

# **Increase the profit by Upgrading the Organization's Capabilities through Implementation of the Building Information Modeling: A Review**

Gandhar Rahane, Prof. P. S. Dange

PG Student, Department of Civil Engineering, Dr. D. Y. Patil Institute and Technology Pimpri, Pune, India

Prof. Department of Civil Engineering, Dr. D. Y. Patil Institute and Technology Pimpri, Pune, India

**ABSTRACT:** Every infrastructure project begins with existing conditions, and massive amounts of data. Gathering and understanding the constraints of nearby assets and landforms along with regulatory considerations can be overwhelming. And for owner organizations, the ability to simultaneously analyze scheduling and costs for multiple projects across a major capital program is hugely valuable. Right away, a BIM approach can improve the accuracy and speed of the planning process by helping to aggregate multiple types of data from a variety of sources into a single reference model. This comprehensive view of existing conditions provides all stakeholders with greater clarity—which can help inform their decisions. Visualizations from this information-rich model can be shared with non-professional stakeholders, helping to ease approvals and further speed the planning process. Just as important, the information and decisions at this point are captured in the model and will remain consistent through project completion. As an example, let's say underground utility locations are captured with ground penetrating radar (GPR) and incorporated into the model for a road rehabilitation project. This kind of information is vital during construction to avoid damage and expensive delays and change orders. With the model-centric coordination that BIM makes possible, designers can minimize potential impact and contractors are in the know long before ground is broken. Later, when the municipality contemplates future expansion or repair, the utility data persists in the model and can be updated as changes are made, with no loss of fidelity or time-consuming rework.

**KEYWORDS:** Building Information Modeling, Benefits of BIM, 3D Modeling.

## **I. INTRODUCTION**

Building Information Modeling (BIM), as one of the recent developments in the architecture, engineering, and construction (AEC) industry, is no longer a strange word. The model built by this technology, known as Building Information Model, could be used for planning, design, construction and facility operation. This survey presents a review of many publications on the broad topic of BIM, as well as the specific topic of site-linked BIM. This review includes among others books and journals published by American Society of Civil Engineers (ASCE), paper and standards from Open Geospatial Consortium (OGC), which is a non-profit international voluntary consensus standards organization that is leading the development of standards for geospatial and location based services. The knowledge base in this field is changing rapidly and there is new material that is constantly published in the form of white papers, news reports from the BIM software vendors websites such as Autodesk R ,Inc., Bentley Systems and Graphisoft SE. This review is aimed to build a clear and systemic understanding about the rapid evolution of BIM is in the AEC and Facility Management (FM) industries, as well as how BIM has been evolving and applied from a global perspective. More specifically, through the reading of these literatures it has been possible to

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 1, January 2017

learn how much work has been done on this topic, what is still missing, what difficulties people in these areas have met, what the major obstacles are and what specific problems that need to be solved in the future.

## Building Information Modeling

In today's design and construction industries, 3D building modeling has become more and more widely used as an efficient process that is changing the way in which the AEC industry delivers projects. Architects use it as a better design tool, which provides a 3D visualization of their proposed design idea to their clients; engineers also benefit themselves from the use of 3D and BIM to better coordinate their designs and to better integrate the analytical part of their professional services detecting clashes between systems and estimating energy efficiencies. Most of the discussions associated with BIM have focused on the preconstruction phase. Some of the hot research issues are related to the ownership of the model", the trends, benefits, risks and challenges of BIM for AEC industry and how 3D and 4D BIM model would benefit the AEC area. However, to this date not much attention has been given to the topic of site linked model which is starting to emerge. Searching the key word BIM or building information modeling through Google, reports more than 11,000,000 hits. However, if we narrow our search by the words BIM site , 3D site model , or site linked model , one would get only one tenth of the original results or less.

