Proposal and Evaluation of a Method for Promoting Organizational Learning to Foster Safety Culture in Nuclear Power Plants

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ABSTRACT

Safety is top priority in nuclear power plants. Safety culture, which is organizational culture which makes members of the organization to pay their attention to safety as their priority, is essential to keep safety. It is known that continuous learning activity using accident and incident database is necessary to develop safety culture. Nevertheless, the learning activity has not been continued, because of the lack of motivation to use database. In this study, therefore, the authors aim at developing a new method to promote learning activity to use database. First, a time-variation model of motivation for using database was constructed based on an interview with a worker in a nuclear power plant who uses his own database spontaneously. This model assumes that an attachment, which is an emotional bond to a particular object, was the most significant factor to enhance the motivation for using the database. Second, “Praising each other’s data” and “adding original data”, were proposed as a method to foster attachment to database. Then, a subject experiment for evaluating the proposed method was conducted. The result showed that the proposed method needs to be modified to include additional factors such as “Quality of praise", and “Degree of interest”.

Keywords: Safety Culture, Organizational Learning, Database, Motivation, Attachment.

1. INTRODUCTION

Safety is top priority in nuclear power plants. Recently, not only technical factor such as maintenance of machines, but also human factor is regarded as important for safety in nuclear power plants. Human factor includes individual factors such as motivation, knowledge and experience, and organizational factors such as shared values among members, working conditions and policies. Especially, it is considered that safety culture as one of organizational factors is essential in order to keep safety, since the IAEA reported the accident at Chernobyl in 1987. Safety culture is defined by IAEA as “assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance.”[1]

According to Reason, a safety culture is an informed culture [2]. This definition of safety culture intends to emphasize the importance of organizational learning to foster safety culture. In this context, the organizational learning means activities which utilize information on the past accidents and incidents occurred in the organization to keep safety.

A large number of accidents and incidents are reported by large organizations such as nuclear power plants. A computer database, therefore, can be a useful tool for the organizational learning because it can provide powerful search functions to support users to find necessary data. From this point of view, electric companies made data-

base system such as NUCIA (NUClear Information Archives) which provides information on accidents and incidents occurred in nuclear power plants [3]. It is desired that many workers in nuclear power plants learn from the database to avoid the same kinds of accidents and incidents. Nevertheless, the database like NUCIA is not utilized effectively. Some studies on introducing information systems to organizations report the same kind of problems [4][5], and they points out that the cause of the problem is that the users do not perceive the value of the database. The authors, therefore, aim at proposing and evaluating a method for promoting organizational learning to use database by enhancement of motivation.

2. SURVEY OF SPONTANEOUS LEARNING ACTIVITY

Subject and method

In order to investigate what kinds of motivation factors exist and what is the most significant factor to enhance the use of database, a preliminary survey to workers of nuclear power plants were conducted. Then it was found that there is a worker who made his own database and uses it for leaning activity spontaneously. He is a chief of a work group in a section of maintenance. Few workers do leaning activity spontaneously, the chief is, therefore, important for this study because he should have unique motivation factors which the other workers don't have. In this study, therefore, an interview with the chief was conducted to reveal his unique motivation factors.

Result

The analysis of the result reveals that there are 4 motivations for making his own database and use it for leaning activity. Those are "perceived value", "cost", "order" and "attachment".

The chief said "My subordinates didn't make their own database because they have never experienced a value of database". This means that one of the chief's motivations is the perception that the database is useful for his activity. The chief also said "I can continue to make my database because the way to gather data is very simple and easy". This means that it is important that the cost to gather data is very low. These two factors, "perceived value" and "cost" are already known to exist as the motivation for using database [4][5]. The chief also said that "I ordered my subordinates to make their own database several times, but they didn't." This means that "order" may be one of the motivations for using database, but its effect does not continue for a long time. Moreover, the chief said that "I made my database as a hobby rather than work" and "I feel that the database is my property." From this expression, we can find the 4th factors of motivation, "attachment". "Attachment" means emotional bond with a specific object. It is originally used in developmental psychology as a concept which expresses special relation between a child and a mother. In another academic definition, this is strength of the cognitive and emotional bond connecting the object with the self [6].

Time-variation model of motivation in database use

Figure 1 shows a time-variation model of motivation for using database which was built based on the analysis described above. As mentioned above, the effect of "order" attenuates over time. "Attachment" takes time to be fostered [7]. "Perceived value" needs to be experienced in actual accidents and incidents to be realized, but the opportunity of the experience is rare because of the technological improvement. Then, "perceived value" also takes time to be realized. These time variation of factors cause "a blank period of motivation", in early phase of database use, before "attachment" and "perceived value" are fostered, as shown in Fig.1. The users may stop to use database because there is no motivation at "a blank period of motivation". A method to bridge "a blank period of motivation" is necessary in order to realize the continuous use of the database.

