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Abstract
Although many contractors in the U.S. have reported their successful implementations of Building Information Modeling (BIM) in construction, they seldom presented challenges and failures they went through. Those contractors, especially in the developing countries, who try to apply BIM to their projects for the first time, could assume that they would get the same success easily as soon as they start using BIM applications. In practice, however, no contractors can apply BIM to their projects from the beginning unless they figure out what BIM can do, what exactly they want to accomplish using BIM, what challenges they would face, and how they should handle those challenges. This paper explores five challenges that contractors in the developing countries may need to discuss before they apply BIM to their projects.

Keywords
BIM, Challenges

1. Introduction

Many contractors in the U.S. have reported their successful application of Building Information Modeling (BIM) to enhance their processes during construction. However, they seldom presented challenges and failures they went through while trying to use BIM for the first time. Those contractors, especially in the developing countries, who are inspired by the successful applications of BIM in the U.S. therefore could expect that they would get the same success as soon as they start using BIM for their projects.

In practice, however, not all contractors even in the U.S. were successful when they used BIM for their projects for the first time. They experienced unexpected challenges when they tried to use BIM for design innovations, cost estimations, pre-construction coordination meetings, quality controls, facilities management, and so on. Understanding why some contractors create the model themselves instead of getting the model from architects, why we don’t see many contractors using BIM for cost estimation, why we don’t see many owners using BIM for facilities management yet may help those contractors in the developing countries successfully apply BIM to their projects without repeating the same mistakes. This
paper explores five challenges that contractors in the developing countries may want to discuss before they apply BIM to their projects.

2. BIM for Design Innovation

Building Information Model (BIM) is an object-based 3-dimensional computer model combined property information of the building components. BIM is also defined as Building Information Modeling, which has something to do with creating a 3D computer model integrated with information or using it for making informed decisions. Most computer applications developed for BIM offer such functions to create an object-based 3D model using parameters that establish the relationship between objects in the 3D model. In most parameter-based 3D modeling applications, geometric dimensions of one object are logically connected with the dimensions of the other objects through parameters. Therefore, changing the dimension of one object can lead to dimension changes of associated objects. Also the 3D model is connected through parameters with multiple 2D drawings showing plans and sections of the 3D model.

Architects were excited about the parameter-based 3D modeling process because it helped them updating the 3D model. Since the 3D model is consisting of objects that are connected to each other through parameters, changing the dimension of one object can automatically lead to adjusting the dimensions of other associated objects. For example, when the location of a certain wall is moving, most BIM applications can adjust the dimensions of the adjacent walls automatically. Since the 3D model is connected with 2D drawings depicting the plans and sections of the 3D model, changing the dimension of one object in 3D can lead to updating multiple 2D drawings representing that object automatically. When the size of a specific window is changed, for example, most BIM applications can automatically update all 2D drawings representing the particular window. When architects were using 2D CAD applications to produce 2D drawings manually, they had to update each and every drawing one by one in order to reflect the design change. Since the drawing revision was done manually, there were some drawings left unchanged and issued to contractors, which could get contractors confused. When contractors are confused, they often have to issue RFIs (Request for Information) to get clear understanding of the designer’s intention, which is wasting time. Inconsistency between drawings has been one of the major causations slowing down the decision making process in construction. Most BIM applications offer functions to synchronize the 3D model and associated 2D drawings automatically while the design is getting revised, and inconsistency between drawings has been removed effectively when BIM is used.

Theoretically, the object-based parametric 3D modeling applications, which is also called as BIM applications, can be used to facilitate architects to design the building in 3D first and produce the associated 2D drawings later. The space in the building or the building components creating the space can be designed in 3D from scratch using these BIM applications. The architect’s design intention could be better understood because it is represented in 3D. Clients who don’t have skills to read 2D drawings can easily understand how the building will look like, and therefore inform the designers of what they like or don’t like more effectively, which eventually helps architects speed up the design process. 2D drawings then can be produced later automatically with few clicks, which facilitates the design innovation.

