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A study on Utilization of BIM Model for the Development of Disaster Response Support Technology

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Abstract : *Recently, studies on diversified platform technologies of integrated information for disaster response as well as service technologies for disaster response and evacuation increased. Although the basic concepts and objectives to be aimed at are almost identical to the existing studies, smart disaster response technologies are continuing to show off as they converge with the 4th industry element technologies such as Cyber Physical System, Big Data, Mixed Reality, Building Information Modeling, etc. In the present study, disaster response support technologies has been arranged within the disaster integrated information platform that is being developed through the study project, along with the utilization plans for BIM model required for development of disaster support technology. In addition, directionality of the disaster support technology to come closer in the near future will be discussed.*

Keywords-*Disaster response, support technology, Building Information Modeling, space information, 3D visualization*

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I. INTRODUCTION

Currently, disaster integrated information platforms and disaster response service technologies are in development through a project called "Development of Integrated Cyber Physical System(CPS) for High Rise Building and Complex Facilities using Open Platform(Multi Disaster Countermeasure Organization)"[1]. The disaster support technology being developed through the present study is aiming at smarter and more effective disaster support by convergence with advanced element technologies such as BIM/GIS Integration, Wired/Wireless IoT, Big Data Analysis, CCTV Networking, AI-based Vision Detecting, etc. For such disaster response technologies to be developed based on virtual environments, virtual buildings having the same form and information as reality will be required, the key technology of which is BIM (Building Information Modeling) for construction of such virtual buildings[2].

In the present article, major services of the disaster integrated information platform has been arranged, of which the disaster support technology constituting intuitive disaster information services has been arranged in connection with BIM information. At this time, utilization plans for the BIM model required for development of each disaster response support technology will be arranged.

II. SERVICES FOR CONFIGURING OF INTEGRATED INFORMATION PLATFORM

Disaster integrated information platform is configured with core server and interface [3], being composed of client dash board to provide end-users with service of integrated disaster information. Each service configuration and detailed contents of the server and the client are as shown in the following Table 1 [4].

Table 1. Services for configuring of integrated information platform

Service name	Detailed contents	Classification
Information integration service for disaster data and facilities	▪Service for integration of static(BIM, GIS), dynamic(Real-time measurement information such as sensor, etc.) data and provision of information	▪Integrated data service(Server)
Determination service for situations per disaster	▪Determination service for real-time situations through disaster rule-set	▪Analysis interface (Server)
Systematic response service to situations	▪Response equipment control service according to disaster response action procedure (SOP)	▪Response interface(Server)
Intuitive disaster information service	▪Dashboard service for disaster information service	▪Dashboard(Client)

Information integration service for disaster data and facilities is the service provided by the key server of disaster integration information platform, and provides users with significant information by organic integration of static information such as facility information and regional information and dynamic information from sensors in real time. In the case of determination service for situations per disaster, it is the service provided by the analysis interface, allowing determination of real-time situations based on the collected sensor values, threshold values, and the result values derived through situation analysis. Systematic response service for situations enables automatic control of the disaster response equipment according to the Standard Operation Procedure (SOP) upon occurrence of disasters. Lastly, in the case of intuitive disaster information service, it means the service that visually provides significant information so as to allow comprehensive situation determination within one dashboard for efficient integration control, and includes systematic disaster response support technology to help decision making.

III. SYSTEMATIC DISASTER RESPONSE SUPPORT TECHNOLOGY

To realize 'Intuitive disaster information service' within the dashboard among platform configuring service mentioned earlier, individual disaster response support technologies have been developed, with their detailed contents being as shown in Table 2.

Table 2. Systematic disaster response support technologies and related BIM information

