Design of Qualitative HRA Database Structure

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1. Introduction

HRA DB is to collect and store the data in a database form to manage and maintain them from the perspective of human reliability analysis. All information on the human errors taken by operators in the power plant should be systematically collected and documented in its management. KAERI is developing the simulator-based HRA data handbook. In this study, the information required to store and manage the data necessary to perform an HRA as to store the HRA data to be stored in the handbook is identified and summarized. Especially this study is to summarize the collection and classification of qualitative data as the raw data to organize the data required to draw the HEP and its DB process.

2. HRA DB Implementation Process

HRA DB implementation process to store and manage the data required to perform an HRA is as shown in the Fig. 1. HRA DB implementation is to collect the raw data required for HRA analysis and based on this, the qualitative data are analyzed to further implement the qualitative HRA DB. From this DB, a quantitative analysis is performed to develop the quantitative HRA DB capable of providing the quantitative results, such as HEP or relative importance of the PSF.

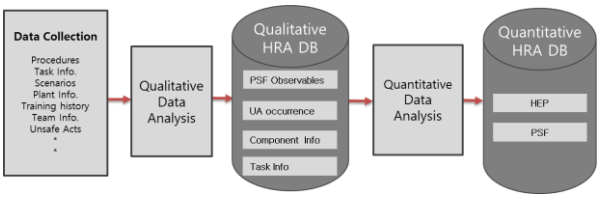

Fig. 1. HRA Database construction process

The HRA DB structure and its elements are shown in the Fig. 2. As shown in the figure, HRA DB can be mainly classified into qualitative HRA DB and quantitative HRA DB according to the functions. Qualitative HRA refers to the DB storing the raw data required for HEP quantification which is composed of: 1) various data collected from power plants (plant information, procedure, machinery information, operation team and simulator experimental records, etc.); 2) errors caused by failure in complying with operating procedure which have been found through the analysis data of simulator experiments; and 3) NON-UA table gathering the information of properly fulfilled tasks.

On the other hand, the quantitative HRA DB provides the human error probability and PSF results through the analysis of quantitative data based on various data tables stored in the qualitative HRA DB, providing the information required for probabilistic stability analysis (PSA) or other human error analysis. As a result, the qualitative HRA DB shown on the left side of the figure should be implemented prior to implementing the quantitative HRA DB and this further refers to a series of processes from the collection of raw data on power plant to drawing of UA and Non-UA results through the analysis of experimental data.

In this study, the requirements for structural design and implementation of qualitative HRA DB must be implemented for HRA DB are summarized.

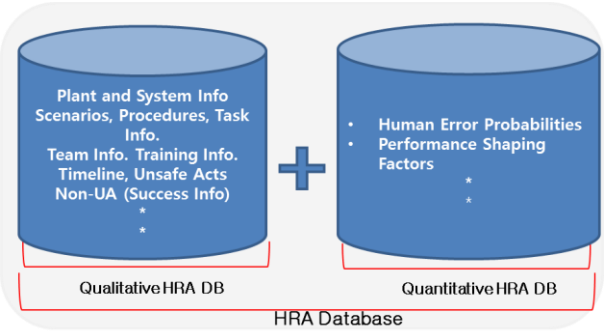

Fig. 2. HRA Database Structure

3. Structure of Qualitative HRA Database

3.1 Qualitative HRA DB

Qualitative HRA DB is a storage of all sub-information required to obtain the human error probability for PSA. This is a DB to store the analysis results drawn from successful execution of tasks (Non-UA) and failure (UA), which have been observed from the operational through the analysis of various data and experimental analysis, such as operations records of operation team and other power plant information, scenario, procedure, machinery information, etc.

The data required for the composition of qualitative HRA DB is as shown in the follows: information of power plant storing various information of power plan,

emergency (abnormal) procedure of power plant, scenario information for practice, machinery information, unit task information of operator's task, and timeline information containing the practice history and time information produced from the practice of simulator, and UA information determined by practice team and timeline analysis. The detailed types are as shown in the follows.

- Procedure_List: Storage of procedure list
- Procedure: Fulfillments at each procedural stage
- Scenario_Info: Scenario information
- Task_List: Performed task information
- Team_Info: General information of operating team
- UA_Type: UA item and type
- Worksheet_A(Plant General): General information of power plant/operation team and general characteristics of operation
- Worksheet_B(Unsafe Act Detail): Details of UA
- Worksheet_Timeline: time history of simulated experiments
- Component_Info: Machinery information

3.2 E_R Diagram

HRA data table should be interconnected with each field item upon the correlation. To do this, the connective dependence between each table is to be determined to prevent the inconsistency or omission of data contained in the table connected each other, ultimately assuring the integration of DB. The E_R (Entity Relationship) diagram expressing the connective dependency of tables is shown in the Fig. 3.

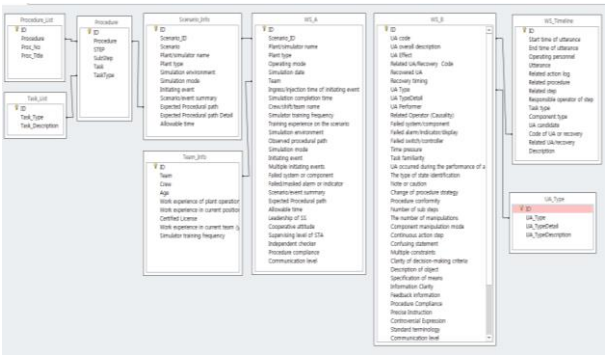

Fig. 3. E_R Diagram of HRA Database

3.3 DB Structural Design

All individuals defined as each table in the E_R diagram shown in the Fig. 3 are DB tables for structural design. The procedure list and the structure of procedure table required to store the contents of procedures in the qualitative DB are shown in the Fig. 4.

