Understanding Team Communication Characteristics using Social Network Analysis

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1. Introduction

An important aspect of human behavior in nuclear power plants (NPPs) is team interaction since operating NPPs involves the coordination of several team members among and within workplaces. Since operators in main control room (MCR) get a great deal of information through communication to perform a task, communication is one of the important characteristics for team characteristics.

Many researchers have been studying how to understand the characteristics of communication. Social network analysis (SNA) which is considered as an objective and easily applicable method has been already applied in many fields to investigate characteristics of team communication. Henttonen (2010) [1] has struggled to perform the research on the impact of social networks in a team and he found some team communication characteristics could be obtained using some properties of SNA. In this paper, SNA is used to understand communication characteristics within operators in NPPs.

2. Brief description of SNA

SNA is defined as a specific set of linkages among a defined set of persons, with the additional property that the characteristics of these linkages as a whole may be used to interpret the social behavior of the persons involved [2]. SNA describes the patterns of interaction and communication, and how to exchange situational information among team members.

There are two ways of SNA to describe the patterns of interaction between team members. One is the graph model which is presented as sociograms. This model displays the relations among network members in two dimensional spaces. Team members are represented as points and nodes of sociograms with a line which explains their relationships. The other one is matrix model which presents a network in the form of array of units arranged in rows and columns. The rows represent network members and the columns represent the same set of members in identical sequence [3].

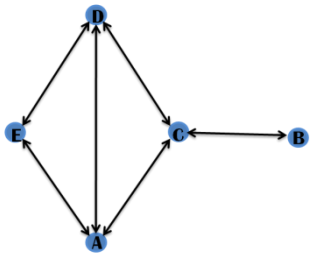

Fig. 1 Example of graph model

The cell of the matrix shows the relationship between team members. Fig. 1 and Fig. 2 show the example of graph model and matrix model assuming that a team consists of five members. Both of them are used to understand team communication characteristics.

There are also some properties which can be derived from SNA such as transactional contents, nature of the links, and structural characteristics [4]. These properties could be obtained using UCINET software.

	A	B	C	D	E
A	2	0	1	2	1
B	0	2	2	0	0
C	1	2	3	1	0
D	2	0	1	2	1
E	1	0	0	1	2

Fig. 2 Example of matrix model

In this paper, the value of density and intuitive structure which are one of structural characteristics is obtained and used. The density is defined as the overall level of interaction among the team members, analogous to the mean number of ties between them [7]. Also, density is used to determine the degree of team cohesiveness; higher density means all the members interact with each other frequently [1].

$$Density = \frac{the\ total\ number\ of\ ties}{the\ total\ number\ of\ the\ possible\ ties} \quad (1)\ [8]$$

3. Application of SNA to understand team communication characteristics in the nuclear Fields

Previous researches on SNA used the questionnaire as an input to SNA [1]. However, speech act coding scheme which was developed by S.H. Kim et al. (2010) [5] is used in this paper to analyze team communication characteristics more objectively. Speech act coding scheme is used to classify and count each communication between operators. Using speech act coding scheme, what kinds of speech act coding scheme operator mentions and their frequencies can be calculated. This is used as an input to SNA instead of results from questionnaire and some properties of SNA such as density and intuitive structure of team communication using graph model can be calculated to

understand team characteristics. In this paper, verbal protocol data [6] from 4 teams are used and some properties are calculated.

4. Result

The matrix models of each team are obtained and shown in Fig. 3.

Team 1	EO	RO	SRO	TO	STA	SS	LO	Team 2	EO	RO	SRO	TO	STA	SS	LO
EO	13	4	4	8	0	6	8	EO	13	1	1	11	0	6	8
RO	4	4	0	2	0	3	3	RO	1	1	0	1	0	0	0
SRO	4	0	6	3	0	0	2	SRO	1	0	3	2	0	2	2
TO	8	2	3	10	0	4	5	TO	11	1	2	14	0	7	10
STA	0	0	0	0	0	0	0	STA	0	0	0	0	0	0	0
SS	6	3	0	4	0	9	7	SS	6	0	2	7	0	11	9
LO	8	3	2	5	0	7	10	LO	8	0	2	10	0	9	13
Team 3	EO	RO	SRO	TO	STA	SS	LO	Team 4	EO	RO	SRO	TO	STA	SS	LO
EO	12	2	1	12	0	5	6	EO	10	8	1	9	0	3	6
RO	2	3	0	3	0	0	1	RO	8	11	1	9	0	4	8
SRO	1	0	2	1	0	0	1	SRO	1	1	4	2	0	0	1
TO	12	3	1	15	0	7	8	TO	9	9	2	12	0	4	7
STA	0	0	0	0	0	0	0	STA	0	0	0	0	0	0	0
SS	5	0	0	7	0	10	7	SS	3	4	0	4	0	9	8
LO	6	1	1	8	0	7	11	LO	6	8	1	7	0	8	13

Fig. 3 Results of matrix model

As shown in Table1, the value of density of each team was varied from 2.5714 to 3.3810 according to their team communication characteristics. Additionally, structures of each team communication were varied as well, and shown in Fig. 4.

Table 1 Density of each team

Team ID	density
Team 1	3.0952
Team 2	2.5714
Team 3	2.8571
Team 4	3.3810

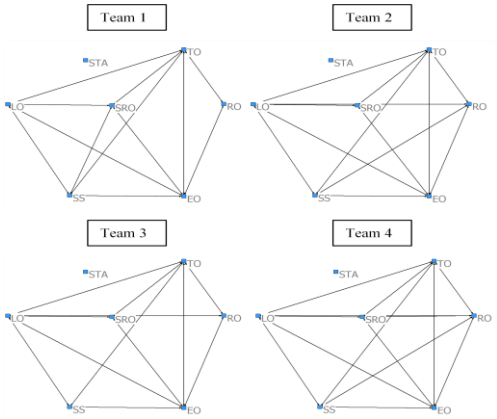

Fig. 4 Result of graph model

4. Discussion and Conclusion

Every four team has different values of density and intuitive structures of team communication. Team communication characteristics can be inferred from different value of density since this value can explain the various degree of team cohesiveness. Higher density value can be interpreted as each team members communicate each other frequently. Addionally, it is shown that a graph model can be used to present the structure of communication between team members, and show the pattern of interaction between team members.

In conclusion, some properties of SNA can be used as means of understanding team communication characteristics.

5. Further Research

This study was originated from assuming that it would be possible to prevent inappropriate communication based on understanding team communication characteristics. For example, more cohesive team with higher density has less chance of inappropriate communication than less cohesive team since groups that more frequently communicate among their members enable its members to achieve a greater degree of coordination, greater information sharing, and stronger sense of accountability [9]. Although a taxonomy of inappropriate communication have been suggested by many researchers, it is difficult to classify which contents are inappropriate. For that reason, it is required to derive more practical taxonomy of inappropriate communication.

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