

APPLICATION OF BIM IN SUSTAINABLE COMMUNITY MAINTENANCE MANAGEMENT SYSTEM

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Received December 2015; accepted March 2016

ABSTRACT. *The task of community management is complex and not easily handled by common residents. According to current statutory regulations, management committees have a term of office; therefore, a multitude of management data and practical experience are not easily passed down. Construction management includes phases of planning, design, commission, construction, and maintenance. This study adopts communities as the subject of study, exploring the current conditions and modes of maintenance management of buildings in Taiwan via documents, and providing integrated recommendations to frequently encountered issues, as well as utilizing BIM environment, ER Studio, database management system, and information technology to develop a “sustainable community management system”. This system would efficiently handle the management of the community, keeping a transparent supervision over the financial status, and represent it via the BIM 3D interface, enabling a complete maintenance of community facilities, in order for the community to achieve the ideal of a sustainable management and use.*

Keywords: BIM, Sustainable community maintenance management, Facility management, Life cycle

1. Introduction.

1.1. **Research background.** In the changing times, the increase in population and modernization resulted in the vertical, large-scale, and complex expansion in size and form of buildings. Their functions and equipment, also due to the demands in providing multiple functions, triggered a demand in services different from the buildings in the past. This includes housing problems such as maintenance and renovation of the facility, residential safety, planning/use of public facilities, and market value of the building. The task of community management is complex and not easily handled by common residents. Additionally, the management committee holds new elections annually, with limited experience and knowledge, various management history data and practical experience are not easily passed down to the succeeding committee [1].

The BIM (Building Information Modeling) is a data integration software with 3D graphs. It enables basic modular technology to fully link up with architectural design database and conduct digital information exchanges during the construction process. One of its features is to be able to create coordinated, uniformed, and computable data for construction projects in design and construction phases [2]. The primary function of BIM in the life cycle of the building is to construct a system with reusable architectural data that can be internally integrated and jointly accessed, which can replace the information and expression in addition to previously inputted data that can be made available for subsequent users, which is helpful in improving project quality, saving time, reducing costs and mistakes [3].

1.2. Research motivation and objective. In order to reduce the costs for maintenance, as well as maintain the functions of the communities, this study utilizes BIM, SOL, and software development tools to create a sustainable community management system, which assists in the management of daily maintenances in the communities. That information includes all resident data, monthly management fees, parking fees, cleaning fees, security fees, and facility maintenance fees. The BIM environment is used to create an architectural information model of the community, representing important facilities in the community in 3D graphs, which in turn enables maintenance personnel to utilize the convenience of Internet to keep informed with the renovation and maintenance histories of the buildings and facilities. This affords manager efficient control over the maintenance of the buildings and facilities, assisting the management personnel to be better at the task of managing sustainable communities. The research purpose of this study includes:

- A. Through document reviews, the current situation of applying BIM to all industries and areas is compiled, as well as collecting relevant applications and performances related to constructions, and exploring system functions required to be applied on the “sustainable community management system”.
- B. ER Studio is used to create the system framework of the “sustainable community management system”, complemented by IT to create the interface for a database management system, and integrate BIM to create a management platform for facility maintenances.
- C. Inputting actual cases into the system to authenticate system functions and data transmission accuracy.

The methodology of this study is discussed in Section 2. System development and functions of the community management and maintenance system are discoursed in Section 3. Brief conclusion is dissertated in Section 4.

2. Methodology-Building Management Maintenance Items. In accordance with apartment building management regulations, there is a broad range of layers associated with building management maintenance; hardware includes water/electricity repair, cleaning maintenance, renovation, fire safety; software includes home security, living services, etc. Management service personnel must improve service quality in order to match up market competitions [4]. This study organized community maintenances into the following seven categories:

- A. General administration: including basic information regarding the building, list of residents, list of parking spaces, basic committee member files, contact information on relevant units, etc.
- B. Management fees: including collecting management fees, management fee follow-up reminders, item requisitions/collections, vendor fee payments/collections, regular financial reports, etc.
- C. The periodic use and repair management maintenance of facilities and equipment include the following two categories:
 - a. Security and fire safety: access control management, fire safety equipment inspection/repair statements, building public safety inspection statements, etc.
 - b. Electromechanical equipment maintenance: repair of warranted equipment by manufactures, electromechanical point inspections.
- D. Regular equipment maintenance management: including miscellaneous expenses of environmental cleaning management, security management, water and electricity, and garbage bags.
- E. Community management organization developments: convene management committee conferences, conduct meeting of the unit owners and handle temporary meeting issues, coordinate disputes in the communities, annual community committee management

rights handover, host elections of succeeding committee members, conduct management right transfers, hold resident events, compile community bulletin publications, community management feedback, and self-evaluations.