In this area, there are some discussions concerning BIM for Civil Engineering. The topic ranges from exploring the different uses of BIM model for Civil Engineering to how could site, road and highways exploit the advantages of a BIM-enabled workflow, and etc. Other discussion focus on the meaning and benefits of using the BIM concept to define site conditions. For example, the contractor's guide to BIM published by Associated General contractors (AGC) concluded the advantages of bringing BIM to the site conditions are: "identifying collisions to reduce errors and corrections in the field, having more reliable expectation of field conditions studying which would enable a safe, simulated environment;; being able to incorporate more prefabricated components and assemblies (Sullivan, 2007)." Furthermore, in some related case studies like the design and construction of Emory Psychology Building, which is located in Atlanta, BIM has been considered very efficient in defining underground coordination. In this case, a site model was created, the early collision detection and interference checking was performed by using Revit Architecture, utility model was created using a 2D drawing and it shows the structure in relation to the underground utilities which revealed several conflicts.

## II. LITERATURE SURVEY

Literature concealed the subject of BIM mainly for collaboration and coordination counter to the usage of BIM for estimating, which is still considered an innovation. Large construction firms ongoing to recognize the importance of BIM model especially in design-build projects and implement them in the design phase and in during the construction for scheduling and clash detection, other construction companies especially building subcontractors did not see the incentive of developing a BIM model for their personal use especially when it is not given to them by the architect of the Construction company. Since most documents favor large-scale developments, this study explored multi-family projects. Broad questions were framed from the literature review owed to the absence of research in this topic. This paper attempted to add rigor to the existing research by addressing the subcontractors' challenges to adopt BIM for estimating with a framing design BIM module

**According to McCuen, (2008)** affirmed the broad benefits of containing scheduling (4D) and cost estimating (5D) in the project which gives spirit to BIM, "Adding 4D and 5D to a BIM project creates an environment that enhances profitability". A case study by McCuen, (2008) proved the planning and estimating involvement that resulted in the success of the project "University of Washington (UW) Research Building" by its completion 40% faster than the projected time. BIM facilitated the alliance between the diverse stakeholders, and exceeded the owner's quality expectations of the project.

**Mortenson, (2007)** claimed that, "The model has proven comprehensive and durable enough to assist in all phases of the project lifecycle—from conception, through design and construction, to operations and maintenance."

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 1, January 2017

**Lu, Fung et. Al. in 2014** proposed the remunerations and result of BIM implementation can be consumed to justify the need to promote BIM in the architecture, engineering and construction industry.

**Edward (2007) claimed** “One of the chief benefits of BIM is that it includes information about length, width, and volume, as well as information about content such as doors, windows, and finishes, all of which can be used for estimation.” Furthermore, approximating based on BIM eradicates overlooked particulars when doing quantity takeoff from traditional 2D mostly with common updates which makes it hard to catch. (Joyce & Erin, 2014).

**In 2012 Nassar** conducted research related to BIM application in estimating. The research based on statistics collected from students functioning on project with BIM/Estimating, a course offered for graduate students, outcomes from the actual projects were used and examined as follow: The application of BIM for estimating purposes can dramatically improve time savings and quantities’ accuracy at any time during the construction process. Since the 3D model is based on updated documents by the side of the relevant data, yet, this process is still delayed by the absence of understanding (Nassar, 2012). Moreover, the automatic takeoff cannot be produced only by BIM. Findings by Stanley and Thurnell (2014) show that “5D BIM takes place out the core BIM model by live linking it to a third party estimating software”. Thus, an importance of introducing approximating software to link BIM and the model (Nassar, 2012). Nassar also maintained the importance of making a specific BIM model for contractor’s benefit rather than working on the BIM model provided by architects and engineers, “The estimating process is more difficult than only listing objects and their sizes”.

**According to Thurairajah and Goucher (2013)** settled that the application of BIM within the project changed the dream of the construction. Surveying specialists are being prejudiced by the growth of BIM. Thus, it promotes its use and makes its presence necessary to the project success. Otherwise, they will chance the menace of dropping behind the competition. It is critical to understand the benefits and challenges of BIM; BIM’s magnitude to impact the project in all aspects and phases. Furthermore, the effective and accurate delivered information, estimates that cost consultants can rely on. Thurairajah and Goucher (2013) found that there is a likely time enhancement with the procedure of automation while meeting the owner’s expectations and the project team’s expectations. However, an absence of motivation of investment is noticed.

