Development on Intelligent Management System for Nuclear Decommissioning Site Characterization

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1. Introduction

The final goal of nuclear facilities decommissioning is to verify regulatory guidance satisfaction and to demonstrate safety for the unrestricted or restricted site release [1].

In Korea, 0.1 mSv/y regulatory guidance is presented for both unrestricted and restricted site release in the Nuclear Safety and Security Commission Notice No. 2016-33 [2], which can be demonstrated through the comparison with DCGLs (Derived Concentration Guideline Levels) and are shown as a result of nuclear decommissioning site characterization through RSSI (Radiation Survey and Site Investigation).

The nuclear decommissioning site characterization generally follows a procedure called MARSSIM (Multi-Agency Radiation Survey and Site Investigation Manual) developed by EPA (Environmental Protection Agency), NRC (Nuclear Regulatory Commission), DOE (Department Of Energy), and DOD (Department Of Defense) in the United States, which includes HSA (Historical Site Assessment), scoping survey, characterization survey, remedial action support survey, and FSS (Final Status Survey). These procedures are carried out from the beginning to the end of nuclear facilities decommissioning [3].

This long-term RSSI evaluation requires the overall management in the evaluation process and results. The MARSSIM, however, requires expert professional judgments which are likely to occur human error.

Currently, some software programs such as the COMPASS and the RESRAD have been developed for RSSI. But the COMPASS has only partially utilizable functions such as grid location of data points on drawing which can be used during RSSI evaluation, and the RESRAD has been used as an exposure pathway modeling code to calculate the DCGLs at decommissioning sites.

This study is to introduce the conceptual design of a management system for supporting RSSI evaluation. The purpose of this system is to reduce the burdens of engineers through AI (Artificial Intelligence) in the process to identify the contaminated areas, to establish the survey plans and to manage the evaluation data. This system complies with procedures presented in the MARSSIM.

2. Intelligent Management System for Nuclear Decommissioning Site Characterization

2.1. Historical Site Assessment Module

When the decommissioning of nuclear facilities is decided such as permanent shutdown of NPPs (Nuclear Power Plants), the first step of RSSI is a HSA.

The purpose of HSA is to determine whether the facility and surrounding environment are contaminated by reviewing all operation records including events and accident reported from the end of facility construction to the present time.

Lots of time and manpower are required to review extensive plant operational data and documents to conduct the HSA. However, there is possibility of error of judgement to differentiate site characteristics whether the site is contaminated or not.

Therefore, the HSA module to be developed in this project would have a natural language processing based AI model, which automatically differentiates the site through the training data shown in Fig.1. The output from this module is an area classification in the nuclear site.

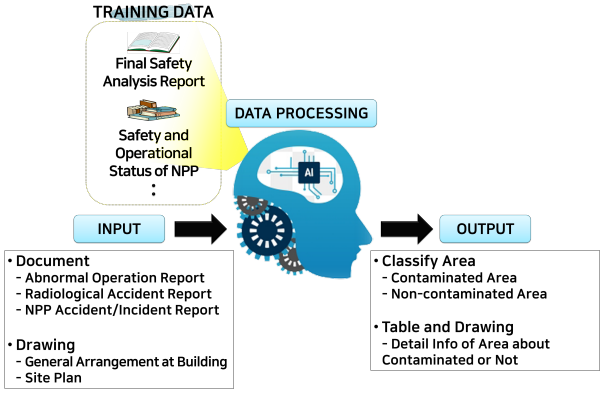

Fig. 1. AI model for HSA

2.2. Other RSSI Survey Module

After completing the HSA, other RSSI surveys should be planned through the preliminary survey. The preliminary survey is conducted to designate the dimension, number and position of survey area resulted from the HSA and to determine a background area as reference.

The results of actual site survey based on the preliminary survey would be the input of the management system. Then the area of site is reclassified

based on the actual survey data by the comparison with the DCGLs.

The comparison of survey results with DCGLs for classified survey unit is performed by a statistical method, typically one-sample statistical test called Sign test, or WRS (Wilcoxon Rank Sum) test which would be reflected in the management system.

Other RSSI survey module will carry out the statistical test with the use of survey results and give the results of reclassification of site area

2.3. DQO Process

One of the most important parts of the MARSSIM is to establish a survey plan in accordance with the DQO (Data Quality Objectives) process. The DQO process is a series of planning steps based on the scientific method for establishing the criteria for data quality and developing survey designs. It assures that the type, quantity, and quality of RSSI data used in the decision making would be appropriate for the intended application. It provides systematic procedures for defining the criteria that the survey design should satisfy, including when and where to perform measurements, the level of decision errors for the survey, and how many measurements to be performed [3].

Since the DQO process must always be satisfied when the user utilizes the system, all of module will demonstrate a result through user input or program analysis depending on the steps of process.

3. Structure of Intelligent Management System

Fig. 2 shows the overall system structure for input, output, and data management of each module in this system.

