

A Market Survey of BIMFM Readiness Among Designers and Builders in the Southeast United States

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The use of Building Information Modeling for Facilities Management (BIMFM) uses a data loaded model as a single repository for operations & maintenance information. The BIMFM model can replace the need for referencing multiple documents to obtain comprehensive asset information. Previous research has shown that the implementation of BIMFM by owners is still in its infancy due to a lack of skills, quantitative Return On Investment (ROI), and culture, however, based on data collected in this research, many owners are still requiring data loaded, as-built models. This research analyzes, with a mixed methods survey, the BIMFM market readiness of designers and builders through the lens of previous experiences with BIMFM, modeling capabilities, and company infrastructure. The survey revealed that 83.3% of the respondents have identified, bid on, or won a project that had a BIM Execution Plan/BIM Guidelines required in the contract, with 50% of the respondents executing a contract that required a data-loaded, as-built 3D model for BIMFM purposes. Although the frequency of these projects is quite low, the expertise within the majority of the companies relies on 15% or less of the managers. The market is willing to execute these contracts with the small percentage of experienced BIM experts, but future growth would require investment to develop more BIMFM experts.

Key Words: BIM, BIMFM, BIM Usage, Facilities Management, Market Survey

Introduction and Background

The use of Building Information Modeling for Facilities Management (BIMFM) is an emerging field of research and practice that utilizes a BIM model, executed during the design/construction phase, for operations and maintenance (O&M) data storage. The data loaded model can be utilized by facilities management (FM) staff as a single repository for O&M information in lieu of referencing multiple documents (plans, specs, O&M manuals, etc.) to obtain comprehensive asset information. Research and case studies have presented the technical viability of BIMFM through interoperable and proprietary systems (Cleveland, 2014; Lin & Su, 2013; Lucas, 2012; Parsanezhad & Dimyadi, 2014; Wetzel & Thabet, 2015), however the implementation of BIMFM by owners is still in its infancy due to a lack of quantitative methodologies for demonstrated value, culture, and a lack of training/skills associated with 3D models (Gilligan & Kunz, 2007; Kassem, Kelly, Dawood, Serginson, & Lockley, 2015; Terreno, Anumba, & Dubler, 2016). Although there is agreement among BIMFM researchers and practitioners that the majority of owners are not using the BIMFM models, more owners are requiring data loaded, as-built models at the completion of construction, regardless of whether or not they intend on using the BIMFM model. This indicates that owners recognize a potential benefit to having a data loaded model for facilities management, even if the owner hasn't identified a usage for the models.

With many owners requiring as-built models and interest in BIMFM continually evolving, it is relevant to evaluate the market readiness of designers and builders by analyzing their previous experiences with BIMFM, modeling capabilities, and company infrastructure. Using a mixed methods survey, quantifiable data regarding the BIM-related infrastructure and resources already in use by designers and builders can be captured. Coupling the infrastructure and resource information with BIMFM experiences and exposures, allows for a comparative

analysis of the aggregated company's software and skills versus the market frequency of the BIMFM contract requirements.

Literature Review

With all the success that BIM has experienced during the design and construction phase, efforts to transfer and use information to the facility lifecycle phase is rare. The utilization of BIM for facility management, is a relatively new usage of building information modeling. Prior to the mid-1990's, to fully utilize the design and construction information during the facility management phase, the issue of data transference needed to be resolved. With dozens of design and construction software programs on the market, developed by a number of different vendors, interoperability between them was non-existent. In 1995, a consortium of twelve companies called the Industry Alliance for Interoperability (IAI) developed an object-based data model that utilized non-proprietary translators that could read the building information across a number of software platforms. The resulting data model was known as the Industry Foundation Classes or IFC (AECbytes, 2004; Wetzel & Thabet, 2015).

In December 2005, the National Building Information Model Standard (NBIMS) Development Team introduced a component to the standard known as the Construction Operations Building Information Exchange or COBie (East, 2007). COBie was released to improve how information is captured during the design and construction phases, and then turned over to the owner for operations and maintenance. COBie utilizes the open data format provided by IFC to attempt to bridge the gap between design, construction, and O&M by mapping commonality within the FM process. By approaching FM activities with an open source, interoperable set of standardized attributes, users can then customize the data to suit their facility needs.

