Building Management System for Supporting the repaired Building

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BUILDING MANAGEMENT SYSTEM FOR SUPPORTING THE REPAIRED BUILDING

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ABSTRACT

Energy storage for updating of a new building represents an opportunity to estimate the costs that this issue should be considered in efficient buildings. Most old buildings have a lot of energy dissipations due to inappropriate control system and building components. According to the sustainable and durable development, repair of the buildings reduces energy consumption and improves the overall condition of the building. To attract the long-term saving of money and convenience of residents, technical innovation has been enhanced as a potential solution of this issue for many years and only computer tools are collected and their information is provided for required examinations. This paper explains improvement in the control and supervision of building services in Building Management System (BMS) and Building Information Modeling (BIM).

KEYWORDS: *BIM, BMS, repair of building, cost*

INTRODUCTION

In recent years, construction work has been boosting the innovation of building and repairing them. Technical innovation has always created better building management. Modern technologies have friendly user interfaces, such as successful management of building systems and relevant cost reductions. For more energy performance in existing building, Building Management System (BMS) and Building Information Modeling (BIM) play a major role in saving energy and cost of living. BMS is used for monitoring of energy performance in the buildings and convenience of customers. This system supports real-time data collected from wired/wireless sensors. These data contain temperature and CO_2 and they can read LUX level. The collection of real-time data is essential for shaping of building implementation. This project emphasizes the use of information and communication technology in supporting mandatory maintenance of building and improvement of their performances. Not only does BIM support BMS, but also it uses building performance analysis.

BUILDING MANAGEMENT SYSTEM (BMS)

Building Management System (also called the Building Automation System) is a system which has automatic monitoring and service control such as light, pumping, service, heating, cooling and ventilation and supports the energy performance and welfare. The purpose of the BMS is to increase condition, supervision and control of the building. BMS has often an effective solution for smart building management strategies and makes it possible for residents to have more efficiency. According to a research of Atlanta association and Ashrae project, investment in BMS is able to save more than 14% of annual cost of productivity and it is useful for heating and improving of weather conditions engineering. [1-3]. The building management system reduces energy consumption and increases internal comfort. When a building with BMS is compared with a building without BMS, The building with optimal BMS stores energy costs in the range of 15%-20% [4-6].

The primary motivation to do this project is the use of BMS to monitor the implementation of building and energy performance. These systems are capable to collect real-time data (such as temperature, CO_2 and humidity, etc.) from wired/wireless sensors. Real-time data collection not only has a definite form of building performance, but also they are used for evaluation and 3D models in BIM.

2-1- Fundamental Structure of BMS

In general, the BMS statement includes all control components such as hardware, controller, link networks and central controllers[7]. The control system consists of three fundamental components: sensor, controller, and controlled instruments. Organization of different components for comprehensive BMS is in the system design. Each component in this design connects to each other and to the communication system [8-10].

BMS includes the level of the field layer, the level of the automation layer and the management level [11-13]. For working with BMS, the central system is the automation layer and it requires the implementation of systems and communications[14]. There are the field controllers to control the transfer of data from one section to another. Moreover, field sensors have signals and simulators and they respond to this sensors in separate modes. Eventually, system interfaces (Web Search Engine) is a program which controls the display for users and it shows system response. Building applications programs are specified to turn off a light automatically and HVAC for users. The fundamental structure of building management system is presented in Fig.1.

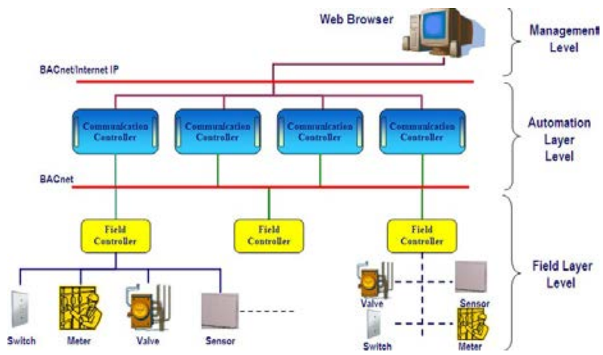

Fig.1. the fundamental structure of building management system

2-1-1- Field Layer Level (FLL)

The file controllers are associated with sensors and triggers in the field layer level and they take real-time data and connect it to automated layer which is at the management level and user interfaces[15]. If data is suitable for predefined parameters, no performance will occur at the level of the automation layer. Otherwise, communication controllers will control the system and its changes which are accordance with the system conditions such as turning on a boiler until it reaches room temperature, and so on[2, 16].

2-1-2- Automation Layer Level (ALL)

Automation layer level includes smart control distribution networks (communication controllers) which relates to field controllers. Smart controllers come with smart systems. Each controller is able to control various system by fixed distribution points of I/O. Likewise, communication controllers are able to run automatically and independently from management level. In addition, the entire system should be able to operate automatically without interfaces and with management level.

