APPLICATION OF 4D-BUILDING INFORMATION MODELING AND ITS CHALLENGES IN AEC INDUSTRY

Ahmad Naweed[1]*, Sakshi Gupta[2], Ashish Kumar Dash[2]
[1]M.Tech Student, Department of Civil Engineering, Amity School of Engineering & Technology, Amity University Haryana- 122413
[2] Assistant Professor, Department of Civil Engineering, Amity School of Engineering & Technology, Amity University Haryana- 122413

Abstract

Despite the fact that the construction industry has been advancing for a considerable length of time and researchers have been looking for inventive answers for quite a long time, various difficulties still exist for making the development procedure faster, more secure, less expensive, and progressively exact. Notwithstanding, it is currently accepted that Building Information Modeling (BIM) can prompt more prominent effectiveness through the steady joint effort. The data in BIM framework are truly valuable and can be created to upgrade the undertaking conveyance forms. Since BIM builds the plan cost and requires a major expectation to absorb information, venture members are altogether worried about the undertaking cost, preventing the reception of BIM for the task conveyance. This work utilizes a contextual analysis, depicting how BIM has the capabilities to help cut expenses, advance the schedule, and provide advantage to all stakeholders. The analysis of project cost and time control focuses on the life cycle.

Keywords: Building information modelling, construction projects, quantity take-off, platform, Revit.

1. Introduction

Building information Modelling provides a tool which brings effective influence on virtual potential enhancing. In context of civil engineering enterprise, BIM method a procedure of feeding property through nicely-structured virtual statistics. Availability of virtual facts for all contributors is a concern (Kreider and Messner.,2013) as it incorporates area facts, material characteristics and allows one of a kind participant to alternate and update information. Inside the past, BIM become used especially as a visualization and employer tool, from the area of AEC (architecture, engineering and construction) and industry entities. Today the purpose of BIM usage has changed and it's miles used as a procedure of enhancing performance throughout the whole life-cycle of homes (Lu et al., 2013).

Building Information Modelling, BIM, is the process of programming, creating, building and managing data right from the start of a (collaborative) project, using technologies based on digital 3D modelling linked to a database that covers the entire life cycle of a building or infrastructure. BIM integrates physical, environmental, commercial and functional data and each of its components, parts and systems.

1D. COLLABORATIVE PROJECT. LAWS, CONTRACTS. Mandatory use of BIM in public works, as in Catalonia, Spain, Europe and the world. Changes in recruitment models- IPD, Alliance – and new requirements.

2D. WORK FLOWS AND THE BIM IMPLEMENT PLAN. Procedures and organizational changes involving BIM in different areas of work. Obtaining of data for a BIM model, and through a BIM model. Implementation options to determine the best decision in terms of economic, working and function parameters.

3D. THE 3D MODEL AND THE "I" OF INFORMATION. Strategies for implementing BIM in a professional environment. Existing software, linked platforms, services, support hardware. Determination of permits, approvals, acceptances, certifications on new map of workflows to manage a project.

4D. PLANNING AND CHECKING CONFLICTS WHICH DELAY CONSTRUCTION. Introduction of the dimension of time in the planning of a construction project. Specific software for temporal planning, constructability and help for the detection of interferences and inconsistencies.

5D. MEASUREMENTS, BUDGETS. Up-to-date methods for obtaining realistic budgets for a construction project. Interoperation between existing budget software and the BIM model.

6D. ENERGY, EFFICIENCY, SUSTAINABILITY, SAFETY AND HEALTH. Link a BIM model with the integration of environmental parameters. Link a BIM model with the implementation of its health and safety plan.

7D. INFRASTRUCTURE AND REAL ESTATE MANAGEMENT, FACILITY AND ASSET MANAGEMENT. The real beneficiary of a BIM model and its use in management throughout the completion of the infrastructure or construction.

8D. REAL AS BUILT, LOD LEVELS OF DETAIL. Workflows to achieve real as built of the construction. Information requirements, levels of detail and scale of work to achieve it. Innovative tools for 3D modelling: laser scans, drones and augmented reality.

9D. LEAN CONSTRUCTION. Work methodology used for the effective completion of the BIM process as part of the production structure in the construction sector, and the use of it digitalization.

10D. INDUSTRIALISED CONSTRUCTION. Current obstacles facing the productivity of the construction sector. The use of the Lean philosophy in a BIM environment seeks to improve the productivity of every phase of the construction life cycle: design, implementation and management of the infrastructure or equipment. Why industrialized construction is the objective.