Support technology name	Detailed contents	Use	Element technology	Related BIM information
Disaster information integration technology	▪Integrate detailed facilities information (BIM) and surrounding area information (GIS) on the level of unit member for integration of reality data ▪Integrate in real time disaster response-related information such as related institution information, etc. and diversified sensing information	▪Efficient decision making based on integrated data	▪BIM+GIS, IoT, DB Integration	▪Shape ▪Facilities statement ▪Space
Response equipment monitoring technology	▪Monitor in real time states of sensors such as heat-sensing sensor, humidity sensor, gas sensor, motion-sensing sensor, door open/close-sensing sensor, etc. and disaster response equipment ▪Technology of visualization within dashboard upon occurrence of problems	▪Securing of real-time of sensors and 3D-based visualization of state	IoT, BIM	▪Shape ▪Space ▪Sensor history
Fire partition visualization technology	▪Construct fire partition by using BIM space information for visualization of fire risk based on integrated disaster information ▪Technology of visualizing risks of adjacent spaces based on analyzed results	▪3D-based visualization of fire risk by the unit of space/partition	Spatial BIM	▪Space ▪Height ▪Slope
Space information-based CCTV transmission monitoring technology	▪Link position information on each sensor, fire partition with CCTV information ▪Technology of simultaneously displaying the CCTV images of the relevant fire partitions and exits within dashboard upon reaching threshold value by the sensor	▪Visualization of fire partition and exits by multiple CCTV monitoring	▪CCTV Networking, BIM	▪Space ▪Position
Visualization technology for proof stress/non-proof stress structures	▪Utilize BIM information of the target facilities to secure safety or access path of the space with occurrence of disasters ▪Technology of visualizing proof stress, non-proof stress structures	▪Establishment of strategy utilizing proof stress/non-proof stress structures upon occurrence of disasters	▪Structural BIM	▪Shape ▪Proof stress /non-proof stress
Maintenance management of disaster equipment/facility	▪Support visualization for smart maintenance management of disaster equipment such as MEP(including sprinkler), fire extinguisher, fire plug, slow descender, emergency mask box, smoke screen, etc. as well as disaster-related facilities ▪Provide maintenance management services based on mobile devices	▪Systematic smart maintenance management including durability, replacement period, etc.	▪QR Code Scanning, Mobile App. BIM	▪Shape ▪Maintenance management history

As 3D visualization domain is emphasized since the results of such disaster response support technology are displayed in the form of visual information in the dashboard, easier visualization is possible if

BIM is put to use at this time. Furthermore, since not only 2D, 3D shape information but also attribute information concerning disaster characteristics due to the characteristics of BIM can be managed, it can be used effectively for development of disaster response support technologies.

IV. UTILIZATION OF BIM FOR DISASTER RESPONSE SUPPORT TECHNOLOGY

To apply each disaster response support technology, a test bed building has been selected, and the target building is composed of parking lot composed of pilotis for the 1st floor, office space for the 2nd and 3rd floors, and solar heat collector installed on the rooftop floor. Architecture of the target building, structures and equipment have been modelled, with the results as shown in Fig. 1.

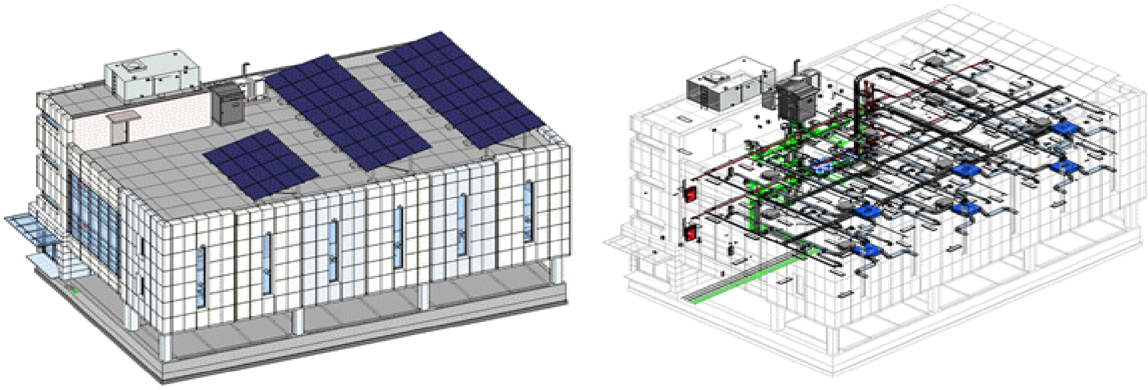

Fig. 1. Construction of building's BIM model(left) / equipment's BIM model(right)

Based on construction completion drawings and actual measurements, BIM model was constructed in the shape similar to a real building, including architecture, structure, equipment, furniture, etc. In particular, the objects specialized for disasters such as sprinkler (including piping), fire extinguisher, fire plug, slow descender, smoke-free facility, emergency mask box, various sensors, CCTV, etc. were modelled additionally, with addition of attribute information such as maintenance management, analysis information, etc. Based on this, the BIM model was expanded to the shape with addition of the information required for development of each disaster response support technology.

(1) Utilization of BIM model for development of visualization technology for fire partition

In the case of existing CAD, space was expressed by using 2D drawings and labels. On the other hand, space modelling is possible that has height and volume in 3D form in the case of BIM, and inputting of attributes such as area, volume, density, allowed number of people, etc. is also allowed. By using such characteristics, fire partition has been modelled, as shown in Fig.2.

Fig. 2. Setting of fire partition based on space information

Fire partition can be visualized in green, orange, red colors according to safe, caution, danger, and effective utilization is possible for space monitoring such as evacuation place and evacuation staircase, etc. In the future, it is planned to be utilized for visualization of analysis results on fire escalation risk, s well as visualization of fire safety based on proximity of finish materials, dangerous objects, etc.