- F. Annual financial affairs: annual financial reports, financial plans, evaluation and selection of service firms for various management tasks.
- G. Living agency services: including public facility use and management regulations, household services, collect mails/newspapers/milk, call cabs, order airplane/bus tickets, pay water, electricity, natural gas fees and rents, house renovation recommendations, provide life information or creative arts event information, arrange resident get-together events, conduct community family events.

3. System Development and Functions. This study uses the ER Model, database management system, and system development software to construct the database, plan and develop system functions; the data base system is a software system used to create management data. The user can issue database-processing data via the database management system, e.g., append data, update data, delete data, and search data, other than permitting users to access data stored within the database, and allow the data, via internal program designs, to further filter records and conduct logic operations by internal program designs, allowing the user to load the latest information through simple operations.

3.1. System component. This study utilizes system development tool to construct community management system. The system is designed with friendly user window interface. System operating elements' primary function includes:

- A. Data paging, edit and search functions: convenient, easy-to-operate, built-in functions such as: append data, update data, delete data, etc. (as shown in Figure 1)
- B. Drop-down menu data input functions: data is able to be inputted via system default or previously entered parameter setting data with drop-down-and-click functions, skipping the cumbersome work of repetitive typing and data inputting. (as shown in Figure 2)
- C. Drop-down date menu single-click data input functions (as shown in Figure 3)

