4th Construction Specialty Conference
4e Conférence spécialisée sur la construction

Montréal, Québec
May 29 to June 1, 2013 / *29 mai au 1 juin 2013*

BENEFITS OF APPLYING BUILDING INFORMATION MODELING IN FACILITY MANAGEMENT

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Abstract: The implementation of Building Information Modeling (BIM) in Facility Management (FM) has been recently evolving. The use of BIM by facility managers will provide all the necessary tools to keep buildings in the required living standards while eliminating all possible waste (time, money, resources, and sustainability impacts) associated with managing them. Furthermore, it enables facility managers to obtain access to the entire life-cycle information of the project, especially the ones during the planning and implementation phases by allowing them to supplement their professional inputs towards a more efficient FM. This paper proposes a methodology to develop an integrated model that can be used as a managing tool in FM. The model integrates BIM tools with the facility's maintenance management system. The model can be used to enhance space management, to generate building analysis in respect of the sustainability aspects of the facility and to secure facilities' information and data (i.e., CAD drawings, operation instructions, maintenance manuals and schedule of equipment). The successful development of the model will enable facility managers to avoid unscheduled maintenance and equipment failures, to evaluate the most suitable timing for equipment maintenance, to specify the precise amount of time required to maintain equipment by choosing the most suitable ones. This will help in reducing the maintenance and operational costs significantly, while improving the overall living/using experience. The model will then be validated to test its capability, workability and outcomes by using a case project.

1. Introduction

On April 6, 2011 CanaData released a report in which it projected the expenditure of new construction in Canada to be $300 billion by 2014 (Carrick, 2011). Compared to the year 1998, Canada spent $52 billion on construction, where $8.5 billion was specifically spent on repairs and maintenance (Louniset al., 1998). On average, 80% of the cost of an asset is spent during its operation stage, which is much more than is spent during the design and construction phases (Underwood & Isikdag, 2010). This means that in 2014 this amount will be approximately $48 billion. This short paradigm reflects the significant amount of money which will be spent on operating facilities and the important role of Facility Management (FM) in a project's life-cycle cost. Facility mangers are facing major problems in securing the required information and data for their buildings due to many reasons, such as lack of systems integration, data vanishing with time, or because it is very difficult to extract (Al-Hussaein, 2000).

BIM is an integrated process which is used to facilitate the exchange of design and construction information to project participants. It is the act of collecting and of using consistent, reliable and sufficient data to support any desired activity along the construction lifecycle. The entire building information is translated to digital format that is represented in the modeling process and is used to support the integrated data exchange in a secure reusable fashion. These models create a platform in which physical and functional features can be explored through visualization, simulation and analysis of the existence of the physical facility/building (BIMCAN, 2011). The use of BIM by facility managers will provide all the necessary tools to keep buildings in the required living standards, while eliminating all possible waste (time, money, and resources sustainability impacts) associated with managing them. Furthermore, it enables facility managers to obtain access to the entire life-cycle information of the project, especially during the planning and implementation phases by allowing them to supplement their professional inputs towards a more efficient FM (Sabol, 2008).

2. Letriture Review

Eastman et al. (2011) predict that by the end of 2012 some innovations would be commercial, such as radio-frequency identification (ID) tagging and tracking for different building components using BIM. Other innovations are under development, such as creating a building model that has the capability to be updated with all the changes that occur during the project life –cycle. Moreover, to secure an accurate source of information about the entier building systems provide facility managers and operators with a realiable tool (Eastman et al., 2011). Additionally under development is a model that supports a real-time monotiring control systems depending on a natural interface of sensors allowing remote operating management of the facility (Eastmanet al., 2011). A study completed by BIM-Canada in 2011 indicated that most of the current commercial tools used in BIM focus on the needs of the planning and designing phases of a building project. Currently, other parts of the building lifecycle are being considered by various software developers to add the required tools to support the activities that take place during the construction and operation phases. These tools will offer access to the new functionality, either by add-on modules or through embedding the new functionality in their own main applications. Add-ons will usually come from third party developers who have access to large vendors' databases. Although this approach has significant benefits to the user, such as effective workflow and seamless integration between modules, there are also disadvantages, such as the often-substandard results arising from trying to realise specialist capabilities in a generalist application framework and trapping users within one vendor's specific solution portfolio (BIMCAN, 2011). Sabol (2008) thinks that Building Information Modeling is a complex application and not suitable for the casual user. She says that technological or complex organizations may have to secure BIM specialists or consultants to sustain their facilities' models. Furthermore, she believes that BIM provides an integrated digital source of information about the entire building components, besides its capabilities to provide users with 3D visualisation of the building components with their details that cannot be easily extracted from the standard 2D building drawings. Thus, the developers of such tools are aiming at the creation of a platform that incorporates an infinite range of data for buildings components to act as a secure and relaible data repository for facility managers.