In practice, however, we have not seen many architects taking advantage of BIM to innovate the design process yet. In many cases, facilities are still designed using 2D drawings. BIM specialists are hired later to convert what is depicted in 2D drawings into a 3D model. Although the 3D model helps clients effectively understand the designer’s intent, the use of BIM has not changed the design process in essence yet. It is to some extent because some BIM applications do not support multi-users working on one model. Unless the building is divided into multiple sections and assigned to individual designers systemically, it is not practically easy for multiple designers to work on one project collaboratively because no two designers can work on the same computer model at the same time. If two designers working on the same computer model in the central repository, the revised model saved earlier by one designer can be overwritten by another revision to be saved by others later. Some BIM applications
support multi-users to access and revise the same file at the same time, but this function has been utilized actively yet. Those who want to innovate the design process using BIM therefore need to plan carefully how they want to have multiple architects working on the same file during the process of designing the facilities in 3D.

3. BIM for Estimation

Building Information Model (BIM) is an object-based 3-dimensional computer model combined with additional information of the building components. Among information to be integrated with the 3D model, the unit cost is of the contractor’s interests. Since the Building Information Model consists of objects, the quantity of a certain object in the model can be easily counted automatically. If each object representing the building component is integrated with the unit construction cost, the total construction cost can be calculated almost instantly with few clicks, which should help construction professionals speed up the cost estimation process drastically.

Then why don’t we see many construction companies using BIM for cost estimation yet? In order to get the answer for this question, we need to take a look at the process of estimating the construction cost. In most cases, the estimation of the construction cost needs to be done at the early stage of the construction project when the detail drawings and specifications of the project are not yet available. Construction professionals therefore assume many things, for example, using the footprint of the building, to estimate the construction cost. Most BIM applications, however, need precise geometric information of the facilities. Otherwise it is not often practically possible to create a 3D model with necessary information attached. It is not possible therefore to expect that the Building Information Model can be created at the early stage of the construction project when no detail drawings and specifications are yet available. How can we use the Building Information Model for estimation then when we can not create it due to lack of necessary information?

Luckily there are some computer applications, such as Beck Technology’s DProfiler, that are designed to facilitate cost engineers to speed up the cost estimation process using the 3D model and information available only at the early stage of construction (Sabol 2008). These applications are diligently following the process that most cost engineers take to estimate the construction cost. They are capable of calculating the cost of construction with a very limited amount of information, such as the footprint or location of the building. For example, these applications help them estimate the construction cost of a 10-story commercial building to be located in Houston even when that is all they know about the building at the moment. The only drawback of these applications is that the cost models created by these applications are not easily transferred to major BIM applications yet, because of the different way of handling 3D models. Therefore, one has to create the BIM model almost from scratch although the construction cost model was produced for cost estimation.

4. BIM for Pre-Construction Coordination

Most general contractors are excited about BIM because it helps them detect clashes between building components in advance, so that they get the chance to fix them during pre-construction coordination meetings (Eastman et. al 2008). To detect clashes, they collect necessary models from architects, structural engineers, and MEP (mechanical, electrical, and plumbing) engineers, and merge them together using BIM reviewing applications such as NavisWorks, which is also capable of detecting clashes automatically. These applications, however, often consider the overlaps between the same building components as clashes, although they are trivial. BIM authoring applications often allow these overlaps, for example, where steel beams meet steel columns, but these overlaps are detected later as clashes. In fact majority of clashes detected by the automatic clash detection function are trivial, and it takes a significant amount of time to make sure that they are not real clashes. Therefore, some advanced project
engineers believe that they can save time by checking clashes between MEP systems and other building components manually.

Once clashes are detected, the snapshot images of these clashes are collected and the discrepancy reports are produced using these snapshot images. Sometimes the names of the building components are extracted from the model and used to explain where these clashes are taking place. However, in many cases, one can describe the locations where clashes are taking place using the snapshot images and key map. In other words, construction professionals use BIM during pre-construction coordination meeting, but what they are really using is the geometry of the model. They seldom use information integrated in the Building Information Model. Who is then using information integrated in the Building Information Model?