**Thurairajah and Goucher (2013)** stated “It is vital that BIM is introduced to organizations as part of a structured implementation plan, with the required levels of sensitivity.” The study also pointed out the shortage of comprehension of BIM among cost consultants, and an essential need for training.

Stanley and Thurnell (2014) found that BIM approximating is extra efficient, accurate, detailed, and predictive for eventual future problems in counter of a conventional quantity surveying. Nevertheless, BIM approximating is reserved to adoption by the succeeding obstacles: Cost, absence of software compatibility, absence of specific coding for BIM elements, deficiency of full info for data, absence of united models.

**McCuen proposed in (2009)** clarified that mined info from BIM are not necessarily efficient (National Institute of Building Sciences, 2007). “The information needs to be in the suitable format and measured accurate and complete before use in decision making” McCuen (2009). This will happen by transmitting data linking numerous dimensions using software that is interoperable (National BIM Standard, 2008).

### III. RESEARCH METHODOLOGY

#### Feasible Methods to Create a Site-linked 3D Model

To create a site-linked BIM model, one needs to first seek for current technology support. As previously stated in this report, there are currently three major software vendors who provide technology resources for this purpose: Autodesk Inc., Bentley System and Graphisoft SE. This chapter reviews the approaches that can be followed to create the site-linked BIM model by using different software provided by these vendors. This is done through the following three steps:

1. Find out the corresponding BIM software for both the site and building modeling.
2. Discuss the software interoperability with other BIM tools.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 1, January 2017

3. Provide all the feasible methods of creating a site-linked building model.

## 1. BIM Tools & Interoperability

Three vendors provide some corresponding BIM solutions for Building and Site design. Autodesk, Inc. has Revit for building modeling and Civil 3D for site modeling. As described by Autodesk, Revit Architecture building design software was built for BIM. And it could help the architects and designers to develop high quality designs, to better capture and analyze concepts and versions through design, and to produce a better coordinated documentation for construction. On the other hand, Civil 3D is a BIM solution for Civil Engineering design and documentation. Bentley system provides Bentley Architecture, which serves the building design like Revit Architecture. For site modeling, InRoads Site Suit runs on Micro station and AutoCAD, provide the powerful functionalities of site, survey and drainage, as well as the cohesive solution for land development and site modeling; Powev Civil offers civil engineers and designers a flexible 2D/3D tool for land development and site model, it is suitable for commercial building sites, campuses, as well as the drainage utility projects.

## 2. Feasible Methods

### Method 1 : Autodesk Revit Architecture

Autodesk Revit Architecture, as described by Autodesk, is a design software helps architects and designers capture and analyze early concepts, and then better maintain designs through documentation and construction. In the real world design, Revit Architecture is mainly used to design buildings - walls, floors, ceilings, doors. However, very frequently, the architects would be asked to add site and structural information into the model, which required the software itself, provide tools to create topographic surface for site work. Revit Architecture provides the very easy-to-use tools for modeling and parametric design, not only for the building itself, but also for the site condition. To simplify the process and reduce the unnecessary cost of using different software products, the first conceptual method this paper is researching on is the use Revit Architecture site tools for the sole purpose of realizing our goal — to provide a site-linked 3D building model.

### Method 2 : Revit Architecture & AutoCAD Civil 3D

Another feasible approach is to use AutoCAD Civil 3D to create the site model and then link it with the building model either in Revit Architecture or AutoCAD Civil 3D. Unlike Revit Architecture, the major aim of AutoCAD Civil 3D is to provide the BIM solution for civil engineering rather than architectural design. As quoted from Autodesk, —the software focus on delivering higher-quality transportation, land development, and environmental projects faster, explore design ideas and analyze what-if scenarios to help optimize performance before projects are built. The intention for the use of this software determines the built-in features to provide better site tools to model the site conditions, Civil 3D is functional in modeling grading and intelligent pipe network, pipes and structures can be changed simultaneously by using graphical or numerical input, and interference checking tool would find any collision between the pipe system or pipe and the excavation for the user. In other words, comparing to Revit Architecture, AutoCAD Civil 3D is more functional for underground utility design. And since Revit supports the integration with AutoCAD Civil 3D, the site data can be transferred between these two software's efficiently, which means the 3D Revit Building model can be linked with modeled site eventually.

