International Journal of Engineering Science Invention
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 6 Issue 11|| November 2017 || PP. 08-12

A Study on the BIM Application for Supporting Analysis of Effect in the BIM/GIS Platform-based Integrated Information System - Focused on Earthquake and Inundation -

[1]Seunghwa Park, [2]Changhee Hong
[1]Post Doctor Researcher, Korea Institute of Civil Engineering and Building Technology, Korea
[2] Senior Researcher, Korea Institute of Civil Engineering and Building Technology, Korea

ABSTRACT: *Recently, human and material damages to high-rise buildings, complex facilities and users have increased due to natural disasters and social disasters. Therefore, there was a need to integrate real-time disaster information and develop effective response systems. While the response system is relatively well established in case of a single disaster response, it is difficult to construct a complex disaster response system because there are many complex factors and corresponding scenarios to consider. Therefore, this study summarized the structure and role of the complex disaster response system based on the BIM / GIS platform, and summarized the role of the system interface for collecting information and linkage in the aspect of information collection, analysis and response. In addition, this study summarized BIM requirements and the scope of preparation for analysis support around earthquake and floods in building BIM model to utilize in effect analysis according to a disaster. Through this effort, we can expect to have effective BIM utilization in disaster response and post-disaster recovery area.*

Keywords: *Building Information Model (BIM), BIM / GIS platform, BIM requirements, effect analysis, disaster*

Date of Submission: 24-10-2017 Date of acceptance: 04-11-2017

I. Introduction

Currently, Multi Disaster Countermeasures Organization (hosted by Korea Institute of Construction Technology) is conducting a convergence research with other participating entities under the theme of building an integrated CPS for high-rise and complex facilities disaster response system based on an open platform. In this paper, we summarized the roles of the open style BIM/GIS interoperability platform[1] which is the core module of a disaster response integrated information system and the system interface[2], and summarized BIM creation requirements and utilization plans for analytical simulation support related to impact analysis per disaster utilizing this system.

II. BIM / GIS Interoperability Platform

In order to integrate indoor/outdoor spatial information, a study was carried out to unify the platforms between BIM (Building Information Modeling) and GIS (Geographic Information System). NBIMS (National BIM Standard) of North America NIBS (National Institute of Building Sciences) stated that it can integrate indoor / outdoor spatial information centering on the contact points of BIM and GIS as shown in Figure 1 (Davis, 2007) [3].

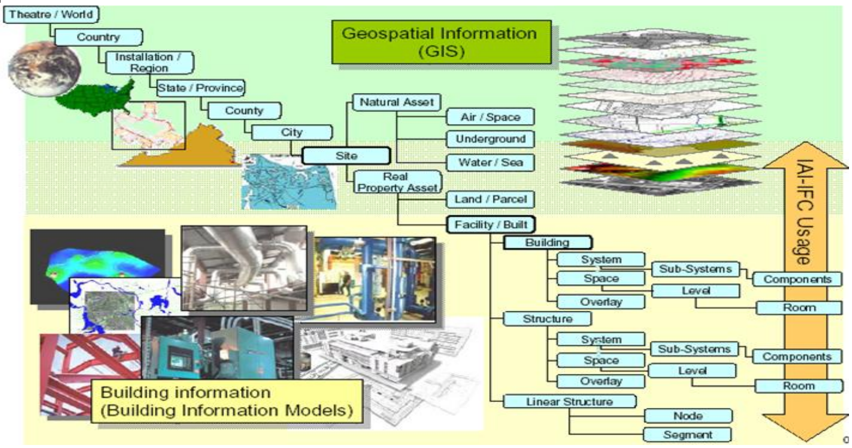

Fig. 1. Hierarchical information relationship between BIM and GIS

Therefore, a BIM/GIS Interoperability Platform that can seamlessly provide spatial information services was developed to make it possible to manage indoor and outdoor information[4] by integrating them when managing a disaster and responding to it as shown in Fig 2.

