Communication Error Analysis Method based on CREAM

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1. Introduction

Communication error has been considered as a primary reason of many incidents and accidents in nuclear industry. In order to prevent these accidents, an analysis method of communication errors is proposed. This study presents a qualitative method to analyze communication errors. The qualitative method focuses on finding a root cause of the communication error and predicting the type of communication error which could happen in nuclear power plants. We develop context conditions and antecedent-consequent links of influential factors related to communication error. A case study has been conducted to validate the applicability of the proposed methods.

2. Qualitative Analysis Method

For qualitative method, Cognitive Reliability and Error Analysis Method (CREAM) can be used both in a retrospective and a predictive manner. [1] The retrospective method describes how CREAM can be used for accident and event analysis. The purpose of the retrospective method is to make a path of probable cause-effect relationships from the observed effect. While the predictive method describes how it can be used for human reliability assessment. In this study, the purpose of a retrospective method is to make a path of cause-effect links to describe how this method analyzes communication-related accidents to find causes. The one of predictive method is to describe which type of communication errors can happen. Specifications for necessary requisites are explained.

2.1 Context conditions

For encoding process of sender and decoding process of receiver, we can consider the effect of factors affecting each process. For example, too less stress make human feel indolent, too much stress make human feel fatigued. But an appropriate level of stress can make human concentrate their situation and work [2]. It helps improve human performance. Whether which factor can make human performance good or bad depends on an environment condition. Therefore, one influential factor can influence different effects to human communication performance with respect to an environment condition.

So in order to find root causes of communication error, an evaluation of the environment condition should be conducted. Environment condition is also emphasized in CREAM as a starting point of retrospective and predictive analysis. They provide 9 categorizations to evaluate the environment condition. In this point, context conditions (CCs) are suggested based on CREAM. To make context condition be specified to communication, some lists are edited. Adequacy of equipments means the quality of the communication related devices. Also the meaning of availability of procedure, workload, and expertise level is also edited as only for communication related procedures [2].

2.2 Communication Error and Causes

Communication error modes and error types are defined based on NUREG-1545 [3] and communication process model [4] as shown in Table 1.

Table Ⅰ Error modes and types of communication

Error Modes	Error Types
Timing	Message is sent at the wrong time.
	Message is not sent at all.
Acoustic Feature	Message is sent with an uncommon acoustic feature.
Channel	Message is sent to the wrong place or person.
	Message is sent through inadequate route.
Contents	Message production is inadequate.
	Message content is inappropriate for the receiver.
	Message content is wrong.
Sequence	Message content is inconsistent with other information.

According to CREAM, genotype is defined as the possible causes such as the functional characteristics of the human that are assumed to contribute to an erroneous action [1]. For causes, person-related, technology-related, and organization-related genotypes are defined. For each genotype, the relationships between general consequent and general antecedent are defined based on CREAM [1], NUREG reports [2, 3], and communication related papers and reports [4, 5, 6].

To find causes of suggested errors, relationships between error modes and general consequent are defined, that is, general consequent is the cause of error type. In this sense, the cause of general consequent is found by the relationships between general consequent and general antecedent. The relationships are suggested as antecedent-consequent links in this study. By repeating the process of finding cause through the suggested links, we can finally find the root cause of the error type.

3. Case Study

The proposed method is applied to a case study of an accident related to communication error. Root causes are identified this method in a retrospective way.

The selected accident caused by communication errors is the Diablo Canyon PWR unit 2 residual heat removal failure that happened in 1987 [5]. The following is a brief explanation about the accident.

At one stage an engineer opened a drain valve without informing the control room. This led to an unexplained leakage from the control tank. Certain actions taken within the control room to correct this led to a gradual, undetected decrease in the reactor vessel water level. The loss of water level led to the reactor residual heat removal stopping. No decay heat removal occurred for one and a half hours, during which the vessel water increased from about 31℃ to 100℃, with steam resulting from the open primary system.

For this accident, a relevant communication error is reported, that is, the control room operator tripped a pump prior to notifying team members of his intended action.

It was reported that the error case is caused by the breakdown of teamwork concept [5]. Thus, this error is chosen as “message is not sent at all” error type. The retrospective analysis to find a root cause of this error type is shown in Fig 1.

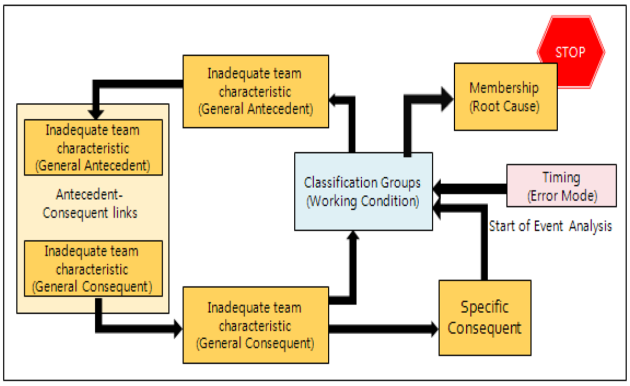

Fig 1. Retrospective analysis of the relevant communication errors

Through the relationship between error mode and general antecedent, the inadequate team characteristic is assigned to a “timing” error mode. Through the organization related antecedent-consequent links, it is decided that inadequate membership is the reason and there is no more antecedent links for membership. It is therefore deduced that inadequate membership is the root cause in this case. This case study provides the usefulness of suggested analysis method. Although the communication erroneous action applied to analysis method is what happened in NPP, all accidents related to communication error can be analyzed by the method.

4. Conclusions

To prevent accidents related to communication errors in NPPs, we have proposed the analysis method to serve a systematic analysis in terms of the speaking process. The qualitative analysis method for communication errors make to do the retrospective and predictive analysis of communication failure. Root causes are found through the retrospective analysis method and expected errors are also found through the predictive analysis method. As a case study, the qualitative analysis method is applied to a communication error case and a root cause of the case is found by retrospective analysis. A more concrete and detailed qualitative analysis might be possible if the antecedent-consequent links are arranged in more detail. This study will not only be useful for analyzing the communication related events but also be the basis for research such as developing the communication support procedure and the communication support tools for cooperation in NPP.

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