A study conducted by Khemlani (2012) in which existing facility management tools (i.e., Autodesk FMDescktop) had been evaluated and analysed to identify their limitations found that the main limitation was the (.DWF) platform, where data is linked to CAD drawings. This means that the data used in this tool to manage the building depends only on the information entered by the architect. Another limitation of this tool is its limited capability to render a maximum of 10,000 objects in the entire project, which means that any object beyond that number will not be rendered. Furthermore, the tool runs only in the Windows platform and requires intensive training in order to know how it operates (Khemlani, 2012).

This paper presents a methodology to develop an integrated model (FM Viewpoint) that will overcome most of the limitations incurred in the currently used tools by incorporating the concepts of BIM. FM Viewpoint wil have the ability to act as a live model that will monitor, control, detect hazards and provide all the required reports to manage facilities in a more effective manner. Furthermore, the proposed model will provide up-to-date information that is collected from various parties involved in the project over its entire life in an electronic format, replacing the current paper-based documents used to manage facilites. FM Viewpoint Classify data into modules to improve information sharing, systems integration and outcomes accuracy. Additionally, to present the information required in a creative scheme based on explicit visualization. The output of the FM Viewpoint model will be a series of professional reports which will provide the facility manager with all the information related to the operation, maintenance, and evaluation of the facility in an effective way. Data analysis will be based on the productivity and application criteria required to ensure safety, cost saving, systems integration, and security information. The successful development of the FM Viewpoint model will enable facility managers to avoid unscheduled maintenance and equipment failures, to evaluate the most suitable timing for equipment maintenance, and to specify the precise amount of time required to maintain the equipment by choosing the most suitable ones (Al-Hussaein, 2000).

3. Methodology

The proposed methodology that will be used to develop an integrated model that can be applied as a managing tool by Facility Managers (FM) is implemented through two main steps. The first step starts by implementing the conceptual modeling, where the model's components and architecture are identified. The second step consists of converting the conceptual modeling into a physical development of the model.

3.1 Step One "Conceptual Modeling"

3.1.1 Model Components

To simplify the development process of the model, the required components are initiated with the user interface functions which will represent all the characterized data in an easy and simple way, as illustrated in Figure 1. The model consists of three modules. The first is the Schedule Module, which consists of the maintenance dates, manufacturers' data and the facility history. The second is the 3D Module that contains data of the as-build drawings, building systems, building components and all the data related to the equipment. The third is a cost module that consists of all the data related to Bill of Quantities (BOQ), suppliers' data and consumption monitoring system.

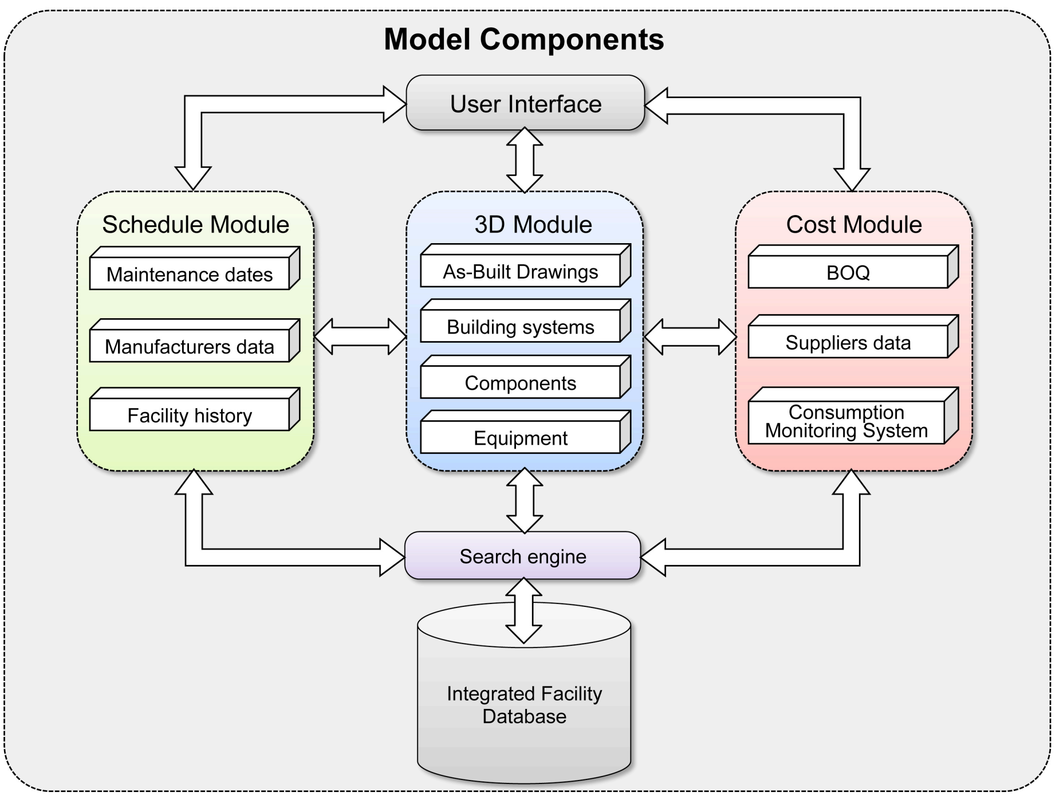

Figure 1. Model's Components

All three modules are dynamically integrated to present the information required in a creative scheme based on explicit visualization. However, the information can be extracted instantly through the search engine that will retrieve required information from the integrated facility database.

