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Research Article

ROLE OF FACILITY MANGERS DURING BUILDING CONSTRUCTION

Abhijit Sarkar

Sharekhan by BNP Paribas

A R T I C L E I N F O

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A B S T R A C T

This research investigates the connect between facilities management (FM) and design on construction projects ,the team owning the responsibility for developing and maintaining a facility support services system, is found to be vital for enhancing the design's supportive function and preventing operation problems from occurring during the occupancy phase.
The paper reveals that a limited integration among the facilities management and design professions leads to a problem mainly caused by the nature of project delivery processes that prevent external input into the design. Accordingly, the research aims of investigating integration in practice and determining the actions to be taken to improve the situation are developed.
Too often the FM is excluded from the design and construction process. But waiting until the end of a project might be too late to influence equipment, products specified, and maintainability of their building. Besides the Owner's Rep, the Facilities Manager represents a stakeholders interests from a building's design, the utilities that are installed through commissioning and turn over.
The Facilities Manager contributes to the proper design and equipment selection from the point of view of maintainability, cost of operations, safety etc., and should participate in the design stage particularly through design standards, sizes of equipment and machine rooms.

INTRODUCTION

Use of several methods including case studies, data sources and validation of findings with industry representatives and conference peer-review processes, have been used to validate the research design and findings during the research process Initial exploratory interviews, observations in industry seminars and industry reports The starting point for this research was the interest on facility managers role in building and work place management To investigate what this interest was in particular, the author had been participating in several industry seminars, where the role was facility manager and their involvement pre construction and post construction phase was on the agenda.

At the same time, several industry reports were published real estate & facility management sector where studied. The observations from industry seminars and reports were used for designing initial exploratory interviews with real estate owners.

These seminars and reports addressed the topicality of the engagement of facility managers in various stages in the sector, which indicate that the research has potential for practical relevance.

Corresponding author:* **Abhijit Sarkar
Sharekhan by BNP Paribas

The Study reveals that the author, have been core advisory member of various associations and in touch with the fraternity and been following the trend globally, author being a core Facility Management professional have been personally involved in pre & post construction stage and have evaluated the benefit deriving out of this involvement.

The study reveals that the author has been doing research and have read various articles.

The findings from the literature review demonstrate that there is a need to involve FM managers in pre construction stage of project.

Case Study

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Article Engagement of Facilities Management in Design Stage through BIM:

Considering facilities management (FM) at the early design stage could potentially reduce the efforts for maintenance during the operational phase of facilities. Few efforts in construction industry have involved facility managers into the design phase. It was suggested that early adoption of facilities management will contribute to reducing the needs for major

repairs and alternations that will otherwise occur at the operational phase. There should be an integrated data source providing information support for the building lifecycle. It is envisaged that

