

A Study to Support BIM Turnover to Facility Managers for Use after Construction

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ABSTRACT

Building Information Modeling (BIM) within the design and construction industries has grown in popularity, complexity and usefulness. Most large firms have adopted it to some degree. BIM use for facility management by the owner, however, is lagging. This research examines the usefulness of BIM beyond construction and into facility management and operations. A survey was used to establish industry use of virtual modeling and BIM and was followed the development of a series of case studies that focused on professionals that have implemented BIM beyond construction. The developed case studies verify that construction firms are faced with challenges when they need to turn over the model to facility owners. This study identifies the keys to successful post-construction BIM utilization and how it can be supported by the contractor. This research aims to bridge the gap between the contractor and owner. It will result in the development of a framework to aid contractors in the process of turning over the BIM to the owner for post-construction activities. This paper discusses the proposed framework and research methodology as well as the initial observations resulting from the case study development. The benefits of this type of system as well as the major obstacles in its creation are also discussed.

INTRODUCTION

The construction industry in the United States is historically slow to evolve and accept changes. Innovation in business practices, operations, and especially technologies takes decades to take hold. The industry adoption of Building Information Modeling (BIM) has been no different. BIM represents the process of development and use of a computer generated model to simulate the planning, design, construction and operation of a facility.

Over the past decade, BIM's popularity and usefulness has shown momentous growth, especially when used by designers and construction professionals (Fitch 2012). The increase in availability and practical capabilities of software and new mobile technologies all attribute to this growth. Even with important technical advances, BIM use for facility operation and maintenance practices by owners is

lagging (Fuller 2010). Mayo et al. (2012) have attributed some of this to owners lacking expertise and knowledge of how BIM can assist them.

With recent technological success and advances, implementing BIM into facility management practices, or at least utilizing it to supply the owner with needed information for facility management, is a logical next step. This research examines the utilization of BIM by contractors to support owners' information needs through a survey mechanism and follow up interviews to develop case studies of practice. The research goal is to create a framework to assist contractors, who are unfamiliar with the processes, in developing BIM execution strategies directed toward the specific owners' requirements, while also identified those specific owner requirements. This paper discusses the research plan and objectives as well as early findings and observations from the survey mechanism and interviews. A clearly laid out strategy for developing and evaluation the framework is also included.

BACKGROUND

Building Information Modeling (BIM) is quickly becoming the standard for design, preconstruction and coordination activities in the construction industry (Azhar, Hein & Sketo 2008). Though many firms have adopted this technology, its effective use in facility management is overdue. This study is taking a look at how BIM is being effectively used industry wide in an effort to extend the use of virtual models to facility management. Virtual modeling has applications originating in design, but applicable to pre-construction and the construction process.

Most contracting documents include provisions for the turnover of paper documents and as built drawings to facility owners in binders and stacks of drawings that many admit are rarely kept updated and often serve little purpose in the general day to day operation of the facility. The Construction Operations Building Information Exchange (COBie) aids in this organization to make sure the information is more accurate and complete (East 2013). COBie serves as a tool for the consolidation of facility information and drawings to a digital, searchable format to assist managers in facility operations. The facility data is compiled through the design and construction process as it becomes available. COBie helps simplify the process of consolidating information but it still ends up being a tedious and manual process (East 2013). The use of BIM, in conjunction with facility management tools such as COBie, presents an opportunity for streamlining the information exchange process and the creation of more accurate and up-to-date information.

When linking BIM to facility management, real-time data access, visualization, maintainability, record keeping, space management, energy monitoring, planning for construction/renovation, and emergency management have been listed among the areas that BIM can benefit the owner (Becerik-Gerber et al. 2012). Efforts directly related to BIM and facility management include the creation of a knowledge-based BIM system for building maintenance (Motawa and Almarshad 2013) and linking the BIM to building automation systems (Forns-Samsó, Laine and Hensel 2012).

