

Use of BIM 4D cost model in design stage

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Abstract: Building Information Modeling (BIM) is the process of creating and managing 3D building data during its development. The process is aimed at achieving savings through collaboration and visualization of building components into an early design process. As the design evolves during the project planning stage, quantity surveyors are responsible for estimating cost implementation of various design options produced by the architect which are often used to make design decisions. Therefore, a 4D BIM cost model is much needed to enhance the project plan and its design. This study was conducted on a residential-commercial building which was situated in Nashik. The study aims to develop and implement a 4D BIM cost model and understands the different aspects of 4D BIM technologies and find out the impact on the design stage. The study indicated that the 4D BIM cost model can be a promising tool for efficient designing. The most significant benefit of 4D BIM cost modeling determined are better visualization & up to date with ever changing market. Additionally, the 4D model can support designers & planners in achieving a detailed and accurate work plan, quantity takeoffs.

Index Terms – BIM, cost model, BIM in design.

1. INTRODUCTION

Building information modeling (BIM) is a process involving the generation and management of digital representations of physical and functional characteristics of places[1]. The architecture, engineering and construction industry is moving towards automated solutions, building information modeling (BIM) is an emerging tool in the design industry for design and documentation. BIM has the ability to simulate a range of design options with real-time cost advice and continue that real-time cost advice throughout the detailed design & construction[2][3].

1.1 NEED OF 4D BIM COST MODEL IN THE DESIGN STAGE

Designing a building is the responsibility of architects, whereas assessing the cost to build it is the domain of estimators. In general, the architect's scope of work doesn't extend to material take offs or cost information. That's left to the estimator. By using a building information model instead of drawings, the takeoffs, counts, and measurements can be generated directly from the underlying model. Therefore, the information is always consistent with the design. And when a change is made in the design – a smaller window size, for example – the change automatically ripples to all related construction documentation and schedules, as well as all the take offs, counts, and measurements that are used by the estimator. As the design evolves during the project planning stage, quantity surveyors are responsible for estimating cost implementation of various design options produced by the architect which are often used to make design decisions[4][5].

The design stage is a very first step in every construction project hence it is very important to implement BIM in this stage. By implementation of BIM in the design stage produces various design options / changes in design. Hence to increase visualization which can be helpful in reducing the cost of the project itself in the designing stage, implementation of BIM very necessary.

2. RESEARCH METHODOLOGY

Problem Statement

Traditionally for building designs 2D or 3D drafting software are used which does not incorporate the elements like the cost but with the use of BIM software design process can be made more effective, hence for the same project, BIM 4D cost model has been prepared to take advantage of BIM technology and to make the design process more efficient.

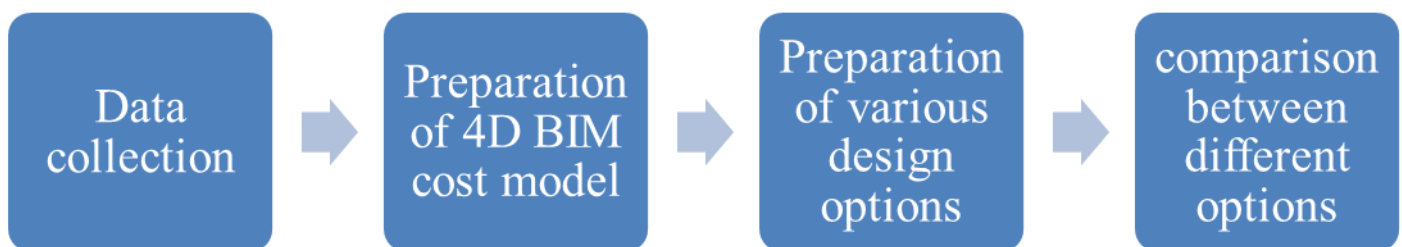


Figure 1: The workflow of Use of BIM 4D cost model in the design stage.

Data collection

- Architectural drawings.
- Structural drawings.
- Price data to build a cost model.

Preparation of 4D BIM cost model

- Preparation of the 3D BIM model in Autodesk Revit.
- Preparation of the 4D BIM model using MS Excel.

Preparation of various design options

- Using the 4D BIM model & its capabilities prepare various design options.

Comparison between different options

- By using above data comparison between various options is prepared with cost data to support it.

3. DATA AND SOURCES OF DATA**3.1 Case Study – Residential-Commercial Building Project**

The site where the training session was carried out is “Morya parashare heights”. The work was already started & targeted until December 2019.

