Direction for the Estimation of Required Resources for Nuclear Power Plant Decommissioning based on BIM via Case Study

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1. Introduction

Although decommissioning of a nuclear power plant is a project that requires long-term decommissioning period and tremendous expense, it must be done to ensure safe liquidation of nuclear facilities. Estimation of decommissioning cost, decommissioning strategy, and decommissioning required resources when making decommissioning plans are some of the mandatory elements to input for nuclear power plant decommissioning. Ways to estimate decommissioning of required resources in the past have imposed great uncertainty since they analyze required resources at the construction stage, analyzing and consulting decommissioning required resources of overseas nuclear power plants.

As demands on efficient management and use of complicated construction information increased these days, demands on the introduction of Building Information Modeling (herein after referred to as BIM) technology has increased. In the area of quotation, considerable effects are expected as to the accuracy and reliability predicting construction costs through the characteristics that can automatically estimate quantities by using attribute information of BIM model. BIM-based estimation and quotation of required resources is more accurate than the existing 2D-based quotations and have many advantages such as reviews over constructability and interference. Accordingly, this study plans to draw out a direction of estimating the required resources of decommissioning nuclear power plants by using BIM through reviews of previous studies.

To achieve this goal, previous cases of BIM construction in nuclear power plants and estimation of required resources using BIM are discussed, and the Project Numbering System (PNS) for nuclear power plants was analyzed to draw out its results.

2. Review of Preceding Research

2.1 Status quo of life cycle management for nuclear power plants

In the plant area, FIATECH (Fully Integrated and Automated TECHnology) has been conducting a project related to collaborations using 3D Neutral Model so that data can be exchanged and shared among participants from a variety of areas. Here, open standard tools such as iRING (ISO 15926 Real-time Interoperability Network Grid) and IFC (Industry Foundation Classes) were applied.

In Korea, research projects such as standardizing technology of plant project management systems, LNG plant research group, and virtual construction research group are now under progress as well as 3D-based intelligent plant information management systems conducted by private companies.

In the area of nuclear power plants, EPRI (Electric Power Research Institute) suggested that any optimized solution for information management systems of nuclear power generation should be self-developed to suit unique environments of corresponding nations or power plants. In Korea, a project called Data Centric Integration/ Automation Technology for NP Project Management System started from July 2011 and has been continued for five years. This project transfers design data from the stage of design to that of construction, and transferring information generated at the stage of construction to the stage of maintenance after its completion (Fig. 1). All data are distributed with international standards and can be interlinked with all legacy systems [1].

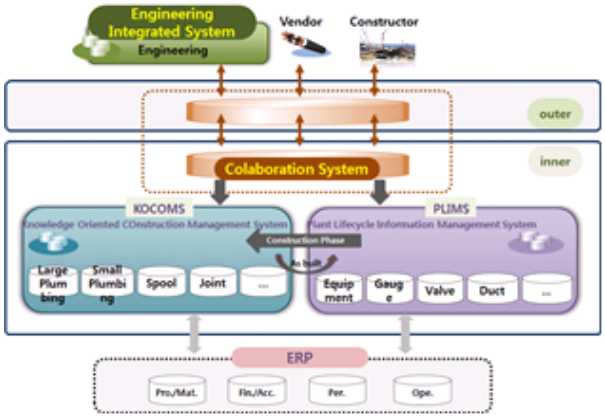

Fig. 1: Project Overview of Data Centric Integration/Automation Technology for NP Project Management System

2.2 Status quo of BIM-based Quotation Automating System in Korea and Abroad

Quotations in Korea were done by hand until the early 1980s to estimate required resources and make detailed statements. Since the mid-1980s, companies for construction informatization have been established, and quotation-related systems have been developed. Then, 3D-based quote systems were tried for the purpose of estimating required aggregates in the early 1990s by several large construction companies, enabling accurate estimations of required resources via 3D models, thereby increasing efficiency of quotations and starting to develop quoting systems suitable for its unique characteristics in Korea.

Estimations for required resources also started by hand-work with making detailed statements were made by using Scale in early days. As buildings have become high-rise and complicated, it caused great inconveniences to be operated by hand. Thus, much effort has been made to develop quotation-related programs by 1980s in order to save time and enhance accuracy (Table 1) [2].

Table I: Status of Quotation Automating System in Korea and Abroad

Program	Details
[Domestic] Koreasoft EMS (integrated details management)	- Compatible with bidding data of government-funded constructions - Can be interlinked with all construction works (civil engineering, landscape, construction, equipment and electricity) using compatible files (TEXT, JDL) with design data of government- funded constructions - Building a database of various resource data sets including Construction Cost Estimating Guidelines for Man-hour and Required Resources Standard, Military and Common Guidelines for Construction Cost Estimation, and Performance Unit Price Used in the Ministry of Land, Transport and Maritime Affairs
[Domestic] UMID system Midware	- Designs based on required resource, composition of quotation detailed statements - Can be extracted as a form of unit price, detailed statements, material and labor cost and expense classifications, and integrated unit price according to the characteristics and conditions/features for each construction - Providing required resources for each detailed item, able to interoperate with process management systems.
[Overseas] VICO	- Divided into Estimator and Cost manager - Constructor (ArchiCAD) estimates required resources by using modeled elements - Creation of detailed statements for quotation and bidding - Cost changes and cost managements by receiving required resource information - Mangement in interoperation with 5D Presenter
[Overseas] Singapore eQbq	- Providing orderer-oriented web-based integrated information system and Bill of Quantities (BQ) - Can be interlinked with the classification systems of national standards in Singapore - Applying Standard Methods of Measurement (SSM)

