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Implementation of Building Information Modelling (BIM) in Construction Industry: A Review

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Abstract
Building Information Modelling (BIM) is methodology that is increasingly used in the domain of Architecture, Engineering, and Construction (AEC) industry. Building information modeling (BIM) enables architecture, engineering, and construction managers to evaluate the performance of green buildings duringpreconstruction. BIM-based sustainable analysis extracts the data from a building model, which supports the assessment for green building certification. This paper presents a review of over recent research to identify the key of elements of awareness, benefits, challenges and strategies and implementation of BIM.

I. Introduction

Lack of coordination between different professional background among construction stakeholders and other relevant parties is major problem during construction process. Rapid technological advancements along with the fierce competition in the construction market for providing better services have stimulated profound change towards using innovative methodologies in the construction industry.BIM provides a machine-readable digital representation of building data in order to improve design, construction, and operation processes, and enhances building lifecycle functions .Adoption of BIM in industry is still low, despite technical advancements due to risks and challenges associated with this change.

Sustainable construction development is a globalconcern. To solve environmental problems, different concepts and approaches have been developed over the past decades, including the green building certification(GBC) and building information modeling (BIM).However, an integrated strategy is required to stimulatefurther innovation and improve the process .The green building certification program promotes theadoption of green building principles. This relatively new program aims to increase the procurement of sustainablebuildings or infrastructure. The public sector and private developers have begun to look for sustainable development strategies in light of rising energy costs and various environmental issues.

Recently, BIM has been implemented by construction companies to improve buildings in terms of long-term productivity. Architectural design uses BIM techniques to extract data from the digital architectural models and then determine the level of sustainability.BIM has been implemented by some architecture,engineering, and construction (AEC) firms because of thelong-term benefits in terms of productivity gains .

II. Literature review

According to the Autodesk Committee, "Building Information Modelling (BIM) is an integrated process for exploring a projects key physical and functional characteristic digitallybefore it is built". BIM represents the process of development and use of a computer-generated model to simulate the planning, design, construction and operation of building facility.The implementation of BIM began in various levels in different timespan involving different technologies as explained in table 1,

Table 1. evolution of levels of BIM with corresponding technology used.

Level of BIM	Technology used
Level 0	CAD is used to produce drawings, then printable documents are exchanged with other disciplines
Level 1	started in the year 2000, 2D designs are combined with 3D models. Level 1 is where most construction stakeholders in the industry apply the current level
Level 2	there was an additional aspect, such as Time Management and Budget Calculation, and complete coordination and partial interoperability using different CAD models.
Level 3	included full cooperation and full integration between stakeholders in a cloud-based environment

BIM has a huge potential to facilitate solving problems of construction projects. For instance, BIM can prevent disputes between construction players, manage the right quantity for each structure, decrease construction cost and avoid project delay. The practical diffusion of BIM in industry, as described by Peansupap and Walker depends on,

- Individual factors: personal characteristics of an individual working with technology, such as IT skills, capability to learn, and previous experience of IT.
- Environmental factors: workplace environment in which individual works, such asavailability of an open discussion environment and the possibility to share knowledge of ICT.
- Management factors: Managerial approaches taken to organise the digital work and availability of ICT.
- Technological factors: functionality, speed and accessibility of technology.

Nevertheless, BIM has become prevalent in the construction industry, especially in the United States and United Kingdom. But, the usage of BIM in the local industry is still at an infancy level. BIM is seen as high-cost technology; hence it is not much used in Indian industry. Small construction companies can increase staff efficiency, productivity and job satisfaction with BIM applications, which will lead to reduction in operating cost. These advantages give companies opportunities to be involved in large construction projects. Therefore, this paper discusses how BIM can benefit construction industry.

BIM in construction industry

From an owner's perspective, BIM helps to increase building performance, reduce financial risks, shorten a project schedule, obtain reliable and accurate cost estimates, ensure program compliance, and optimize facility management and maintenance. From an architect's perspective, BIM improves building design, analysis, simulation, and checking and therefore, it provides a basis to develop a better conceptual design, consistent construction documentations, and integration and communication among disciplines. From a contractor's perspective, constructability analysis and clash detection, quantity take-off and cost estimation, construction planning and controlling, offsite fabrication, and facilitated handover and commissioning are BIM applications.

- **Application in preconstruction phase**

Preconstruction phase includes planning, design, scheduling, cost estimate and site analysis. Key decisions are taken during this phase, i.e. architectural configuration of the building, its structural assessment, the choice of materials, the design of electromechanical systems, the energy and environmental assessment of the building, as well as other tasks. hence considered as most important phase. The BIM dimensions associated with the design phase are mostly costing (5D), sustainability assessment (6D) in addition to 3D traditional modelling. Life cycle assessment (LCA) is recognised as a powerful tool in AEC industry to assess environmental impacts and energy consumption in the building sector. These BIM-integrated approaches enable the identification of design possibilities and drawbacks and can be visually assessed on the building model in conjunction with LCA results and visual design guidance.