The brief information about the site is as follows: -

- Name of project: Morya parashare heights.
- Name of developer: Devkinandan Buildcon.



Figure 2: Morya Parashare Heights (Building Elevation)

- Location of building: - “Morya Parashare Heights”, P no 62 +57 S.no 891 at Chetana Nagar, rane Nagar, near Guru Gobind Singh college, Nashik- 422009.
- Residential & Commercial project.
- 2BHK & 3BHK luxurious flat.
- All RCC & architectural drawings. (Attached in Annexure I)
- Basement + ground + 7 floor building.
- Total NO of Units.

Table No 1: Total No of Units

ITEM	UNITS
2 BHK	14
3BHK	14
Commercial shops	8

Table No 2: Unit Cost of Material

material type	cost	unit
Cement	285	bag
20 Mm Aggregate	2400	brass
Steel	48.5	kg
Wash Sand	4400	brass
Crush Sand	3100	brass
Natural Sand	8000	brass
4" Red Brick	4.5	piece
6" Red Brick	7.3	piece
600X600 Vitrified Tile	40	sq. ft
Neru	80	bag
Saint Gobain Gypsum	250	bag
W Window	8255	Nos
W1 Window	6600	Nos
V Window	1400	Nos
FD Door	11150	Nos
FD1 Door	9915	Nos
FD2 Door	8670	Nos
FD3 Door	7435	Nos
D Door	1500	Nos
D1 Door	1500	Nos
D2 Door	1500	Nos

Table No 3: Labor cost

Labor Type	cost	unit
RCC Labor	125	sq. ft
Brick & Plaster Labor	110	sq. ft
Tile Labor	40	sq. ft

Table No 4: Material + labor cost

With Material	cost	unit
Paint Work	110	sq. ft
Plumbing Work	54	sq. ft
Electrical Work	80	sq. ft
Supervision Charges	14	sq. ft

4. ANALYSIS OF DATA

4.1 Preparation of 4D BIM model

The 2D Architectural drawings and RCC Drawings help for the Preparation of 3D BIM is in Autodesk Revit. The 3D model is made in the Revit by constructing 3D elements in the Revit like Column, Wall, slab Beam, etc. The cost model is developed using MS Excel, in which unit cost of each family in the 3D model is computed using MS Excel and then this Cost data is used to develop cost model in the Autodesk Revit.

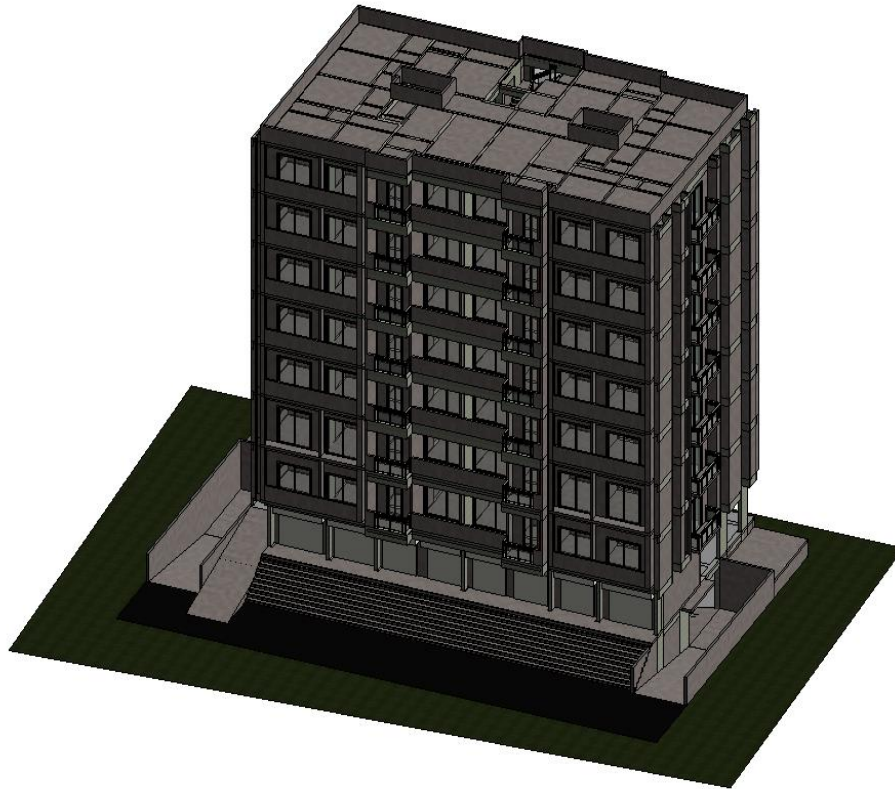
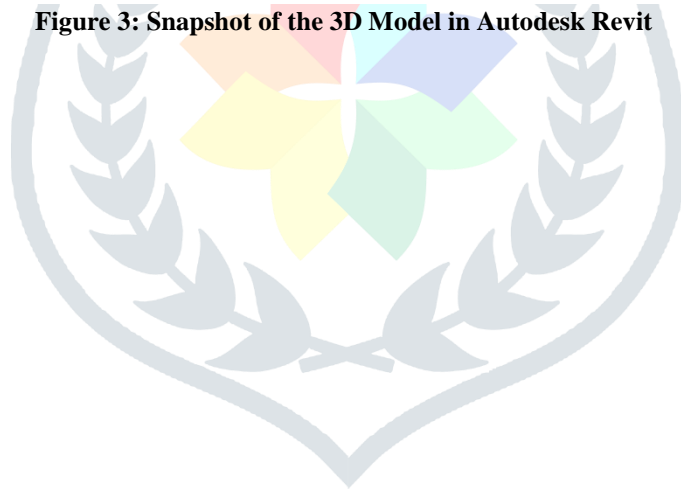