5. BIM for Quality Control

We often expect that buildings being built on the jobsite are identical to the Building Information Model. In many cases, buildings on the jobsite are built accurately and they are identical to the associated Building Information Models. In some cases, however, especially when cast-in-place concrete is used for structural components, the accuracy level of the building is affected somewhat by the field operation. Formworks are often sagging or wiggling while fresh concrete is being placed and vibrated, which ends up producing concrete beams and columns that are sagged or wiggled. Those who want to use the prefabricated modules that would be attached to these concrete beams and columns, and those who prefabricated these modules using information extracted from the Building Information Model, may not be able to yield the expected level of productivity because what has been built is not identical to what is represented in the Building Information Model. For example, when concrete beams constructed on the jobsite are sagged or wiggled, metal modules that are prefabricated in the factory using BIM could not be perfectly aligned with the concrete beams because of the beam’s deflection.

In the U.S., some contractors expect that laser technology can be utilized to collect the x, y, and z coordinates of the points on the surface of beams or columns built on the job site. Especially they expect that Robotic Total Stations (RTS) can be utilized to collect these coordinates effectively. RTS, which is capable of transferring point data from the Building Information Model and marking them on the job site, is also designed to collect the point data on the job site and bring them back to the Building Information Model. Point data collected from the job site then can be used to revise the Building Information Model, which then can be used by sub-contractors who may want to prefabricate the building components that will be perfectly aligned to the existing building components on the job site. The research team at Texas A&M University confirmed that RTS technology enhanced the process of collecting point data from the job site and bringing them back to the Building Information Model.

6. BIM for Facilities Management

Why owners want their contractor to use BIM? Many professionals believe that owners want contractors to use BIM because it enhances the construction processes. BIM helps contractors detect clashes in advance and fix them during pre-construction coordination meetings. Some professionals believe that BIM can facilitate contractors to effectively use Integrated Project Delivery (IPD) system, which helps owners, architects, and contractors be in the same page from the early stage of the construction project, which then helps them complete the project with better quality (Autodesk 2008). Some owners, however, do not appear to care how contractors use BIM. They just appear to be happy as long as contractors complete the project on time under the budget. In many cases, what they are really interested in, when contractors are using BIM, is how they want to use BIM for facilities management.

Now, do owners know what information is needed for facilities management? Some owners do. However, there are some owners who still investigate how they want to use BIM for facilities management.
management. What they want to figure out is what kind of information they want to store in the Building Information Model. For instance, in order to make decisions for facilities management, how can we use door information in the Building Information Model? What about information on windows? One may find that majority of information registered in the Building Information Model may not be good for facilities management. Onuma (Sawyer 2011) asserted that only 5% of information registered in the Building Information Model could be used for facilities management. Then one may wonder why we are putting information in the Building Information Model that no one is using? Those who want to use BIM for facilities management may need to figure out what information we really need for facilities management and how we want to handle it in the course of design and construction.

7. Conclusions

This paper explored five challenges that some BIM professionals in the U.S. are working on. In the U.S., BIM has been well used to transform the architect’s drawings in 2D into a 3D model. However, not many architects take advantage of BIM to innovate the design process in essence yet. Many contractors still use traditional method to estimate the construction cost, although most BIM applications are capable of handling cost information. BIM has been actively used for clash detection during pre-construction coordination meetings. However, contractors mainly use geometric information of the 3D model for clash detection. Being able to use prefabricated modules with confidence is one of the advantages that contractors can enjoy from using BIM. However, the building being built on the job site can be different from the 3D model especially when cast-in-place concrete is used, and some advanced contractors are using laser scanning technology to reflect the status on the job site back to the Building Information Model as quickly as possible, so that specialty contractors can use it for prefabrication. Owners may yield the most tangible benefit from BIM when they can use information registered in the Building Information Model for facilities management. However, most owners have not had a chance to develop the list of information they need to extract from the Building Information Model for facilities management yet. Most information registered in BIM, therefore, are not used effectively yet in the course of design, construction, and maintaining the building yet. Those who want to use BIM effectively in the developing counties need to take a look at these issues and carefully come up with the plan to best utilize information registered in the Building Information Model.

8. References