2.3 Analysis on Project Numbering System (PNS)

PNS endows identification numbers to all information such as works, materials and data generated during the project implementation process in order to exchange information, collect and analyze information, and construct comprehensive information systems. PNS includes technical data number, material number, process unit work number, construction cost management account and other special numbers which are developed and applied appropriately to meet respective characteristics. In addition, since all numbers use Physical Breakdown Structure (PBS) and power plant number in common, identity of management standards can be secured and interlinks between information are easy to carry out [3].

3. Results and Conclusions

3.1 Application of BIM

From a number of circumstances, BIM was used not only in the plant but also in the information management

based on 3D such as IFC, and yet there were no case that has applied BIM in case of nuclear power plant, and 3D data based life cycle information management system was developed on its own. Thus, it can be desirable to estimate decommissioning required resources in nuclear power plants using BIM as well as using tools that are compatible with usual international/industrial standards.

As we looked into the cases where required resources were estimated, using BIM in Korea and abroad, they dealt with estimation of required resources, estimation of construction cost and process management at large. In each area, methodologies, classification systems, BIM, and realization tests have been used variably. Nonetheless, several problems have been reported, and among them, it is noticeable that although BIM standard classification system exists, no case was found that has used standard classification system. This means that no interlink among OBS (Object Breakdown Structure), WBS (Work Breakdown Structure) and CBS (Cost Breakdown Structure) was possible. Thus, for nuclear power plant decommissioning, decommissioning method and process, etc. shall be defined clearly in the stage of decommissioning strategy establishment, so that classification systems must be set up based on clear definitions aforementioned, followed by 3D modeling and defining attributes regarding decommissioning of required resources for each model according to the classification system.

3.2 PNS and WBS

Decommissioning process, which is a head-start to calculate required resources, is conducted in the following order: preparation prior to the operation shutdown, permanent operation shutdown, planning of decommissioning and authorization, preparation of decommissioning after authorization, decommissioning activities, and completion of decommissioning. In Korea, there have been some experiences of decommissioning in research reactor and uranium transformation facilities, but no experiences in decommissioning of nuclear power plants under operation. As a result, detailed technologies regarding decommissioning methods and processes are required. Based on this, 3D modeling of estimating decommissioning required resources shall be followed.

PNS endows identification numbers to all information such as works, materials and data, etc., generated during the project execution process in order to facilitate exchange of information, collection and analysis of information and construction of comprehensive information systems.

Analysis results of preceding researches show that if current PNS system is well-kept and data-based concept is introduced thereby, constructing integrated data models for all devices and equipment information required for the entire life-cycle through collaboration of all project participants such as designers, apparatus suppliers, contractors and ordering organizations from the stage of design as well as production, input and maintenance of the information effectively based on this, we expect consistent and reliable information can be transferred to the stage of operation. Based on the rationale above, it seems that the current PNS, which has been used throughout the life-cycle of nuclear power plants is not difficult to use at the stage of decommissioning as well. The existing WBS is rather focused on the design, purchase, construction and trial run, so that it may be vulnerable to be applied to maintenance and decommissioning, which requires our review as well.

3.3 Application of IFC and IFD

According to the plan of Korea Hydro & Nuclear Power (KHNP) Co. Ltd, an integrated model of BIM will be constructed while using Revit of Autodesk Co. when designing nuclear power plant, which can be used in estimating required resources of decommissioning by revising and complementing the model. Nonetheless, it is preferable to comply with IFC-based standards in terms of long-term storage and collaboration of BIM integrated model. IFC is an opened BIM data format that is used for standardized data format to exchange and share BIM data, which has advantage of data exchanges regardless of application systems or software versions of specific vendors over IFC-based opened BIM configuration.

However, IFC, which is a strict and independent data structure as an opened BIM format, has a limit that it cannot manage all information used in the construction process internally. In the current technology level, IFC can be linked with external data or database to make use of and manage actual construction information. However, IFD (International Framework for Dictionaries) is required for bilateral data exchange between applied software programs. IFD has ben mainly developed by IFD Library Group, an affiliate of building SMART League of Nations, and can be applied to the exchange of IFC data information between IFC-based BIM softwares and input/output of properties. Using IFD, new attribute information can be added as well as standardized attributes of IFD can be used in information models of a variety of applications. If any addition of user-defined attributes for required resources of decommissioning is required, more IFD shall be made use of.

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