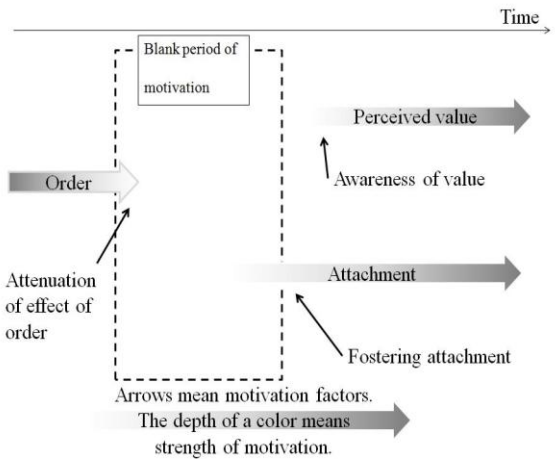

Fig. 1: Time-variation model of motivation for using database.

3. PROPOSAL OF A METHOD TO PROMOTE FOSTERING ATTACHMENT TO DATABASE

Selection of suitable factor for enhancement

There are 4 strategies to bridge "a blank period of motivation", reduce of "cost", enhancement of "order", "perceived value" and "attachment". Reducing "cost" can promote somewhat use of database but it has lower limit because "cost" is negative factor. The fact that the chief's attempts were all failed means that "order" is not suitable factor to bridge the blank and it is difficult to realize "perceived value" by external cause. Therefore, the authors focus on "attachment".

Elements to foster attachment

Some studies on "attachment" indicate that an object which meets some requirements tends to be a subject of attachment [7]. One of the requirements is meeting psychological desire, such as self efficacy, being gratified. Social relationship is also one of psychological desires inherently [8], and then it is considered to be one of the requirements. Self expression is also one of the requirements [9]. Spending psychological cost, such as time and effort, on a specific subject yields attachment to the subject [9]. These elements should be taken into consideration for fostering attachment.

A method to foster attachment to database

A method to foster attachment to database is proposed as shown in Figure. 2. This method consists of "Praising each other's data" and "Adding original data". "Praising each other's data" means that users of database are required to praise up the other's data with brief comment. This assumes that the database is used in a small group like the chief's group in nuclear power plants. This method will contribute to foster attachment through meeting psychological desires, "being gratified" and " social relationship". "Adding original data" means that the users are required to input original data generated by the users such as the user's opinion or impression towards accidents and incidents in addition to the objective data. This method will contribute to foster attachment through making database more self-expressive and increasing psychological cost.

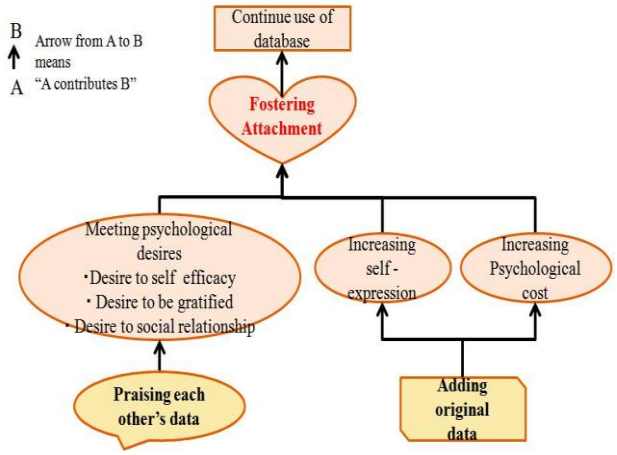

Fig. 2: A method to foster attachment.

4. EXPERIMENT TO EVALUATE A METHOD TO FOSTER ATTACHMENT

Purpose and subject

An experiment was conducted in order to evaluate the proposed method to foster attachment. The method should be evaluated by applying to the workers in nuclear power plants, because the objective of this study is to develop a method which can promote learning activity to use database in nuclear power plants. However, it is very difficult to conduct the experiment in a real nuclear power plant because it may disturb the operation of the plant. Therefore, 40 university students were employed as the subjects and records of scientific and technical papers were selected as the contents of the database. These compromises are acceptable only when the relation between database and users in nuclear power plants is equivalent to the relation between database and users in the experiment. As shown in Table 1, both of workers in nuclear power plants and university students are busy for their business, and their "perceived values" towards the database are not enough to drive them to make their own database and use them spontaneously. It also can be assumed that few students have strong motivation to make database, like few workers in nuclear power plants.