Utilizing IFC and COBie for interoperability has allowed project teams to transfer design and construction data to owners at the beginning of the facility management phase; however, the implementation of these processes remains an uncommon occurrence. Although interoperability plays a significant role in BIMFM implementation, it is just one piece to the data transfer puzzle. In today's market, owners, researchers, and software developers have all realized the issues related to data transfer from the end of construction to the O&M lifecycle phase. Owners have attempted to mitigate the issues by developing BIMFM requirements and writing detailed contracts, BIM oriented specifications, and issuing BIM Management Plans that provide project specific methods in order to deliver facility data in a format that the owner is able to utilize.

Researchers such as Lucas (2012), Kiviniemi and Codinhoto (2014), Lin and Su (Lin & Su, 2013), and others have attempted to synthesize and bridge the gap in data loss between the end of construction and the beginning of the FM phase in complex buildings. By utilizing data exchange frameworks, analysis, and modeling, researchers are pursuing a seamless interaction between construction and post-construction phases. Software developers such as Bentley Systems are developing intelligent models (i-models) to intake, organize, and present equipment and facility data from a number of varying software sources into a single model (Cleveland, 2014). Middleware solutions, such as EcoDomus, act as a bridge between a BIM model or database and an application. These systems have shown promise for sizeable organizations but are relatively expensive (Parsanezhad & Dimyadi, 2014). Cheaper alternatives, such as Navistools, Datatools, Dynamo, and iConstruct, are application developments that target a specific task, but are not comprehensive enough to service all data transfer needs.

Although the systems and research being utilized are young and still problematic, studies of organizations that have successfully integrated BIMFM to some extent, often sizeable government organizations and universities, have shown promising results for utilizing BIM throughout the facility lifecycle. One such study shows a Return on Investment (ROI) of about 64%, with a payback period of 1.56 years (Teicholz, 2013). These savings are realized through the intelligent use of the data collected through the design and construction phase and the integration of BIMFM to make better and faster maintenance decisions based on the data. A study by Kassem et al. (2015) identified seven value-adding aspects of BIMFM including the availability of data, work planning, and visualization. Terreno et al. (2016) executed a case study of three educational institutions that had implemented some form of BIMFM. The findings concluded that, "implementation of BIM in FM had a considerable impact on the success of FM business operations in these organizations… BIM was found to have an influence across all

FM Value Concept groups (People, Process, Economy, and Surroundings), and on most FM Value Parameters (Culture, Satisfaction, Image, Productivity, Innovation, Flexibility, Quality, Collaboration, Cost Decrease, Risk Control, Asset Value, and Sustainability (Terreno et al., 2016)).

Research Methods

This research used a mixed methods survey in Qualtrics in order to obtain responses from industry professionals representing their company. As an initial study on the matter, the research limited the scope to companies with a presence in the Southeast United States. Results from the survey would dictate whether a national survey would be appropriate. The inclusion criteria for the company representative taking the survey is as follows:

- Management level (project manager or higher) personnel in a construction company, design firm, consulting firm, or design/builder.
- Knowledgeable of your company's software, BIM utilization (or lack thereof), contracts, and project closeout/turnover process.
- 18+ years or older.
- Able to read and write in English.

In order to obtain responses to the survey, the research utilized a listserv of companies maintained by the research team's university. The 76 companies on the listserv all received an email invitation to participate in the survey. Surveys were distributed through a primary contact person identified on the listserv. The initial invite included the inclusion criteria so the survey could be distributed to the appropriate individual within the respondent company.

Results

The survey received 26 (N=26) valid responses from designers and builders in the AEC industry, a 34.2% participation rate. The survey obtained demographic information about the respondent's company, the BIM infrastructure of the company, and the company's exposure and execution to BIMFM related contract requirements.