Building Information Modeling (BIM) would fill the gap by acting as a visual model and a database throughout the building lifecycle. This paper develops a framework of how FM can be considered in design stage through BIM. Based on the framework, the paper explores how BIM will beneficially support FM in the design phase, such as space planning and energy analysis. A case study of using BIM to design facility managers' travelling path in the maintenance process is presented. The results show that early adoption of FM in design stage with BIM can significantly reduce life cycle costs.1. Introduction. According to the International Facility Management Association (IFMA), facility management (FM) is defined as "a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, processes and technology" [Industries in varieties of areas are adopting BIM for FM. Organizations such university, government, healthcare, retail, and information technology are taking a survey for the adoption of BIM-based FM. Different parts of FM are adopted with BIM in these organizations. However, few efforts in the construction industry have involved facility FM into the design phase [3,4]. It was suggested that early engagement of FM would contribute to reducing the needs for major repairs and alternations that will otherwise occur at the operational phase. There have been rare effective approaches or processes to engage FM in design stage. The proposed framework of this paper is going to integrate these FM works into early design stage which could potentially strengthen the collaboration between design team and FM team and reduce alternations. BIM is envisaged to be an effective tool, as proposed in this paper. Considering the multidisciplinary and interoperability of this Process, there must be a data source providing convenient integration and access to the relevant information. Building Information Modeling (BIM) is a conceptual approach to building design and construction that comprises all the graphic and linguistic data of building for design and detailing which facilitates exchange of building information between design, construction, and operational phase. A BIM model could comprise individual 3Dmodels of each building component with all associated properties such as weight, material, length, height, geographical information system GIS and information. Beyond the inherent information, BIM also includes external association between building components. For example, the column with name Advances in Civil Engineering management Maintenance and repair Space management Quality assurance and control Noncapital construction Real estate management Others Commissioning and closeout. With the ease of access to lifecycle information of all the building components BIM provided, proposed building plan could be optimized and lifecycle cost could be reduced with the FM knowledge and experience. The backend database was not adopted as an approach to integrate the massive information such as asset portfolios, instructions, and design manuals in this multidisciplinary process. Mostly, the operation and maintenance process of a facility occupies more than 80% in its lifecycle for both cost and time During the FM process, facility managers have to acquire, integrate, edit, and update massive information related to diverse building elements such as operational costs, warranties, and specifications from varieties of systems. BIM could effectively merge these prima-ry data and provide convenient storage and retrieval of these FM data. Based on the work of Becerik-Gerber three types of FM data should be incorporated into BIM: (1) equip-ment and systems, (2) attributes and data, (3) portfolios and documents. Figure 3 illustrates the structure of the proposed BIM database for FM. Every facility in buildings is regarded as an individual entity with two kinds of properties-attributes and portfolios. Types of basicequipment such as HVAC, plumbing, and electrical are represented as entities in BIM. Each entity has its attributes (vender information, location information, etc.) and attached documents (specifications, warranties, manuals, etc.). Specifically, serial numbers of products specified by vendors will be collected as unique identifier for each facility. Model and part numbers will act as reference information during the maintenance. Location information is comprised of building number, floor, and room number. Description stores the status of the facility. Attributes include weight, power, and energy consumption. In order to integrate the whole information into one standardized BIM database, interoperability needs to be assured. This is partially because in different circumstances different Advances in Civil Engineering Equipment and systems Portfolios and documents Specification Manuals Certificates HVAC Plumbing Electrical Network Fire safety Sensor Attributes and data Vender Attributes Description Warranties Instructions Test reports information Location information Nevertheless, all these software have their own data structure and usually they are not compatible with each other. International Alliance for Interoperability (IAI) published the Industry Foundation Classes (IFC), a standard for BIM data structure based on an ISO standard (ISO, 1994) enabling exchange of information among heterogeneous systems [11]. BIM will provide supporting information for many categories of FM work such as maintenance and repair, energy management, commissioning, safety, and space management. Three categories of FM during the building's lifecycle are determined to be the most proper and specially discussed in this paper-(1) maintenance and repair, (2) energy management, and (3) commissioning. The decisions made in the design stage affect all aspects in maintenance stage and viceversa. The designer's relationship with the other participants in maintenance stages is very important [12]. Therefore, the maintenance team should also be involved into design stage for decision making. Additionally, different energy saving alternatives can be explored and simulated in early design stage with BIM [13]. Last but not least, commissioning stage ensures that a new building or system begins its life cycle at optimal productivity [14], in which coordination and information sharing between designer and participants essential. This transformation will provide evaluation information for the design team and make the decision making much easier in both strategic-tactical and operational phase. For the former, the facility manager could provide post occupancy evaluation of facilities for the design team as feedback. For the latter, bringing these FM jobs into the design stage will avoid redesign and reduce the maintenance job. The following subsection discusses the BIM role in FM engagement in design stage in detail. Maintenance and Repair. Maintenance is defined as activities required keeping a facility in as-built condition, while continuing to maintain its original productivity [12]. During this procedure, FM personnel have to identify the components' location and