3.1.2 Model Architecture

The proposed model “FM Viewpoint” consists of several elements and its architecture includes: data input, data analysis, criteria, and output, as illustrated in Figure 2. The data input is categorized into three different parts. The first part is related to the facility, where the inputted information is related to the building, which is entered by facility managers. The second part is the information related to scheduling of the operation and maintenance of the facility. The third part is related to the contacts information of all the parties involved in the project.

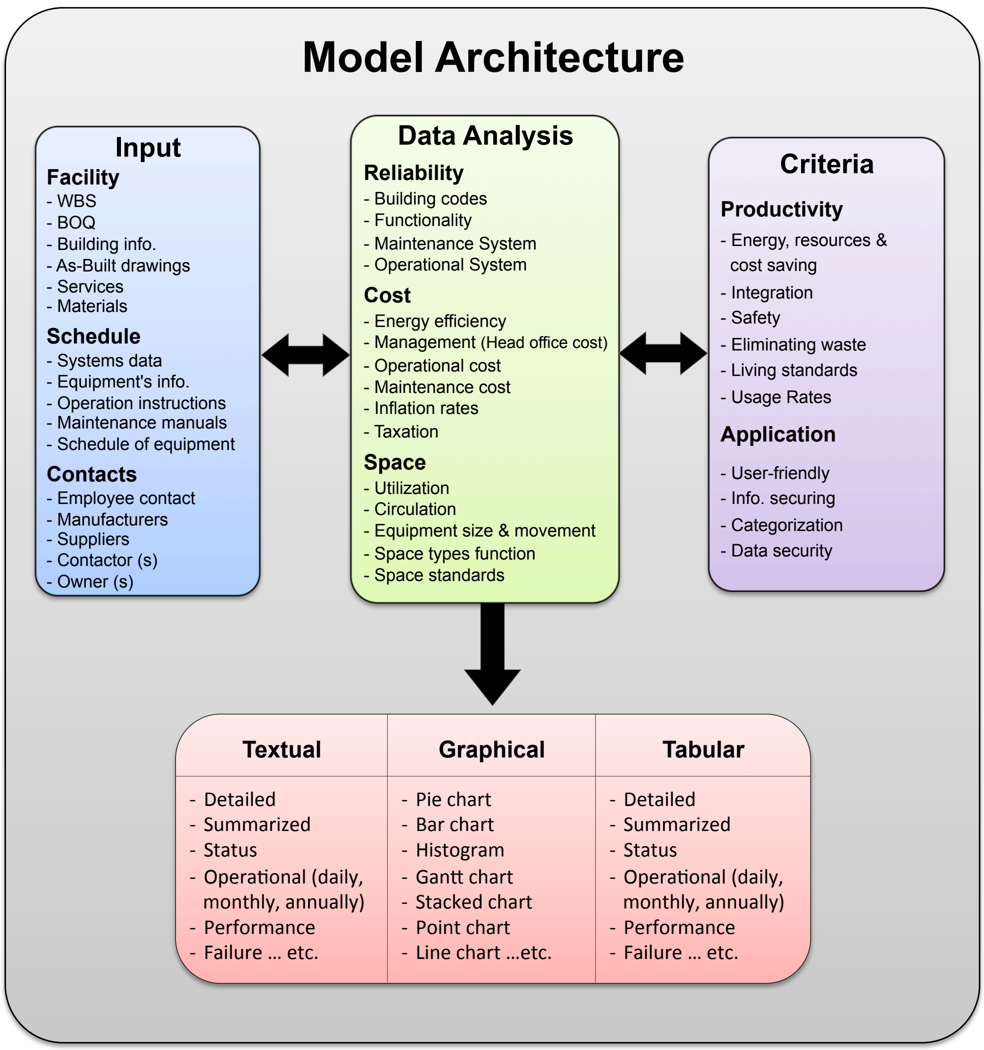

Figure 2. Model Architecture

The data analysis, in its turn, is divided into three sections, the reliability factors of the data used, the cost efficiency factors and the space factors that should be analysed to ensure the consistency of the data used and the effectiveness of the overall data outputs. All the data analysis will be based on the productivity and application criteria required to ensure safety, cost saving, systems integration, and security information. The output of the FM Viewpoint model will be a series of professional reports which will provide the facility manager with all the information related to the operation, maintenance, and evaluation of the facility in an effective way.

3.2 Step Two “Physical Development”

The successful development of the FM Viewpoint model will enable facility managers to avoid unscheduled maintenance and equipment failures, to evaluate the most suitable timing for equipment maintenance, and to specify the precise amount of time required to maintain the equipment by choosing the most suitable ones (Al-Hussaein, 2000). The platform of this model is developed using the BIM concept, in which systems integration is achieved by using an existing BIM model, or creating a new one and assuring data updating from all the parties throughout the project life cycle.

