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Modelling and Project Planning Of a Residential Building by Implementing 5D BIM Technique – A Review

M. Subhi
PG Student,
Department of Civil Engineering,
Sri Ramakrishna Institute of Technology Coimbatore-10,
India.

Dr. R. N. Uma
Head
The Department of Civil Engineering,
Sri Ramakrishna Institute of Technology,
Coimbatore-10, India.

***Abstract*- Basically traditional methods of building construction process is a backward to proper task scheduling and planning of the on-going construction project work at site, which is resulting in poor monitoring of complete process. The current study on concept of building information model (BIM) derives a platform where all the key information of every single element of the process of construction can be integrated virtually. It assists the Architects, Engineers and Constructors to foresee what is to be built in simulated environment and to recognise potential design, construction or operational problems. The BIM expands this methodology into 3 dimensional (3D) drawings in the three primary dimensional width (b), height (h) and depth (d) with time as 4th dimension and cost as 5th dimension. BIM in terms of 5D modelling saves a lot of time and money comparing to traditional scheduling process. This paper gives a clear view on implementing the 5BIM techniques in the Residential building construction.**

KEYWORDS- 3D Modelling, 4D Planning, Project Cost Management, Scheduling, Visualization.

I. INTRODUCTION

With the growing complexity of construction projects and shortage or availability of resources there is a need for better, more sophisticated tools for construction planning and management. There is a need for system which run more efficiently (save time and money, requires less resources and without compromising the quality), that facilitate better coordination and communication among project team members, and also communicate the same idea of the project to all stakeholders involved in the life cycle of the project.

The construction industry is emerging with various new advancements being included in every technique used. Earlier, stakeholders used to employ the 2D technique to get the constructions done. This method required 2D drawings for dimensional details of all the construction elements, which in turn needed the access to many different documents. This process was not of great use as it was prone to human error, mistakes and cumbersome. These reasons paved the way for other accurate and simplified options to overcome the problems experienced by a professional using the 2D technique. The development of efficient techniques which could be engaged throughout the lifecycle of a construction project was highly required. Researchers and engineers worldwide have continuously made their valuable contributions in this field. Recently, Building information modelling (BIM) has been developed and gaining popularity in this area.

BIM is a primary digital representation of a 3D building and its intrinsic physical and functional characteristics which forms a reliable basis for decision making during the life-cycle of a construction project. It is a database and creates a perfect platform to share knowledge and communicate information between project participants. The term BIM does no longer sound strange and has become an integral part of construction industry. BIM is a wonderful, intelligent, object-oriented and data-rich technology where the appropriate data can be extracted and analysed according to the need of a user who then makes decisions to improve the process of delivering the facility. In the light of the above explanation, BIM is not just software but it is a combination of both process and software which makes substantial changes in the workflow and project delivery processes.

From the perspective of a software, BIM is a project simulation which is comprised of the 3D model of the project components containing links to all the required information of the project planning, design, construction or operation, while, BIM could also be seen as a virtual process that merges all aspects, disciplines, and systems of a facility within a single, virtual model, permitting all the team members such as owners, architects, engineers, contractors, subcontractors and suppliers to collaborate more meticulously and efficiently than traditional processes. The team members could constantly refine and adjust their work portions according to project requirements and design changes to ensure the model is as accurate as possible, while the model is being created. This could be achieved before the start of the project.

In recent years, the various technologies like 3D (which represents the visualization of an object by height, length and width in a space coordination system) and 4D (4D is a mix of 3D coordinates and the time as 4th dimension) BIM have been employed in many construction projects where significant improvements in these tools to enhance the building process have been observed. Although, 3D and 4D techniques improve the execution of construction in the multidisciplinary and multi-organizational field to a great extent, but using these tools on an live project it is a complicated process where a great deal of coordination is

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required. Some of these problems have paved the way for many new concepts such as 5D BIM, which is the combination of 4D (time) and cost estimation as 5th dimension.

II. LITERATURE REVIEW

Bonsang Koo and Martin Fischer (2000) showed that 4D models are a useful alternative to project scheduling tools like CPM networks and bar charts. They enable more people to understand a schedule quickly and identify potential problems. By developing a 4D model for a commercial construction project, we would be able to detect the incompleteness of the original schedule, find inconsistencies in the level of detail among the schedule activities, and discover an impossible schedule sequence. Can also able to anticipate potential time-space conflicts and accessibility problems. They also showed the effectiveness of 4D models in evaluation and execution of a construction schedule. They also emphasized on the need for further advancement of 4D tools in their study. They also showed that 4D models are superior to previous tools like critical path method (CPM) networks and bar charts.