According to Eastman et al. (2011) BIM is described as "one of the most promising growth that permits the introduction of one or more accurate virtual digitally constructed models of a building to help design, construction, fabrication, and procurement activities thru which the building is realized"

NBIMS (2014) (National BIM Standards Committee) additionally defines BIM as "the digital representation of bodily and useful characteristics of a facility. As such it serves as a shared information useful resource for information about a facility, forming a trusty foundation for selections for the duration of its life cycle from inception onwards".

In the report of the commercial industry cost of BIM – Getting Building Information Modeling to the Bottom Line of Mc GrawHill Construction (2009), BIM is described as "the method of developing and the usage of digital models for design, building and/or operations of projects" (Figure 1).

Sawhney et al. (2014) present that a holistic definition of BIM contains three interlinked aspects: the model itself, the manner of developing the model and, the use of the model. These elements are described below:

- The model itself: A countable illustration of the physical and practical characteristics of the project.
- The procedure of creating the model: The hardware and software used for growing the model, digital records interchange, and interoperability, collaborative workflows, and definition of roles and duties of project group participants in relation to BIM and a common information environment.
- The use of the model: commercial enterprise models, collaborative practices, standards, and semantics, producing actual deliverables for the duration of the project life cycle.

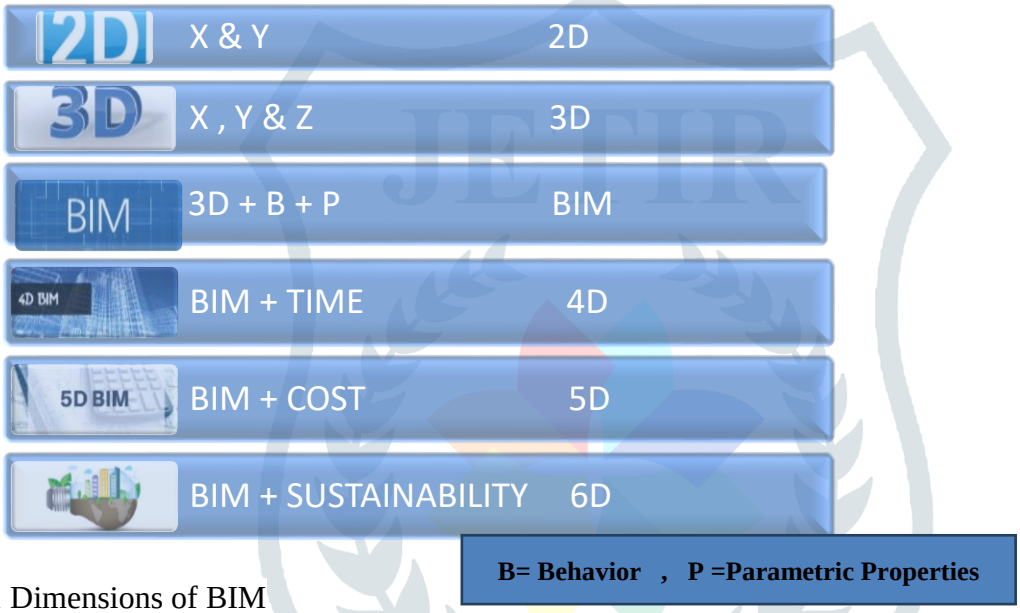


Figure 1 Dimensions of BIM

2. Quantity Takeoff

Quantity takeoff is the muse of different responsibilities in construction management, consisting of price estimation and schedule making plans, and its accuracy can directly affect downstream analyses and decisions. historically, quantity takeoff is a manual process for the duration of which quantities of layout elements are measured based at the layout drawings or the 3D model, and this guide quantification is relatively blunders-prone (Liu et al. ,2014). Quantity takeoff is implemented at some stage in the construction system. In the early levels it affords the base for a preliminary fee estimate for the task; inside the tendering stage it's miles used to help in the estimation of the undertaking's fee and period of the construction sports; earlier than the development level it's miles used to forecast and plan the development sports; and all through the development level it's miles used for the economic manage of the project. An accurate quantity takeoff is decisive for the economic balance of the contractor's budget as it's miles the simplest manner of accomplishing a thorough analysis of the productivity and of the distinctive kinds of costs in a particular project.

3. Literature Review

The improvement of BIM inside the international is developing with a promising destiny. Consistent with smart market report (2015), the very best boom has been pronounced in Brazil wherein the fee greater than tripled from 2013 to 2015, jumping from 24% to seventy-three percent. Japan skilled the smallest growth fee of about 16% - 27% in 2013, hurdling to forty-three percent in 2015. however, if as compared to different nations, the US had the best progress in using BIM as shown by means of a fee of utilization of seventy-nine percent in 2015. on the other hand, south Asian nations like India, creation projects still rely upon a 2D drawing (Fitriani et al.,2019).