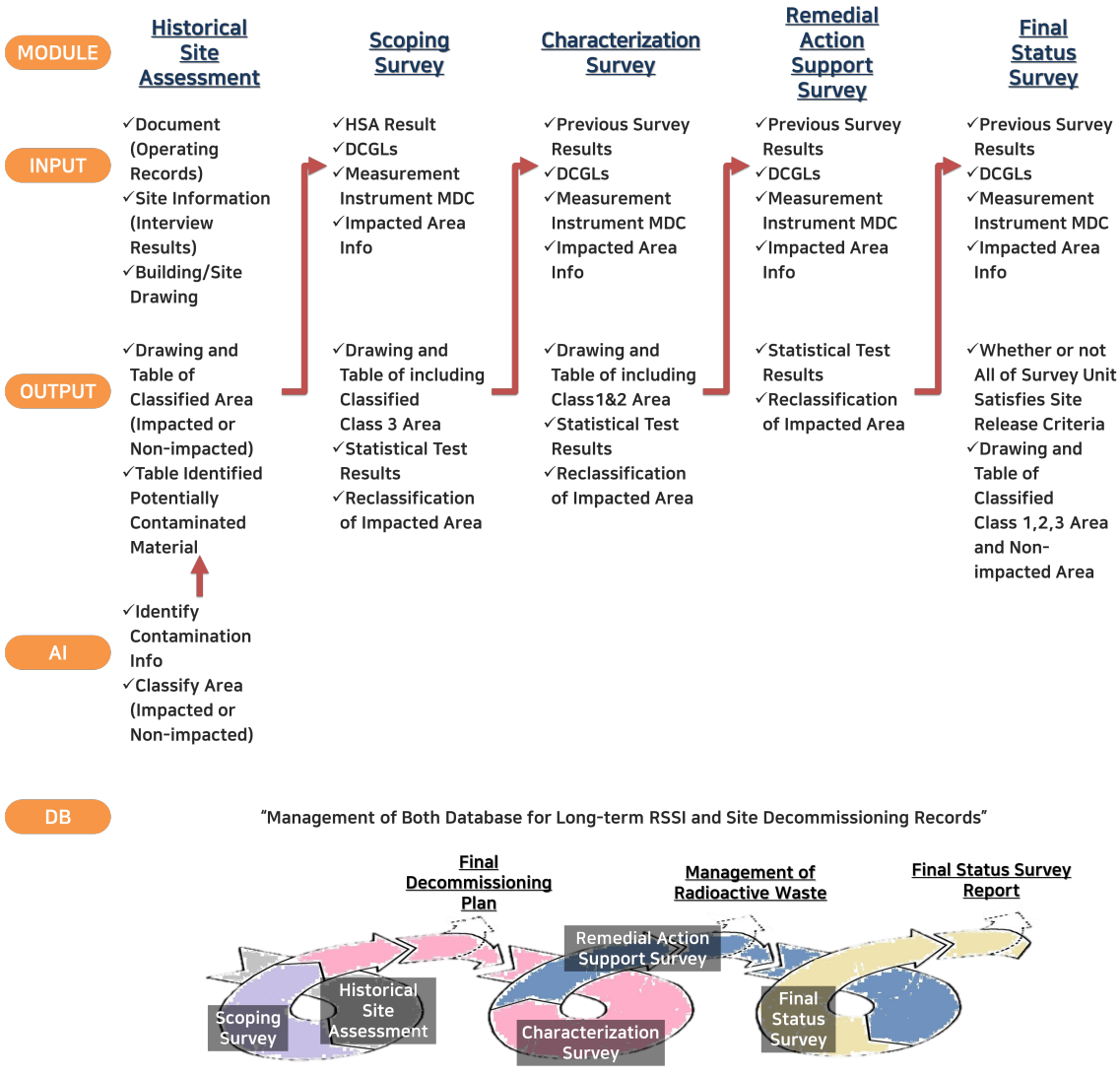

Fig. 2. Structure of intelligent management system for nuclear decommissioning site characterization

The system to be developed consists of survey modules according to the MARSSIM based procedure and data management module, especially the HSA module will be developed using AI model.

The user should input basic information of DQO process and measured value of radioactive nuclides and should provide survey documents and drawings into the management system. The system processes all of user input data to automatically set up the survey unit, calculates the number of data points, and decides the sampling location.

Fig. 3 shows the flow diagram of HSA module, which has the user input, processing and output functions.

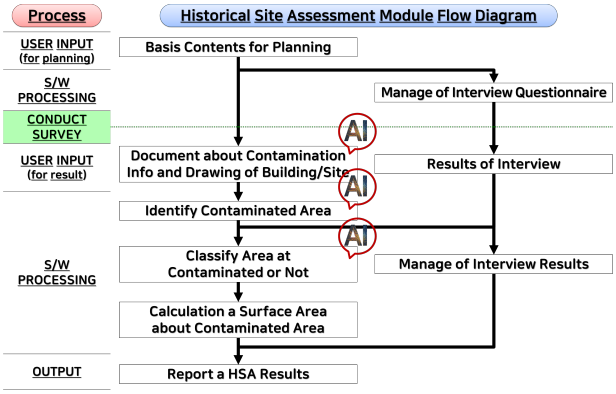

Fig. 2. Flow diagram of HSA module

The input and output of each survey module would be controlled by the data management module during the long-term RSSI.

4. Conclusion

The Intelligent management system which is currently developing is to computerize the procedures performed during the RSSI based on the by MARSSIM. It has a structure of user input, data processing and assessment, and reporting, Especially the HSA module would be developed with the natural language processing based AI model. In addition, the data management module will control the entire process of RSSI evaluation for the long-term evaluation.

It is expected that the intelligent management system would minimize the engineering cost such as time and manpower, the burden of engineer's judgement as well as the errors during the site characterization for nuclear decommissioning.

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