The model interface is designed to provide a comprehensible set of tools required by facility managers. The user-friendly manner will allow the user to choose from nine options (including the search engine), as shown in Figure 3.

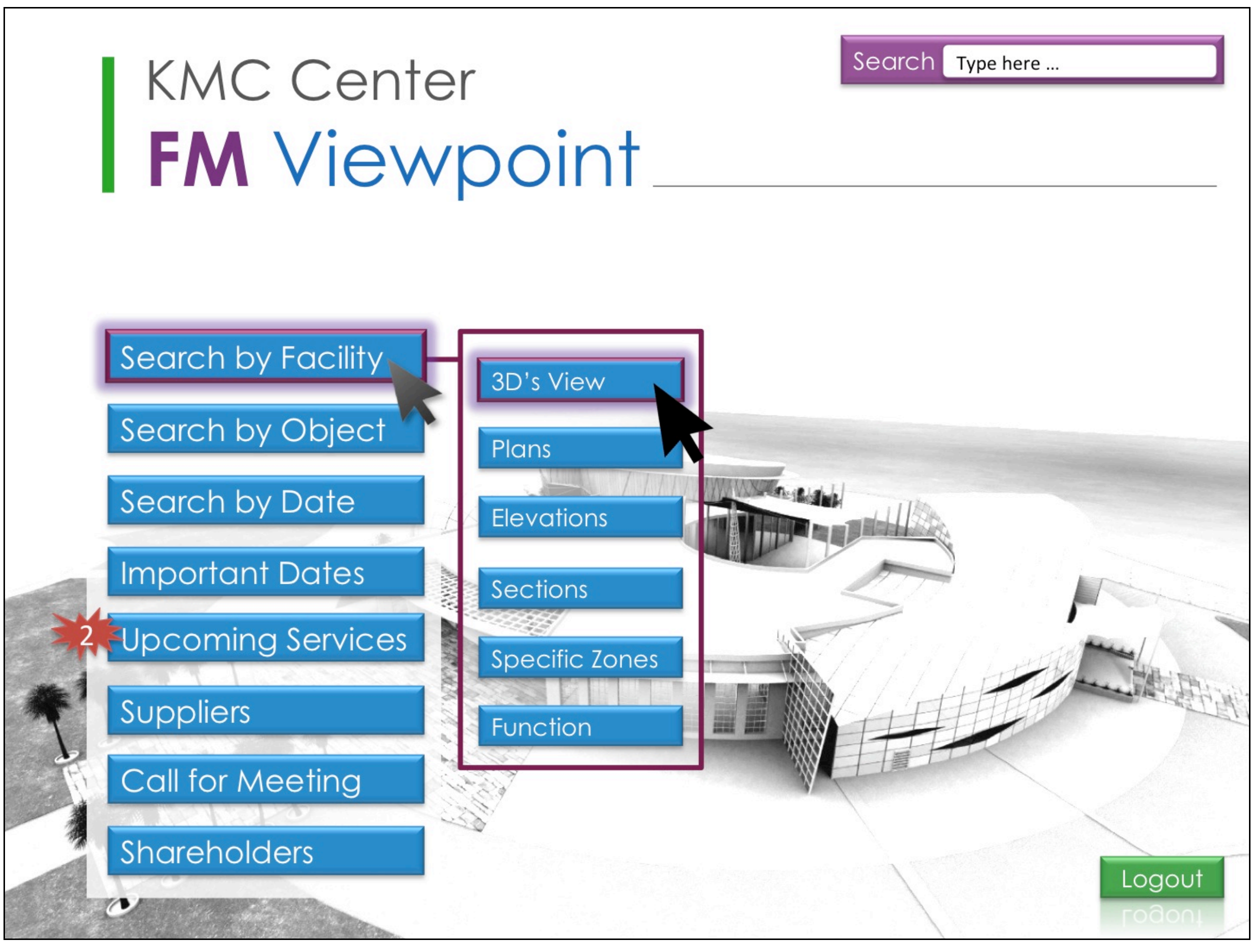

Figure 3. Model Interface

By searching the 3D View, the model will directly categorise the different facility components by using color-coding, along with a keynote located in the right bottom corner showing the name of each facility, as illustrated in Figure 4. In this case, the user can also go back to the homepage, print any displayed information, get more information about the facility, go back to the pervious page and sign off by clicking on one of the buttons under the search engine.