PURPOSE OF RESEARCH AND STUDY OBJECTIVES

The goal of this research is to identify the Building Information Modeling needs of facility owners and develop a framework for the transfer of this information. This framework will create a systematic approach to identifying what owners require in a model while assisting in making BIM practical for use by various types and sizes of owners and construction firms. The framework will facilitate the smooth transfer of a model tailored for use in managing the facility.

The first part of this research evaluated how owners are influencing the creation and use of models through the survey and interviews. It was found that information required by owners can be ambiguous and often owners may not understand what they need. A contribution of this research is the resulting framework that will help industry firms in evaluating the owners need for a model and subsequently meeting these needs.

This research submits that if construction and design professionals will take a vested interest in ensuring that the models meet clients' needs for facility operations through communications with the owner, much of this tedious work could be avoided. Currently, many modeling software providers, including Autodesk's Revit, are creating plug-ins and tool kits that allow the exchange of information with facility management programs, namely COBie (Autodesk 2013). This exchange of information can take place at the end of a project, assuming a complete model is in place. In order for this complete model to be achieved, the requirements need to be known upfront. Identifying owners' needs as early as possible is a major component of the framework and the key to successful utilization of the framework.

A complete facility model will deliver a full representation of a facility and be tagged with the associated information and documents. The model itself can serve as the as built drawings with pertinent information only a click away with direct links to facility management software. The completeness of a model is a function of the level of delivery that an owner chooses in preconstruction conferencing. The model can then be built through the progression of design and preconstruction, with associated documents and information attached throughout project procurement. Figure 1 below shows the basis of a framework for an interface that can assist owners and contractors choose the appropriate information needed to render a complete model.

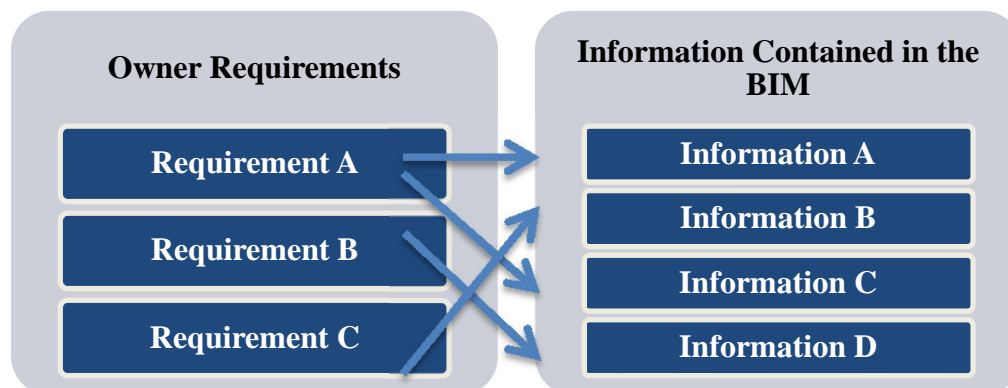


Figure 1. Framework.

METHODOLOGY

The procedures used by this study are laid out in Figure 2 below and elaborated upon in the following methodology sections. The road to creation of a practical, applicable framework for BIM utilization requires the research to dig deep in to the needs of owners and then draw the links to current contractor practices. The details of the information gathering process and the associated linkage to industry practices forms the basis for the creation of a framework that can be easily tailored to fit most clients, projects and contractors.

