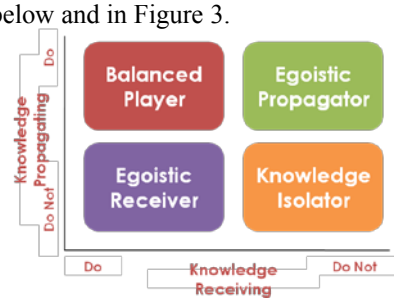

Figure 3 Types of member in CoP

- Balanced Player (BP): A member who is propagating knowledge to and receiving knowledge from other members. If node type is ordinary or carrier, then it can be assumed that they are a balanced player.
- Egoistic Propagator (EP): A member who is propagating knowledge to other members, but is not receiving knowledge from other members. If the node type is a transmitter, then they are assumed to be a egoistic propagator.
- Egoistic Receiver (ER): A member who is receiving knowledge from other members, but is not propagating knowledge to other members. If the node type is a receiver, then they are assumed to be an egoistic receiver.
- Knowledge Isolator (KI): A member who is not propagating knowledge to or receiving knowledge from other members. If the node type is isolated, then they are assumed to be a knowledge isolator.

For an active knowledge sharing in a CoP, the ratio of balanced player should be high. If the ratio of egoistic propagator or egoistic receiver is higher than the ratio of balanced player, knowledge in that CoP will not be shared actively. Therefore, CoP is able to be scored depending on the types of CoP member using balanced level score.

Balanced level score(BLS) is calculated by below formula.

$$BLS=(\sum w_i x_i)/n \quad (2)$$

n= the number of members in a CoP
wi= the weight of each member type
xi= the number of members of each type
i= type of member in a cop (balanced player, egoistic propagator, egoistic receiver or knowledge isolator)

Depending on the situation of the organization, the weight of each member type can be varied. Regarding to relative importance of member type, the weight is determined by the KM leader and expert using AHP.

Furthermore, it is obvious that network density(ND) of CoP reflects the connection of CoP member. Therefore, using balanced level score and network density, the status of CoP can be diagnosed. In short, the status of CoP can be expressed in two dimensions; (BLS, ND). Every CoP in an organization can be measured by this methodology and this will be used for benchmarking in order to make strategy for successful knowledge sharing in a CoP.

V. Case Study

Company P is currently the best manufacturing company in Korea and is 4th in the world in terms of production. It was established in 1968 using government support and was privatized in 1994. It has about 17,000 employees. Their production of crude steel is 33 million tons, their volume of sales is more than 30.6 trillion won, and their operating profit was 6.5 trillion won in 2008.

Company P introduced a CoP to capture the core knowledge of the company and make it into a company asset to achieve the management strategy goal. The predecessor of the CoP was workshops or self interest groups. Based on these offline groups, company P started a CoP activity from 2004, and it became part of regular operations in 2005. Finally, the CoP became a formal innovation infra in 2007. Now, more than 1,600 CoPs are operating with a 5:1 CoP to person ratio.

Pre-processing

Company P conducts innovation, learning and work activities using a CoP and tries to integrate these activities together. The innovation activities of the CoP mainly relate to six sigma activity from the team level to the project level. Learning activities are conducted through the CoP including on-the-job training, Q&A sessions and life-long practice. Work activities can also be performed by sharing work schedules, posting the voice of customers and maintaining work manuals.

CoP members post about ideas, issues, questions and specific topics that they want to discuss. Other members read the posts and sometimes they reply to them. For a period of logged data spanning the 1st quarter of 2008, the subjects were 43 CoPs on from field operations and 16 CoPs from offices. The general statistics for these CoPs are shown in Table 1.

Table 1 General statistics on CoP subjects

	Overall	Field	Staff
# of CoPs	59	43	16
# of members	4,537	3,606	931
# of writings	16,442	12,822	3620
# of writings per person	3.62	3.56	3.89
# of readings	270,173	227,502	42,671
# of readings per person	59.55	63.09	45.83

We consider the creation of the posts as a knowledge propagating activity, and the reading of other members' posts as a knowledge receiving activity. We regard the posting of a reply as a knowledge propagating activity, and the original writing as a knowledge receiving activity. From this perspective, we can construct a knowledge sharing matrix as shown in Figure 4. The knowledge sharing matrix is used as the input data for the SNA.

	강대선	김강희	김복신	김민재	김병삼	김석겸	김석래
강대선	0	1	0	2	2	0	0
김강희	3	0	0	97	17	0	0
김덕진	0	0	0	0	0	0	0
김민재	0	0	0	0	0	0	0
김병삼	0	1	0	2	0	0	0
김석겸	0	0	0	3	1	0	0
김석래	0	0	0	0	0	0	0

Figure 4 Example of a knowledge sharing matrix

Analysis

This step shows general statistics for an SNA and the analysis results for three CoPs as an example. In order to conduct a SNA, the NetMiner 2.0 system is used. General statistics on basic indexes including member types and network density are shown in Table 2.