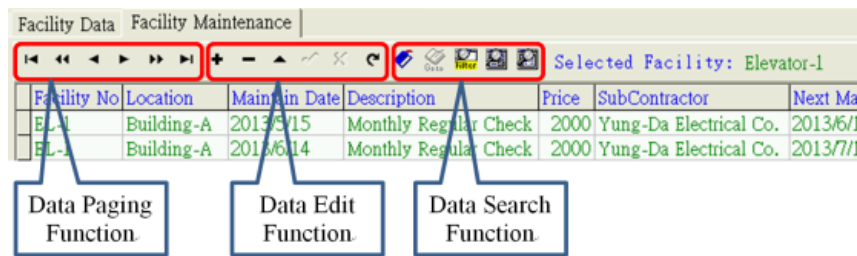


FIGURE 1. Data hot-key buttons

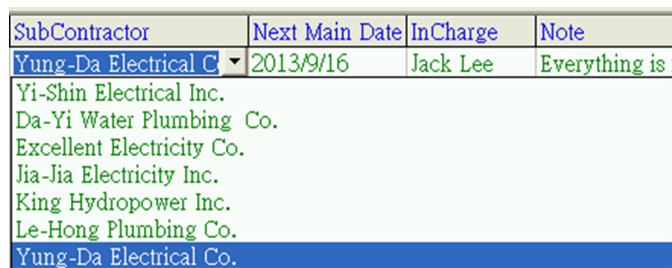


FIGURE 2. Drop-down menu display

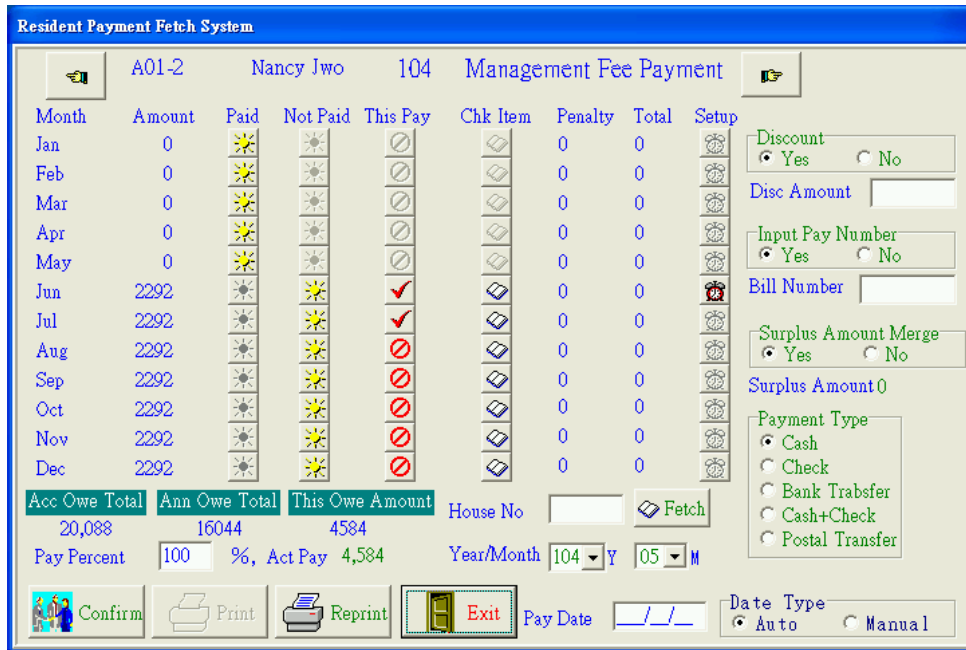


FIGURE 5. Resident payment fetching system

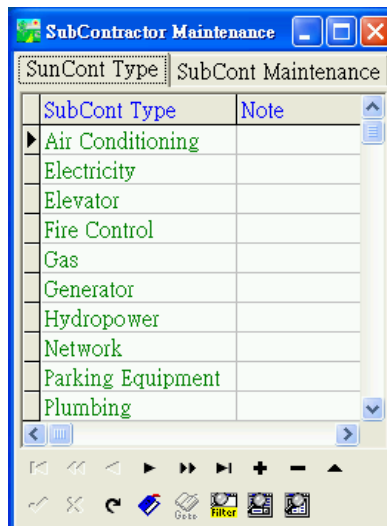


FIGURE 6. Subcontractor type table

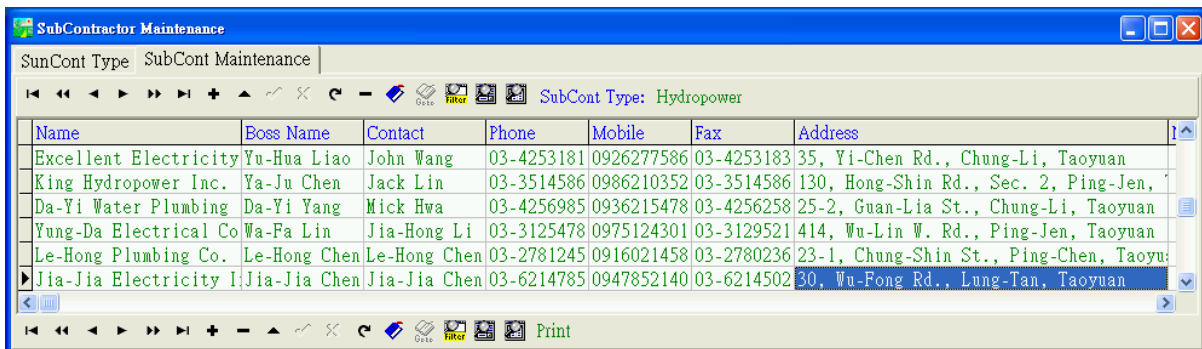


FIGURE 7. Subcontractor maintenance display – Subcontractor maintenance table

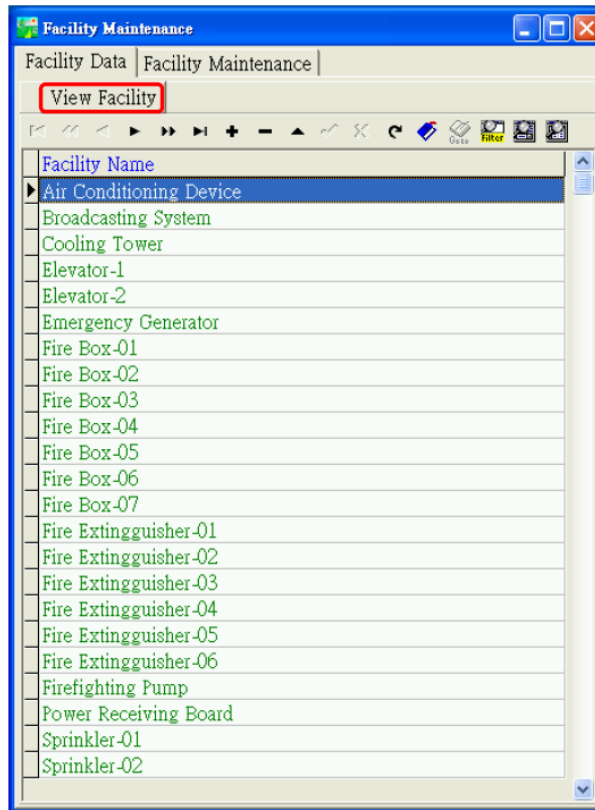


FIGURE 8. Facility maintenance display – Facility data table

The screenshot shows the same software window, but now displaying a detailed maintenance table for the selected facility, "Elevator-1". The table has columns for Facility No, Location, Maintain Date, Description, Price, SubContractor, Next Main Date, InCharge, and Note. The "Selected Facility: Elevator-1" is indicated at the top of the table area. The table contains 25 rows of maintenance records.