get access to the relevant documents, and finally, the maintenance information. In the state-of-the-art design phase, facility management relevant information such as working space of equipment, storage condition, and weight are not considered. This directly leads to the inappropriate allocation of space and incorrect estimation of load expectations .Location information of facility could help facility man-agers efficiently identify the location of specific building components, especially for those who outsource the FM tasks.The knowledge and experience of facility managers could inform the architecture designers with working condition and space of different facilities. Both interior and exterior space requirements must be considered for the normal installation and implementation. Interior space refers to the working space, storage space, and privacy of the space. Exterior space includes the spaces needed for installation and, in case of emergency, for people's escape route. All the above issues could be incorporated into BIM and shown in graphical interface for the discussion between designers and facility managers. Additionally, FM personnel could retrieve the relevant data of task from BIM's graphical interface in real time. For example, when troubleshooting a printer, FM personnel have to check the maintenance history, get the maintenance manual, generate maintenance reports, and close the request. Conventionally, they have to log on to different electronic document management systems (EDMSs) and toggle between multiple databases to retrieve relevant information. Preventative maintenance (PM) is defined as the care and servicing by personnel for the purpose of maintaining Advances in Civil Engineering equipment and facilities in satisfactory operating condition by providing for systematic inspection, detection, and correction of incipient failures either before they occur or before they develop into major defects [For the matter of regular inspections, a schedule will be prepared. Detailed work description is preferred for improving the overall productivity that is work order ID, facility ID, location, description of the preventive work, documents required toper form maintenance, estimated and actual labour hours, and frequency of maintenance work [12]. All these data could be incorporated into BIM database as attributes and documents. Considering the unique ID of every facility, each one could be assigned an associated barcode for the ease of access to relevant information in real time through mobile device. Additionally, after every time of maintenance, status information and working hours will be sent to BIM as feedback and reference for next turn. Energy Management. Statistics from the US Green Building Council show that in the United States, 72% of electricity consumption, 39% of energy use, and 38% of all carbon dioxide are from buildings. However, most buildings are not optimized in terms of energy consumption or not professionally optimized with advice or knowledge of facil-ity management teams [13]. Torcellini et al. [17] identified "designing and constructing low-energy buildings (buildings that consume 50% to 70% less energy than code-compliant buildings) require the design team to follow an energy-design process that considers how the building envelope and systems work together." Energy consumption design must be set by the design team in the p redesign phase. Afterwards, virtual prototyping will be created to simulate the energy efficiency. Acquainted with knowledge on energy codes and standards, the building energy consultant in FM team can provide all the information related to energy consumption for the basic energy analyses [17]. However, traditionally, most building energy analyses have been conducted late in design. Due to the difficulty and expense of modelling the energy systems, identifying and validating energy saving alternatives with different models is not economically possible. A large portion of time will be consumed in converting floor plans to energy management system graphics [4]. BIM is envisaged to be the platform for data exchanging avoiding reentering all the building geometry, enclosure, and HVAC information. Inter-operability can be overcome by the data exchange standard gb XML (Green Building Extensible Markup). BIM software such as Bentley, Autodesk Revit, Graphisoft Archi CAD, and Google sketch Up are able to export energy analyses dataingbXML format. For overall BIM energy design of a building, three steps have to be executed based on Kim et al.'s [13] work as follows.(1) Create BIM Model of Building. BIM model could be created based on the existing floor plan. This model comprises BIM+FMM aintenance PM Feed back as history Regular inspection Order ID Facility ID Location Description Working time Documents Figure 4: BIM-based PM workflow. structured building components which include spatial data, texts, and databases of other properties. Based on these data, volume can be calculated, as well as energy estimates.(2) Integrate Energy Consumption Data and Test to Identify an Alternative. After modelling, energy consumption relevant data could be exportedingbXML format and analysed by tools such as Ecotect, Green Building Studio, and DOE-2.gbXML data could be used to analyse the energy consump-tion of the whole building, estimate water usage and cost evaluation, visualize solar radiation on surfaces, and simulate daylight factors [18]. Alternative design could be simulated by changing the lighting, roof, and walls.(3) Validation of the Proposed Design. After a design alter-native is specified, validation from energy consultant is essential. Logic and assumptions of the energy model must be carefully reviewed. Figure 5 depicts the framework of energy management design using BIM. Treating each energy-consuming object as an entity, real time and period energy consumption will be collected as one of its property. Thus, cost information of a room/zone could be calculated by adding up all the energy cost of energy-consuming objects in it. Some high-energy-consumption facilities' information could be predicted by the historical data.

Advances in Civil Engineering 5 BIM model Energy consumption No Energy analysis model Test and tune Yes No Validation Approved energy design Yes Figure 5: Framework of energy management design using BIM.2.3. Commissioning and Handover. Building commissioning is defined as "a quality assurance program intended to dem-onstrate that the building is constructed well and performs as designed. If the building materials, equipment and systems were not installed well and are not operating as intended, the health, productivity and other benefits of high performance design will not be achieved" [19]. Building commissioning is a key process for the building operation and maintenance, as the Department of Energy (DOE) suggested that "it ensures that a new building or system begins its life cycle at optimal productivity and improves the likelihood that the equipment will maintain this level of performance throughout its life. Building commissioning is the key to quality assurance in more than one way" [20]. For evaluating the project quality and identify potential significant design defects before it is too late or expensive to make changes, building commissioning should be embedded in the following phases: predesign phase, design

phase, construction phase, transition to operational sustainability, post occupancy and warranty phase, And retro commissioning [21]. This section is focused on the first two processes: pre design phase and design phase. In design stages, commissioning scope and commissioning team must be identified. Since different facilities have different features and budget limitations and different projects have special systems to be commissioned, commissioning team has to be involved in early design stages for the decision making.