Demographics of Respondents

A significant portion, 80.8% of the survey respondents identified their employer as a "construction company", with the remaining 19.2% being distributed among "design/builder" at 11.5% and "design firm" at 7.7%. The size and scale of the 26 companies varied. Figure 1 presents the number of employees from each respondent's company within a specified range, while Figure 2 identifies the annual volume (in dollars) of the companies. Of the 26 valid responses, only 25 gave responses to annual volume.

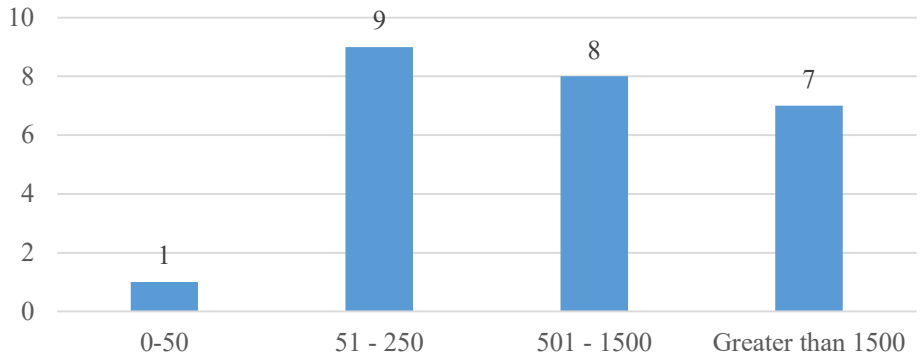

Figure 1: Number of employees of respondent companies

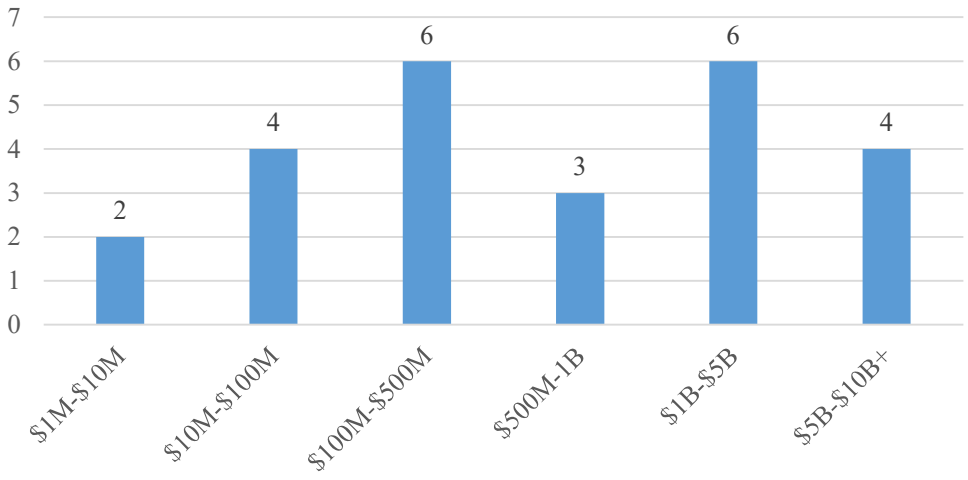

Figure 2: Annual volume of respondent companies

BIM-Related Infrastructure

BIM-related infrastructure plays an important role in a company's ability to execute BIMFM contracts. For this research, "infrastructure" not only relates to the software needed for modeling and data transfer, but also the knowledge base of the employees within the company. In order to gauge the infrastructure of the respondent's company, three questions were asked:

1. Does your company utilize any BIM-related software (Revit, Navisworks, Tekla, BIM 360 Glue, Microstation, etc.)?
2. Does your company have the capabilities to update a project model as construction progresses and provide an as-built model or record model to an Owner if the contract required?
3. What percentage of project managers/closeout managers/design managers in your company are well-versed in BIM software?

Results show that 80.8% (21/26) of the companies utilize some sort of BIM-related software, with Autodesk (e.g. Revit & Navisworks), the BIM 360 series, and SketchUp being the software primarily used. Of the 19.2% (5/26) of respondents who do not use BIM-related software, four of them were identified as a "construction company" with one described as a "design/build", presumably the construction side of a design/build J.V.