2-1-3- Management Level

Management level information is accessible via automation layer level and it has a wide access to the network sections. Hence, management level makes a possibility to exchange the successful information with independent systems in the building[17, 18]. Successful, efficient, flexible information communication is an important tendency factor used in design and building management. The control function is limited at the management level because most of these functions occur in "ALL". In addition, the management level has the same overview on the systems with the user interface. Control systems play a crucial role in energy management [15] and the control of the main parts, cooling, ventilation and light, consumer estimates, access control, location alert, and alert of companies are related to the systems[19].

Owners of the building and facility managers respond to user interfaces and they control the implementation of the buildings. For instance, information of building conditions (current temperature, humidity, and level of CO_2) and application of building energy (total energy consumption per year, month and day) are available for obtaining more efficiencies in the buildings.

There are many benefits for implementing of BMS which are mentioned in the following.

- Center controller, remote controller, and supervision of construction operations
- Fewer operating costs
- Increasing of the indoor air quality
- Keeping of comfort conditions
- Efficient using of building resources and services
- Sign of quick alert and fault detection
- Possibility to control a separate space

Researchers and partners of the industrial section are able to successfully accomplish BMS in Environmental Research Institute at Cork University and currently it has completely operational applications. In the next section, this issue will be discussed with the details.

2-2- An example of application of building management system

An environmental research institute (eri) accomplished a research on three-story building which consists of meeting rooms, computer laboratories, web laboratories, clean rooms and controlled temperature rooms at University College Cork (UCC). Moreover, owners of the buildings have some experiences in green building operations. These buildings are reinforced by concrete structure and contain a high level of thermal mass. In addition, they provide mechanical and natural ventilation with night cooling as needed. In the eri building, BMS is within Cylon control range [14, 16, 20, 21]. BMS runs for different sensors and its estimation is for temperature, humidity, CO_2 sensor, bypass valves, and heat valves of building floor that are used for environmental control conditions in the building. Supervisory items include internal and external estimations which consist of air temperature, water temperature, CO_2 ppm, relative humidity, pumps, light intensity, wind speed, wind direction, etc.

Figure 2 represents a part of the first floor in BMS, and most of the rooms contain a temperature sensor which shows temperature set points and temperature sensitivity level and they are indicated by magnetic signs. Most booths represent the heat situation and valves in the room. Moreover, temperature sensors have real-time temperature at the surface of the field layer. The temperature set points in the input section are in advanced mode, and then the communication controllers automatically display the temperature at the level of the automatic layer. If the light is on for the valves, they will be open, and steam condition also indicates $FC_{X.XX}$ where X.XX represents different digits. Specific booths contain RH (Relative Humidity sensor), CO_2 ppm, and Bright Temperature sensors. These lights are next to the windows and indicate open window (on) and closed window (off). For instance, the current temperature is 23.8 °C and facility management has adjusted the temperature at 20.5 °C with temperature sensitivity of 0.5 °C. Hence, no function is operated and lights will turn off [22-24]. Otherwise, if the temperature is below the temperature set points of 20 °C, the valves should be opened to increase the room temperature which is suitable with comfort of the residents.

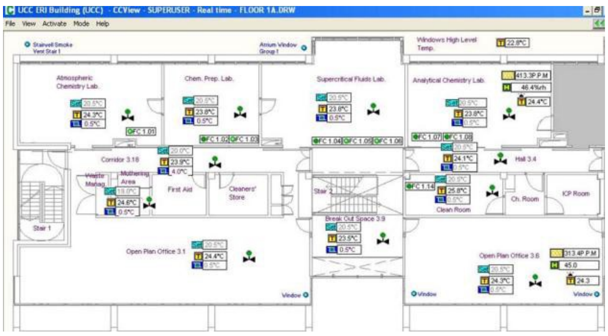

Fig.2. the first western floor in BMS

It can be proven by this example that BMS is appropriate for user to mention the recovery information. The main information is related to performance of the buildings which are available at any time. In addition, energy estimation and sensors are more suitable and effective for greater efficiency. The network of sensors is one of the basic components in BMS and it shows the required accuracy specified in the scheme [25].

Building information modeling has a great opportunity to design sensor networks and store sensor characteristics.

BUILDING INFORMATION MODELING

Building information modeling is an implementation process and data managements of the buildings during the life cycles [26-28]. Generally, modeling software of dynamic buildings has used three-dimensional real-time for increasing the efficiency of building design and construction [29-31]. The complete digital system illustrates the components of creating modeling and their relationships [32-34].