### Method 3 : Bentley Products

The third method is to use Bentley products. This method is quite similar to method 2. InRoads/Power Civil is playing the role of Civil 3D while Bentley Architecture is taking Revit Architecture's place. One marked feature of Bentley, comparing to Autodesk's products, is that it dedicates in delivering solutions for the infrastructures rather than buildings. Specifically, Bentley products provide efficient solutions for bridges, factories, roads, rail and transit. It also provides buildings, roads, paving and assets. With its core design tools: Inroads site, power civil and Geopak site, Bentley offers a complete solution for easy site modeling, survey data management, digital terrain modeling, water/sewer line layout and analysis, street design and so on. Similar to using Revit and Civil 3D, the process is to use Bentley Architecture to create the building model, and then according to the project information, chose either InRoads or PowerCivil to create the Site model, than link them together. Bentley Navigators could be applied or not to integrate the two models together.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 1, January 2017

## Method 4 : ArchiCAD & Other BIM software

The fourth method is to use ArchiCAD to create the site model. ArchiCAD, as architectural BIM software developed by the Hungarian company Graphisoft, could be integrated with other BIM applications including Autodesk Revit and Civil 3D. Although the mesh tool in ArchiCAD is not intended for Civil Engineering, still, it could be used to present the virtual building by modeling terrain of the site model. To create a topographic surface, one can either start out with a Scanned Image or in the form of a civil engineer's DWG files, import and simplifying the contour maps, specific steps). One can also add roads to the site, develop terrain and paving meshes, modeling foundations, cut a hole on site as excavations and so on. And since ArchiCAD has good file format compatibility, the site model could be brought into other BIM software so that the building model and the site model could be linked together. Some of the choices are, export the site model as AutoCAD's Vectorial DWF format, which is the supported format of Revit; or export it as MicroStation's DGN, which would incorporate with Bentley products creating solid site model with the mesh tools from the contours solutions for campus design and operation, which is comprised of sites, utilities,

## IV. DISCUSSIONS

The objectives of this survey are to investigate feasible methods to create a site-linked BIM model, and to discuss the benefits and limitations of bringing BIM concept to the site conditions. Four different methods by using different software developed by Autodesk, Bentley and Graphisoft were discussed in the previous sections, Method 2, which is using Revit Architecture and AutoCAD Civil 3D was used and testified as a feasible procedure through the case study. The following conclusions specifically focus on the benefits and limitations when it comes to the topic of site-building integrated model.

### Better visualization and documentation

Every BIM software, either Revit or AutoCAD Civil 3D provides the users with a much better visualization comparing to the old fashioned 2D design software.

### Single and integrated information resource

A site linked BIM model integrates information from different project parties together as a single information resource. In the case study of WPI new sports and recreation center, before the site-linked BIM model was built, the project has many pieces of information resource, the paper drawing and structural building model from Cannon Design, Inc., the as-built CAD drawing and a building model developed by Gilbane, Inc., the geotechnical report prepared by Haley & Aldrich, Inc. As the figure shows, there are pieces of information everywhere, however, by bring in the integrated BIM model, all of these information could be carried by one single 3D site-linked building Model.

### Time Saving Utility Design

AutoCAD Civil 3D provides the powerful functionality to create, swap or move pipe networks in the plan view, one can easily define his pipe network to contain pipes only, structures only or like in this case, both pipes and structures according to the real site condition. It has a full list of multiple pipes and structures ready to use, the size and style can always be redefined after the network has been set up.

