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Applications of Building Information Modeling (BIM) to Real Estate Projects of Ahmedabad

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Abstract: Building Information Modelling (BIM) is a process involving generation and management of digital representations of physical and functional characteristics of a building or a facility. It is a holistic documentation process for operational visualization, design coordination, estimation and project scheduling. BIM software defines objects parametrically and it is a tool for virtual reality. Primary advantage of implementing BIM is the visual coordination of the building structure and systems such as Mechanical, Electrical and Plumbing (MEP) and it also identifies the possible conflicts between the building systems. This paper is an attempt to develop a model which would highlight the primary advantages of application of BIM pertaining to real estate development projects. It has been observed that about 40% of the Architecture, Engineering and Construction (AEC) companies use BIM but primarily for their outsourced projects. Also, 65% of the respondents agree that BIM would be used quiet strongly for future construction projects in India. Further, about 40% of the users would like to use BIM for project co-ordination, about 20% for conceptual design and about 15% for detailed design. The 3D models developed with Revit 2015 software would reduce co-ordination problems amongst the architects, structural engineers, contractors and building service providers (MEP). Also by means of virtual reality, the client would be having a feel of the building model before actually the building is constructed. The chances of the collisions of the different utilities and services are also minimized.

Keywords: Building Information Modeling (BIM), 3D Models, Real Estate Projects, Building services.

I. INTRODUCTION

BIM is the documentation process consisting of information about different phases of any project like design, construction planning, construction facility management and operation. It is one holistic documentation process beneficial for operational visualization and construction application such as estimating, scheduling and design coordination. Main advantage of implementing BIM is the visual coordination of the building systems such as MEP (Mechanical, Electrical, and Plumbing) systems and it also identifies the possible conflicts between the building systems. By detecting the conflicts, problems can be resolved before actual construction which in turn saves time and money invested (Kumar and Mukherjee, 2009).

Building Information Modelling (BIM) is a process involving the generation and management of digital representations of physical and functional characteristics of building projects or infrastructure related projects. Building Information Models (BIMs) are files (often but not always in proprietary formats and containing proprietary data) which can be exchanged or networked to support decision-making about a project. Current BIM software is used by individuals, businesses and government agencies who plan, design, construct, operate and maintain diverse physical infrastructures, from water, wastewater, electricity, gas, refuse and communication utilities to roads, bridges and ports, from houses, apartments, schools, shops to offices, factories, warehouses, prisons, etc. (Kumar and Mukherjee, 2009).

BIM software defines objects parametrically and it is a tool for virtual reality. BIM enables a virtual information model to be handed from design team the client and to the main contractor & subcontractor. Each professional adds discipline –specific data to the single shared model. This paper is an attempt to develop a model which would highlight the primary application of BIM for real estate projects.

II. LITERATURE REVIEW

A. BIM Application

BIM is the extensive process of developing and using a computer-generated model to simulate the phases of a construction project digitally. This technology includes simulation of planning, design, construction and operation of buildings and structures (Azhar et al., 2008). BIM can also be looked upon as a modeling technology that can produce, communicate and analyse building models. In the area of BIM, building models are characterized by components represented by digital objects that contain data regarding graphics, attributes and parametric rules that allow them to interact in an intelligent way.

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The components carry data that describes object-related behavior, which can be used for analysis such as quantity take-off, clash control, digital energy and performance testing (Eastman et al., 2011). Thus, BIM is an intelligent parametric representation of the building or structure from which data can be extracted and processed in order to generate information that can be used as a basis for facilitating decision-making (Azhar et al., 2008).

BIM has a lot of applications and purposes. Visualizations through 3D rendering can be generated, drawings and shop drawings can be extracted and building codes can be reviewed through analysis of object parameters. Facility management can be facilitated with regards to renovations, maintenance and operation, cost estimation can be done through analysis of the quantity of materials, and construction sequencing can be used to make scheduling more effective. Apart from this, a large number of different analysis and simulations can be carried out on the model to improve the overall performance of any project (Azhar et al., 2008).

Goedert and Meadati (2008) explain, BIM represents real world elements such as walls, doors, and windows as three-dimensional (3D) objects. In addition to geometry details, other information can be attached to these objects including manufacturers, fire rating, schedule, and cost estimates. Another BIM advantage is the ease to insert, extract, update, or modify digital data by owners, clients, engineers, architects, contractors, suppliers, and building officials. 3D object-oriented CAD models can serve as communication between different phases of construction like: conceptual to design development to construction to operation & maintenance.