In general, creating of the information modeling has two main components:

- It remains the essential design information in a digital forms which simplifies the information updating that has collaborative and valuable parts for researchers to study on this field.
- The relationship is defined based on the real-time between data of digital design and based on the technology of innovated and parametric construction modeling[30-31]. In other words, the results of this relationship are saving significant amounts of time and money and increasing the efficiency and quality of the project [35-37]. In this chapter, two functional aspects of the BIM are presented. In the beginning, BIM is utilized to design the sensor network and store the BMS data. Another important application is use of the performance analysis in energy simulation modeling which has been repaired based on the old buildings.

3-1- DEFINITION OF THE SENSOR CONDITIONS

Building Information Modeling is an integrated database for coordinate information that many participants put together this information in distribution of design process [38, 39]. It is an appropriate way to store and use the data for light sensor condition during the BMS process. The geometry of buildings, HVAC system and light systems should be installed in BMI. Their performance shows the sensor condition in the buildings. It should be specified and performed for sensor network design. In addition, as shown in Fig 3, sensor characteristics are stored in BIM after completion of the sensor network design [40-42].

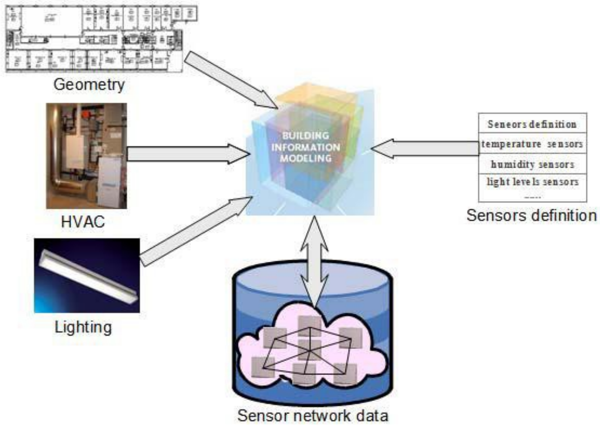

Fig.3. the role of BIM in this system

3-2- Energy simulation model

There is a stable analysis method to obtain successful improvement of building efficiency and cost reduction. BIM provides key information of buildings which is suitable for performance analysis. Geometric sections, HVAC system, and light systems in BIM of virtual buildings are saved as 3D model. Simulation models are defined as a data source to generate simulation performance. BMS can be utilized to continuously monitor organizations and provide the related data for calibration and simulation model. Autodesk Revit and Revit MEP software application are applied to create the model with details.

The existing geometry of the building not only is created in Revit scheme, but also HVAC and light systems are created by Revit MEP. The other section of the software (limited IES VE and Integrated Environment Solution) are located in Revit MEP, and this section is used for heat simulation in available models. Energy consumption is illustrated by BMS and energy simulation, and also, evaluation of 3D model is shown in

BIM. In addition, simulation model is created for ERI buildings. Figure 4 shows a 3D model for energy simulation. After simulating, a detailed report about loading and warming is provided for each section.

Fig.3. 3D model of ERI building

Simulation loads report shows the real thermal load (includes heat and electrical application at 218.7 kW) for ERI building. This numerical values are obtained by hourly operation of 2096 hours with 80% efficiency of a boiler. Hence, (1) shows the total energy consumption during a year, and (2) is formulated for ERI building.

$$\frac{218.7\ \text{kW} \times 2096\ \text{hr}}{80\%} = 572994\ \text{kWhrs} \quad (1)$$

$$\frac{572994\ \frac{\text{kWhrs}}{\text{yr}}}{3258\ \text{m}^2} = 175\ \frac{\text{kWhrs}}{\text{m}^2 \times \text{yr}} \quad (2)$$

At this time, the data has energy usage for BMS, and then it shows that energy consumption contains gases and EBS which is $182\,\frac{kWhrs}{m^2 \times yr}$. It is obvious that the obtained results completely resemble the simulated results for BMS.

CONCLUSION

There are many smart technologies which help reduce energy consumption and also, construction costs for this issue is considered. The BMS method is essentially a solution in the buildings that represents a comfortable, safe, and energy-efficient environment. Residents can use BMS for application of automated buildings such as lightening system and HVAC, and it allows managers to prevent customers' complaints to reduce operation costs in the range of 15%-20%. Moreover, BMS shows historical data and real-time data. The previous state is important because owners and managers provide piece of information about this process named maintenance which requires parts of the device and energy application for users such as tenants and residents. Based on the intelligent decisions, it can be concluded that the part of information, their replacement, and other required resources in terms of performance are essential. Historical data are also important because they are capable for calculation of the costs and budgeting. Identifying of the energy supply costs is very useful to look at the energy supply forms and check them out. In the last case, real-time data give owners and managers the chance to make decisions that it sometimes occurs only if the convenience for the customers is very crucial issue. In addition, there is question that it needs to specify management facilities, and owners should find an alternative to make it easy to use. BIM allows managers of sensors to create the data which is needed for making decisions. There is also a graphical display which is easily understood and performed by owners and managers, and it indicates the use of UCC ERI building.

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