### Interference checking, less collisions

Some BIM software carries this functional tool: interference checking. By having the well-defined site model with existing underground condition and the excavation pad on site, this tool would simply allow the user to identify the following two situations and would play a significant role in reducing possible collisions during future constructions.

## V. CONCLUSIONS

After the successful analysis of all survey we conclude how BIM has upgrade the organizations capability as well as provide the maximum profit with minimum duration. Basically the nature of the construction business is also set to



# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 1, January 2017

witness a sea change in the operating styles and will lead to the coming together of various entities to cater to this massive demand. To remain relevant, an organization will have to be capable to work gracefully not only within itself but also with its partners. It will have to be capable to not only deliver but also to exceed the demands of its clients while remaining financially viable. Companies that successfully integrate Building Information Modeling (BIM) into the strategy, processes, and IT systems of their organizations can establish a business advantage, improve project quality, enhance team collaboration, and potentially expand their services. Companies that have well adopted BIM can understand substantial savings in project design and delivery budgets and timetables, create better-informed decisions at an earlier phase in the design procedure, and avoid costly faults and rework. Aligns BIM abilities and benefits with an organization's overarching business goals and priorities, including objectives around competitive positioning, operational excellence, and effective delivery.

## REFERENCES

- [1] Azhar, S. (2011). Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry. *Leadership & Management In Engineering*, 11(3), 241-252. doi:10.1061/(ASCE)LM.1943-5630.0000127.
- [2] Choi, J., Kim, H., & Kim, I. (2014). Open BIM-based quantity takeoff system for schematic estimation of building frame in early design stage. Retrieved from <http://www.sciencedirect.com/science/article/pii/S2288430014000037>
- [3] Giel, B. K., & Issa, R. A. (2013). Return on Investment Analysis of Using Building Information Modeling in Construction. *Journal Of Computing In Civil Engineering*, 27(5), 511-521. doi:10.1061/(ASCE)CP.1943-5487.0000164
- [4] Goldberg, H. E. (2007). Automated Estimating and Scheduling Using BIM. *Cadalyst*, 24(9), 45-48.
- [5] Joyce, E. (2014). Show Me the Money: 5D-Cost Estimating Tools Paying Off. *ENR: Engineering News-Record*, 273(6), 44.
- [6] Kraus, W. E., Watt, S., & Larson, P. D. (2007). Challenges in Estimating Costs Using Building Information Modeling. *AACE International Transactions*, 01.1-01.3.
- [7] Lu, W., Fung, A., Peng, Y., Liang, C., & Rowlinson, S. (2014). Cost-benefit analysis of Building Information Modeling implementation in building projects through demystification of time-effort distribution curves. *Building & Environment*, 82317-327. doi:10.1016/j.buildenv.2014.08.030
- [8] McCuen, T. L. (2008). Scheduling, Estimating, and BIM: a Profitable Combination. *AACE International Transactions*, 1-8.
- [9] McCuen, T. L. (2009). The Quantification Process and Standards for BIM. *AACE International Transactions*, BIM.01.1-BIM.01.11.
- [10] Nassar, K. (2012). Assessing Building Information Modeling Estimating Techniques Using Data from the Classroom. *Journal Of Professional Issues In Engineering Education & Practice*, 138(3), 171-180. doi:10.1061/(ASCE)EI.1943-5541.0000101
- [11] Sattineni, A. (2011). Building Information Modeling: Trends in the US Construction Industry. *Design Principles & Practice: An International Journal*, 5(4), 187.
- [12] Smith, P. (2014). BIM & the 5D Project Cost Manager. *Procedia - Social And Behavioral Sciences*, 119(Selected papers from the 27th IPMA (International Project Management Association), World Congress, Dubrovnik, Croatia, 2013), 475-484. doi:10.1016/j.sbspro.2014.03.053
- [13] Stanley, R., & Thurnell, D. (2014). The benefits of, and barriers to, implementation of 5D BIM for quantity surveying in New Zealand. *Australasian Journal Of Construction Economics And Building*, The, 14(1), 105.