Sarkar et al. (2015) stated that BIM is an intelligent model based process that provides insight for creating and managing building and infrastructure projects with faster speed, economy and quality. BIM helps in predicting building performance and also helps in reducing construction wastes. It can also reduce the adverse impact of construction and helps to integrate analysis, simulation and visualization into workflow primarily to make informed decisions throughout the project life cycle.

A technology is truly beneficial, if its usage is made versatile and applicable to multiple sectors. A close proximity of interrelationship and overlaps can be traced out for the selected research topic which deals with BIM & facility management.

B. Conceptual Design

BIM can be used at the pre-construction stage by designers for conceptual design, sketching, space planning, orientation on site, and ensuring program compliance with regards to site-related factors.

In addition, the design information generated through the conceptual design allows for preliminary analysis and simulations of what is being built. By using design exploration tools, designers can create mass objects in free forms and shapes that can act as a basis for more detailed design in later stages. Compared to 2D sketching, this quick and easy form of 3D sketching can more easily communicate visual and spatial information between concerned project parties (Eastman et al., 2011).

BIM has become a central subject in the AEC industry. There is an ongoing transition that proceeds from basic 2D drawings towards the use of 3D and object based BIM models. These models, filled with project information, can be utilized in many ways, by various stakeholders and in many areas throughout the lifecycle of a project, all the way from feasibility study to the maintenance of the structure (Eastman et al., 2011).

There are innumerable benefits originating from the use of BIM and it is of utmost importance to make them visible in order to promote further implementation of BIM in infrastructure. This section will address a number of important benefits that stems from the implementation of BIM.

C. BIM Benefits: - Visualization

Looking back, Engelbart (1962) stated that working with computer aided systems is working in an augmented way which is supposed to enhance the human intellect. As mentioned in the introduction, the way of working with BIM is a model-centric methodology. Compared to working with 2D CAD drawings, this enables for enhanced visualization of the structure (Azhar et al., 2008). Various benefits that originate from improved visualization such as, 1. Better overview and understanding, 2. Compatibility and clash detection and 3. Risk Reduction.

D. Obstacles in BIM Implementation

Kaner et al. (2008) states that the investment costs needed for training and software purchase is relatively high when implementing BIM.

The success factors for BIM implementation is to a large degree people-oriented and apart from the fact that too little research concludes case study evidence of the economic benefits with BIM, there is a social and habitual resistance to changing the way that work within the construction industry is carried out (Yan & Damian, 2008). This is supported by Eastman et al. (2011) who stated that resistance to changes of the current work process is an obstacle for successful BIM implementation.

III. RESEARCH METHODOLOGY

The methodology adopted for this study is primary data research, where the primary data was collected from the real estate project sites through efforts of the authors. A questionnaire comprising of the attributes of BIM was also prepared. The primary data focuses on records related to the awareness of BIM in Ahmedabad based Architecture Engineering and Construction (AEC) companies whereas the secondary data contains attributes of BIM. The overall research methodology is presented in figure 1.

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To evaluate the awareness of BIM the survey questions are based on a number of criteria. For each of these criteria, respondents indicated their preference by rating it on a 5 point scale, where 1 indicates "Not Important" and 5 indicates "Very Important." The additional questions arerated on a 3 point scale, where 0 indicates "unknown", 1 indicates "Yes" and 2 indicates "No".

For recognizing the current "status check" on the awareness of BIM a questionnaire has been designed. The questionnaire was sent to the AEC industries, faculties and professional practitioners belonging to different parts of Ahmedabad and surrounding regions.

There are three main objectives of this questionnaire.

1. To identify the percentage usage of BIM amongst the AEC companies of Ahmedabad.
2. To record the benefits of BIM as comprehended by companies using BIM.
3. Exploration of the barriers that hinder adoption of this technology.

