

Application Scenario of BIM-GIS Test-bed Implementation for Facility Management

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Abstract—According to people stay inside longer, an importance of Facility Management (FM) is getting higher. This is one of main factor relating a cost reduction. Building Information Modeling (BIM) contains object-based geometry & property data, and it is able to offer the personalized data with 3D viewing. This research relates BIM what is dealing with indoor data to Geographic Information System (GIS) what is dealing with outdoor data. Based on this, the research proposes an application scenario of BIM-GIS test-bed implementation for FM.

Keywords-Building Information Modeling (BIM); Geographic Information System (GIS); Open platform; Test-bed; FM.

I. INTRODUCTION

Recently, the cost of maintenance after completion in a life cycle of building has been significant as to building owner and resident as well as the cost until completion. Even the well-constructed building, which is substantial and designed fashionably is important, to manage and operate building effectively after completion is one of the main factors relating to the long-term cost directly [1]. So, the various cases and studies about Facility Management (FM) system of existed buildings have been increasing.

The integration between Building Information Modeling (BIM) data including geometry/property information and Geometry Information System (GIS) including location information is appropriate to operate FM data based on city/building. It offers an object-based 3D visualization data and supports an easy operation management for sites, which includes several facilities on map-based system. BIM on GIS platform, which has been developed at Korea Institute of Civil Engineering and Building Technology (KICT), provides these services and it can handle the securement of data interoperability BIM and GIS, the visualization of 3D data, the light-weight algorithm for large scale data, and others [2][3].

This study builds the test-bed for substantiation of developed technology, and proposes the scenario for FM with BIM on GIS platform, as shown in Fig. 1. It aims four goals; BIM-GIS DB structure, BIM-GIS based 3D BIM modeling, Application scenario using BIM-GIS test-bed and

verification & test-bed operation. These technologies are implemented on ‘BIM on GIS platform’, in Section 3.

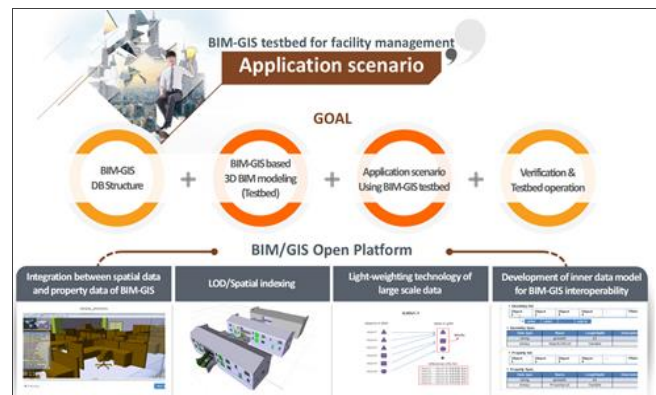


Figure 1. Research overview

In Section 2, we analyzed a research trends: BIM/GIS integration and BIM-based FM in domestic/abroad. In Section 3, BIM on GIS platform was introduced, which has been developed at KICT for 5 years, and it is a foundation of this research. In Section 4, we constructed BIM/GIS test-bed, and it was processed as follow, 1) modeling of geometry and property data, 2) construction of BIM/GIS FM DB, and 3) shooting UAV and construction of true ortho-images. In Section 5, we designed of use-case scenario for facility management, firefighting and energy consumption. Finally Conclusion and Future work were proposed.

II. RESEARCH TRENDS

This study analyzed the research trends of BIM/GIS integration and BIM-based FM in domestic/abroad. Kang, T. W. et al [4] studied the software architecture for effective BIM/GIS based facility management data integration. For interoperability between two different data, it proposes BIM/GIS-based information for Extract, Transform, and Load architecture and tested it. Berlo, L. van et al [5] developed the CityGML GeoBIM Extension to get semantic IFC data into GIS context for integration of BIM and GIS. Niu, S. et al [6] proposed the solutions for data conversion of integration between BIM and GIS, and developed a BIM/GIS integrated web-based building energy data

visualization system. Wetzel, E. M. et al [7] studied a BIM-based framework to support safe maintenance and repair practices for facility management. It also proposes the data processing and rule-based decision making with safety attribute identification and classification. Lee, K. S. [8] deduced BIM applicable elements according to related legal system, present technical level of BIM, and the requirement of FM for BIM utilization in the maintenance of urban metro facility.

Most of above researches approaches focus preponderantly the development of algorithm for enhancing interoperability BIM/GIS and the process or framework of BIM-based FM. According to increase of the importance for maintenance, there are various attempts to improve the problem about existing inefficient FM process. Thus, in this study, we have two goals, one is to construct the test-bed targeting real site by BIM modeling software (Revit Architecture) and verify it with BIM on GIS platform [2][3]. The next step is to extend availability of FM with scenarios.

III. INTRODUCTION OF BIM ON GIS PLATFORM

ICT Convergence and Integration Research Institute, KICT has been performing the study “Development of Open Platform for Interoperability between BIM and GIS” (2012.01~2016.12, total 5 years), which is one of main researches in KICT. This study develops BIM on GIS platform based on open source. Also, the element technology and information flow, which can apply indoor/outdoor spatial data effectively to the phase after construction are developed through 3D spatial data establishment for facility management and operation (Fig. 1, Fig. 2).