(2) Utilization of BIM model for development of CCTV transmission monitoring technology based on space information

To realize CCTV transmission monitoring, BIM modelling was performed for CCTV and fire partition. In addition, for more precise transmission monitoring, space division for CCTV transmission monitoring was performed based on fire partition information and installation position of CCTV as shown in Fig. 3 (Right).

Fig. 3. Fire partition and CCTV position (Left) / Space partition for transmission monitoring (Right)

ID for the divided space matches with position information of each sensor, and the list of CCTV for activation of transmission monitoring has been prepared by considering position information of the divided spaces. Subsequently, attitude informationvalues (Panning/Tilting/Zooming value) of CCTV have been set in advance to effectively monitor each divided space, with development such that transmission monitoring is activated based on the relevant divided space when the alarm sounds at a particular sensor.

(3) Utilization of BIM model for development of visualization technology for proof stress/non-proof stress structures

When BIM authoring tools such as Revit™ or ArchiCAD™, etc. are used, attributes of a proof stress structure and a non-proof stress structure can be added, and the results are as shown in Fig. 4.

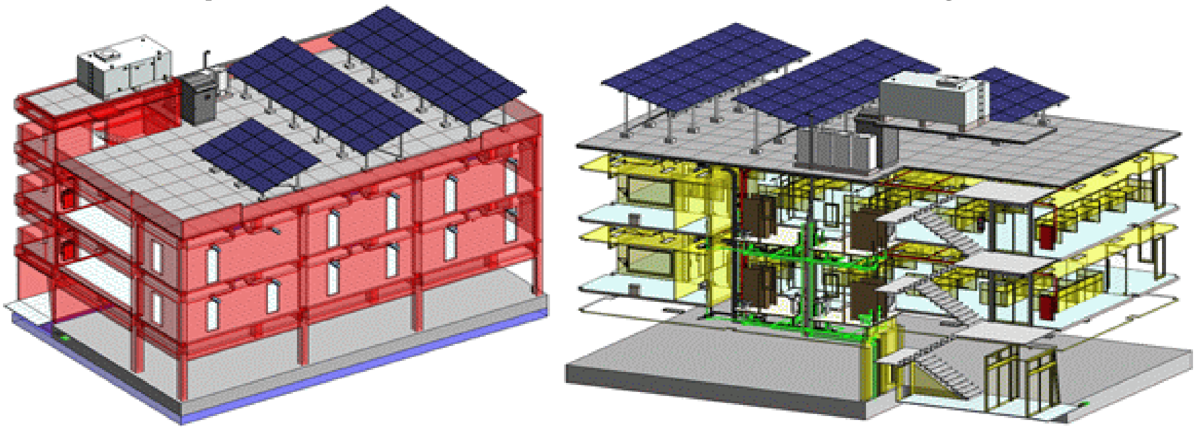

Fig. 4. Visualization of proof stress structure(Left) / Non-proof stress structure(Right)

The BIM model constructed in this way can be utilized usefully between implementations before operation. First, when the access path is blocked upon evacuation of the room occupants inside the building where damages occurred due to a disaster, securing of access path, evacuation path is possible by excavation of the non-proof stress structure. Secondly, risks of burial can be reduced when position of the proof stress is considered even upon accessing, allowing implementation of safer operations. In the future, its utilization is also considered possible in development of mobile strategy maps.

(4) Utilization of BIM model for development of maintenance management technology for disaster equipment/facilities

For development of BIM-based smart maintenance management technology, not only basic information such as identification information, size information, finish material information, analysis information, etc. but also maintenance management-related attributes such as manufacturing information, installation information, checkup information & monthly regular checkup information, etc. per target object were added. Based on this, it has been arranged as shown per each object in Table 3 what the added attributes were.

Table 3. Inputting scope for attribute information per target object

Classification		Space	Column	Beam	Wall	Floor	Door	Window	Piping	Lighting	Air conditioning	Fire fighting	Furniture	Equipment	Electricity	Piping
Identification information	Classification, floors, type name	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Size information	Area, size, length, height, thickness	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Finish information	Floor finish, wall finish, ceiling finish	●														
Manufacturing information	Manufactured country, manufacturer, model name, model No. manufactured date, warranty period	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Installation information	Installation business, installation description, installation date						●	●	●	●	●	●	●	●	●	●
Analysis information	Basic information for analysis							●		●						
Checkup information	Replacement period, checkup period, checkup tool, checkup history	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Monthly regular checkup information	Checkup items ID, result, volume content, action content, remarks									●		●		●		

