

A study of BIM based building facilities online repair system

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Abstract

When facilities was exceptionally occurs, the traditional operation method is either to repair or replace. Before operation procedures starts, it needs to be taken through a series of actions of notification with paperwork. Thus, the management on site tends to make the operation procedure with inefficiency and inconvenience. The recent rise of BIM. Due to BIM's functionality and data-rich of facilities, it can help improve the efficiency of operation of the management unit. The purpose of this study is to use BIM to generate a facilities repair system platform. When a facility needs to be repaired, the platform can be used to quickly informed and able to understand the current status, the location, and maintenance data of facilities,. In this study, the data of BIM facilities in windows system functions through the list of exporting, importing into the system database, and graphics output with BIM to achieve functional model reveal it. The components of the proposed system includes facilities maintenance records QR Coding , different facilities and equipment positioning method; combined facilities data encoding systems, as well as abnormal conditions different equipment repair orders; Users most concerned about the maintenance status inquiries; management unit management menu. Reporting and management systemFs will be combined together to explore the use of newspaper repair system users and managers through viewpoints of both. After using the system to get a few results of this study, presented in the visual effects quickly locate facilities, facilities and equipment standard encoding, facilities and equipment exception, BIM model to enhance the convenience and efficiency of users and managers.

Keywords –BIM, QR Code, Facility management

1 Introduction

The importance of property management has gradually been recognized in Taiwan. Aside from the management of buildings, the life cycle of the buildings also requires the same level of attention. Both new and existing buildings require a suitable management

approach. Currently, building information modeling (BIM) has advanced considerably in Taiwan, and the establishment of models has also been relatively fast. The major benefit of BIM is not exactly in three-dimensional (3D) modeling, but in the provision of detailed building information. Although a model can show how a building will look upon completion, the information provided has a wide range of applications in areas such as cost budgeting, supply management, project scheduling, collision detection, and management and maintenance. BIM, along with the large amount of information it generates, contributes considerably to the development of architectural engineering and property management.

Adequate management and maintenance of a building and its amenities are key factors in prolonging the building's life-span. Deterioration over time can lower the function and value of a building to an extent that, if timely repair and renovation are not performed, severe problems can ensue. The incorporation of BIM into property management effectively facilitates restoring deteriorated amenities, thus maintaining the building's function and value in the long term. In addition, BIM also supports 3D visualized management and provides relatively accurate information that enables decision makers to work more efficiently. Earlier, information management was performed manually with pen and paper, which can be complex and error-prone. Currently, the enhanced efficiency in operations and data storage pertaining to BIM offers considerable advantages over the manual method. Computerized information management and database technology enable the transfer of data to platforms that are easily accessible for general users to check and review the maintenance records of amenities registered in the BIM system. This effectively overcomes the technical limitations and enables more users to master the BIM.

1.2 Purpose

This study explored an approach for extracting amenity data from a BIM system and incorporating existing database systems into a proposed framework

for application in the management and maintenance of amenities and facilities.

The present study was aimed at generating an amenity maintenance platform from existing BIM data, which enables expedited reporting for repairs and a comprehensive listing of the status, location, and maintenance records of amenities and facilities. In summary, the purpose of this study was twofold:

- (1) To establish a BIM amenity database framework;
- (2) To develop an amenity maintenance platform incorporating the BIM framework.

1.3 Scope and Limitations

- (1) This study aimed at developing a building amenity maintenance platform incorporating the BIM framework. The scope, target, and limitations of the present study are defined as follows:
- (2) In terms of the research scope, this study sought to establish an amenity maintenance system and explore the system's application from the perspectives of both users and administrators. Information stored in BIM was exported through the tools' "schedule" functions for the system database which, through its graphic output functions, enabled visualization of the model.
- (3) Considering the wide variety of amenities and facilities in a building, the research scope was limited to the window/door system.

1.4 Methodology

The present study commenced with identifying the research motivation, purpose, and scope, then determining the research framework through a literature review. Finally, an amenity maintenance system was proposed for the application of BIM information.

2 Literature Review

The literature revealed that BIM is used throughout the life cycle of a building. In terms of the maintenance and management of amenities and facilities, the literature also reveals various applications of BIM and multiple positive effects it can generate. Numerous software providers are known to release property management products incorporating BIM technology, but such products tend to be less practical than expected. Therefore, the present study also examined BIM from an alternative perspective by exploring its functions and effectiveness in reports on the repair of amenities and facilities.