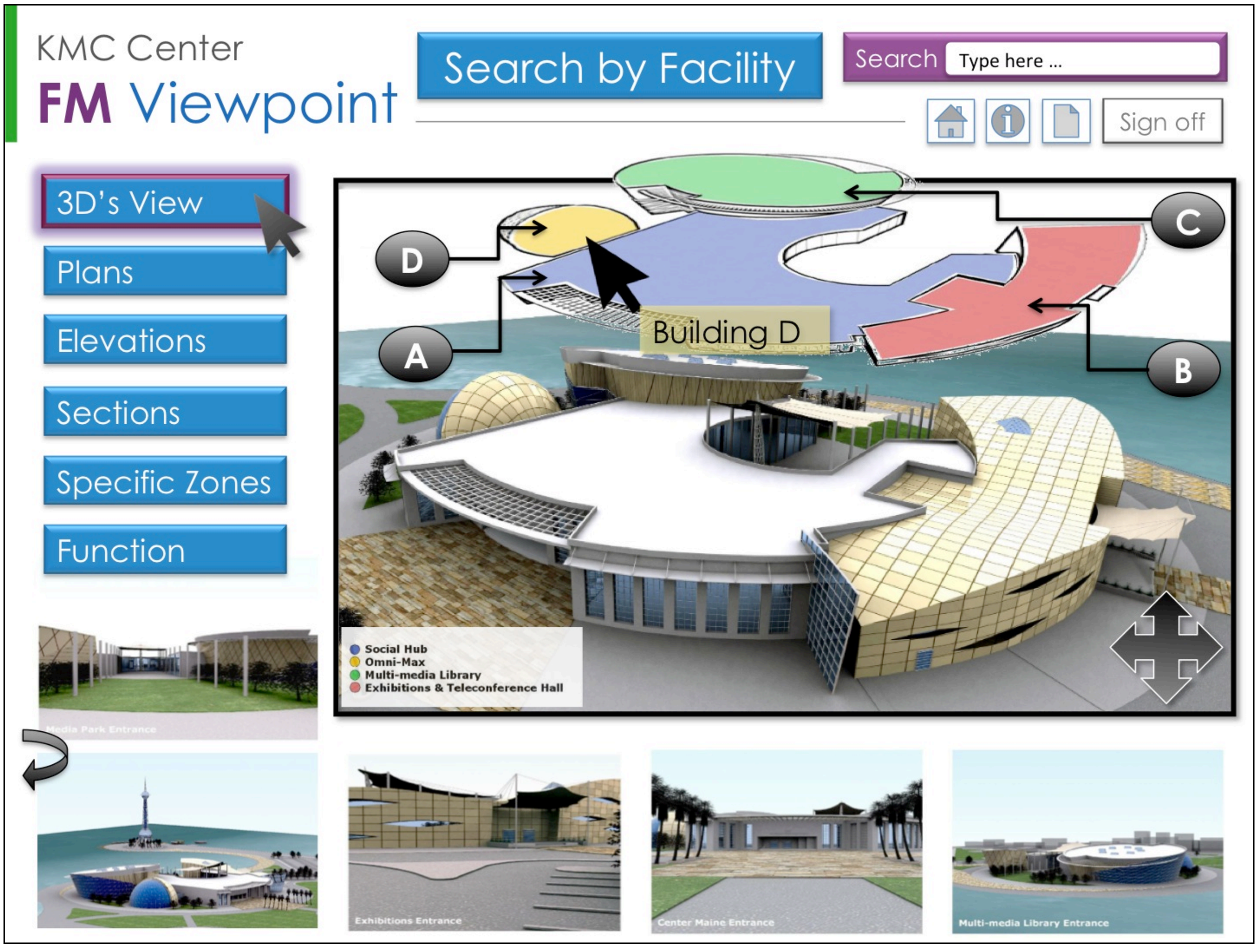

Figure 4. Model Development (3D view option)

When hovering around a facility, the name of the facility will also appear with the same color code. Different 3D perspectives will be available to choose from to ensure the selection of the right facility from various angles. The application will also allow for zooming in and out of each view while rotating it 360º by simple clicking and moving towards the required direction. Facility components are also available to be selected through plans, elevations, sections, space zones, and functions.

Through selecting one of the facilities, facility “D” for example, the title page will reflect the facility color-coding to remind the user of the selected facility. The application will give the user the option to select from various viewing options, such as 3D perspectives, plans, elevations, and sections of this specific facility. Selecting specific zones or a distinctive component in the facility is also provided, as illustrated in Figure 5. As shown in the figure, the user can select to view sections of the facility, where he/she can also move around the facility’s sectional view, zoom in and out with the help of the complete section placed at the bottom of the page.