This approach will also enable knowledge sharing between different parties. However, in the process of commissioning, massive 2D documents, images, maintenance, and operation information need to be collected and accessed frequently. For example, in the commissioning process of the Maryland General Hospital (MGH), the following systems need to be commissioned: a new 2000KVA normal power substation, a new 500 KW emergency generator and paralleling switchgear, three new automatic transfer switches and distributions, 2 new 650 ton electric centrifugal chillers and 650 ton cooling towers, temperature and humidity systems, and duct work, air handlers, dampers, and fans [21]. There has to be an easily accessed platform for data exchange and integration. BIM is envisaged to overcome the problem of interoperability and provide easy access for these massive data. When scoping which facilities need to be commissioned, similar projects' information could be retrieved from BIM database, as reference for the decision. The graphical interface of BIM could also improve the collaboration among owner, designer, and contractor. Schedules and commission facilities could be predesigned and stored in BIM models by each facility/zone/room. These plans are shown as timeline, which act as a simulation of actual commissioning practice. Thus, the logical faults and collision between activities can be easily identified. Moreover, design errors and conflicts of plumbing, HVAC, and electrical from different team could be discovered in the integrated view of BIM. In the design phase, different commissioning tasks have to be assigned to the specified experts for individual commissioning. After all these commissioning subtasks are approved, the whole sys-tem has to be commissioned together. For example, plumbing and electrical systems in a room need to be commissioned in a designed order. After both are approved, it must be ensured, these systems could work together successfully. Thus, the overall commissioning task must be done. When commissioning the plumbing or electrical system in different areas, a logical order must be specified. Simulating this schedule and identifying an optimal alternative will reduce the commissioning cost and time.

Case Study The project of Shanghai Disaster Tolerance Centerisanidealexample of bringing FM to design stages through BIM. 6 Advances in Civil Engineering Drawing HVAC Individual commissioning Drawing Plumbing Drawing Electrical Barcode system Overall commissioningimulation Integrated defects checking BIMH and over Operation and maintenance Individual commissioning Individual commissioning Figure 6: BIM-based commissioning streamline. Travelling path of facility manager is predesigned in BIM thus reducing the maintenance time and providing easy access to the location information of facilities. Project Overview. Shanghai Disaster Tolerance Center is in the north of the North Industrial Park in Shanghai, China. It was designed in September of 2010 as a State Grid Corporation of centralized information systems datacenter. The construction area is 28,124 square meters with one underground layer and four floors on the ground. The diesel generator room and pump are 9.1 meters in height, with construction area of 1,703 square meters. Shanghai Municipal Electric Power Company is the construction company. Shanghai Modern Architectural Design Co., Ltd. is the design company. This project is complicated in facility systems with a tight schedule. High-standard requirements of materials and labor cost control are other characteristics of this project .BIM has been decided to be the tool to bring the FM work into design stage for predesign and simulating the maintenance work in FM. BIM Services Content. Accurate BIM model of the mechanical, electrical, construction, and interior decoration are created based on 2 Ddrawings provided by the owner. Clash detection of pipelines is conducted and optimized.BIM model is used for scheduling and guiding the on-site construction work. A 4D construction simulation is also conducted based on the BIM model. Security control and quantity takeoff are based on analysis of pedestrian stream. Construction schedule needs to be incorporated into model in order to visualize the construction process in BIM model. Last but not least, a database platform is developed. This improves the monitoring ability and security level of the disaster tolerance center.3.3. BIM-Based Travelling Path Optimization in Maintenance. During the process of maintenance, FM personnel have to identify the components' location, getting access to the relevant documents, and finally, the maintenance information. Location information of facility could help facility managers efficiently identify the location of specific building components, especially for those who outsource the FM tasks. Conventionally, they have to log on to different electronic document management systems (EDMSs) and toggle between multiple databases to get the location information, relevant maintenance manuals, and warranty documents. BIM could integrate all these information together in a graphical view. By predesigning the travelling path in the maintenance job, travelling time is well scheduled and reduced and latent hazards could be avoided. Traditionally, after identifying the building number and room number, FM personnel just goto the maintenance spot through a normal path, which maybe not the shortest path. Moreover, latent hazards are not identified because of lack in relevant knowledge. After discussion between spatial experts and FM team, an optimal path is specified and incorporated into BIM database, which is safe and consumes he littlest time. In the following scenario, using BIM to design, optimize, and simulate the path of troubleshooting, the reciprocating compressor is illustrated.