Quantity takeoff is a vital mission in construction tasks. It affords fundamental facts for different duties within the design and creation process. As an example, inside the layout section, it's far used to estimate the initial project cost for a feasibility have a look at. In the preconstruction segment, it's far used to estimate the task cost and put together the bill of portions for bidding or tendering the undertaking. Within the production phase, it's far used for agenda planning, purchasing materials, monitoring development, and calculating trade order sand extra work bills. Most of those tasks are related to the undertaking price. The reliability of the predicted fee is depending on the accuracy of the quantities provided (Khosakitchalert et al.,2019).

price estimation and venture scheduling have been of hobby to scholars for many years, and several efforts inside these domains had been carried out in current many years. conventionally, preceding research in those areas have targeting purposes which include schedule optimization, cost estimation fashions, and time-value change off, and have aimed to supply extra accurate and optimized assignment schedule and envisioned cost. however, with the current emergence of BIM, BIM-based applications inside the creation enterprise were any other recognition for plenty researchers. several BIM-based totally applications and gear for value estimation and scheduling planning had been evolved to enhance the performance of production practitioners (Liu et al.,2014).

There are a number of techniques used to estimate production charges, which do now not contain the information about whilst/the way to select, adjust or determine the applicable fee facts. those methods are called assignment assessment estimating, vicinity & quantity estimating, meeting & machine estimating, and unit price & schedule estimating. a unified version of these four strategies includes amount and pricing. formerly estimation and product pricing needed to be captured in a single entity and the product, product capabilities, and constraints had to be captured in every other single entity. these tactics are frequently hard to combine into current computing practices due to the fact it's miles a ‘black field’ and difficult to apprehend (Xu et al.,2013).

Fitriani et al. (2019) investigated BIM adoption amongst India AEC companies. the examine discovered that BIM had been no longer fully implemented due to excessive fee of funding and lack of dedication through senior control. Dabo (2010) studied the utility of BIM in the nearby production industry in foremost towns

in Malaysia. it became observed that the general public of customers really use AutoCAD for their design services. Because of its many benefits, BIM is revolutionizing the development industry because it has the potentials for fee savings, higher-informed choice making, decreased layout conflict, higher collaboration and improved mission overall performance, among others (Fitriani et al.,2019). A collective team of authors from Universities from Nottingham dealt with drafts of competition and their impact on budgeting in BIM of their work: "value estimation in Building Information Modeling". The authors kingdom that: "the facts requirements for the value estimation may be summarized into five factors: the building products facts, the value item information, the amount facts, the useful resource records and the fee facts" (Vitasek,2019).

BIM have the potential to enhance the communique and coordination among the one of a kind stakeholders of a challenge. the benefits of BIM variety from simple upgrades in coordination and performance to greater customer delight. it must additionally be conscious that there are number of modern-day barriers of BIM that ought to be taken into account (Khochare and Waghmare, 2018)

4. Quantity Takeoff using BIM

On this project, BIM became applied for changing BQ from a manual layout to a digital layout. The proposed format become meant to remedy problems related to overall performance and visualization in BQ preparation and use. The proposed format represents BQ with BIM perspectives which can be easier to visualize than the conventional BQ and offer awesome capability to Contractor's QS to offer better assignment-primarily based estimating and costing related services. For the reason of BIM software in measurement for quantity surveying, the BIM model for the task might be looked upon from three components. First off, the model offers the vital data approximately constructing elements. Secondly, exceptional views of the constructing can be extracted from the model, and ultimately, building perspectives can be annotated for the reason of emphasizing the constructing parts in attention to be quantified.

3.1 Case Study

The case suggested on this paper is an extension works' project for an existing secondary school in Hong Kong. The extension works consisted of major elements. The lower component became located at the floor floor and first floor. Extra 40 seats lecture rooms and one shop room at ground floor have been built, while on the first floor, three multi-cause rooms and two lavatories have been built in a creation region of 17.25 m×8.12 m. The 3D perspectives of building before and after production are shown in Fig. 2a, b. The upper part became positioned at the fifth and sixth floor. At fifth floor, it protected one amphitheater with 144 seats and 3 additional 40 seats school rooms. All extension works have been built on one present outside basketball courtroom. The development vicinity became 19.2 m×22.5 m. At sixth floor, one sky garden changed into built on pinnacle of the brand new amphitheater and lecture rooms. At the sky garden, sun panels had been endorsed to be hooked up for providing hot water. Those additives are shown in Fig. 3a–d.