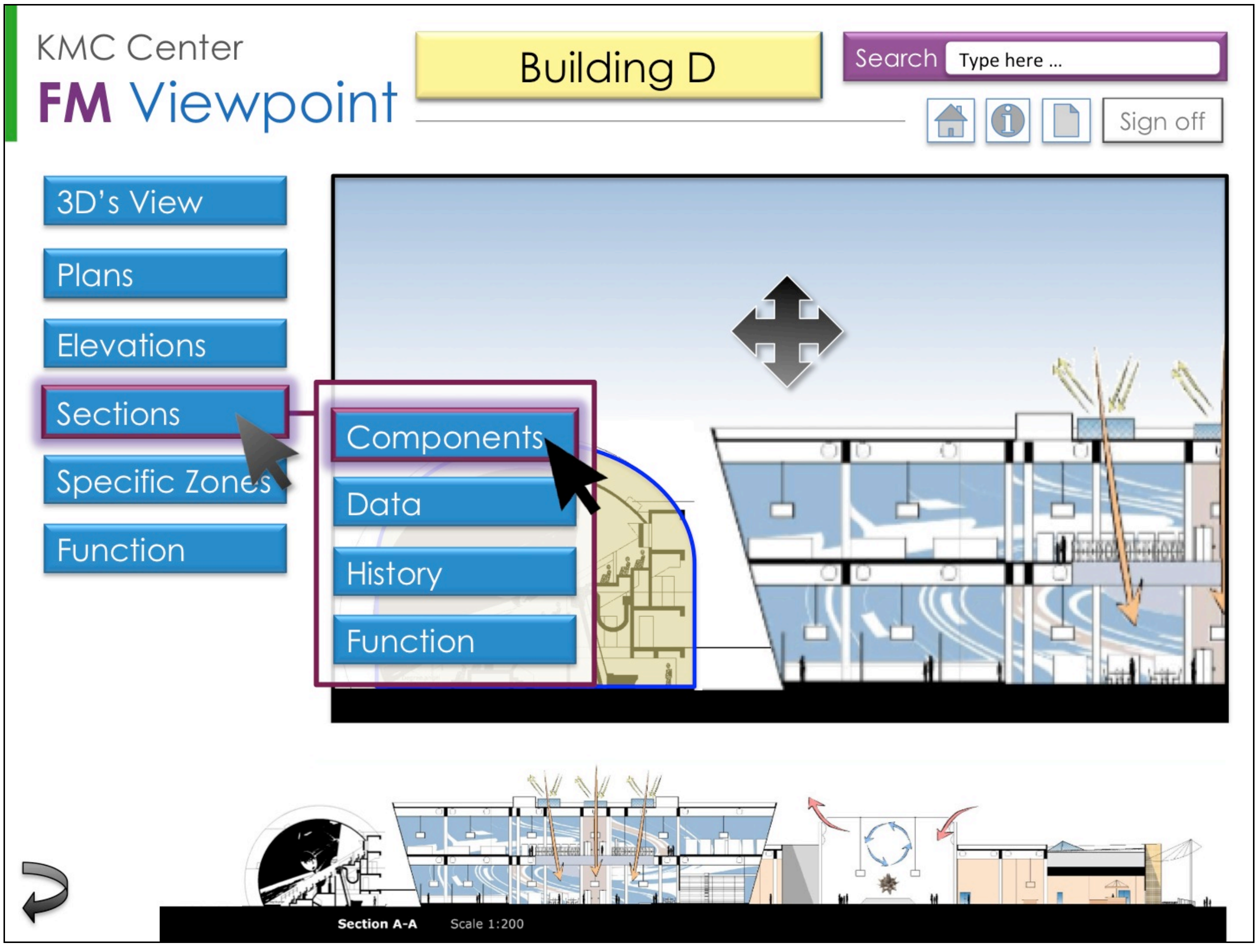

Figure 5. Model Development (sections view option)

Afterwards, the facility manager can choose to obtain the information required from the facility components, data, history, or functions provided. By clicking on the components option the users are provided with more detailed and a zoomed representation of the facility section, as illustrated in Figure 6. In this case, the facility manager needs to point the arrow towards any component of the building that he/she would like to investigate. For instance, if he/she places the arrow on the Projector, a pop-up window will appear showing the exact location of this component, its name, and the code assigned to it, which allows the user to search the projector instantly in the future by just clicking on the item code, where the search engine shows the recent items explored. Moreover, the total hours of usage and the expected bulb's life, which will be automatically integrated with the schedule and a reminder notice, is issued to insure securing the bulb before it is completely consumed. Furthermore, the system's manual can be reviewed to obtain any required information related to the required maintenance of the projector. The manufacturer information will also appear in the same window, however, when clicking on the manufacturer name, another window will pop up offering to conduct a live chat with the manufacturers, to send an instant message, to call, to require more information, or to obtain their geographical location (address).