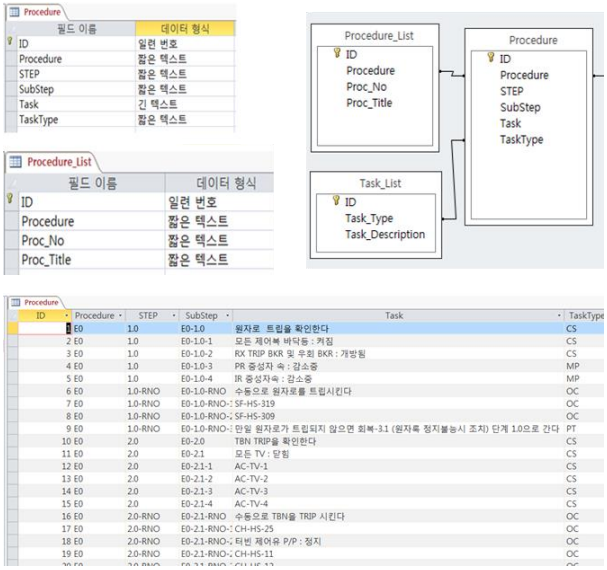

Fig. 4. Data Structure and Example of Data Entry (Procedure)

- Procedure_List

Procedure list and its details required for analysis are to be stored. Items to be essentially stored include procedure number, procedure abbreviation, procedure title, etc. Based on the information stored here, a procedure table that stores the sub stages of procedures and tasks to be performed at each stage is implemented.

- Procedure

The tasks at each stage of the procedure are stored. The items essentially stored include the procedure number, procedure stage and sub-stage and tasks to be performed at each stage, and type of task. The examples of data table structure and data input for the procedure are shown in the Fig. 4.

3.4 Practices of Qualitative HRA Database Application

Each table and data in the qualitative HRA DB are storing the UA and related supporting information caused by the operator. This data is used in providing the applications for many purposes, especially as raw data to draw the relative significances of HEP and PSF.

The practical examples of qualitative HRA DB are as shown in the following Fig. 5. This utilizes the data stored in the DB to draw the task demand that becomes the denominator of HEP. As shown in the figure, various tables (procedure, scenario information, worksheet-A) stored in the DB are used to draw the occurrence of task demand and UA as a denominator of HEP calculation and this result and the type of errors are combined to calculate the HEP.

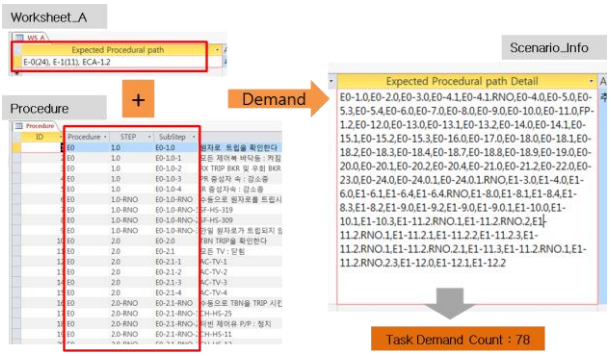

Fig. 5. Practical Examples of Qualitative HRA DB

The occurrence of UA and the number of task demand of user should be known to calculate the HEP for given task. Thus, the data stored in the qualitative HRA DB are used to draw the task demand, and its procedure is processed as shown in the follows.

First the operation team in the power plant is participated in the simulator experiment and the fulfillment records are stored in each table of the qualitative HRA DB. Here, the progress of each step in the procedure performed based upon the given scenario is recorded in the general item of 'Observed Procedural Path' of [Worksheet_A]. This is further compared with the 'Expected Procedural Path', the execution stage in the procedure to be ideally performed in the experiment to propose the evidence to determine the secession/returning of procedures performed by the experimental team.

In addition, the 'Expected Procedural Path' is combined with the procedural table set as an example in Fig. 5 so becomes capable of drawing the task demand that becomes the denominator of HEP. Considering that it is entered in the 'Expected Procedural Path' of [Worksheet_A] as follows, it refers to a procedure to draw the task demand.

Expected Procedural path = "E-0(24),E-1(11),ECA-1.2"

This shows the procedural stage to be performed by the operating team. In other word, the actual simulation was started at the first step of the E-0 procedure. After that, actual simulation flow was transferred from the 24th step of the E-0 procedure to the first step of the E-1 procedure. In addition, there was another transition from the 11th step of the E-1 procedure to the first step of ECA-1.2 procedure to complete the scenario.

If done in this process, this is said an ideal pathway. This item is further combined with the items of procedural table to create the Expected Procedural Path Detail and this finally becomes a number of task demand.

4. Conclusions

Qualitative HRA DB is a storehouse of all sub-information needed to receive the human error probability for PSA. This is a DB to store the analysis results drawn from successful execution of tasks (Non-UA) and failure (UA), which have been observed from the operational through the analysis of various data and experimental analysis, such as operations records of operation team and other power plant information, scenario, procedure, machinery information, etc.

In this study, the requirements for structural design and implementation of qualitative HRA DB must be implemented for HRA DB were summarized. The follow-up study of the quantitative HRA DB implementation should be followed to draw the substantial HEP..

ACKNOWLEDGEMENT

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