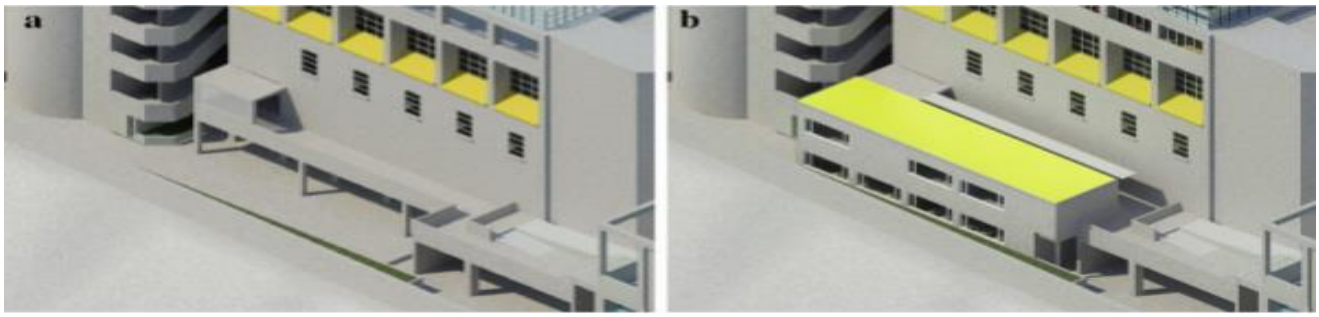


Figure 2 a Existing structure. b View after completion

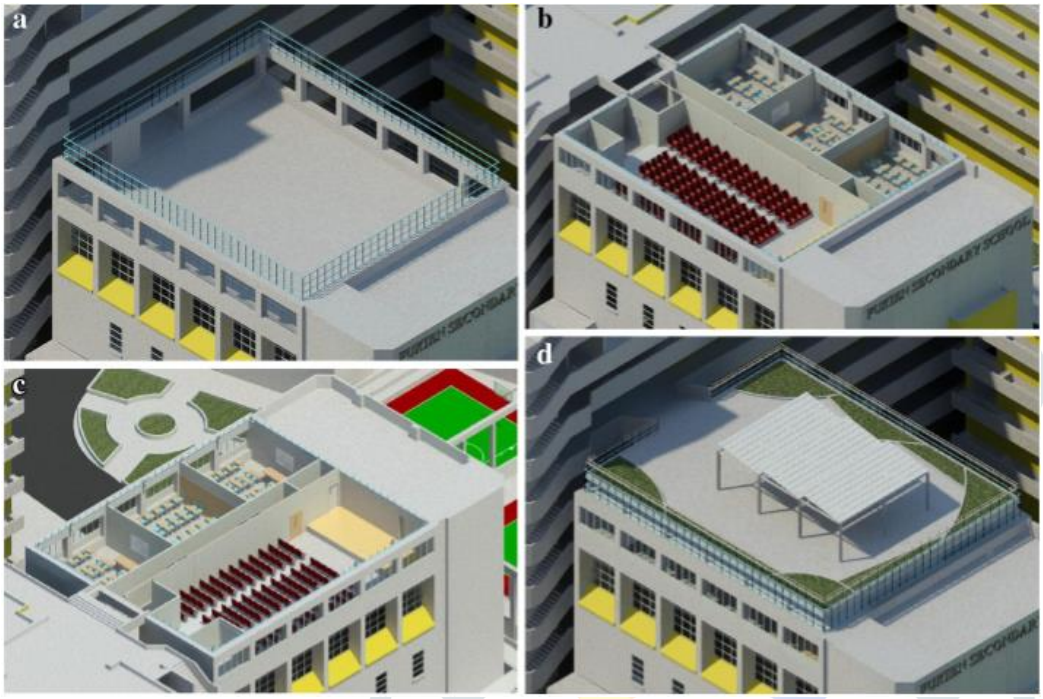


Figure 3 a Existing structure. b View after completion of 5/F. c View after completion of 5/F. d View after completion of whole works

A brand new BQ layout is created in this examine containing all vital fashions and graphical photos to show for each BQ items. Collectively with the traditional 2nd drawings and specifications, the contractors' quantities surveyors within the estimation process can recognize the design standards easily with the possible uncertainties and ambiguities to be minimized. The fabric and work scope quantities generated from the BIM version are classified and positioned into the BQ. Parent 6 suggests a one-page pattern of the new BQ layout with the graphical data showing the visible element of labor scope and dimensions of a selected paintings element (highlighted in purple colour). It may be reviewed in 3D along.