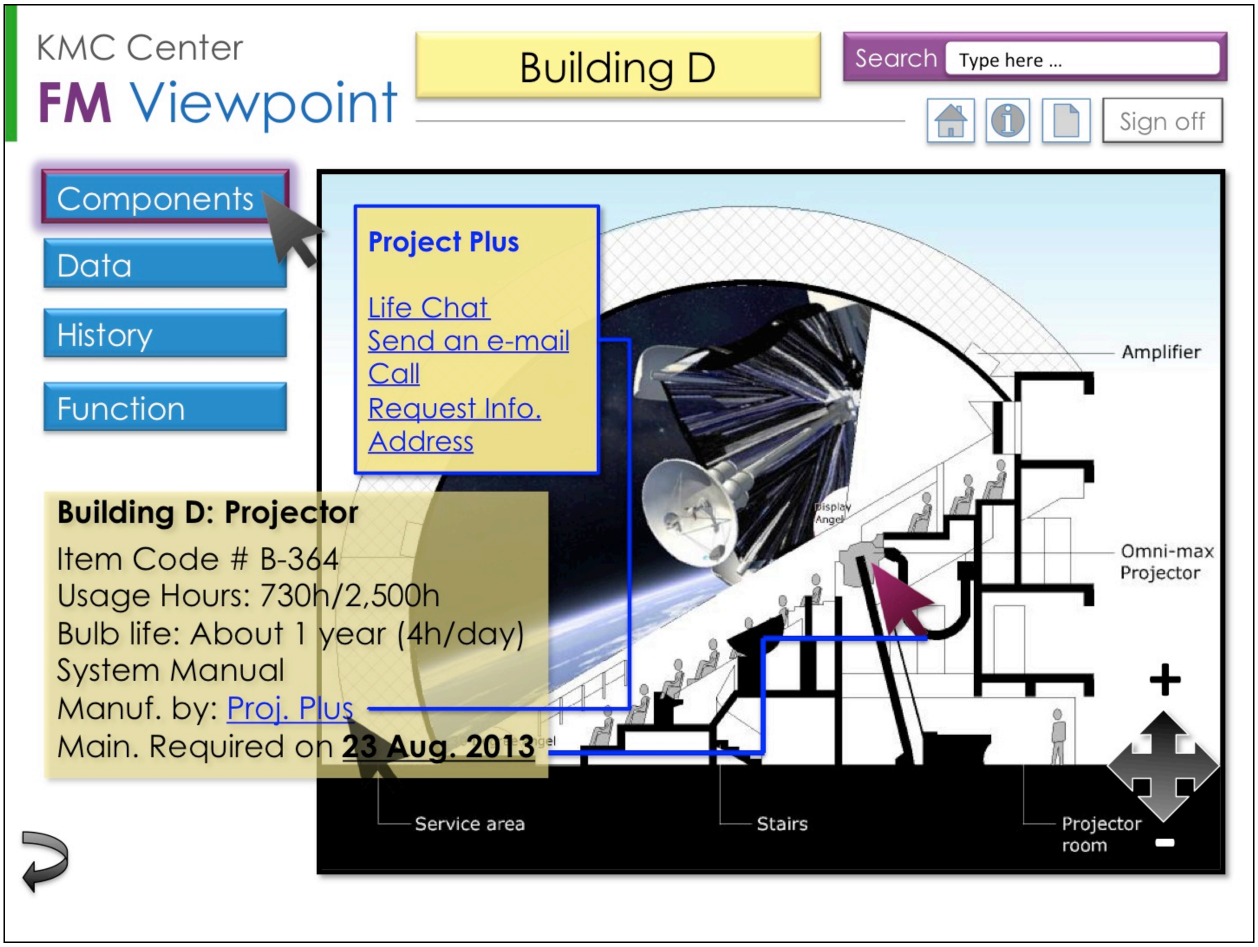

Figure 6. KMC Center - Model Development (detailed information representation).

4. Validation

The model has been validated to test its capability, workability and outcomes by using a hypothetical case project developed by integrating FM and BIM. Al-Khobar Multimedia Center in Saudi Arabia (KMC) is an educational and entertainment center with multi-floors and facilities with different functions that are connected in the floor plan. Based on the previously explained stages, the model was created using BIM tools to test the competences of generating the desired outcomes.