When asked if their infrastructure could support a contract requiring an as-built/updated model, 80% (20/25) responded that their in-house capabilities could support an as-built model, while 20% stated they would need to hire a third party for model updates. One company did not respond to the question.

Although a significant portion of the companies reported using BIM-related software and have the company-wide capabilities, the data shows that the project managers, who would ultimately be responsible for the BIM information, are not knowledgeable in the software. In fact, the majority of companies (57.7%) rely on 15% or less of their management staff for BIM-related knowledge and execution as shown in Table 1. This limited number of available "experts" could negatively impact the company's ability to pursue multiple, concurrent projects with BIMFM requirements.

Table 1

The percentage of BIM software "experts" within respondent firm

Percentage of BIM "Experts" in Company	Frequency	Percent	Cumulative Percent
0%	2	7.7%	7.7%
1% - 15%	13	50%	57.7%
16% - 40%	7	26.9%	84.6%
41% - 65%	3	11.5%	96.2%
66% - 80%	1	3.8%	100%
81% - 100%	0	0%	100%

Of the companies that show a high aptitude (greater than 40%) for BIM software, two are construction companies, one is a design firm, and one is a design/build firm.

BIMFM Related Contract Requirements

In order to identify a company's exposure to BIMFM related contract requirements, the research needed to identify a number of factors that are required to successfully implement BIMFM. Factors include the creation of an as-built models, interaction with a BIM Execution Plan, and the company's desire to work on a project with BIMFM requirements. In addition, the research wanted to quantify the number of projects executed with BIMFM deliverables and in particular a data-loaded, as-built 3D model for FM use.

First, the research identified the percentage of projects that require an as-built BIM model after construction. Figure 3 shows that the majority of companies (52%) encounter this contract requirement on 16% or more of their projects. These percentages only reflect that a model was required after construction, it does not reflect a requirement to place any O&M information in the model or accompany the model with any model-related O&M data (i.e. COBie). It also does not identify whether or not the owner utilized the model for any FM related tasks.

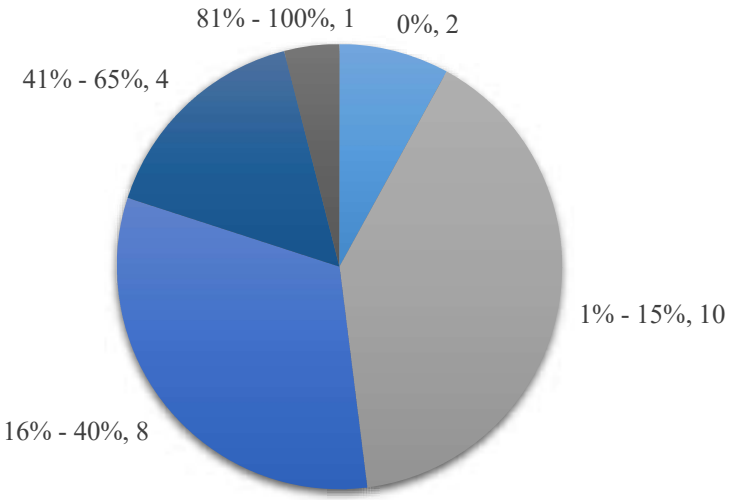

Figure 3: Percent of projects that require an as-built model upon completion of construction, number of respondents out of 25.

Further analysis of the data shows that the results from Figure 3 are not surprising when considering that 83.3% (20/24) respondents have identified, bid on, or won a project that had a BIM Execution Plan/BIM Guidelines required in the contract. Perhaps more surprising is 50% (13/26) of the respondents stated they turn over a data-loaded, as built 3D model for O&M purposes (BIMFM model). Of the 13 respondents who have submitted a

BIMFM model, 9 were able to identify a frequency of their projects that require a BIMFM model. Figure 4 presents these results.