Fig.2. BIM/GIS Integrated Interoperability Platform

Its feature is that it has implemented GIS-based spatial information and BIM-based building information in a single platform, and in order to manage such a large amount of information, shape information is managed according to the visualization magnification, and attribute information was visualized step by step through linking with shape information. In addition, it is possible to query between BIM / GIS integration space and attributes and it is possible to inquire information by member unit based on spatial and attribute LOD(level of detail). In addition, to reduce the disparity with outdoor satellites, a drone aerial photographic image was mapped to the BIM model. Based on this, we are expanding to meet various disciplines such as SOC facility management, energy management, facility maintenance management as well as disaster countermeasures, and we are also developing applications for services by utilizing this platform such as virtual reality/augmented reality.

III. Configuration Of Integrated Information Platform And System Interface

Basically, a multi-disaster countermeasures system consists of a BIM/GIS platform that can contain and manage integrated information, and a system interface for collecting and linking information between information analysis and response/recovery and the configuration is as in figure 3.

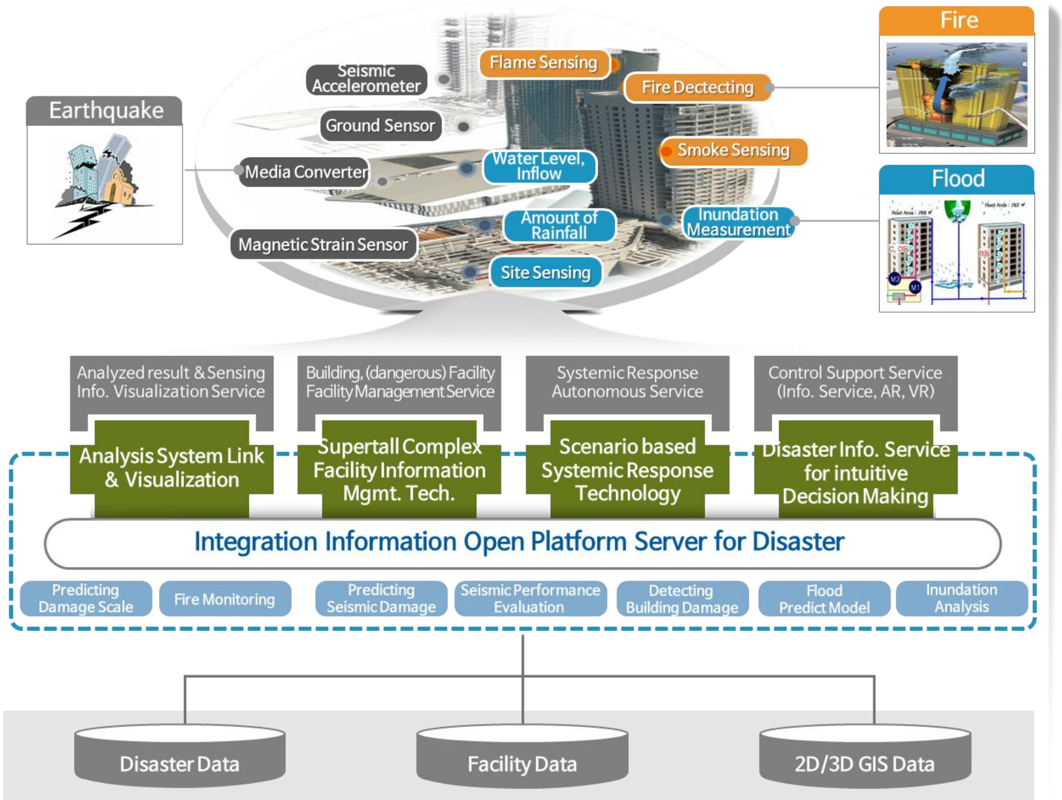

Fig.3. Composition of Multi disaster Countermeasure system

Analysis simulations such as fire monitoring, earthquake damage prediction, and flood forecasting will be conducted based on disaster data collected from earthquake accelerometer for earthquake measurement, ground sensor, magnetostrictive sensor, flame detection for fire detection, smoke detection, temperature sensor, flood depth measurement for flood depth measurement, rainfall and flow rate detection, facility data which has the information on high rise-complex facilities, and GIS data for recognizing the surroundings of buildings and facilities, and a response scenario based on the results shall be constructed and based on this, disaster response and post-disaster recovery will be supported.