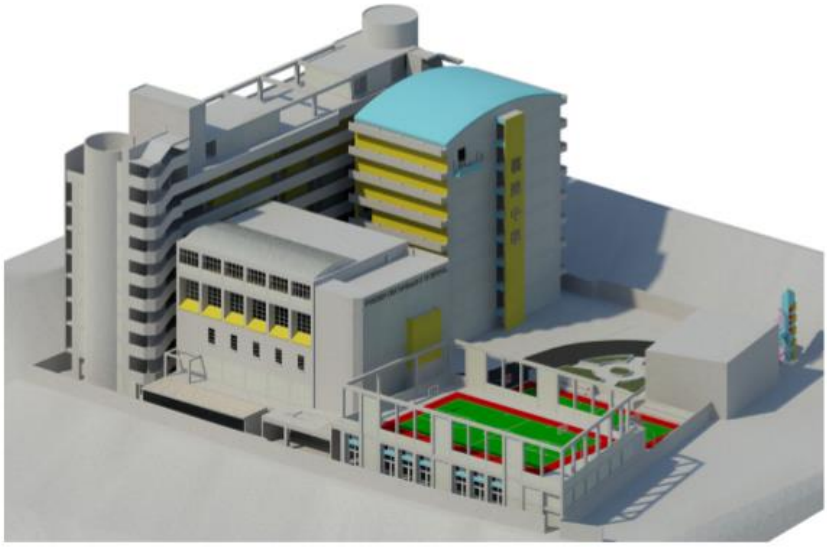


Figure 4 BIM model in this project

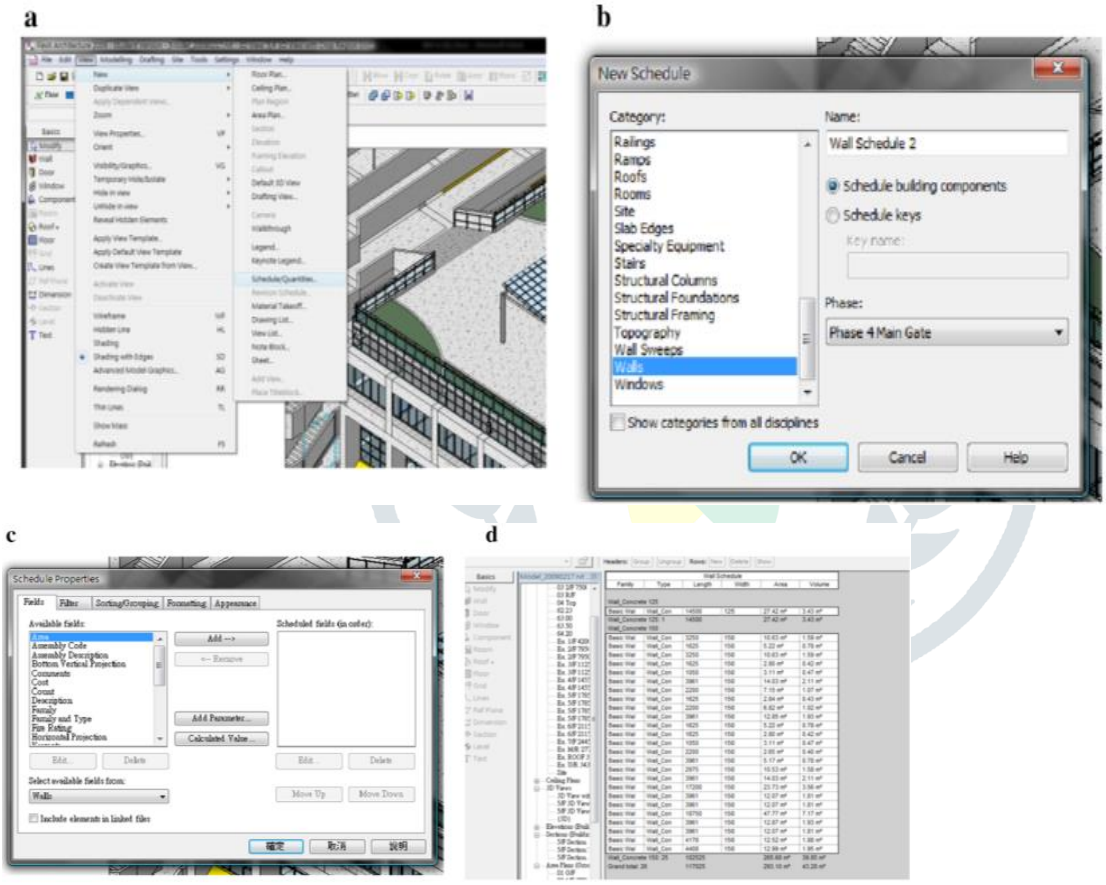


Figure 5: a New schedule. b Categories of schedule. c Schedule settings. d Walls schedule