R. Liu 2013 to clarify the frequently occurring maintainability problems and to investigate the potential areas that can use BIM technology to solve the maintenance problems in early the design phase. A

survey was conducted to collect perspectives from the industry practitioners for the maintenance problems and their frequency.

Changyoon Kim 2013 BIM can be used in numerous applications for facility management. This study aims to incorporate the strength of mobile systems and BIM in facility management. The proposed system, which utilizes smartphone technology, allows engineers to conduct facility management functions, such as maintenance planning, inspection, and assessment, irrespective of a user's location. The integration of building information modeling in a system provides detailed visual information of the building components.

The means of extracting BIM information from a database were explored for the use of an amenity maintenance system. This combination, with an online report-for-repair feature, was expected to successfully introduce BIM into the domain of property management.

2.1 Tools for BIM

Software tools for BIM that are commonly used in Taiwan include Autodesk Revit, Graphisoft ArchiCAD, and Bentley MicroStation. Autodesk Navisworks was also used in the present study.

Level of development

The level of development (LOD) is discussed in this section to provide a set of standards for the establishment of a BIM system.

One problem that is inevitably encountered in establishing BIM is that the model designers are multidisciplinary professionals who do not follow a set of unified standards. LOD provides a set of standards upon which model users can specify the degree of detail in a model, the ownership of the model, and the BIM requirements and documentation formats. LOD also defines the model management responsibilities from the beginning to the end of the architecture project.

According to protocol E202TM-2008 of the American Institute of Architects, the LOD is a BIM tool comprising five progressively detailed levels of completeness. The five levels are coded LOD100, LOD200, LOD300, LOD400, and LOD500 on the basis of the legal requirements for the contents of models for each LOD.

After the introduction of the LODs, a conclusion is reached that if BIM is to use the LOD at the building operations management stage, LOD300 is the minimum level required for such a task. In other words, the introduction of BIM into a building's maintenance and management starts as early as the building's construction stage, because basic information required for the maintenance and management of amenities, such as their actual lengths, widths, heights, locations, and orientations, become available at this stage.

The BIM used in the present study was based on LOD300; therefore, some additional amenity-related information had to be added for the use of the amenity maintenance system proposed by this study.

3 Design of the Amenity Maintenance System

After the study's motivation and purpose were defined, the development of the amenity maintenance system commenced. However, user requirements needs and system functions had to be identified first.

(1) User Requirements

Users of the proposed amenity maintenance system can be divided into two categories: general users and administrators. A user requirements analysis revealed that for general users, both the interface and presentation of information should not be too complex to ensure ease of use and quickness of control. The progress of repairs was the one feature that these users wanted to see the most in the inquiry interface.

Interviews with personnel in the property management industry revealed that for the administrators, aside from basic information such as the measurements of amenities, the most necessary information was maintenance details such as life-span, cost, caretaker, and maintenance service provider of the amenities. To keep the interface simple and ensure information security, the amenity repair inquiry function would display only basic information. Administrators can gain access to complete information through the model inspection function.

(2) System Functions

This amenity maintenance system enables tenants to request repairs on their own. Administrators are then alerted by the request and can confirm the progress of repairs through the system.

(3) Tools

Concerning the design of the proposed amenity maintenance system, the present study chose Autodesk Revit and Autodesk Navisworks for the BIM and rendering of 3D models. This author also chose Autodesk Revit and Autodesk Navisworks as the research tools for the study.

Microsoft Visual Studio and Microsoft ASP.NET were used in the design of the amenity maintenance system.

3.1 Introduction of the request-for-repair process

The proposed system uses information extracted from BIM as the basis for the system database, providing an online report-for-repair platform for general users and administrators. General users can

access the system through the Internet or by scanning the quick response (QR) code on the amenities, and then file a request for repairs from their residence. Therefore, this system would provide great convenience for general users. Upon reception of the request, administrators can check the location and basic information of the malfunctioned amenity and its maintenance records in the office for an effective appraisal of the situation and to ensure control over the repair process. The adoption of this system would facilitate improving the efficiency of property management.

Amenity/Facility Information: The table contains information extracted from BIM, which contains a large amount of data including amenity/facility information found in architectural models, structural models, and MEP models, as well as maintenance information and serial codes of amenity elements linked to the relevant parameter settings. The amenity/facility data in the BIM can be compiled using the "schedule" function and then exported to the system database. Also included are 2D and 3D floor plans to facilitate displaying amenity/facility locations in the system.