K. W. Chau et.al (2004) developed a 4D visualization model that has aimed to help construction managers plan day-to-day activities more efficiently in a broader and more practical site management context and to thereby add to our knowledge and understanding about the relevance of modern computer graphics to the responsibilities of the construction site manager.

Manish Goyal and K.N.Jha (2007) focused their study on developing a prototype 4D model which was generated by linking 3D geometrical model with scheduling data, which would ensure the project stakeholders to visualize and follow the process of construction with the progress of time. This study was basically aimed at developing this program which would enable the users to eradicate all the flaws at any instant of the project and also before the execution of the project. Even though this test was done on a simple construction project but the results were promising and overall helped to improve the project strategy and planning.

Kyuman Cho et.al (2010) several efforts have been made by many researchers to develop a model for schedule and cost integration in construction projects, but it is difficult to integrate and manage schedule and cost in an actual construction site using such a model. The integrated schedule and cost model developed in this study 1enables the planning and control of repetitive construction processes and can be used by a project manager in an actual construction site. Furthermore, an integrated schedule and cost model for the core wall construction, which is an important repetitive process in the recently booming high-rise building construction in terms of scheduling, was developed using the integration model developed in this study. It is expected that the integrated schedule and cost model developed can allow project managers to integrate the schedule and cost of repetitive construction processes more effectively and support the project managers' decision-making.

Tsai et al., (2010) estimated the time taken in a live project by recording the 2D data and simulating it into 3D by Autodesk Revit software, MS Project, and BIM application and created 3D and 4D models. These techniques allowed the stakeholders and builders to determine the human resource requirements as well as the time cost of the construction project. Using these tools also increase the understanding of their application procedure.

Ning Gu and Kerry London (2010) have consider a current state of BIM in the Architecture, Engineering and Construction (AEC) industry and a re-assessment of its role and potential contribution in the near future. The paper analyses the preparation of the industry with respect to the product, processes and people, to position BIM adoption in terms of current status and expectations across disciplines. The detecting indicates that there were both technical and non-technical issues that need consideration. The indication also prefers that there are changing levels of adoption and thus the need for a specific tool to facilitate BIM adoption. The study shows that even the market leaders who are early technology adopters in the Australian industry in many cases have varying degrees of practical experiential knowledge of BIM and hence at times different understandings and different levels of confidence regarding the future diffusion of BIM technology throughout the industry.

Saini and Mhaske, (2013) have adopted the BIM-based technique to compare the scheduling processes with that of achieved using traditional methods. They have also explained the methodology by which 4D softwares can be used to estimate the scheduling process of a building project. This study also shows how BIM can help in following a construction process in real time while helping in acquiring an accurate data which also contributes to speed up the process. They have also proposed an idea of integrating various other dimensions such as materials, cost, resources, site, etc. with BIM to create 5D or nD models.

Atul Porwal and Kasun N. Hewage (2013) have analysed that BIM implementation is still a challenge for the North American construction industry. The Canadian construction industry, in contrast, is well behind that of the U.S. in its BIM adoption rate. Capability and adoption of BIM depends mainly on the client or the owner in construction projects. Public sector clients often think that the market is not ready for BIM adoption and are afraid to increase project costs by implementing BIM in limiting competition. Moreover, if the contractor is not added in the project in the design phase, BIM has limited power. This paper prefers a 'BIM partnering' based public procurement framework to ensure best value in construction projects. The case study described in the paper confirmed the feasibility of proposed BIM based procurement in publicly-funded construction projects. This paper suggests that the contractual arrangement for the project which resulted in improved productivity, better coordination, and reduced error, and rework.

Daegu Cho et.al (2013) Cost, schedule, and performance control are three major functions in the project execution phase. Along with their individual importance, cost-schedule integration has been a major challenge over the past five decades in the construction industry. While much effort has been exerted to propose an ideal integration system, a distributed approach has prevailed. Consequently, cost-schedule integration has remained an unsolved problem. The

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primary purpose of this paper is to propose a new approach to integrate cost, schedule, and performance data. This paper concentrates on project execution data related to project control functions including quantity take-offs, cost estimation, cost control, schedule control, periodic monthly payment, and performance measurement. The terms for an ideal integration are analyzed, and a construction information database framework (CIDF) is proposed that supports multiple perspectives and levels of detail with a relatively Small number of control accounts.