With zooming in/out and rotation. To apply the reinforcement concrete footing as an instance, the amount surveyors can see what has been measured in the provided portions with the assessment coverage on the variety, layout, and shapes of the footing. The method can mitigate the opportunities of uncertainties and ambiguities via analyzing 2D drawing sand is aimed to increase the efficiency of estimation. In Fig. 7, the fabric portions are generated from the BIM version immediately. The principle contractor can use these fabric quantities to determine the gentle price or remeasure the substances quantities manually by amount surveyor. Regarding the paintings flows at the production of new BQ layout, some of software programs had

been used. Autodesk Revit series was chosen because the version introduction device on this project. After the finishing touch of the layout, part of the models have been selected and exported in 'fbx' format. Another software Autodesk 3Ds Max layout changed into used to transform the 'fbx' format to '3ds' layout. The ultimate step become to merge the BQ file (Microsoft word) and '3ds' version file in Adobe Acrobat. This created a new BQ format in zoom-in a position and rotatable 'pdf' format to be finished and equipped for presentation. 'IFC' (business basis training) format can also be used to export directly to Adobe Acrobat; however, there was a risk for materials in formation from the model to be misplaced. Consequently, greater steps on file layout conversion via using Autodesk 3Ds Max layout have been implemented.

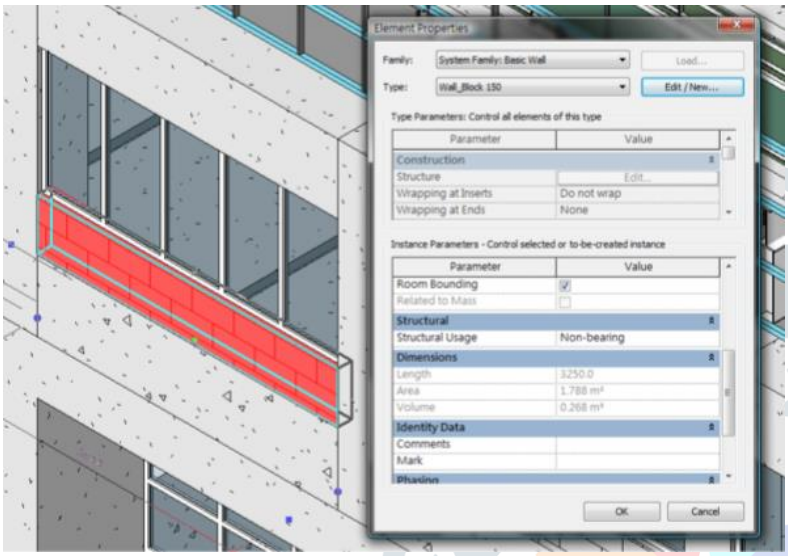
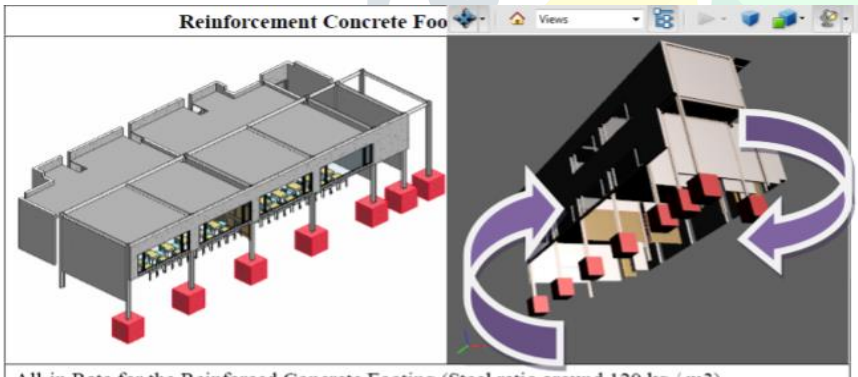


Figure 6 Length, area, and volume of a block wall object



All-in Rate for the Reinforced Concrete Footing (Steel ratio around 120 kg / m3)

Types	Number	Volume (a)	Rate (b)	Total Amount (a) x (b)
1000mm x 1000mm x 1200mm	7 (1.2 m^3 each)	8.4 m^3		
Reinforcement	8.4 m^3 x 120 = 1,008 kg	1,008 Kg		