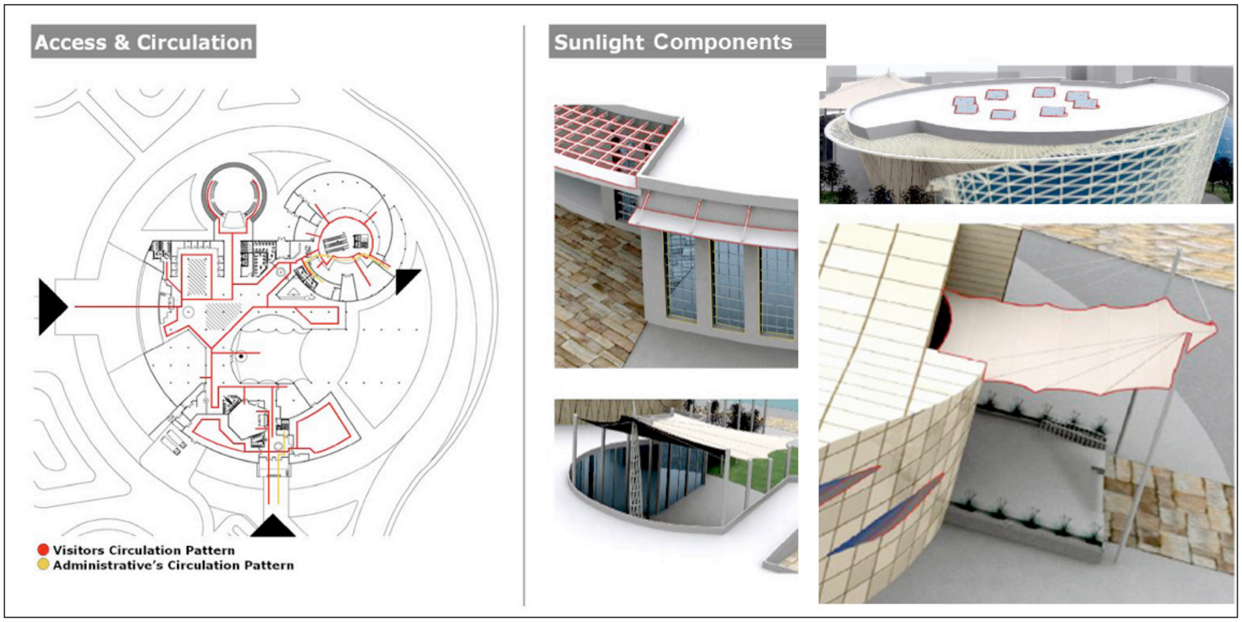

Figure 7. KMC Model Validation - Graphical Reports I

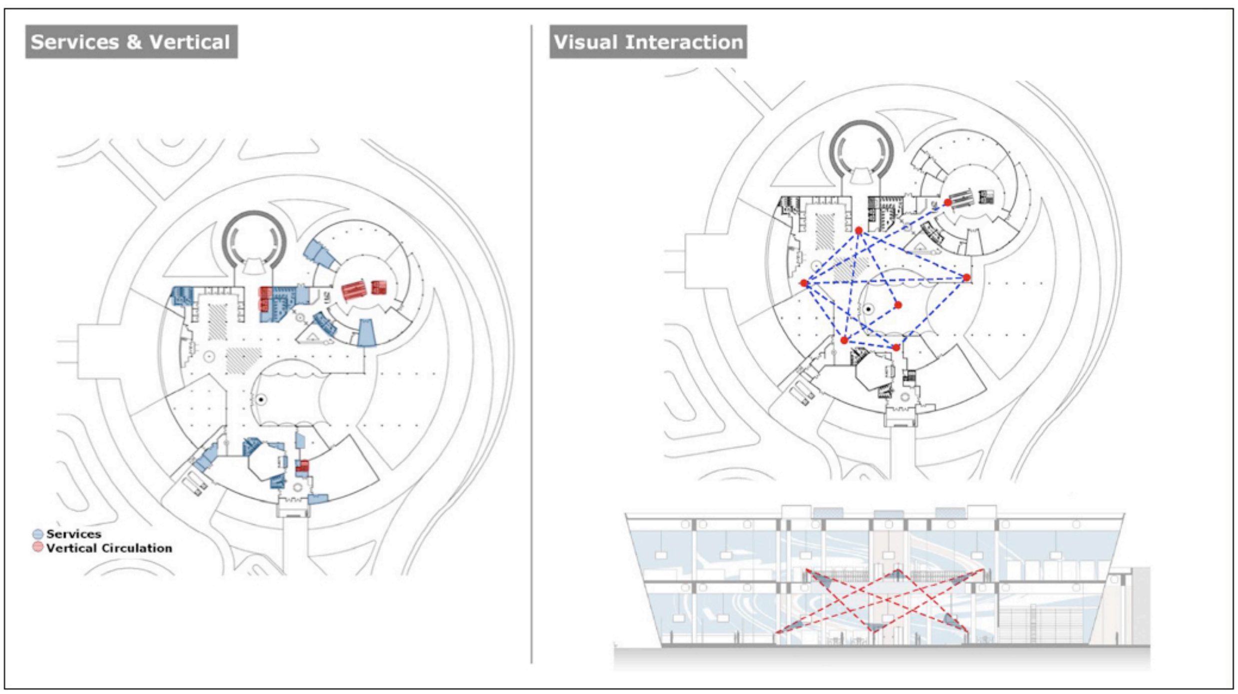

Figure 8. KMC Model Validation - Graphical Reports II

Figure 7 shows a sample of the graphical reports that FM Viewpoint can generate. Focusing on the space management, the first output (located on the right) explains the proposed circulation for both the visitors and administrative patterns. The other part of the figure (located on the left) addresses the sustainability by explaining the current sunlight treatments implemented in the building. On the other hand, Figure 8 illustrates the locations of the services in the entire facility with the available vertical circulation. Besides this, a visual interaction report which explains where the people can spend most their time in the facility and how to serve them in an efficient manner is presented.

Ongoing research work is underway to achieve a fully automated process that integrates BIM tools with other applications for scheduling and estimating, as well as remote sensing and data acquisition.

5. Conclusion

In this paper, the development of a model that integrates facility management with BIM tools has been discussed. The currently used tools were explored and evaluated to identify the limitations of the current practices in FM. The model development supported an innovative and integrated platform that can be enhanced as necessary in the future to create a primary comprehensive application in which BIM is fully implemented. The proposed model provides all the necessary tools needed to keep buildings running under the required living standards, while minimizing all possible waste in resources (time, money, etc .) associated with managing and operating the facility. Moreover, it will enable facility managers to obtain access to the entire life-cycle information of the project and use professional inputs of the various contributors towards an effective facility management practice.

6. References

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