IV. Role Of Integrated Information Platform And System Interface

This multi disaster countermeasure system for earthquakes, fires, and flood is physically composed of a single system although redundancy, protection, security, and distributed computing are applied due to the characteristics of the system. However, due to the nature of multi-disasters, the main platform and system interface are logically separated for reasons such as information collection by disasters, measurement information linkage, and effective linkage with analysis and response systems. In addition, one of the goals of this project is practical application and given that it is possible to apply it additionally to the disaster prevention center where a response system is built already, we would like to build it in a module type as following. Table 1 shows the roles and functions of each module.

Table 1. Roles and Functions of Platform and Interface Modules

Category	Roles and functions of disaster response platforms and interface modules
Integrated Information Platform (Daily management)	▪ Daily facility and disaster prevention related facility management based on BIM/GIS platform ▪ Smart maintenance based on mobile tagging ▪ Detection of false alarms by disaster including false fire alarm
Integrated Information Platform (Emergency Management)	▪ Visualization of disaster information for intuitive judgment such as management and evacuation ▪ Disaster management dashboard for integrated situational recognition and response ▪ CCTV Auto-tracking, MR-based simulation training, smart operation chart, etc.
Analysis system linked interface module	▪ Identification of spatial information for supporting analysis of disaster (fire, earthquake, flooding) of high-rise complex facilities ▪ Spatial information processing for disaster analysis system support ▪ Linking the analysis system with the integrated information platform for response to disaster (fire, earthquake, flood)

Measurement Information Linked Interface Module	▪ RealTime reception of measurement information ▪ Identification of thresholds for RealTime-based measurement information (fire, earthquake, flood) ▪ Selecting the risk scenarios associated with Event signal identification ▪ Linking with 911(Emergency Call)
Autonomous control linked interface module	▪ Rule-Set DB call for facility control ▪ Rule-Set-based facility automatic control and response correspondence ▪ UX/UI configuration for quick integrated response ▪ Information link with CCTV, disaster facilities

V. BIM Model Creation Scope

We have summarized the creation scope of BMI model required when building a BIM model within BIM/GIS platform for effect analysis support by disaster in Table 2. It is organized according to analysis/purpose by disaster, and the BIM model built included detailed equipment and facilities in the creation scope for visualization and impact simulation visualization for dashboard in this system.

Table 2.Scope of creation for BIM model

Category	Creation scope
Structure	▪ Foundations, columns, beams, walls (bearing walls), floors (slabs), roofs, stairs, ramps, deck plates
Construct	▪ Space: Floor, hallway, room ▪ Walls (non-bearing walls), secondary walls (partition walls blocked top to bottom), doors, windows, fireproof shutters, curtain walls, exterior panels, stairs, elevators, railings, ceilings, roof secondary structure ▪ 50mm thick finish materials
MEP	▪ Main facilities of machinery room, gas piping, water tank, main piping, main valve, sewer pipe, drainage pump ▪ Distribution board, main lighting, lighting switch, power generator ▪ Air duct, ventilation fan, damper
Fire-fighting fac ilities	▪ Duct, fire hydrant, sprinkler, fire extinguisher, water pipe, fire shutter, ventilation equipment (blowing fan, ventilation duct, damper) ▪ Duct piping, fire hydrant piping, sprinkler piping ▪ Emergency lighting, descending life line, escape ladder, cardiopulmonary burner, broadcasting equipment
Sensor / System	▪ Fire: Fire sensor ▪ Earthquake: Earthquake accelerometer (building, ground), acoustic emission sensor, micro vibration sensor ▪ Flood: Flood sensor, groundwater level, settlement gauge ▪ Others: CCTV, temperature, humidity, GPS, anemovane, inclinometer, strain gage, sensor wiring
Site / Civil Engineering /landscape	▪ Land, packaging, surrounding facilities (outdoor), gate, parking lot, gas piping ▪ Topography (including DEM, surface elevation), aerial photographs (orthoimage), ground information (standard penetration test: SPT, columnar section), groundwater level, soil and rock property information
Other facilities	▪ Main research facilities, partitions, furniture, system cooling and heating, solar thermal facility

Typical BIM authoring tools provide complex object modeling capabilities to facilitate creation of complex layers (finishes, cores, insulation, sound insulation, etc.) of key architectural objects. Because there are cases with a single building object and cases where simulation analysis is conducted by limiting for finishes and outer materials depending on the analysis types, appropriate modeling guidelines should be presented according to the situation.