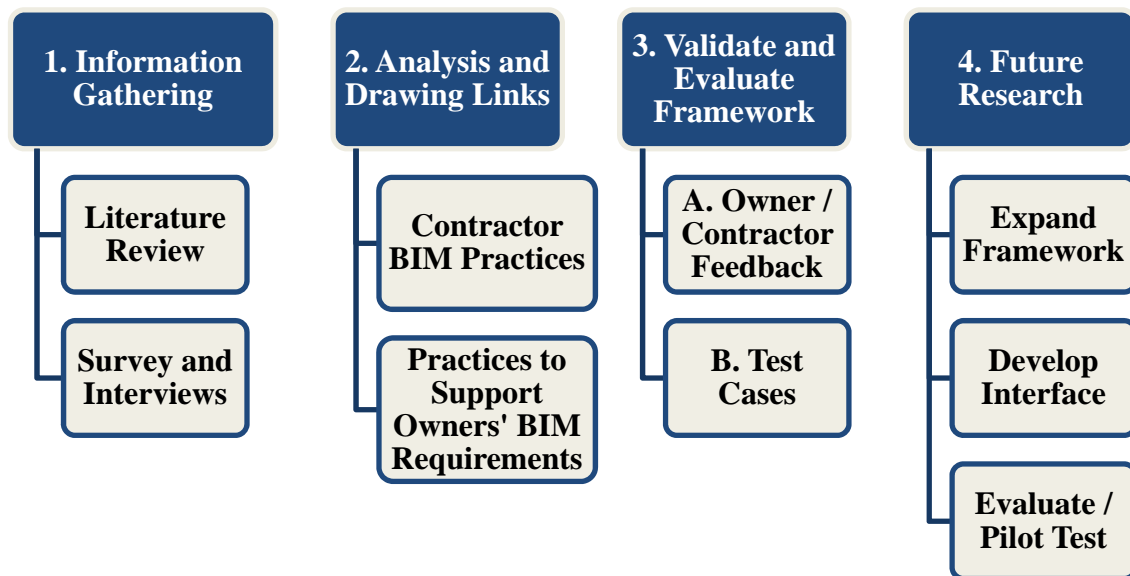


Figure 2. Research map.

1. Information gathering. The preliminary mode of research for this study was an in depth literature review for current BIM utilization within the industry and in facility management. The literature directed the initial path of the research and was instrumental in the development of the research survey. The utilization of a survey allowed the study to establish how BIM is being used industry wide, the demographics of firms that are currently using BIM, and identify the degree to which construction firms are implementing the technology. The survey asked a variety of multiple choice, Likert scale, and open ended questions that provided both qualitative and quantitative information. The survey was hosted on an online survey site and a link was distributed to the select group of respondents via email. The survey identified a group of companies that regularly use BIM for design, preconstruction, construction, and who are beginning to extend the model to owners for facility management. These firms were generally characterized by having a designated BIM department.

Three of the firms identified by the survey were asked to participate in the research as case studies. Participating firms took part in an in-depth interview into their internal use of BIM for project completion. Beyond the firms use of BIM the

interviews explored how the firms are meeting owners' needs and providing a model for facility management. Special attention was placed on how the company identifies the needs of the owners and the process for turning the model over upon project completion. The case study interviews were conducted as lengthy conversations guided by several key ideas. The interviews were conducted at the firms' offices and with the heads of the BIM departments for each firm. The first guiding principle was detailed discussion of how the firm utilizes modeling in preconstruction and execution of their projects. Following this, the interview went on to establish the frequency that BIM is used and on what types and sizes of projects it is being used on. This included information on how the use of BIM creates value for owners during preconstruction and construction and any benefits witnessed by the use of BIM in facility management. Owners needs for facility management and the firms' ability to execute a model to meet these needs was a key principle of the interviews.

2. Data Analysis and Framework Development. Following the gathering of data, the information is being analyzed to identify trends among construction firms. These trends relate to the current use the degree the firm has adopted BIM use and the ways in which the technology is being utilized. The information from both the survey and the case study interviews are shedding light on the discontinuity between construction firms and the owners when it comes to the creation of a model that meets the needs of both the contractor and the owner. The information from the study is being leveraged in a way to establish links between current contractor BIM practices and these practices can be tailored to fit the needs of the owners and result in a model that is applicable to long term facility management. These links between current practices and owner needs serve as the structure on which the framework will be built.

3. Validate and Evaluate the Framework. The frame work established by the gathered information and resulting links will be validated by contractor / owner feedback. The framework will be presented to various contractors and owners in an effort to acquire the opinions and recommendations for further development. Following the validation of the framework by industry partners, the next test of the effective of the framework will come by way of test cases. The framework will be applied to real and simulated cases to determine if the framework utilizes the capabilities of the contractors to meet the needs of the owners. This testing process will take place in such a way to prevent biased responses from the owners and contractors that are testing the framework. The evaluation process will involve the researcher testing framework established guidelines against the responses given by owners and contractors. Please refer below to Figure 2: Research Map.