Figure 7 A sample of new BQ format

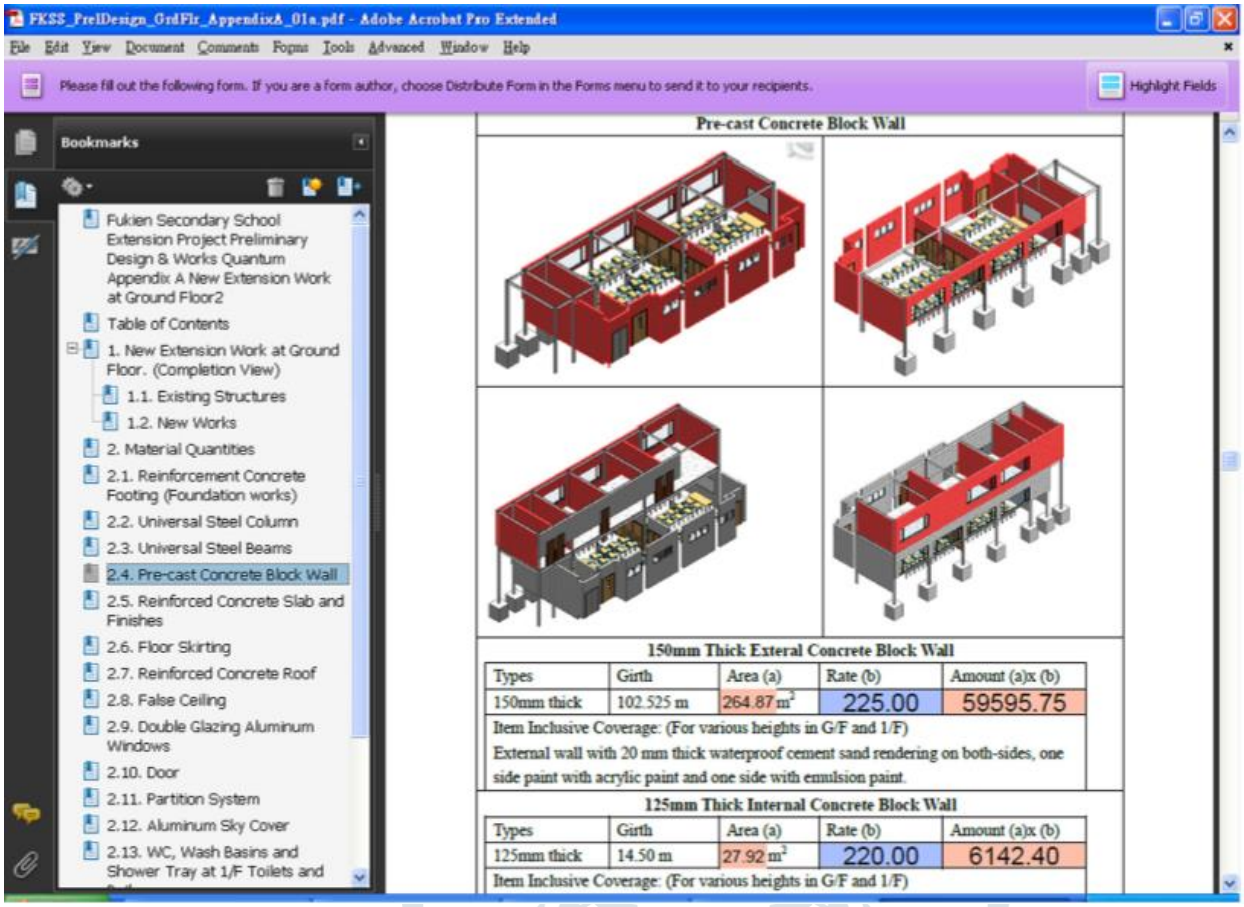


Figure 8 BQ with BIM views

Bookmarked table of contents is furnished for less complicated accesses to every bill object;

• paintings object of the invoice object is excessive lighted in red colour

• With the three-D views exported from the BIM version, such perspectives can be challenge to zooming and rotating.

• covered fields for the materials quantities are highlighted in light red color.

• Interactive fields for the enter of unit charges are highlighted in blue coloration for the estimator to insert unit costs.

The itemization of this new BQ layout with 3D BIM perspectives isn't always completely in compliance with the traditional SMM. For any deviations, it's far essential to iterate inside the Preamble segment of the bill of portions. The manner to supply BIM perspectives from quantity surveying component is one of the crucial steps for the BQ training. The amount surveyor needs to get familiar with the version viewing in Revit platform. In the course of the technique of amount takeoff from the BIM-based version, the choice of 3D BIM views and the spotlight place of the objects should be decided simultaneously. The consultant's amount surveyor must do not forget from the viewpoints of contractor's amount surveyors and provide sufficient statistics for his or her processing of estimation for biddings.

5. Limitations and Challenges

5.1 Limitations

BIM have the capacity to enhance the communication and coordination between the one of a kind stakeholders of a task. The advantages of BIM variety from easy enhancements in coordination and efficiency to more client pride. It must also be conscious that there are range of current limitations of BIM that have to be taken under consideration.