When the information inputted in this way is utilized, checkup plans for facilities with replacement dates coming up can be established. This is because problems can be prevented in advance if replacement plans are established by considering replacement periods based on installation dates and supply of materials is planned in advance by utilization of manufacturing information for instance. At this time, for the object whose replacement period is coming up, visualization is possible by utilization of the BIM model according to durability. Not only that, more detailed management of regular checkups is enabled, for verification of which checkup-related history information was constructed as DB for the subject of lighting, firefighting, and equipment, management of monthly regular checkups was performed based on the fire-fighting facility checklist, and detailed regular checkup items at this time are as listed in Table 4. The form for fire-fighting facility checklist has been partly extracted from the announcement[Separate sheet/ No. 5 & No. 6 form] concerning independent checkup items for fire-fighting facility, and the table was prepared by adding checkup item ID to facilitate management of checkup items [5].

Table 4. Form of fire-fighting facility checklist for inputting of monthly regular checkup information

Fire extinguisher(A)						
Checkup item ID	Classification	Checkup content	Checkup result			Remarks
			Result	Defect content	Action content	
A01	Fire extinguisher	. Is the inspection date recorded in the checklist?				
A02		. Is qualification seal not dropped off of the fire extinguisher body?				
A03		. Are how to use & applicable fire displayed				
A04		. Is the part with painting peeled in the container body not being corroded?				
A05		. Is a display of fire extinguisher available in the installation place?				
A06		. Are valves and packing not aged or dropped out?				
A07		. Are there any foreign objects fit in nozzle, etc.?				
A08	Automatic fire-fighting apparatus	. Is the indicated pressure value optimum for fire extinguishing agent container?				
A09		. Is the installation place of receiver and the sound volume of sound device optimum?				

A10		. Does the sensor operate upon gas leakage test and is the installation place appropriate according to fuel characteristics?				
A11		. Is there no obstacle upon release of fire extinguishing agent from the release port?				
A12		. Is the gas shutoff valve sturdy and opened/closed normally?				

Monthly regular checkups were conducted according to the form of fire-fighting facility checklist mentioned earlier, and a part of the DB arranging the results has been summarized as shown in Table 5.

Table 5. An example of regular checkup results for fire extinguisher

ElementId	Type Name	Level	Space Name	Checkup history	Checkup item ID	Result	Defect content	Action content	Remarks
1971556	Powder fire extinguisher (ABC) Unit 4	2F	Control room	2017.6.30.	A01	Normal			
					A02	Defective	Partly erased	Person in charge to check up	Completed
					A03	Normal			
					A04	Normal			
					A05	Normal			
					A06	Normal			
					A07	Normal			
					A08	Normal			
					A09	Normal			
					A10	Normal			
					A11	Normal			
					A12	Normal			

When the checkup results of Table 5 are analyzed, according to the checkup result for the item “Isqualification seal not dropped off of the fire extinguisher body?”, the checkup state was distinguished to be defective as the qualification seal had been partly erased, and it can be seen that the action has been completed through the checkup by the person in charge. Since the smart maintenance management system is used mainly by the field managers, it is developed as a mobile application, and mounting of convenience functions such as QR Code Tagging will be possible in the future.

V. CONCLUSIONS

Thus far, major service technologies constituting the integrated information platform and detailed disaster response support technologies have been arranged. In this way, it has been confirmed that the disaster response technologies having gone one step further can be developed through convergence with advanced technologies. In addition, it has been confirmed that BIM data was actively utilized for 3D visualization and information linkage. Not only the disaster response support technologies mentioned earlier but also technologies of false report detection based on Big Data analysis, threshold value calibration technology, fire safety analysis technology based on BIM, systematic disaster response technology based on SOP, AI and CCTV preferred display technology based on AI image analysis, etc. are in development. Through such technologies, opportunities allowing golden time for disaster response to be secured are considered to be increased, and it is the author's expectation that technologies which people experiencing disasters are able to actively apply can be developed much further through convergence of more diversified element technologies in the future.

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REFERENCES

[1]. Y. Baek, Research Organization on the Countermeasure of Multi Disaster for Complex Skyscraper Facilities, Proceeding of KSCE 2017 Convention, Korean Society of Civil Engineers, 2017.
[2]. SIEMENS The Magazine, Three perspectives on digital twins, https://www.siemens.com/customer-magazine/en/home/buildings/three-perspectives-on-digital-twins.html, 2018.
[3]. 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, pp.361-366.
[4]. C. Youn, S. Park,Service Architecture Design of Disaster Response Platform based on BIM/GIS, Proceeding of 2018 Summer Conference, Society for Computational Design and Engineering, 2018.
[5]. Ministry of Public Safety and Security, Announcement on independent checkup items for fire-fighting facility, etc, Announcement by Ministry of Public Safety & Security No.2017-27, 2017.

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