Figure 2. Overview of BIM on GIS platform

In Korea, recently, several government agencies and institutions like Ministry of Land, Infrastructure and Transport, Seoul Metropolitan Government, Ministry of Public Safety and Security, Korea Land & Housing Corporation, and so on have made plans and tried to offer useful services integrating BIM for indoor spatial data and GIS for outdoor (city) data. As there are growing interests in the availability of BIM on GIS platform technology, and the use-case and possibility are required through this study.

IV. CONSTRUCTION OF BIM/GIS TEST-BED

For location of test-bed, we decided three places: main headquarter of KICT where is mainly composed of official buildings and facilities, and Fire Research Institute and Ricer Experiment Center where are composed of test laboratories & test buildings. Each place was planned for BIM/GIS modeling, working process of DB construction and development of operating technology.

First of all, 3D architectural modeling data was designed with data gathering and field survey based on existing 2D drawing plan, documents of facility history management. Also MEP and main research equipment were modeled with 3D BIM/GIS data. Then to visualize the effective 3D model, we shoot aerial images and built DSM data, and completed the test-bed modeling. The architecture of BIM/GIS test-bed was processed as follow, 1) modeling of geometry and property data, 2) construction of BIM/GIS FM DB, and 3) shooting UAV and construction of true ortho-images.

A. Modeling of BIM/GIS geometry/property data and FM-DB Construction

Beginning construction of satellite/aerial image, which was based on the platform, we worked the confirmation of site boundary/name, POI, standard classification system, basic property data, site survey, and actual images. Then based on these, we modeled BIM main data and building shape data with texturing according to Level of Detail (LOD). After that, main MEP and structure BIM modeling was worked, and all data was exchanged to Industry Foundation Classes (IFC), which BIM standard format for data verification. Finally through data converting, last data was loaded on BIM on GIS platform with inner format for interoperability.

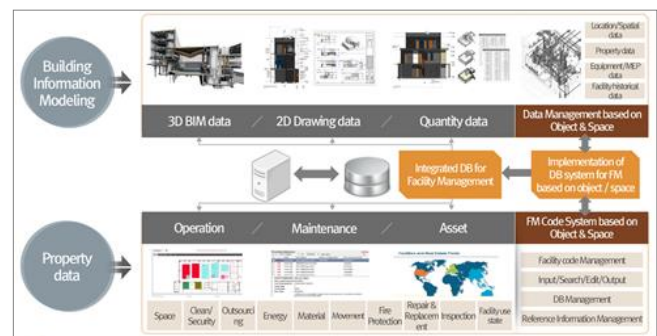


Figure 3. BIM/GIS Property data modeling process based on 3D architectural drawing

Fig. 3 shows the modeling process of BIM/GIS property data based on 3D architectural drawing. 3D BIM data was designed by 2D drawing and existed FM data. About the parts of non-updated like newly-built, extension, remodeling, we took photos with camera and drone. In the case of property data, we selected the main tasks among various FM works (space, clean and security, outsourcing, energy, material, movement, etc.), and connected data for operation, maintenance, asset with FM code system based on object and space. The DB structure was built with managing data

(position data, spatial data, property data, equipment data, history data, etc.) by object and space, and saved at integrated DB for FM. Fig. 4 is an output of mapping images.



Figure 4. Output of mapping images to BIM/GIS modeling data

B. Mapping UAV and True ortho-images

The texturing of building shape like Google Earth, V-World makes BIM modeling image more realistic than before. To relate Image data by drone, shooting UAV and field survey to above BIM/GIS modeling data, we produced texture map with edited photography/distorted images. Finally, BIM/GIS modeling data and well-made image data were matched together.

V. DESIGN OF USE-CASE SCENARIO

Test-bed for BIM on GIS platform is able to manage by BIM object unit. This study reflected user requirements from KICT FM manager in priority to develop the system, which is adaptable in working-level. We discussed with FM team periodically about a current working process and designed the useful scenario based on this.

Data acquisition and deduction of requirements were much important to object-based FM system. We adopted many issues from analysis of other FM systems; therefore, designed the scenarios for long-term application. The scenarios would be proposed for three phases: FM, Firefighting, and Energy.

A. Facility Management

The scenario for facility management is as follows. To design it, we checked current KICT situation and FM process targeting KICT headquarter with FM manager. DB was constructed according to each work based on field survey, and FM data would be managed by space/floor/building unit (Fig. 5).