Maintenance Information: This table contains specific information that cannot be obtained through setting the parameters of the BIM elements such as information on maintenance service providers and maintenance records. This table is an effective supplement for the maintenance information in the system database.

Abnormal Conditions: In the system, the display of abnormal conditions varies depending on the type of amenity/facility. This study focused on the windows and doors, which have 14 and 8 types of abnormalities, respectively (these conditions are further detailed in the following section).

This table enables operators to mark the categories of abnormal conditions when filing requests for repair to the system.

Feedback: This table plays a critical role in the database. A request for repair is added to this table after it is submitted to the system, after which the administrators are alerted of the situation. The system also allows administrators to track the repair progress of each request, and their feedback is immediately added to this table to provide updates on the situation for display in the system's progress inquiry page.

The procedures for general users were designed with consideration of principles such as convenience, promptness, and real-time response.

For general users who would like to make a request, the most efficient approach is to scan the QR code on the amenity/facility by using a mobile device, which immediately brings up the system's request for repair page.

The system menu for general users consists of only two options: request for repair and repair progress inquiry. Because most users would be interested only in the progress of the requests they have submitted, it is allocated in a column in the system's repair progress inquiry page, which is updated according to feedback and track records from the administrators (figure 1).

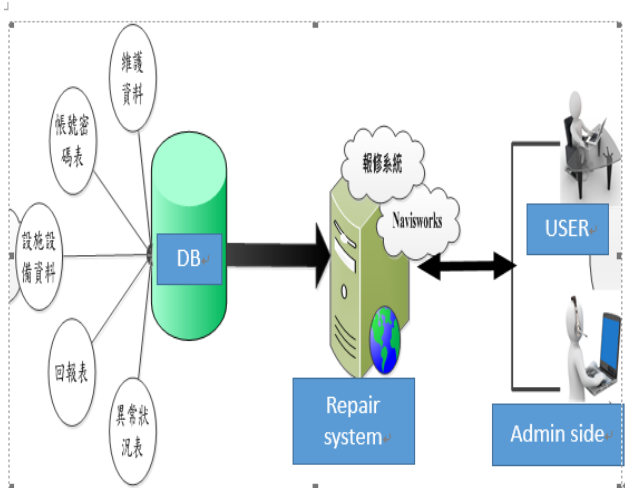


Figure 1 Repair / maintenance system architecture

Upon reception of a request, this request is immediately shown on the administrator feedback page. The first step taken by the administrators is to determine whether an appropriate maintenance service provider should be informed of the request. The decision is usually based on provisions in the service contract, because the service provider is bound to certain maintenance and warranty responsibilities within the term of the contract, which would substantially reduce the repair costs ensued. A decision not to inform a service provider is typically for one of the following reasons: expired warranty period or contract term, unaffordable preliminary repair quotation, or minor problems that could be remedied by the administrators. The next step is to determine whether the amenity/facility concerned can be fully repaired. When it can be repaired, the case can be closed upon completion of the repair. Otherwise, the amenity/facility must be replaced. The case is considered concluded after the replacement has been installed.

3.2 Serial Code Guidelines and Abnormal Conditions

This section defines the serial codes and details the types of abnormal conditions. The serial codes give each amenity or facility an exclusive identifier akin to a personal identification number, thereby preventing mistaken identification. Abnormal conditions of the

amenities/facilities are categorized by damage types to assist general users in quickly recognizing and selecting appropriate categories in the system interface

The serial numbers comprise two parts: the first part is based on the item numbers proclaimed by the Public Construction Commission (PCC), and the second part is based on the location (to ensure quick positioning). The combination of the two forms a set of codes that can be used to identify individual amenity/facility (Table 1) ..

Table1 individual amenity/facility code

082104654A	-	A1EW1
item numbers proclaimed		location codes

- The item numbers compiled by the PCC were adopted for the present study because they are relatively comprehensive and the codes are relatively short.
- Regarding the location codes, they consist of five digits, making them short and easy enough for quick identification and positioning. The meanings of the digits were as follows:
 - First digit (building number): Identifies the specific building the amenity/facility is in.
 - Second digit (floor): Identifies the specific floor the amenity/facility is on. Codes A–Z are used to denote 1F–26F, and 1–9 are used to denote B1F–B9F.
 - Third digit (room): Identifies the specific room the amenity/facility is in, or the room immediately after the amenity/facility.
 - Fourth digit (orientation): Identifies the specific location of the amenity/facility in a room according to the cardinal directions.
 - Fifth digit (order): Identifies the sequential position (from left to right) of the amenity/facility among its type in the same room when viewed from the front.
- Combining item numbers of the PCC and the location codes obtains the complete 15-digit serial codes.