- **Application in construction phase**

BIM enables demonstration of construction process, including access and exit roads, traffic flows, site materials and machineries. Provides better tracking of cost control and cash flow. It enables tracking of work in real time,and provides faster flow of resources and better site management is done.

i) 4D BIM - scheduling

Gantt chart is used to develop the timeframe of construction activities and is the most widely used method for project scheduling but lacks the ability for visualization of a construction timeline.4D Building Information Modelling (4D BIM) concerns the intelligent linking of a 3D digital model with an extra layer related to time or schedule information for improved team coordination and communication which allows a smoother scheduling process.

ii) 5D BIM e cost estimation

5D BIM can help in the accurate prediction of the budgetary requirements along with the changes in scope and material, providing in this manner the project team with accurate cash flow forecasts and detailed project risk analysis. Due to the dynamic nature of design when different scenarios can be applied, or in cases where unpredictable changes cannot be avoided, the budget requirements usually fluctuate The BIM's ability to clash detections and quickly readjust changes to all dimensions can eliminate unbudgeted changes on projects.

iii) 6D BIM

6D BIM, refers to the widely used 6-dimensional building information modelling applied in the Construction industry. This dimension links 3D CAD individual components or assemblies with all aspects of project life-cycle management information. Energy performance analysis, Carbon dioxide - equivalent emissions analysis, Planning, calculation and visualization of indoor lighting, Human comfort analysis, waste management can be studied using 6D BIM

- **Application in post construction phase**

BIM helps to keep track of built asset, manages facilities proactively and enables scheduled maintenance and its review.BIM and IoT (Internet of Things) can be integrated such as energy management, monitoring of construction activities, health and safety management, and building facility management. However, BIM and IoT integration research is still in early stage and therefore is mostly theoretically proposed.

Fig 1. Advantages of using BIM in construction industry[11]

Benefits of Using Building Information Modelling

Advantages of using BIM in construction industry is depicted in fig 1.Effective use of BIM can have a dramatic impact on a project through improved design, enhanced constructability, and quicker project completion, saving time and money, both for the owner as well as the project team. BIM is also emerging as the solution to reduce waste and inefficiency in building design and construction, although some organizations are taking a wait-and-see approach regarding BIM, seeking clear evidence for return on the investment that it would entail. The most significant benefits of BIM include the following:

- Lower net costs and risks for owners, designers, and engineers.
- Development of a schematic model prior to the generation of a detailed building model allows the designer to make a more accurate assessment of the proposed scheme and evaluate whether it meets the functional and sustainable requirements set out by the owner, thus helping increase project performance and overall quality.
- Improved productivity due to easy retrieval of information.
- Improved coordination of construction documents.
- Coordination of the construction reduces construction time and eliminates change orders Contractor and Subcontractors' costs and risks are reduced.
- BIM allows accurate and consistent 2D drawings to be generated at any stage of the design. This in turn reduces the amount of time needed to produce construction drawings for the different design disciplines while minimizing the number of potential errors in the construction drawings process.

- Increased speed of project delivery.
- Embedding and linking of vital information such as vendors for specific materials, location of details, and quantities required for estimation and tendering.
- BIM allows the project team and owner to visualize the design at any stage of the process with the understanding that it will be dimensionally consistent in every view, thereby improving monitoring efficiency and reducing operating costs.
- Realtors, appraisers, and bankers save money.
- BIM technology will generally facilitate coordination and collaboration by multiple design disciplines. This shortens the design period, while helping to reduce potential design errors and omissions. It also affords greater insight and early detection of possible design problems, thereby allowing for better performance prediction.

Challenges and strategies for BIM adoption

- Low Awareness of BIM causing fear and uncertainty, Difficulties in the employment of skilled BIM manpower- can be tackled by undertaking periodic trainings and providing good infrastructure and power supply.
- High cost of implementation and maintenance, lack of National BIM Guidelines - can be managed by involvement of government, drafting standard BIM guidelines and subsidising the software price .
- Integration, Storage and Compatibility issues within various stakeholders- can be eased by collaborating strategic approach framework between AEC industry

III. Summary

BIM changes the way the project parties interact with each other, due to the concept of collaboration and knowledge sharing between project parties, which it promotes. Therefore, BIM changes the nature of the construction industry from a linear, fractured nature to a nature of sharing common goals between project stakeholder. One of the most valuable functions of BIM is its ability to improve the coordination between multiple design disciplines, thus reducing errors. Thus, it can be concluded that BIM has the potential to respond to an owner's need for predictable costs, quality, and on-time delivery.

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