VI. BIM Requirements And Utilization Plans To Support Analysis By Disaster

The target disasters for analysis were limited to earthquakes and floods, and BIM data requirements and utilization plans for analysis purposes were defined, and the range of application of BIM shape and attribute information data was summarized as shown in Table 3 below.

Table 3.BIMRequirements and Utilization Plan

Disaster area	Analysis Usage	BIM Requirements and Utilization Plan	Application range
Earthquake	Structural analysis	▪ Convert the analysis result of PERFORM 3D into OpenSees ASCII type (Node, Element structure) and input it as attribute information	▪ Visualization, input data of analysis by utilizing HPC
	Ground analysis	▪ Convert the information of ground information (standard penetration test: SPT, columnar section), soil and rock property information and input them as attribute information	▪ Input data of analysis by utilizing HPC
	Architecture Behavior analysis	▪ Construction of model by base, column, beam, wall, floor, roof, tech plate, thickness, position, material information input and node and element structure	▪ Input data of displacement, strength, and acceleration analysis of buildings due to earthquakes
Flooding	Flood analysis	▪ Convert information of foundation, columns, beams, walls, stairs, ramps, spaces (floor, corridor, room) to ASCII form of TecPlot (Node, Element structure) and enter sewer pipe, drainage pump, and ground level information	▪ Numerical model input data for predicting flooding

We determined that we could apply the basic BIM data in structural analysis, ground analysis, building behavior analysis and flood analysis. However, although it is considered that indirect use of existing simulation tools as input data is possible, additional tasks such as ensuring compatibility between systems, conversion of data, and creation of mapping tables are necessary, in order to directly link with existing simulation tools.

VII. Conclusion

We have summarized the role of the disaster response integration information system composed of the open type BIM/GIS interoperability platform and system interface so far, and we have summarized the requirements, utilization plan and construction creation scope of BIM mode that can support impact analysis simulation by disaster such as earthquake and flood. It is meaningful that, by recycling BIM model which contains not only the shape but also the attribute information, we can minimize the waste factor due to duplicated production of information and it is possible to utilize it as basic materials for various simulations. In the future, we plan to extend the range of disasters to disasters such as fire and terrorism to further define the BIM requirements and utilization plan, the definition of the BIM model creation scope, and conduct analytical simulations by utilizing them to assess the possibility of support for disaster impact analysis and summarized the application results.

Acknowledgements

This research was supported by the National Research Council of Science & Technology (NST) grant by the Korea government (MSIP) (No. CRC-16-02-KICT).

References

[1] S. Park, C. Hong, A Study for Extension of BIM/GIS Interoperability Platform linked External Open Data, *Journal of the Korea Academia-Industrial cooperation Society, 18(3),* 2017, pp.78-84.

[2] S. Park, C. Hong, Roles and Scope of System Interface In Integrated Control System for Multi Disaster Countermeasure, *International Journal of Safety and Security Engineering, 7(3),* 2017, pp361-366.

[3] D. Davis, BIM GIS Integration, *AEC Infosystems,* 2007.

[4] K. Lee, A plan to Introduce BIM to prevent and respond to firefighting and disaster areas efficiently, *Journal of Korean Institute of Architectural Sustainable Environment and Building Systems, 11(2),* 2017, pp.23-34.

[5] Society of Fire Protection Engineers, Building Information Modeling and Fire Protection Engineering, 2011.

Seunghwa Park A Study on the BIM Application for Supporting Analysis of Effect in the BIM/GIS Platform-based Integrated Information System - Focused on Earthquake and Inundation -." International Journal of Engineering Science Invention(IJESI), vol. 6, no. 11, 2017, pp. 08-12.