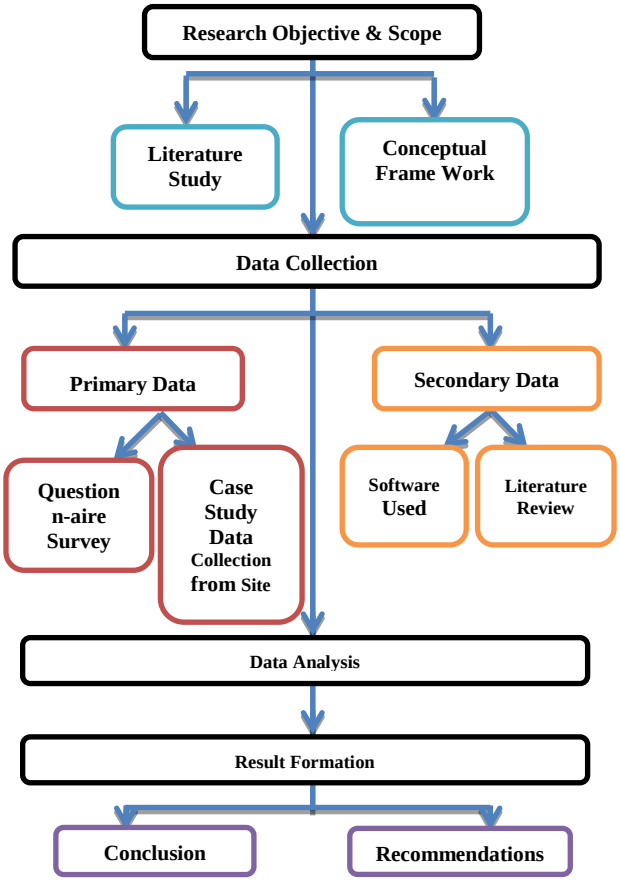

Fig. 1. Flow Chart for Research Methodology

The Questionnaires have been filled by personal interview, mailing and using google doc. files. Building Information Models are prepared in Revit software for an Ahmedabad based Real Estate Project by collecting 2D drawings.

These models Architectural, Structural, MEP and HVAC are prepared for case study.

IV. CASE STUDY AND ANALYSIS

Primary Data has been collected from the project site. A survey was carried out to comprehend the level of awareness about BIM in Ahmedabad AEC Companies. Various questions were posed to varied AEC professionals.

The data for developing 3D models has been collected from a real estate housing project in Ahmedabad, Gujarat, India. The project named as "Shatpatra" is a luxurious 3- 4 BHK apartment. The client is K.M. Infrastructure & IRM Infra Projects (P) Ltd. The construction cost is about INR 23.5 million. The overall scheme is ground + four stories (G + 4), and the plot area is 5326 sq ft. Typical floor area is 3880 sq. ft. The period of construction is 24 months. The data collected from this project was primarily utilized to develop 3D models using Revit softwares.

A. Building Information Modeling Survey

In order to analyze the use of Building Information Modeling in the Indian construction industry a survey was conducted web-based as well as manually. This survey targeted varied stake holders belonging to the Indian AEC Industry. These construction professionals represented a range of business sizes and disciplines from across the industry, including architecture, engineering, and surveying.

After conducting the survey, about 60 responses were obtained from respondents for various categories of attributes pertaining to BIM.

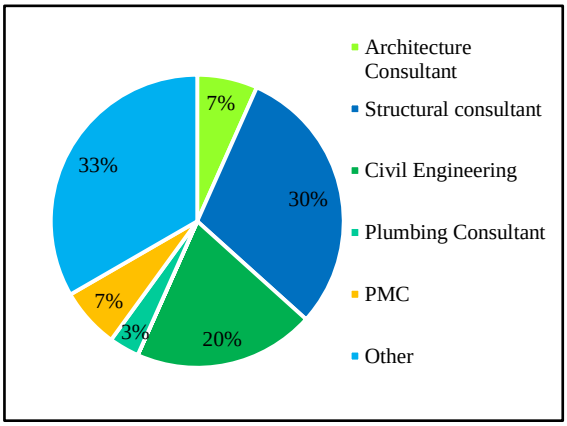

Fig. 2. Company Categories

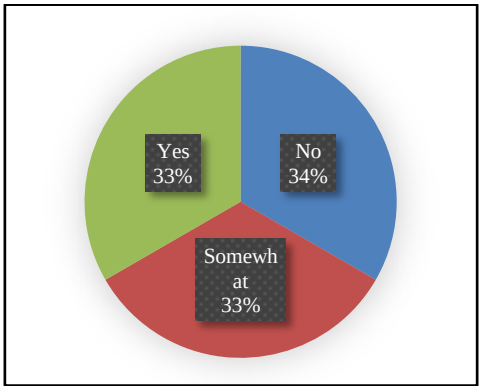

Fig. 3. Knowledge of Building Information Modeling (BIM)