- **Cost factors**

The high cost of BIM implementation has been suggested as a major barrier inside the production enterprise. The implementation of BIM in production companies calls for the acquisition of applicable software program and hardware as well as train the personnel to use it correctly which will increase general undertaking fee. Software packages want periodic updates, so it's miles important to add updates charges to the complete BIM implementation cost (Enshassi et al. ,2019).

- **Technological factors**

The technological elements check with BIM-based totally software program packages restricting elements. Loss of BIM software program packages is said as one of the proscribing elements that prevent BIM adoption. Many software program corporations are cashing on BIM programs that simplest treat quantitative elements and do no longer treats all manner (Azhar, 2011).

- **Innovation**

The aim of BIM is to assign constrain and parameter to wise gadgets to improve the efficiency, there are capacity to inhibit innovation which are viable to the automated manner and shared understanding that BIM presents. Those corporations are enforcing BIM need to view the parameters and data constraints as a global database that permits designer to store time related to the update and configure product facts repetitively for distinctive projects, consequently growing the amount of time spent on device layout and innovation (Somnath and Ashish,2018).

- **Transition from Drafting to Modeling**

While transferring from a CAD-primarily based drafting surroundings to a BIM-based modeling surroundings, an exchange in the workflow will surround what was easy drafting duties such as copying markups or choosing up redlines. These obligations now require a higher-stage skilled layout drafter who has a knowledge of the mission and the substances used. The charges related to education and maintaining a professional layout modeler are higher than a draftsman and not using an understanding of the change. Some agencies may also be pressured to live out of the BIM global altogether because of the time- and information-extensive nature of BIM.

The transition from conventional CAD will even location an accelerated level of responsibility on the designer to make certain that all gadget components are coordinated with the other layout professionals along with structure and engineering offerings and that website online problems are reduced to a minimum. Corporations have a few distinctive enterprise models to do not forget while considering group of workers schooling with respect to BIM.

- ❖ the first choice includes the education of present day designers to adopt all in their design in the BIM surroundings.
- ❖ the second entails up-skilling all in their drafting personnel to a higher technical level to undertake layout duties.
- ❖ The 0.33 is a mixture of the first two in which there's a selected set of guidelines and hints for mark-united states of America so that layout mark-u.S. May be translated into the model sincerely and efficaciously. In any case, the BIM system permits for coordinated delivery in advance within the design method so that potential double managing or remodel is avoided. This benefit outweighs the cost of any extra education to up-talent staff irrespective of what commercial enterprise version for the shipping of BIM initiatives.

5.2 Challenges

One of the maximum rigorous discussions in enforcing the BIM comes from private beliefs in the direction of this idea. In a recent survey, display that if the task crew participants do no longer sincerely accept as true within the importance of BIM and its benefits on a production undertaking, the final results will no longer be quality. In some other survey, (Qian 2012) indicates that top rated areas of BIM for funding includes software program and hardware, developing inner collaborative BIM workflow and procedures, and BIM schooling. (Brewer et. Al. 2012) state that the demanding situations for using BIM on production tasks can be grouped and supplied as 1) technical challenges, which can be normally conflicts and issues regarding statistics sharing amongst group events and BIM softwares' issues; 2) talents and training demanding situations, which can be mainly about the schooling mission group contributors and enhancing their abilities; 3) felony and procedural challenges which discuss with the lack of a well-known and prison definition for BIM expert duties; and four) price demanding situations, which occasionally hinder the construction corporations from changing and upgrading their contemporary structures to a BIM oriented device, (Saeed 2015).

6. Conclusion

This study introduces BIM limitation factors which includes four essential issues such as cost factors, technological factors, innovation and transition from drafting to modeling. With the aid of knowing more approximately the issues of the day, better answers might be determined. In, from the general mentioned issues, it is able to be concluded that many issues would be resolved over the years by using imparting extra real examples. This paper also described the development of a new shape of BOQ for tendering technique. The brand new format uses BIM technology to provide BIM views inside the proposed layout that is supported on the latest variations of portable file readers. In the paper, it describes tendencies to the existing body of expertise that must be emphasized in future associated works. After knowing the results of this study, it'd be beneficial to behavior in addition observe about the use of BIM. Due to the fact the AEC industry continues to be at a degree moving into the 3D world, loads greater studies might be required to promote the development of new strategies. Basic, the cost of the BIM and its helping technologies may be expensive on the start. But, the effective makes use of BIM growth income, lowers cost, and shorten scheduling time. In this paper only one case was studied, and the kind of project have been limited.

Consequently, a course for destiny paintings in this challenge is to expand extra research on various initiatives. Extra research approximately the relationship and compatibility of BIM tools.

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