Analysis of the Possibility of Required Resources Estimation for Nuclear Power Plant Decommissioning Applying BIM

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1. Introduction

Since the Fukushima nuclear accident, a great extent of attention has been paid to nuclear power plant decommissioning. In addition, as nuclear power plants in Korea have reached its design life, possibility of early nuclear power plant decommissioning in Korea has been emerging. Estimation of decommissioning cost, decommissioning strategy, and decommissioning quantity at the time when entering into any decommissioning plans are some elements whose inputs are mandatory 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.

One of the important issues at the overall construction industry for efficient use of information is to create, use, and manage information by applying Building Information Modeling (BIM). The area estimating required resources in BIM has been under way to make use of information of objects and cases where such required resources estimation information is used in quoting area are increasing. Therefore, this study aims at analyzing whether required resources for decommissioning nuclear power plants can be estimated, applying BIM.

To achieve this goal, this study analyzed the status quo of BIM such as definition, characteristics, and areas applied, and made use of them when drawing out study results by examining types and features of the tools realizing BIM.

2. Status of BIM

2.1 Definition of BIM

BIM can be either Building Information Model, which includes three-dimensional geometric shape and attribute information, or Building Information Modeling, which emphasizes a process that creates and reuses the information within the objects of building information model, but no significant difference is found between them in their fundamental meanings [1]. According to BIM application guideline in the construction area provided by the Ministry of Land, Infrastructure and Transport in Korea, BIM is defined as "a digital model that provides a ground for reliable decision making for the life cycle of structures in accordance with the physical or functional characteristics of structure objects in the overall construction areas including construction, civil engineering, and plants as well as work procedures to make and enter into it", which includes definitions of both Model and Modeling.

2.2 Characteristics of BIM

The characteristics of BIM represent core technology of BIM in contrast to 3D CAD. Models that cannot reflect these characteristics cannot be regarded as BIM technology. Typically, following models cannot be regarded as BIM[2].

- 3D shape information is included but any object attributes cannot be endowed
- A model that cannot support parametric technology
- A model where 2D CAD reference files must be combined to define information of structures
- A model that cannot automatically reflect modified matters on other Views once the information of structures is modified at one View.

2.3 Used Area of BIM

In previous studies, application fields of BIM in the construction management were suggested as shown in Table I [3].

Table I: Fields where BIM is applied to construction management

Main category	Sub-category
Operation management	−Collaboration at the planning stage −Establishment and application of construction planning
Process management	−Process information management −Project scheduling management −Process risk management −Process table creating management

Cost management	−Management of project budgeting −Minimization of design changing costs −Budget management planning −Accurate quote management
Design quality management	−Design-related meeting and collaboration −Review on detailed design drawings −Securing standards for design quality management −Review and management of engineering analysis −Review of design errors −Review on building and space layout planning −Creating and managing design instructions −Management of changes in design −Interference review −Review of alternative designs
Construction quality management	−Construction-related meetings and collaborations −Interference review −Management over construction safety −Construction VE −Supporting decision making for construction methods −Review on errors during construction −Review and management of construction detail views
Customer management	−Repairing defects −Review on trial run plannings −Maintanance −Material management
Purchase· procurement management	−Material management
Document management	−Record of changes in design −Collecting drawings and documents −Operation manual establishment −Record of changes in construction −Design/process/cost related reports

3. Types and characteristics of BIM embodiment tools

Tools that realize BIM are specialized for each software. Areas hereof at which we can make use of BIM are design, planning, rendering, interference check, evacuation/smoke exhaustion simulation, 4D simulation, 5D estimation and quotation of required resources, eco-friendly analysis, structural interpretation, structural modeling, MEP (Mechanical, Electrical, Plumbing), civil engineering, and maintenance (FM), and in this study, only the area of 5D estimation and quotation of required resources was discussed.

Most of the BIM authoring tools (ArchiCAD, Revit, Digital Project and Microstation etc.) provide required resource estimation information such as types of schedule table or spreadsheet (Excel, etc.). However, the user should allocate interlinks with other details based on the extracted required resources [4].

3.1 FIN 8.0, RC 8.0 (Koreasoft)

It provides functions of required resource estimation and quotation through interoperation between BIM tools and quoting programs by Koreasoft, which are used most frequently in Korea and supports ArchiCAD and Revit. By mixed use of 2D-based quoting mode, it supports quotations for objects that cannot be represented at BIM Model (such as rebars, etc.)

3.2 Innovaya(Innovaya)

They are the modules of Visual Quantity Take-off, Visual Estimating, Design Estimating, etc. provided by Innovaya Co.