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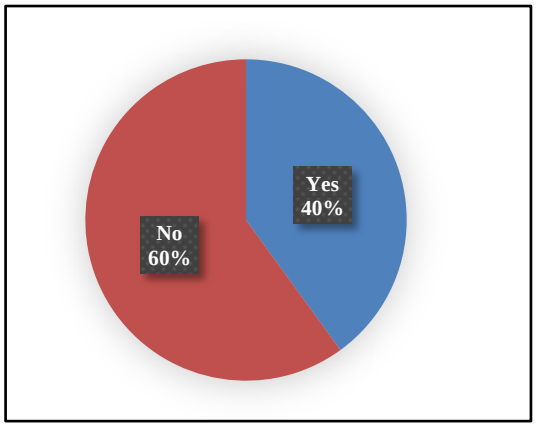

Fig. 4. Use of Building Information Modeling (BIM) in Company

According to figure 2, it is observed that about 7% of the architectural consultant companies are using BIM for their on-going projects. About 30% structural consultants, about 20% civil engineering organizations, 7% project management consultants, 3% plumbing consultants and about 33% other organizations use BIM. According to figure 3, it is observed that about 33% of Architecture, Engineering and Construction (AEC) fraternity have knowledge about BIM, about 33% have somewhat knowledge and about 34% reveals that they are unaware about the knowledge of BIM. According to figure 4, about 40% of the AEC fraternity would encourage the use of BIM in their organization and about 60% of the fraternity are a bit sceptical about the usage of BIM in their organization.

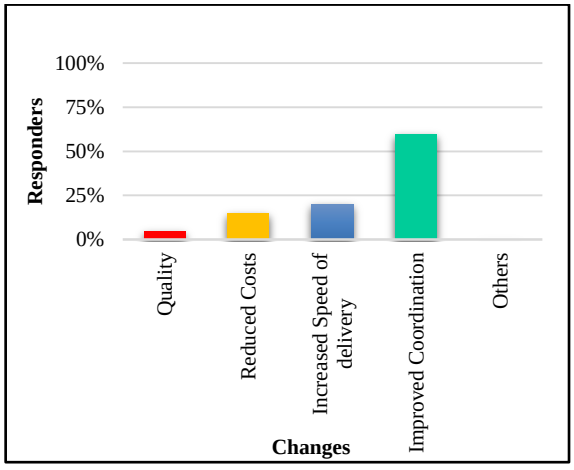

Fig. 5. Purpose of use of BIM

Further, according to figure 5, the survey results shows that the future of BIM is quiet promising in terms of its applications in construction industry. About 5% users would use BIM for project analysis, about 40% for project co-ordination, about 20% for carrying out conceptual design, about 15% for carrying out detailed design, about10% for documentation, about 5% for fabrication related works and another 5% for operation and maintenance related works. It is also observed that none of the users would prefer BIM for the use of code reviews and energy efficiency related works. Finally according to figure 6, the survey results about the potential changes which BIM can bring into a project are "quality" which is the opinion given by 10% of the respondents, "reduced costs" (given by 20% of the respondents), "increased speed of delivery" (24% of the respondents) and "improved co-ordination" (given by 60% of respondents).

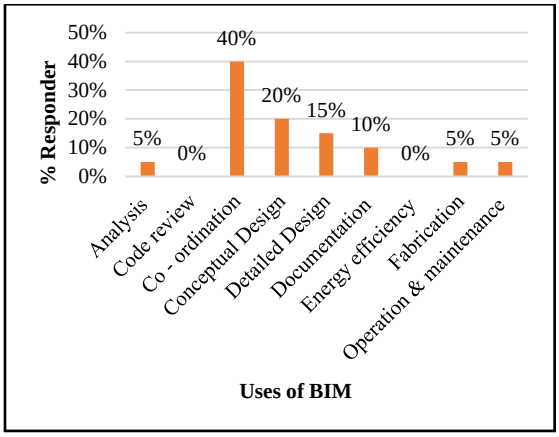

Fig. 6.Changes in Projects due to BIM

Fig. 7.Actual Structural Model of Case Study

B. 3D Models

BIM is considered as a means of providing an interoperable model to bring together the work of various disciplines through the centralized model. This resulting model is a three dimensional (3D) representation of constructed facility. The 3D model thus generated is a virtual model which is digitally constructed to simulate planning, design, construction and operation. It works on parametric rules and contains data attributes pertaining to different fields.