Figure 3: Snapshot of the 3D Model in Autodesk Revit



4.2 Preparation of various design options

The options are prepared in Autodesk Revit by modifying the original model and as the cost data is linked with it cost of new options is computed automatically with it.

Option:1



Figure 4: Model options 1 in Autodesk Revit

As seen in the picture there are two options A (left side) and option B (right side) prepared in Autodesk Revit. The option B i.e. right-side option will take Rs. 2,98,845 more than option A i.e. left side option for construction.

Option:2





Figure 5: Model options 2 in Autodesk Revit

As seen in the picture there are two options A (TOP side) and option B (bottom side) prepared in Autodesk Revit. The option A has glass railing which is replaced by brick wall. The option A i.e. top side option will take Rs. 4,43,606 more than option B i.e. bottom side option for the construction.

4.3 Preparation of various material selection options

Type	Quantity	Options		
		1	2	3
wall core material (sq.ft)	72113.52	red burnt bricks	siphorex block	fly ash bricks
cost		INR 3,145,591.74	INR 2,307,632.64	INR 2,981,894.05
wall internal finish (sq.ft)	94203.8	single cost plaster + neru finish	single cost plaster + gypsum finish	double coat plaster finish
cost		INR 1,695,668.40	INR 3,768,152.00	INR 2,826,114.00
Tile (sq.ft)	79377	single charge vitrified tile	marble tile	double charge vitrified tile
cost		INR 2,778,195.00	INR 14,287,860.00	INR 4,762,620.00
wall external paint (sq.ft)	47975.1	ACE	Apex/ ultima	texture
cost		INR 479,751.00	INR 671,651.40	INR 1,487,228.10
wall internal paint (sq.ft)	94203.8	OBD	Royal	luster
cost		INR 1,413,057.00	INR 2,260,891.20	INR 2,543,502.60
concrete for RCC (m3)	1024	wash sand	natural sand	wash sand (50%) + natural sand (50%)
cost		INR 4,015,104.00	INR 4,033,536.00	INR 3,764,224.00

Figure 6: cost comparison for different options in MS Excel.

As seen in the tables six main materials are selected i.e. wall core material, wall internal finish, tile, wall external finish, fine aggregate for concrete for RCC. There are many options with a variety of cost range, which can be selected for these 6 types of material. The quantity of material is taken out with the help of Autodesk Revit model and unit cost is collected form site and from that total cost for that option is calculated using MS Excel.

5. CONCLUSION

- The design options made for this study can make a difference between 0-15% of total building cost.
- This additions cost can be saved or invested in the project and this decision can easily be taken in the design stage.
- Implementation of the 4D cost model can be useful in decision making by better visualization.
- In addition, the 4D cost model can assist in achieving detailed and accurate work plans, quantity take.
- It's possible to prepare various design options using BIM
- As the cost of project changes according to changes into the project automatically its saves time.
- It's easy to choose one design form option as the cost data is associated with it.

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