Facility No	Location	Maintain Date	Description	Price	SubContractor	Next Main Date	InCharge	Note
EL-1	Building-A	2013/7/15	Monthly Regular Check	2000	Yung-Da Electrical Co.	2013/8/15	John Chen	Everything is normal
EL-1	Building-A	2013/8/15	Monthly Regular Check	2000	Yung-Da Electrical Co.	2013/9/16	Jack Lee	Everything is normal, ne
EL-1	Building-A	2013/9/16	Annual Regular Check	5000	Yung-Da Electrical Co.	2013/10/15	Jack Lee	Everything is normal
EL-1	Building-A	2013/10/15	Monthly Regular Check	2000	Yung-Da Electrical Co.	2013/11/14	Jack Lee	Everything is normal
EL-1	Building-A	2013/11/14	Monthly Regular Check	2000	Yung-Da Electrical Co.	2013/12/16	Jack Lee	Everything is normal
EL-1	Building-A	2013/12/16	Monthly Regular Check	2000	Yung-Da Electrical Co.	2014/1/15	Jack Lee	Everything is normal
EL-1	Building-A	2014/1/15	Monthly Regular Check	2000	Yung-Da Electrical Co.	2014/2/14	Jack Lee	Everything is normal
EL-1	Building-A	2014/2/14	Monthly Regular Check	2000	Yung-Da Electrical Co.	2014/3/14	Jack Lee	Everything is normal
EL-1	Building-A	2014/3/14	Monthly Regular Check	2000	Yung-Da Electrical Co.	2014/4/15	Yu-Lung Li	Everything is normal
EL-1	Building-A	2014/4/15	Monthly Regular Check	2000	Yung-Da Electrical Co.	2014/5/15	Yu-Lung Li	Everything is normal
EL-1	Building-A	2014/5/15	Monthly Regular Check	2000	Yung-Da Electrical Co.	2014/6/16	Yu-Lung Li	Everything is normal
EL-1	Building-A	2014/6/16	Monthly Regular Check	2000	Yung-Da Electrical Co.	2014/7/15	Yu-Lung Li	Everything is normal
EL-1	Building-A	2014/7/15	Monthly Regular Check	2000	Yung-Da Electrical Co.	2014/8/15	Yu-Lung Li	Everything is normal
EL-1	Building-A	2014/8/15	Monthly Regular Check	2000	Yung-Da Electrical Co.	2014/9/15	Yu-Lung Li	Everything is normal, ne
EL-1	Building-A	2014/9/15	Annual Regular Check	5000	Yung-Da Electrical Co.	2014/10/15	Yu-Lung Li	Everything is normal
EL-1	Building-A	2014/10/15	Monthly Regular Check	2000	Yung-Da Electrical Co.	2014/11/14	Yu-Lung Li	Everything is normal
EL-1	Building-A	2014/11/14	Monthly Regular Check	2000	Yung-Da Electrical Co.	2014/12/15	Yu-Lung Li	Everything is normal
EL-1	Building-A	2014/12/15	Monthly Regular Check	2000	Yung-Da Electrical Co.	2015/1/15	Yu-Lung Li	Everything is normal
EL-1	Building-A	2015/1/15	Monthly Regular Check	2000	Yung-Da Electrical Co.	2015/2/16	Yu-Lung Li	Everything is normal
EL-1	Building-A	2015/2/16	Monthly Regular Check	2000	Yung-Da Electrical Co.	2015/3/16	Yu-Lung Li	Everything is normal
EL-1	Building-A	2015/3/16	Monthly Regular Check	2000	Yung-Da Electrical Co.	2015/4/15	Yu-Lung Li	Everything is normal
EL-1	Building-A	2015/4/15	Monthly Regular Check	2000	Yung-Da Electrical Co.	2015/5/15	Yu-Lung Li	Everything is normal
EL-1	Building-A	2015/5/15	Monthly Regular Check	2000	Yung-Da Electrical Co.	2015/6/15	Yu-Lung Li	Everything is normal

FIGURE 9. Facility maintenance display – Facility maintenance table

function to view maintenance history. Figure 9 is the detail maintenance data for facility “Elevator-1”.