Peter Smith (2014) explores the global issues which are related to be a part of project cost management professionals in the performance and evolution of Building Information Modeling (BIM) in the construction industry. The paper is based on a review or analyse of current industry trends and issues with BIM implementation and detailed interviews with quantity surveying firms in Australia. This also gives an importance for project cost management professionals to be basically involved to be involved in all the phases of the construction. In this paper it ends with the findings that the greatest value with the modern-day project cost manager lies in their ability to be 5D literate and to be able to utilise electronic models to deliver detailed 5D estimates and living cost plans in real time.

Hexu Liu et al., (2014) presented detailed cost estimation and construction project scheduling using an integrated framework based on BIM. This work was achieved by developing a BIM product model using Autodesk Revit software. The literature regarding BIM cost estimating and scheduling were taken into consideration and surveyed before proposing the project framework. A simple building project was used as a case study to facilitate the outcome

Byungjoo Choi et.al (2014) This paper categorizes work space by its function and movability and suggests a framework for a work-space planning process that contains five phases, including 4D (BIM) generation, work-space requirement identification, work-space problem identification, work-space occupation representation and work-space problem resolution. The planned framework in this paper can improve the accuracy of work-space status representation and work-space problem identification by introducing the work-space occupation concept and the integrated work-space planning process that considers characteristics of activity, work space, and construction plan. In addition, this paper aims to enhance the work-space planning process through path analysis and a formalized work-space problem resolution process. To validate the proposed approach, a case project was tested. The result shows the efficiency and effectiveness of the proposed framework on improving the work-space planning process. Based on the result of this study, a project manager will be able to prevent possible work-space problems and their negative effects on project performance by making a pertinent work-space plan during the preconstruction phase.

Prakash Chandar, Dhivya Shree (2015) conducted a study which was focused on benefits that a construction project manager and the construction industry can draw from carrying out the 4D planning. The platform was based on integrating components of 3D model with that of scheduled time which will generate 4D planning methodology which significantly have proved to be effective in on-time-delivery of the project. Reanalysis of the project was completed in traditional method by using 4D planning to avoid all the discrepancies of the same project.

Patil and Bhirud, (2015) examined in the study the implementation of BIM and its impact on traditional conventional building design method. BIM a technical tool in which a virtual project is built that creates consistent, coordinated construction project with computable information which can thus be used to produce quality construction documents, decision making for design, cost estimation, planning, and for managing and operating the facilities. Further, they mentioned the extension of BIM methodology to create 4D and 5D models taking time and cost in consideration.

Jiang Xu (2016) This study analyzes the current situation of the development of the construction industry and the construction phase of the project management problems and also it analyses the application principle of Building information modelling (BIM) technology and the modeling flow of BIM 5D. In this a detailed analysis of BIM technology in the Central Grand project with specific application, showing the BIM technology in the construction phase of the specific implementation process, at the same time to improve the construction quality, reduce construction costs and achieve the green construction of fine management requirements for BIM Technology in the construction process management .

Jing Jiaa et.al (2016) aims to cover this gap by studying the application of BIM on residential buildings' design stage under the commonly used DBB (Design-Bid-Build) mode. Through the inspection and participation of several projects, this paper constructs BIM application value system including specific implementing scheme and delivery forms based on the DBB mode. The system covers the phases of scheme design, preliminary design, construction drawing design and detailed design and involves the professional fields from general layout, municipal facility, landscape, architecture, structure, MEP (Mechanical, Electrical & Plumbing) and refined decoration.

Xue Lia et.al (2017) through assisting the building information model and BIM5D software in the construction schedule management not only the resource requirements, equipment demand and capital requirements can be identified but also in the actual construction process Timely monitoring, the amount of deviation from the budgetary fund,

Timely supervising, quality check, safety issues, repairing the defects and then the project checking can be done in the actual construction process.

III. CONCLUSION

Based on the above review it shows that BIM is not only made for 3D modelling and 4D time management of a building and they can be used in many other ways as like 1) A perfect visualization tool to monitor the project progress 2) It is very easy and appropriate tool to be used for construction cost and resource management. 3) All the steps of construction could be modified and managed at any point of time by simply clicking on the element and activity. 4) Using this technology,

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time, cost and labour management becomes smooth and feasible. 5) These are user friendly and could be easily adopted by quantity surveyors, engineers, project managers etc.6) In order to reduce the cost, time, rework5D BIM techniques can be used in their project. All in all, more research should be focused on the development of practical 5D BIM model.

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