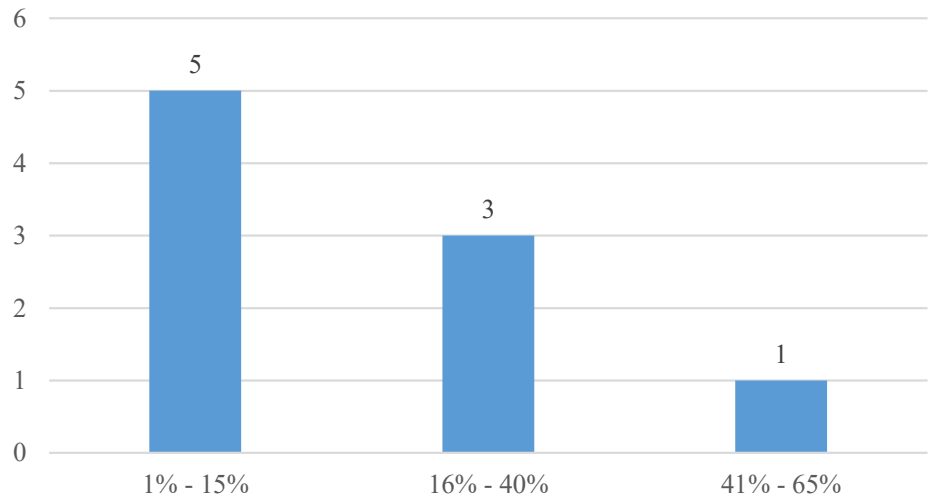

Figure 4: Frequency of projects requiring a BIMFM model among designers and builders who have been required by contract to submit an as-built, O&M data loaded model

Conclusion and Discussion

By analyzing the BIM-related infrastructure and resources to a company's BIMFM experience and exposure we can extrapolate a market readiness for designers and builders. The data has shown that most of the designers and builders have identified work that required the knowledge and infrastructure to execute an as-built model, with half of the respondents submitting a BIMFM model after construction. Although the data shows that the frequency of these types of requirements is still quite low, the number of contractors that have been exposed to this requirement is not. This appears to show a contrary result to many studies showing a lack of BIMFM implementation, however it is important to understand the distinction between submission of a BIMFM model and the use of the BIMFM model. Regardless, this data indicates either a growing desire to implement BIMFM, or Owners asking for a model without a clear understanding of how to use the information.

Despite the reasons contracts are requiring BIMFM, the exposure to this requirement appears to be significant, while the expertise within the majority of the companies to deliver these requirements is limited to less than 15% of management staff. At this point, it does not appear that the disparity between skill set and requirement has impacted the designers or builders desire to chase work with BIMFM requirements. When asked, all respondents stated that they would pursue work that had a BIMFM model requirements. Interestingly, even respondents that had never worked with a BIM Execution Plan or do not have the in-house capabilities/expertise to execute a BIMFM model responded in the affirmative.

Likely due to the inconsistent frequency of the BIMFM contract requirements, the market is willing to execute these contracts with a relatively small percentage of experienced BIM experts. However, with less than 15% of managers well-versed in BIM, it is safe to assume that any advancement to the field or desire by large industries (higher education, government, industrial, or healthcare) to move further into this direction would require training to a much larger percentage of company management.

Future research would expand the number of companies surveyed to obtain a more comprehensive view of the complete market. Although not intentional, this research analyzed results from companies with fairly substantial annual volume. It would be interesting to see how small to medium size firms are impacted by BIMFM-related contract requirements. Additionally, a limitation of the study is the lack of true design firms. With 2/26 respondents identified as true "design firms" and 3/26 as "design-build firms" the results may have been slightly skewed due to

the construction firm majority (21/26). Although this may have influenced the results, the results of the study still hold value as BIMFM requirements are often the burden of the contractor or design/build entity. In other words, although the study represented a majority of true construction firms, ultimately the requirements to execute and deliver BIMFM is often a contractual obligation of the entity during the construction phase. Regardless, future research would address a more multi-disciplinary group of respondents.

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