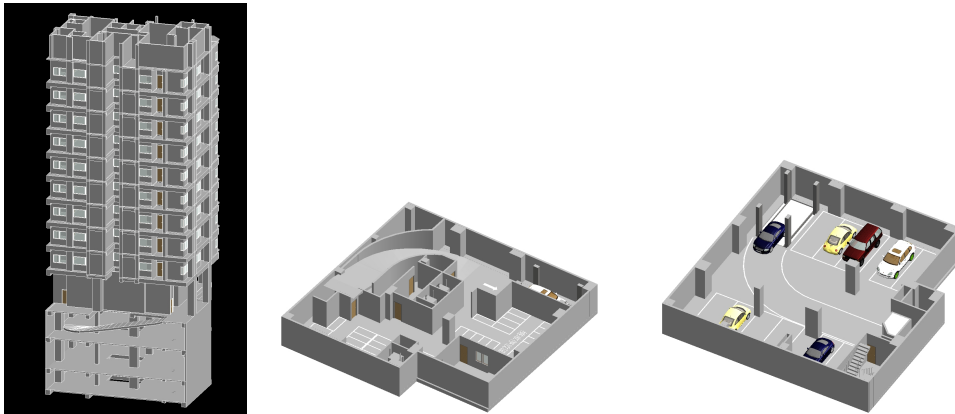
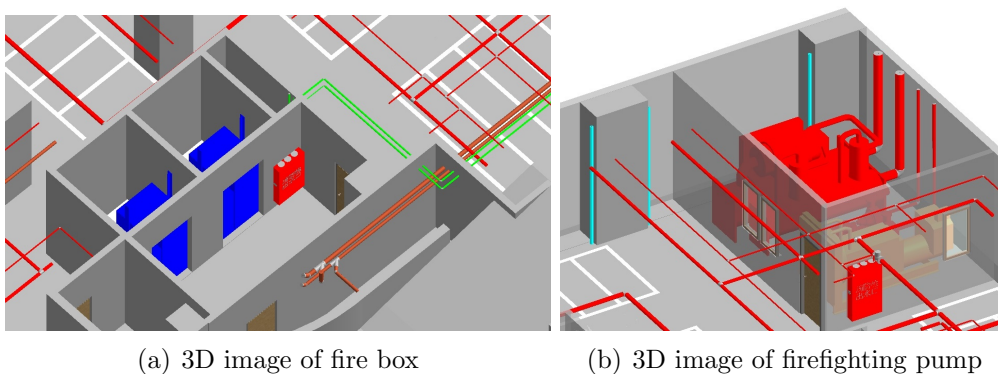


FIGURE 10. 3D views constructed by BIM environment in this study



(a) 3D image of fire box

(b) 3D image of firefighting pump

FIGURE 11. 3D images of the selected facility

3.4. BIM 3D display. This study used BIM to construct 3D model of the community (Figure 10). Administration staffs can view these 3D displays to easily control office management jobs. In Figure 8, when certain facility is selected and push the “View Facility” button, the 3D image of the selected equipment will be displayed (Figure 11).

4. Conclusion. This study aims to improve the maintenance and management efficiency of buildings, provide a standardized management procedure regulation and tool for community organizations with limited experience and knowledge regarding community management issues, reduce unnecessary waste of time, manpower, materials, and avoid mistakes or human-malpractices to improve the quality of use of buildings. Explanations on the contributions of this project are as follows:

- A. Assist regular communities in solving issues of current management committee being unfamiliar with community management tasks; improve the feasibility of self-management by the unit owners; and resolve the issues of management experiences being hard to pass down for the residents and committee, as well as past management records being hard to preserve.
- B. Allow residents to accurately be aware of monthly incomes and expenditures of the community. Software management can avoid human mistakes and possible malpractices.
- C. For residents with arrears in rents, accurately calculate the duration and amount unpaid, and automatically print out reminders, legal attest letters, and warrant of payments. This makes early residents arrear with rents to be brought to daylight, also improve the paying rate of management fees from the residents via the release of the arrears list and supervision of residents.

- D. Avoid unnecessary data entries and complex repeating operations, reduce unnecessary time and costs for document and financial affairs, reduce human errors in traditional operations, and implement the management work and standard procedure.
- E. Able to allow the residents and committee to look up on every management data, and provide management personnel with latest information to solve unexpected problems.
- F. Able to provide management personnel with facility maintenance schedules to ensure normal operations of all facilities, as well as quality and safety of the residents. Via 3D perspective screens, improve the availability of community facility maintenances.
- G. The open and transparent community network management system can reduce the distrust of the residents toward the committee.

The smart phone integrated with QR code is suggested for possible future study to provide a more convenient and powerful tool for mobile version of community management and maintenance tool.

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