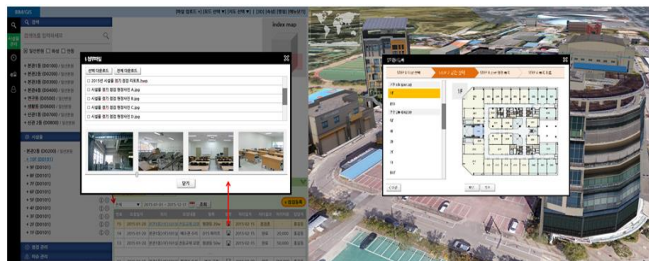


Figure 5. User Interface of BIM on GIS platform for FM

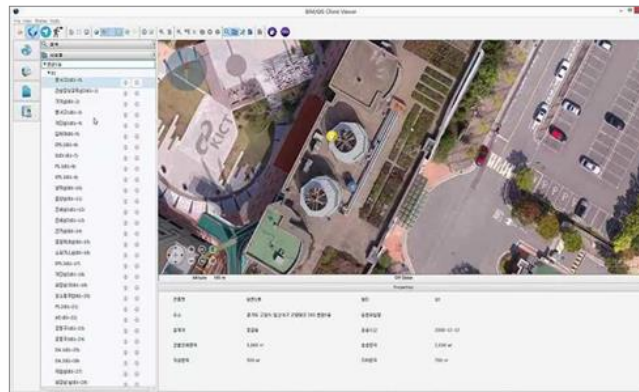


Figure 6. Searching facility lists by building unit

This can search and show data depending on user's objective systematically by applying hierarchical order of space-floor-building-area (Fig. 6). And also based on existing KICT portal system, the scenario makes FM manager to Search/Read/Edit/Check with fundamental basic functions. The general users including FM manager can control a room schedule, a history management of joint equipment, site navigation, remodeling plan of institute, and so on because of object-oriented BIM modeling data. This FM process and FM system based on platform will be affiliated with KICT main system.

B. Firefighting

The scenario for facility firefighting can provide data of relevant building and site to fire department before they arrive at site, and it makes them to handle the place quickly with advance information. When a fire breaks out in the KICT headquarter, the alarm and warning sign operate, and firefighting system in BIM on GIS platform shows the spot (building) where the accident takes place automatically.

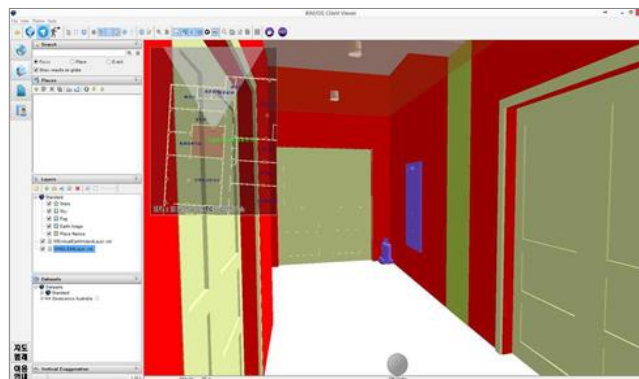


Figure 7. Visualization of firefighting objects

To understand clearly for firefighters, the platform turns out and shows from general architectural 3D model to structural 3D model, (Fig. 7). In the event of fire, firefighters generally should figure out the building structure with 2D drawings and analyze which objects are bearing structure for evacuation route and a rescue operation. These information

are transmitted from BIM on GIS platform to firefighters as soon as case of fire.

This special model is composed of main structure objects from general 3D model with algorithm. As the purpose of data application, the structural model is able to visualize by objects and 2D/3D drawing of relating floors. Also this system analyzes and informs the path of emergency exit route from the spot to people. The simulation for fire drill usually can be worked.

C. Energy consumption

This scenario is for visualizing the energy consumption of each building in test-bed through sensors, which are situated at buildings before. When user converts a default mode into an energy consumption mode, basically the number of consumption is shown by sites with table or graph (Fig. 8). As selecting the site where the user wants to manage, the results are monitored in real time with space/floor/building/site for usage.

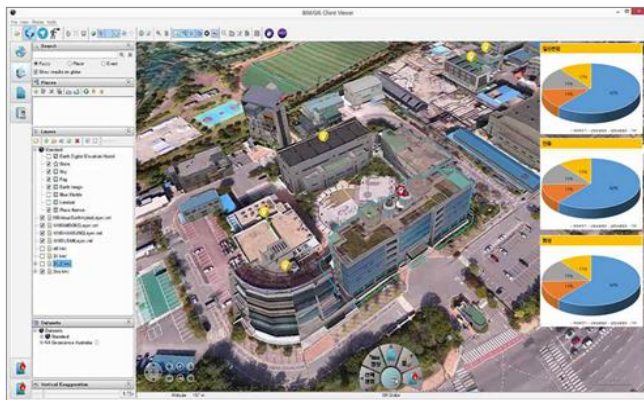


Figure 8. Searching for energy consumption of buildings

When a problem of sensor, energy manager can confirm the position of sensors with 3D model directly and take a measure soon. Also in case of unusual symptom for some building, this system can help the manager figuring out reasons with last statistics data (consumption number, records, etc.).

VI. CONCLUSION AND FUTURE WORK

This study designed the test-bed for verification of BIM on GIS platform application and considered the use-case scenario for FM, firefighting, and energy consumption. In the future, as well as BIM on GIS platform, the needs of indoor spatial data are expected to rise integrating with VR/AR, smart city, etc. The most important thing is what users want to do. Considering the specific purposes of users as well as various fields requiring indoor-outdoor spatial data, the system has to apply and develop.

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