Table 1: Comparison between workers and students

	Infomation of incident for workers in nuclear power plants	Information of academic paper for students
Their situation	Workers are busy because they have a lot of every day work.	The experiment was conducted at end of term then students are busy for preparation of exam.
Their state of motivation	They know value of Informattion because they took orders, but It is not enough to move them because of busyness.	They know value of Information because they have to read papers for their study, but it is not enough to move them because it doesn't profit in
	Few of them have enough motivation to make database spontaneously.	Few of them are interestied enough to read academic paper spontaneously.

Condition and method

Subjects were 40 university students from first grade in bachelor course to second grade in master course, form 18 to 26 years old. Average age was 20.58 and SD (standard deviation) was 1.79. They had wide variety of majors. They were paid 10 thousand Japanese yen to join the experiment as part time worker. The subjects were divided into an experimental group and a control group. (All subjects answered questionnaires shown in Table 2 in advance and the division was made based on the result in order to reduce the difference between the groups.) Each group consists of 20 subjects. The subjects of the experimental group were divided into 4 sub groups. Each sub groups consists of 5 subjects. The period of the experiment was 1 month. All the subjects were required to read 2 papers a week (total 8 papers), and input data of each paper to their personal database constructed on the Internet. The items they were required to input were title, authors, keyword, abstract, originality and usefulness of study described in the papers. The subjects of the experimental group were also required to input summery or impression of each paper with over 400 Japanese characters as their "original data" and to praise the data inputted by the other subjects who belong to the same sub group. In the experimental period, all the subjects were required to answer a questionnaire shown in Table 3 every time they finish inputting the data of the paper. The questionnaire shown in Table 3 is related to the subject's motivation factor, especially attachment. After the experiment, ex-post questionnaire was delivered to the subjects, in order to know their impression to the experiment, especially to the method "Praising each other's data".

Table 2: Prior questionnaire

Section	Sentence of questionnaire	Factor
A1	You tend to continue after school lessons long.*1	Attachment
A2	You cannot discard things*1	Attachment
A3	You want to be praised anytime.*1	Effect of praise
B	Have you ever read academic papers?*2	Experience(cost)
C	Papers you have to read is that about human interface. How much are you interested in this area of resarch?*3	Interest

*1 answered in 7 points scale (-3 = I don't agree at all, +3 = That is true).
*2 answered in yes or no (Yes = 1, No = 1).
*3 answered in 7 points scale (-3 to +3)

Table 3: Questionnaire during the experiment

Section	Sectence of questionnaire	Factor
1	I feel attachment to my database.	Attachment
2	If my database was destroyed, I would feel disappointment.	Attachment
3	Inputting data is not so hard.	Cost
4	I feel self expression in my database.	Attachment
5	I feel like to review my database.	Attachment
6	If I was praised about my database, I would not be pleased.	Effect of positive comment

answered in 7 points scale (-3 = I don't agree at all, +3 = That is true).

Result

Attachment scale: The number of valid answers to the questionnaire during the experiment was 34. Cronbach's alpha of section 1, 2, 4, and 5 of questionnaire was calculated to be .83. Then, sum of these sections for each day can be treated as "attachment scale". Average of the attachment scale in each groups of each day is shown in Fig. 3. Figure 3 shows that the average of the control group maintains an upward trend. By contrast, the average of all experimental group remains on the same level, and was overtaken by the control group at day 18 and day 22. The 4 experimental groups show different trends in the attachment scale. The group 1, 2, 4 show down ward trend, the group 2 shows up ward trend singularly.

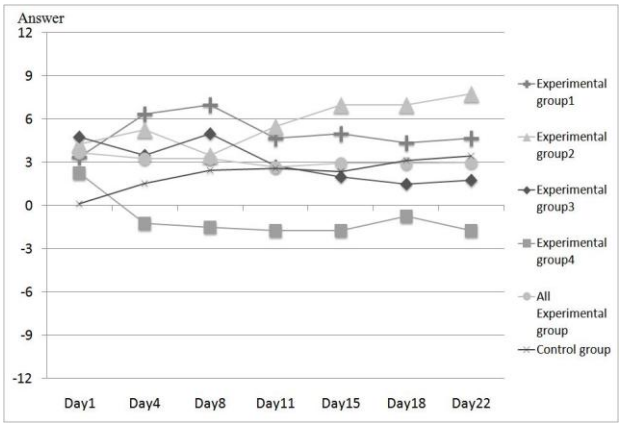

Fig. 3: Time variation of attachment scale

Praise: Total number of praises and average of characters for each praises in each group are shown in Fig. 4. Kruskal Wallis test with 4 each experimental group reveals significant difference (χ^2 =219.09, p<0.01) in average of characters for each praises. Moreover, number of characters has relation to "quality of praise" which is degree of excellence of praise. For example, a very simple praise such as "good summery" is low quality. By contrast, a long praise which praises specific points of the summery is high quality.