Access to the maintenance manuals, warranty documents, and maintenance history is also provided in the BIM model. After choosing the action of "go the maintenance site," an optimal path is visualized which is safe and timesaving .A third person view is also provided for the simulation of travelling. Arrow keys in keyboard can be used to control the character. The FM staff follows the path and troubleshoots the reciprocating compressor with maintenance manuals in a mobile device. Reports are uploaded to BIM central database as history. Status of the reciprocating compressor is updated as "Normal."In this case, BIM is utilized as a database and visualization platform to predesign the travelling path in the maintenance job. With knowledge of FM experts, travelling time is well scheduled and reduced, and latent hazards are avoided in the design stage.

The contribution of this paper is the development of an innovative framework, which integrates FM work into early design stage via BIM. Furthermore, one aspect of the whole frame work is validated for the proof of the concept. An innovational concept of gathering designers with the FM team through BIM is proposed for strengthening collaboration as well as information sharing and gathering. The purpose is to avoid and reduce the potential issues such as rework and inappropriate allocation of workspace in the operational phase. As little research has identified the approach and benefit of integrating FM with early design stage, this study aims at bridging this gap by providing a working pattern of providing the essential information with BIM. Due to the difficulty of altering the main structure and core service areas in the operational phase, it is practical to design for adaptability by considering operational condition and the facilities' own attributes. It is very difficult to achieve without the relevant information from FM team and appropriate integration platform. With the ease of access to lifecycle information of all the building components BIM provided, the proposed building plan could be optimized, and lifecycle cost could be reduced with the FM knowledge and experience. Acknowledgments CCDI of China provided support for the traveling path optimization case study, which is a large architectural consulting firm that provides integrated services for urban construction and development. Data and projects of Shanghai Modern Architectural Design Co., Ltd., Shanghai Municipal Electric Power Company, and Grid Corporation of centralized information systems data center belong to the CCDI company. The contents of this study reflect the views of the authorswhoareresponsibleforthefactsandtheaccuracyofthedatap resented herein. The contents do not necessarily reflect the official views or policies of these companies.

DISCUSSION

Involving facility managers early and often in the design-assist phase of construction is the key to extending the operational lifecycle of the commercial building. An ideal time to bring the facility manager into a project is during the pre-construction meetings. Pre-construction meetings provide the opportunity to begin communicating and problem solving with the construction team, owner, architect, and other parties who address both design and construction concerns. By determining possible obstacles early on, the necessary changes can be implemented on paper before the start of the construction phase.

Since facility managers are involved in the daily operations and maintenance of buildings, they have acquired the knowledge to contribute at the design stage that can inform the construction team of the building's use and needs. To complement the performance requirements of the building, the building enclosure contractor will have solutions regarding design considerations, materials used, and even building methods, that will ensure cost-effective building operation and maintenance.

Involving the facility manager during the pre-construction stage & meetings is a systematic process that includes design review, installation verification, proper system start-ups, functional performance tests, operations and maintenance training and complete documentation of the installed systems.

CONCLUSION

The role of a facilities manager incorporates a number of different functions, from strategic planning and maintenance to managing third-party suppliers and supporting staff. But, despite the overwhelming amount of tasks required to keep a built environment operational, the importance of a facilities manager is often overlooked. Whether this is because building owners are happy managing premises on their own, or they're simply unaware of the benefits that an effective facilities manager can offer.

Without a facilities manager, most businesses would struggle to improve the efficiency of their properties. That includes the running of day-to-day operations, maintaining buildings, and retaining a productive workforce.

Some of the important consideration

1. FM's should be engaged early where possible at design phase so as to influence the selection of the plant, equipment and finishes.
2. Participate in regular site inspections to check the build/installation quality prior to any covering up
3. Attendance at commissioning and testing so as to fully understand asset operation.

If there is an Owner's Representative on the project, he/she the will seek out their input in the planning and installation of services so it is designed with consideration for ease of maintenance and that this does not bring unnecessary difficulties in the future.

All too often when the FM is brought in late into the project, they may point out that while the mechanical systems were built as designed or "per plan", they may not have been right for their needs. At that stage, it may be too late or too costly to make changes.

Buildings can last a very long time, and it is better to design for efficiency and cost-effective operations and maintenance from the beginning. By ensuring that all stakeholders assess the environmental, operation and maintenance issues at the project design phase is vital.

When planning for a new building or a renovation of an existing building, it is important to look for a combination of a stable and healthy structure, a functional building that meets the needs of the people using it, and an aesthetically pleasing space. A successful construction project must include the input and expertise of facility managers clients, architects, interior designers, engineers and construction professionals. The missing expert is the facility manager. Including the facility manager early on will result in reduced operational and maintenance costs and the more efficient use of a building over time.

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