4. Future Research. Once a basic framework has been established by this study further research will develop the framework in more detail and position the framework for widespread application. The framework is the substance that further research will develop into an interface utilized for BIM delivery. The interface will provide a service to both contractors and owners alike for establishing what the owners need from a model and identifying the model components required to meet these needs. The interface, like the framework, will be validated by owner and

contractor feedback. After strenuous validation, the interface will go through evaluation by pilot testing by contractors and owners on real projects.

PRELIMINARY FINDINGS

The survey of construction firms reflected that just over 71% of the participating 24 responding companies are implementing BIM in their operations to some degree. This statistic is in line with the 2012 McGraw Hill Smart Market Report and represents a broad snapshot of the industry. The firms represented specialize in various types of construction with noted concentrations in industrial and commercial work. The respondents represent firms from across the United States excluding two respondents from Europe. 78% of firms that are implementing BIM in their operations typically gross \$100 million per year or more. The survey identified a group of companies that are utilizing BIM at a high level and these firms were invited to participate in case studies.

Two major southeast construction firms have been interviewed to date. Both firms participate in commercial, light industrial, multi-use, data-centers and healthcare work. The larger of the firms has an annual volume of \$1.6 billion (Firm A) and the smaller has annual revenue of \$500 million (Firm B), both firms hold rankings with Engineering News-Record.

Key Observations. A consistent theme among the completed case studies was the high degree of ambiguity regarding the modeling needs of owners. The owners seem to have very general wants for a model or often simply do not know what they need from the model. The construction companies that have participated in case studies have designated BIM departments. These departments are responsible for owner BIM conferencing and creation of the model. The creation of models by both case study companies follows the levels of development as established by the BIM Forum (Reinhardt & Bedrick 2013). The BIM forum defines LOD as: “The *Level of Development (LOD) Specification* is a reference that enables practitioners in the AEC Industry to specify and articulate with a high level of clarity the content and reliability of Building Information Models (BIMs) at various stages in the design and construction process”(Reinhardt & Bedrick 2013).

After a model is created for any given project that seems to meet the needs of the owner, what then? The process of turning the model over to the owner is a historically tumultuous task. The framework created by this study will include a series of steps that can be taken to streamline the process and ensure that the model is usable. The case studies revealed that commonly contractors simply hand the model over the owner at the end of construction saved to a disk or portable drive. The problem with this is that the owner now has the responsibility of utilizing a massive file that they likely have no experience with and may not even own the software to open the file. The turn-over process that will be included with the framework will address this issue with initiatives such as the contractors’ participation in preparing the owners for use of the model.

Identified Processes. The two construction firms interviewed to this point both use the BIM Forum levels of development as benchmarks when building models for their

clients. The LOD used is collaboratively decided during client BIM conferencing. The LOD's used often meet most of the needs of the owners, but the resulting model may not be gear toward future use in facility management. These models are often built in-house and usually are the consolidation of models received from designers and engineers. These models are created primarily for use during preconstruction and construction. The contractor receives the obvious benefits of using the model and the owner benefits from a helpful graphical representation of their future facility. The model however is not typically being fully utilized after construction is complete. At best, the model is serving as the as-built drawings, reducing paperwork and maybe as a reference point for the client. The model however is not being fully utilized to maximize on its potential and the model is almost never being updated to reflect the lifecycle changes of the facility.

CONCLUSION

The use of Building Information Modeling has greatly benefited the construction industry in design, commissioning, and the construction process. Yet to be achieved are the benefits that reach far beyond that of construction and can help ensure the usability and efficiency of facilities through most of its life. Owners' understanding of BIM is often elementary, and they do not know the benefits they could gain from BIM use. The framework created by this research will identify the specific needs of owners, guide the creation of a model to meet these needs by the contractor, and streamline the turn-over process. The input from top contractors and facility owners are guiding this study making sure the framework is accurate and practical for use. This study stands to further the scope of BIM benefits, making BIM a viable tool for facility management.

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