Ex-post questionnaire: The number of valid answers was 37. It was found that some subjects felt that the experiment was boring. All subjects of the experimental group 3 didn't answer that the experiment was interesting. By contrast, subjects of the experimental group 2 felt the experiment was interesting. 3 subjects of the experimental group 4 didn't answer the ex-post questionnaire.

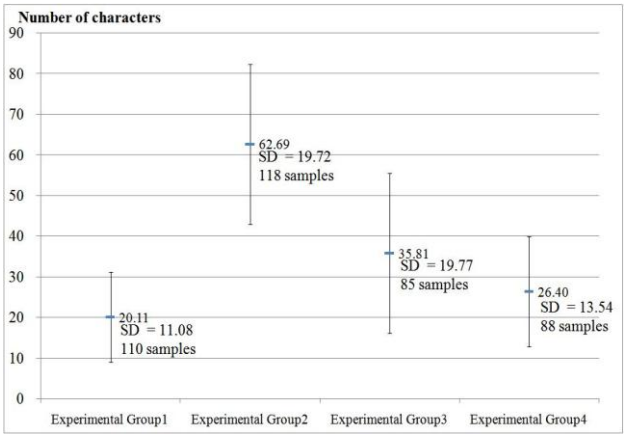

Fig. 4: Average number of characters of praise in each experimental group

Discussion

The experimental group 1 and 2 shows a higher trend than the experimental group in attachment scale singularly. By contrast, other experimental groups a lower trend. Especially, only the group 2 shows upward trend. This single success of the proposed method in the group 2 suggests that additional factors, which were not covered in the proposed method shown in Fig.2, affected fostering attachment positively in the group 2 but negatively in other groups. Personal and group factors are possible to be the additional factors.

Personal factors: The result of the ex-post questionnaire implies that the inequality of "degree of interest" affects the attachment scale of each subject. It can be confirmed from the fact that the group 2 shows up ward trend in attachment and all the subjects of the group 2 had high interest. Nevertheless, "degree of interest" was taken into consideration by prior questionnaire and it was confirmed that there was no significant difference between groups. This implies that there is a difference between prior expectation and after impression.

Group factors: The result of Kruskal Wallis test indicates that, "quality of praise" have uniformity trend in each group. In other words, "praise rate" particular to each group emerged as time passed. This means that the subjects decide the quality of their data referring to the one of the others. T he experimental group 2 shows the highest "quality of praise", and up ward trend in the attachment scale. By contrast, the experimental group 4 shows a low trend both in "quality of praise" and the attachment scale. Therefore, this suggests that "quality of praise" affects fostering attachment.

5. CONCLUSION

In this paper, a new method to foster attachment to database was proposed aiming at the continuous use of database for organizational learning for safety culture in nuclear power plants.

First, based on the result of a survey with a case of spontaneous use of database, a model of motivation factor in database use and a time-variation model of motivation were constructed. Next, from the analysis of

these models, it was suggested that "blank period of motivation" is a cause of the problem that database use doesn't continue. Then, in order to bridge the blank period of motivation, two methods to foster attachment, "praising each other's data" and "adding original data" were proposed. Finally, an experiment was conduced to evaluate the methods. The result shows that the proposed method is insufficient because "quality of praise", "degree of interest" and "praise rate in each group" was not taken into the consideration.

The revised model of fostering attachment is shown in Fig.6. It is expected that this model is more accurate than the model shown in Fig.2, but the effects of group factor and personal factor were complexly interacted and mixed. It is, therefore, difficult to decide the strict relation between each factor. Further research is necessary to reveal the strict relation between the factors.

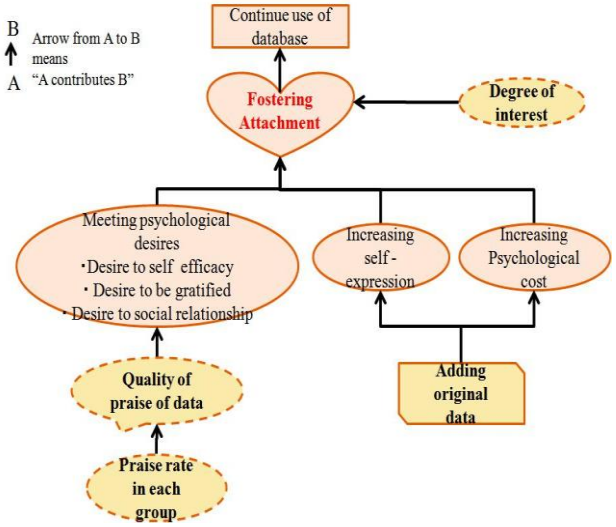

Fig. 6: Revised model of fostering attachment.

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