Verbal Communication Analysis of Operators in Advanced Main Control Room under Emergency Situation

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1. Introduction

Verbal communication problems have been regarded as one of the biggest causes of trouble in many industries. This led to extensive research on communication as a part of human error analysis. The results of existing research on verbal communication have revealed that maintaining a good quality of communication is essential to secure the safety of a large and complex process system. Therefore, unless communication is performed efficiently, the quality of task and performance of team lower. Furthermore, since communication is highly related to situation awareness during team activities, inappropriate communication causes a lack of situation awareness and tension and stress are intensified and errors are increased [1].

The advanced main control room (advanced-MCR) is the one that allows for reactor operations and maintenance based on instrumentation and control systems (I&C) incorporating the state-of-the-art digital technology. In the advanced-MCR the shit-supervisor (SS) takes advantage of the computerized procedure system (CPS), which enables him to check operating parameters and information through a large display panel (LDP) and digitalized operator console (IPS).

Due to applicability of digital aspects of advanced-MCR like CPS, IPS and LDP, the accessibility to plant status information is increased that those of conventional MCR. Therefore, it is expected that communication characteristics of operators in advanced-MCR are different from those of the conventional MCR. It is essential to conduct a verbal communication analysis of operators in the advanced-MCR. The objective of this study is to elucidate the communication pattern characteristics of an operator's conversation during an emergency situation in the advanced-MCR of APR1400 nuclear power plant.

2. Verbal Communication Analysis

2.1 Extended Act Coding Scheme

KAERI suggested Extended Speech Act Coding Scheme to observe communication characteristics of operators to cope with an emergency or abnormal situation in the main control room of nuclear power plants [2]. Communication messages in the main control room (MCR) of a NPP generally contain various data types to be classified. It is composed of 7 main categories with 18 sub categories, all of which are arranged in Table 1.

Table 1 A Speech act coding scheme used in this study

CATEGORY		DEFINITION
CALL	Call	A call for a specific person for communication.
	Response	A response for the Call.
	Call-Identification	A Caller's self-identification to target person
	Call-Id-Ack	A Receiver's Response for caller's self- identification
INQUIRY	Inquiry	A statement for asking.
	Reply	An answer for the question.
	Reply-Ack	A statement representing a reply was received
COMMAND	Command	A specific order of responsibility by one to another to manipulate an object.
	Command-Ack	A statement representing a command was received
	Command-Confirm	A Confirm message that command was sent successfully to receiver
	Suggestion	A statement of recommendation for specific action or an introduction of an idea for consideration
OBSERVA -TION	Observation	A statement that describes status of the plant or equipment
	Observation-Ack	A statement representing an observation was received
JUEGMENT	Judgment	An expression that judge the situation
	Judgment-Ack	A statement representing a Judgment was received
ANNOUNCE -MENT	Announcement	A statement to the public which gives information about something that happened or that will happen.
	Announcement-Ack	A statement representing an Announcement was received
ACKNOWLE -DGEMENT	Acknowledgement	A statement representing a message was received

2.2 Data Collection

The emergency scenario used in the verbal communication analysis was related to cope of operator's activities when steam generator tube rupture, small break loss of coolant accident and station black out. In the data collection, all kinds of operator activities (such as valve or pump operations) including communications among the crew members can be recorded. Thus, all kinds of verbal communication messages were examined with the extended speech act

coding scheme and classified into each categories.

3. The Results of Verbal Communication Analysis

The protocol analysis under a simulated emergency condition was performed on the basis of main categories and sub categories of the speech act coding scheme. Fig. 2 shows the results of the communication protocol analysis.

The overall result of the communication patterns for an emergency operating condition are shown in Fig 1.

- CALL (15.3%): Call, Response, Call-Identification, Call-ID-Ack
- INQUIRY (50.4%): Inquiry, Reply, Reply-Ack
- COMMAND (20.6%): Command, Command-Ack, Command-Confirm, Suggestion
- REPORT (13.6%): Observation, Judgment, Announcement
- ETC (0.1%): Acknowledgement and etc.

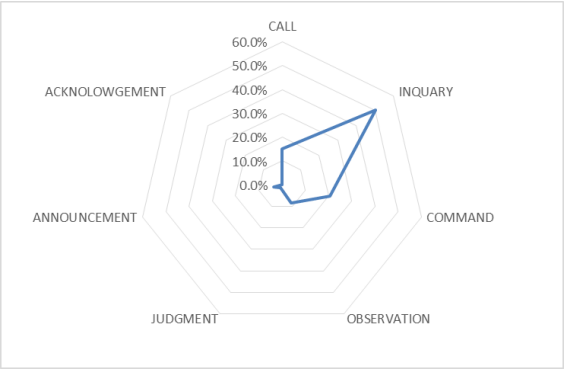

Fig. 1. The composition of communication categories under emergency condition (main category)

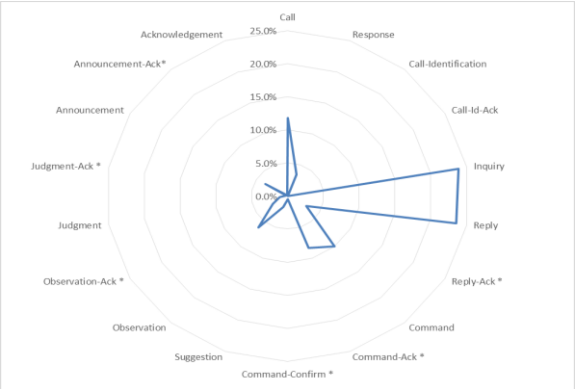

Fig. 2. The composition of communication categories under emergency condition (sub category)

According to the main category analysis, the solution process in the emergency condition was carried on in the order of 'CALL', 'INQUIRY/REPLY' and 'COMMAND', which represent recognizing the symptoms of the emergency condition, identifying countermeasures for problem, and carrying out countermeasures, respectively. These 3 main communication patterns occupy 86.3% of total area.

We obtained some insights from results of the analysis.

First, the three major communication patterns are 'CALL', 'INQUIRY', 'COMMAND' Patterns and they cover 76.9% all the communications.

Second, the 'Inquiry (23.8%) / Reply (23.6%) / Reply-Ack (3.0%)' set occupied the highest portion (50.4%) of a conversation because understanding a symptom or trouble and the solving activities were usually expressed by this message pattern types.

Subsequently, the 'Command (10.0%) / Command-Ack (8.4%)/ Command-Confirm (0.5%), Suggestion (1.8%)' set was the second frequently used pattern during a communication under an emergency operating condition.

4. Conclusions

The protocol analysis under a simulated emergency condition was performed. Since the extended speech act coding scheme was developed to observe the verbal crew responses of conventional MCR, it is wondering that the existing speech coding scheme is suitable for verbal communication analysis of crew activities in advance MCR. As a result of the study, the extended speech act coding scheme can be adapted for verbal protocol analysis not only for conventional MCR but also for advanced MCR. To prove the confirmation of such a fact, however, further research will be necessary, that is to say, comparing communication patterns by expanding to other scenarios or comparing actual performance and 'Multi-Way' communication.

ACKNOWLEDGEMENT

This research was supported by the Nuclear Research & Development Program of the National Research Foundation of Korea (NRF) grant, funded by the Ministry of Science and ICT (MSIT) (Grant Code: 2017M2A8A4015291).

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