Table 2 Basic indexes of the SNA

	Overall	Field	Staff
Proportion of BP (%)	48.7	50.1	43.4
Proportion of EP (%)	7.0	7.5	5.3
Proportion of ER (%)	28.9	28.7	29.6
Proportion of KI (%)	15.4	13.9	21.7
Network density	0.114	0.100	0.150

In order to measure balanced level score, the weight of each member type have to be determined. Using AHP, the leader of KM team and experts discuss relative importance of each member type and decided weight. Table 3 shows the pair-wise comparison matrix for member type and the result of AHP. KM leader of company P and KM experts discussed that balanced player is the most important member in a CoP, and egoistic propagator is more important than egoistic receiver. Egoistic propagator writes their knowledge in KMS, in other words, they store knowledge. They mentioned that knowledge which is stored in KMS, can shared anytime when other people access that knowledge. Knowledge isolator, needless to say, is needed to change into other 3 member types. Although Knowledge isolator is not important in a CoP, weight of knowledge isolator is not zero. They don't act actively in a CoP, but they still have potential for change. If they join CoP activities, they will be supporters for active knowledge sharing.

Table 3 The pair-wise comparison matrix

	BP	EP	ER	KI	Weight
BP	1	5	6	9	0.641
EP	1/5	1	2	7	0.198
ER	1/6	1/2	1	5	0.123
KI	1/9	1/7	1/5	1	0.038
Inconsistency Ratio: 0.09					

After deciding weights of member type, balanced level score of each CoP was calculated. Figure 5 shows the network density and BLS of 59 CoPs. Mean and standard deviation of network density are 0.103 and 0.117; mean and standard deviation of BLS are 0.340 and 0.137.

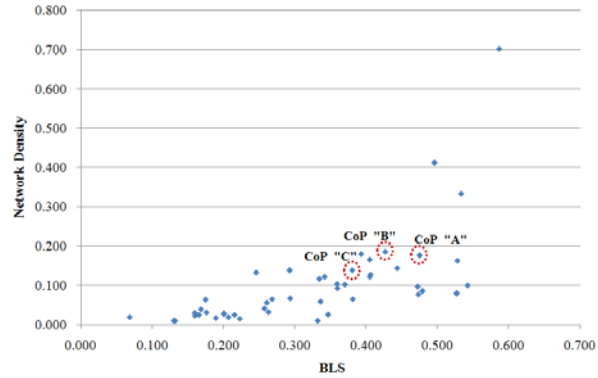

Figure 5 Current knowledge sharing activity status of CoPs

Table 4 explains details for three CoPs, named A, B and C. The number of balanced player of CoP A and B exceed 50%, on the other hand, CoP C doesn't. BLS reflects this result.

Table 4 General statistics and analysis results for 3 CoPs

	CoP "A" (CoP#29)	CoP "B" (CoP#57)	CoP "C" (CoP#32)
# of members	78	71	31
# of writings	464	232	42
# of readings	5,720	3,371	621
# of BP	53	42	15
# of EP	0	2	4
# of ER	25	23	11
# of KI	0	4	1
Balanced Level Score	0.475	0.427	0.381
Network Density	0.176	0.185	0.138

VI. Conclusion

CoP has become highlighted as one of the more effective KM methods, and the need to connect the CoP activities to an organizations' strategic direction, and the need to

diagnose the current status of a CoP is increasing [31] [9] [19].

Previous research about CoP strategies was usually based on the diagnosis of current CoP knowledge sharing activities. Therefore, the suggested strategies can guide a business at the organization level, rather than at the individual level [19] [28] [29] [15] [32]. On the other hand, some research about diagnosis methodologies was conducted. However, diagnosis methodologies use subjective methods e.g questionnaires, interviews and ratings [20] [26] [5] [11]. Even though some of these methods explain the current knowledge sharing activity exactly, these are hard to conduct periodically due to the high cost needed and the long time required to carry it out. Other research using objective methods, such as SNA, did not suggest any strategic direction and required too much effort to gather the data [6].

Taking account all the above details, this paper contributed as follows: First, this research developed a sustainable diagnosis methodology using SNA. Second, the proposed diagnosis methodology created new frames for identifying member types, participation types and CoP types. Third, this research suggested customized strategies for individual CoP knowledge sharing activities based on a diagnosis of the current status.

In future, research on the best way of utilizing the previous and proposed indexes is needed. By using these indexes and conducting further analysis, more strategies can be generated for individual CoPs. Also, research about the methods for extracting knowledge propagation and receipt activities would be able to explain the scenario more accurately. Finally, integration of the suggested method with previous qualitative diagnosis methodologies could complement the shortcomings of other methodologies.

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