3.3 MIDWARE (Umid System)

It estimates and quotes required resources through interoperation between 2D quoting systems and BIM models (Supported by Revit and Microstation). It also interlinks with 4D and manages schedule progress.

3.4 TOCOMAN(Tocoman)

It is a software to estimate and quote required resources developed in Finland. It can interoperate with Revit, ArchiCAD and Tekla Structure. With a mode interlinking database of detailed records and BIM, it supports many-to-many connections.

3.5 Maya (Autodesk)

It is a 3D modeling tool which provides functions of animation and rendering, thereby, widely used in film production. It has its own language called as MEL, so the user can control all things easily. It was developed by a joint venture of two Canadian companies, Alias and Wavefront, which was later merged and acquired by Autodesk.

3.6 Vico Office (Trimble (Vico Software))

It takes in BIM data, thereby estimates required resources and performs quotations and alternative simulations. By dividing and combining the BIM model,

it can partially overcome LOD problems of BIM model. It provides a model that is interoperable with 4D as well as providing various data application, while interoperating with excel files. It can identify information for each member through interoperations with 3D models. Required resources and costs for each design alternative can be compared with one another. The company was acquired by Trimble Co. in 2012.

4. Results and Conclusions

In order to review how BIM could be used for decommissioning nuclear power plants, the definition, characteristics and applied areas of BIM were discussed.

BIM designs objects of the structures (walls, slabs, pillars, stairs, windows and doors, etc.) by 3D technology and endows attribute (function, structure and usage) information for each object, thereby providing visualized information of structures for participants in construction projects. Major characteristics of BIM attribute information are as follows:

- Geometry: The information of objects is represented by measurable geometric information
- Extensible object attributes: Objects include pre-defined attributes, and allow extension of other attributes. Any model that includes these attributes forms relationships with other various attributes in order to perform analysis and simulation.
- All information including the attributes are integrated to ensure continuity, accuracy and accessibility, and all information used during the life cycle of structures are supported.

This means that when information of required resources is added as another attributes other than geometric information defined fundamentally, any required resources can be estimated. The attributes regarding any decommissioning required resources should not only define the required resources of basic 3D mass, but also define cuts of pipe or valve, etc., equipment separations, and interrelated required resources such as decommissioning crane works and required resources regarding the removal of radiation or radioactivity.

The following characteristics were found out after analyzing BIM tools.

- AllPlan of Nemetchek Co.: It provides features of estimation of quantities, structural analysis, interference identification and facility management, etc.
- Bentley Architecture of Bentley Co.: It is mainly used for information integration management systems at the plant area.
- FIN 8.0, RC 8.0 of Koreasoft [Estimation of required resources]: ArchiCAD and Revit supported
- MIDWARE of Umid System [Estimation of required resources]: Revit and Microstation supported
- TOCOMAN of Tocoman Co. [Estimation of required resources]: It can interoperate with Revit, ArchiCAD and Tekla Structure.
- Revit of Autodesk Co.: It can operate in specialized areas of construction, structures and MEP.
- Revit MEP of Autodesk Co.: It is a Revit platform for equipment, duct, pipe, and illumination, etc. It allows energy analysis and system load evaluation. It allows mechanical system, and identification of ducts, and electric illuminations, electrical wiring layouts and interferences.

The analysis results show that several software applications estimate required resource and are compatible with representative model authoring tools. However, among them, Revit of Autodesk Co. thinks that MEP can effectively applied to a number of nuclear power plants. In addition, it can interoperate with Maya, which is specialized in resource estimation developed by the same company, thereby, enabling its application without much difficulty. Compatibility with international standards and the fact that it is widely distributed in Korea, which also the case in ArchiCAD, are also its advantages.

BIM library can make use of BIM data in many ways from simple modeling to modeling for drawings (various planar representations are required depending on drawing scales), modeling for structural analysis, modeling for required resource estimation, and modeling for energy analysis, etc. Therefore, BIM library should be developed in consideration of such various areas of use. This means that BIM library should be constructed by modeling, still in consideration of estimating required resources for nuclear power plant decommissioning.

Libraries in BIM tools include not only shaping information of 2D and 3D, but also attribute information, so characteristics of each element are given and relationships with other elements are established. In addition, since it is interoperable with other software programs for required resource estimation using such attribute information, attributes of required resource estimation (mass quantity, cut quantity, radiation/radioactive quantity, and mobile equipment input quantity, etc.) for nuclear power plant decommissioning must be defined precisely.

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