The 3D models for the case study, "Shatpatra" have been created using Revit 2015 software. Figure 7 represents the 3D view of the actual structural framework of the building

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under study. Figure 8 represents the 3D layout of the building services, primarily Mechanical, Electrical, Plumbing (MEP) and Heating Ventilating & Air Conditioning (HVAC).

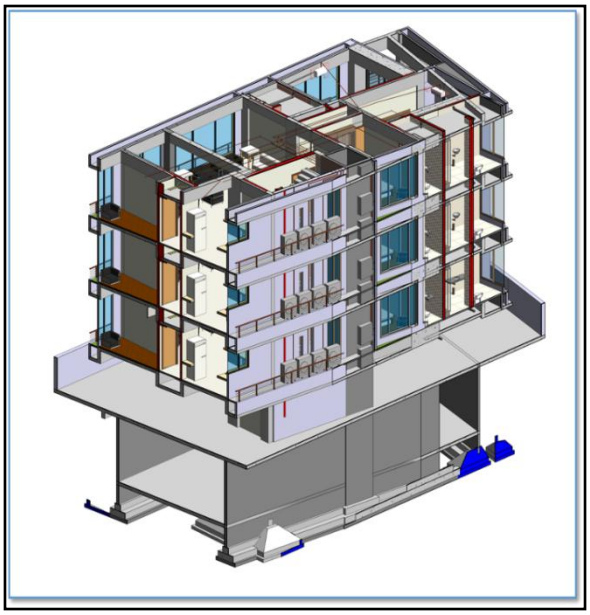

Fig. 8. Three Dimensional Live Section of Case Study (Highlighting MEP HVAC)

V. CONCLUSION

Through questionnaire survey responded by 60 respondents, who were primarily architects, engineers, consultants & real estate developers, it was observed that the knowledge of BIM was available with 33% respondents, 33% were having somewhat knowledge & remaining 34% absolutely did not have any knowledge of BIM.

About 40% of companies communicated that, they used some form of BIM but primarily for their outsourced projects. Also, 65% of respondents agree that BIM would be used in Indian construction industry in future.

About 5% users would use BIM for project analysis, about 40% for project co-ordination, about 20% for carrying out conceptual design, about 15% for carrying out detailed design, about10% for documentation, about 5% for fabrication related works and another 5% for operation and maintenance related works. It is also observed that none of the users would prefer BIM for the use of code reviews and energy efficiency related works.

The 3D models developed with Revit 2015 software would reduce co-ordination problems amongst the architects, structural engineers, contractors and building service providers (MEP). Also by means of virtual reality, the client would be having a feel of the building model before actually the building is constructed. The chances of the collisions of the different utilities and services are also minimized. This would reduce time and cost overruns of the project and would enhance the probability of successful completion of the project within stipulated time and cost frame.

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BIOGRAPHIES

Dr. Debasis Sarkar has graduated in Civil Engineering from Bangalore University, India in 1996, received M. Tech in Building Science & Construction Management from Indian Institute of Technology, Delhi in 2001 and Ph.D in Project Management from D. D University, India 2009.He is presently Associate Professor and Head at Dept. of Civil Engineering, Infrastructure Engineering & Management Programme, School of Technology, Pandit Deendayal Petroleum University, Gandhinagar, Gujarat, India. He has about seven years of industrial and about twelve years of academic experience. He was also employed as senior engineer and site incharge with Delhi metro rail project. He has published about 32 research papers in peer reviewed international and national journals. His research interest includes project management, risk management, metro rail construction technologies, other advanced construction technologies, green building materials and technologies, statistical quality control, ready mixed concrete and value engineering.

Dr. Sarkar is life member of Institute of Engineers India and annual member of Indian Roads Congress. He is also the editorial board member of a number of peer reviewed international journals.

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