3.2.1 Abnormal Conditions:

Because the present study focused on windows and doors, only the abnormal conditions commonly seen among windows and doors are specified here.

The present study identified eight abnormal conditions that are commonly observed or can be found after dismantling the components of windows: corrosion, seeping, peeling of waterproof material, broken glass,

frame warpage, damaged knobs, rust-corroded screws, and damaged window screens.

4 Practical Testing

A practical test was performed in a community in Hong Kong. The target was a villa with two floors above ground and one below ground. BIM was introduced early in the design stages as an auxiliary tool (Figure 2). A window in the living room on the first floor was selected for a request for repair, and the tenant was granted access to the system either by scanning the window's QR code or by logging into the system through the Internet with a set of account and password (. Once entered into the system, the tenant made a request for repair, and was required to pick an amenity/facility for the task. The tenant was able to locate it either by entering the serial code or by going through a dropdown list to specify the building, floor, and room it is in. Here, the tenant selected to use the dropdown list, and when the room was specified, the window could be selected from a plan of the room; subsequently, the request form page was displayed. When selecting the floor, the tenant was also able to open the floor plan and search for a specific item from there.



Figure 2 Use a smart phone to scan QR Code

The request form page contains a section in which the tenant can manually enter a brief description of the abnormal condition the concerned amenity/facility before clicking on the "finish" button to submit the request. Afterwards, the tenant can check the progress by using the inquiry function. After the request has been received, the administrators are alerted by the feedback table (Table 2), which also briefed them on the situation. By clicking on the location button embedded in the

request form, the administrators can access the BIM to quickly locate the problem (Figure 3).

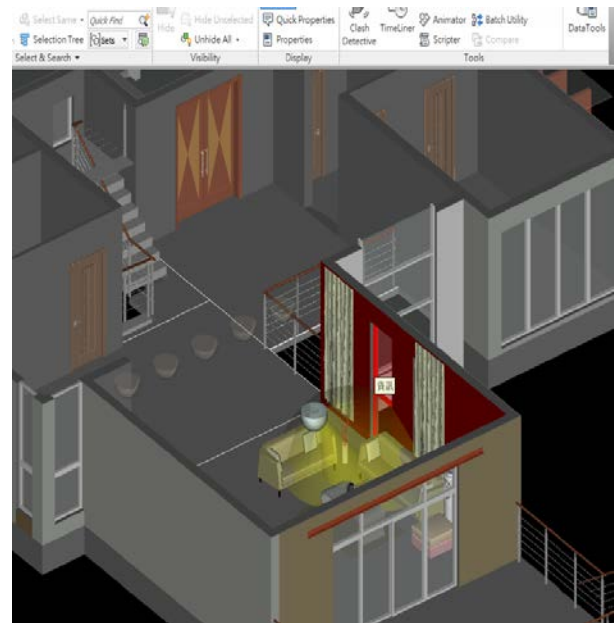


Figure 3 show the location

Table2 Repair / maintenance resume

Facilities basic information			
amenity/facility code	08510RK02A-AAGE2	TYPE	C0823
budlding	A	floo	1F
Maintenance information			
Years of use	20	Last maintenance date	2017/02/07
manufaturer	AA	Repair status	Repair confirmation

After the administrators checked the request information, they assessed whether a service provider should be contacted or if they should repair the damage themselves. Furthermore, the progress of repairs can be monitored through the system's feedback page, which is synchronized with the inquiry page to enable the tenant access progress updates.

5 Conclusions and Suggestions

This section summarizes the results of the present study. Suggestions are also offered as a reference for future researchers.

5.1 Conclusions

The visual display supported by Navisworks provides a graphic user interface that enables the administrators to quickly locate amenities/facilities in need of repair. The serial code system designed for this system is a combination of the item numbers from the PCC and location codes for building amenities/facilities. The advantages of this measure are that the first part of the code is already known to local industries, and the second part is an effective indicator of the location of specific amenities/facilities. The introduction of the serial codes and QR codes provides both general users and administrators with four easy methods for quickly locating a specific amenity/facility. Common abnormal conditions are categorized to enable convenient and accurate selection for general users. The categorization also enables administrators to take appropriate actions. The application of BIM information in the property management of a building, or more specifically, its use in a maintenance system, enables administrators to enhance efficiency and reduce the number of operational errors and minimize expenditures.

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