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Building Information Modeling (BIM) a New Approach towards Project Management.

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Abstract

The Architecture, Engineering and Construction (AEC) industries have long sought techniques to decrease project cost, increase productivity and quality, and reduce project delivery time. Building Information Modeling (BIM) offers the potential to achieve these objectives. BIM represents the development and use of computer-generated n-dimensional (n-D) models to simulate the planning, design, construction and operation of a facility. It helps architects, engineers and constructors to visualize what is to be built in simulated environment and to identify potential design, construction or operational issues. It has the potential to bring about great efficiency as well as harmony among players who all too often in the past saw themselves as adversaries. In this paper, the benefits of Building Information Modeling (BIM) for the AEC industries are discussed. Implementation of BIM in the projects throws light on various risks and future challenges for the AEC industries.

Keywords: Building Information Modeling (BIM), Architecture, Engineering and Construction (AEC), n-Dimensional Modeling, Parametric Modeling, Visual Simulation, Identify potential design, construction or operational issues

Introduction

Construction industry is the second largest industry in India. At the same time due increase in cost of labor and material and also due to the fierce competition the profitability is decreasing day by day. That is why to increase the profitability there should be strict vigil or control over the project activities of the work. There should be stringent control on the cost and time over run.

In the present scenario, the contract has becoming time bond contract. The conventional methods of contract have been replaced by PPP, BOT. In these conventional contracts all parties have to play a specific an important role. The duties and responsibilities of the contractors are very big and risky because he has to invest huge amount from his own pocket. Naturally he has to be more shrewd and vigil about timely completion of job with zero cost and time overrun.

In BIM he gets the feel of the project in terms of various resources and also in terms of time and cost. In the case of real estate the developer is also investing huge amount in the form of land and construction. He is always interested to complete the project in time so as to get the payment from client at the earliest. For this purpose he is very much concern about speedy and timely completion of task.

There are different scheduling techniques such as Bar chart, Gantt chart, and Milestone chart. Software's like M.S. Project, primavera are available for effective project management. However, these tools will talk about planning of resources and about time parameter but it will say less about the money investment and mainly about cost overrun

There is need of tool which will cover all above parameters and also give the dynamic information about status of the project in the form of 3D modeling. Which will be user friendly and even a layman can get present status of the project including time and cost overrun. It also help the planner to take appropriate decision by taking the time parameter in consideration.

BIM is a new technique, which is having the potential to meet all above state of requirement. This may prove to be an important tool in project management in day to come.

Methods

As competition goes up the profitability has been coming down due to change in the nature of contract. There should be a method to understand to the common customer (who is basically investor), about the physical progress of the project and also what fluctuation has taken place between the proposed and actual work done which is important in project is represented by geometric form. That is why the whole importance in project management of real estate is taken by BIM.

To get more acquainted with concept of BIM, an ongoing work of G+6 residential building projects based in Kolhapur is selected. Project size 14,400sq.ft.. This project is

owned by M/S. Patki-Joshi Engineers & Contractors. The name of selected project for BIM study is Vishwa Residency. By formulating the BIM the study of cost and time parameter is done. Also the cost effectiveness of BIM is studied by physically going to the site at regular intervals, to monitor the building activities and casing the difference between the planned work progress and actual work progress.

The following steps comprises the general work flow of the project:

1) Creating 3D model in Revit 2014 and extracting quantities from the model
2) Defining specification for each item of work in the project, and assigning cost per unit to each item of work
3) Preparing work breakdown structure in Microsoft Project (MSP), and giving time to each task.
4) Assigning resources and cost to each task in MSP, and assigning quantity of each task and arriving at duration and cost of the project.
5) Further exporting MSP schedule and 3D model to the Navisworks Manage 2014 and creating visual results for planned schedule and actual schedule.
6) 4D and 5D models are developed by adding time parameter and cost parameter respectively to the 3D model.

Developing 3D Model:

Figure 1: 3D model of the project prepared by the objects having definite material and geometric properties

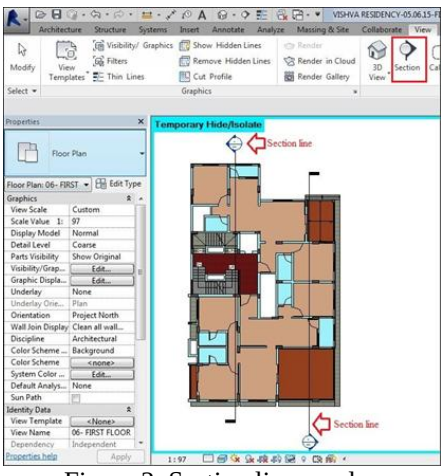

Figure 2: Section line on plan

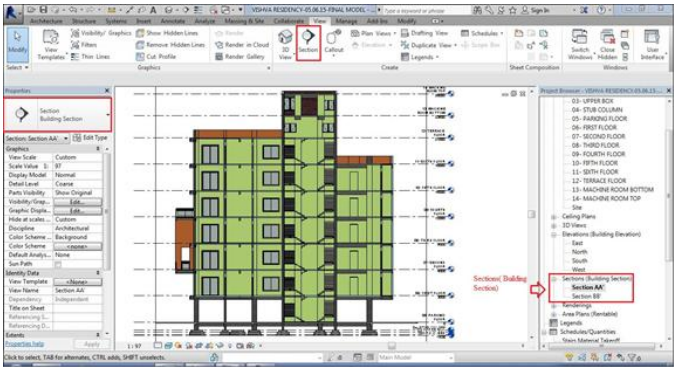

Figure 3: Section AA'

Figure 4: Elevation of Building Output from Revit

Quantity extraction→ Material rate and specification→ Scheduling in Microsoft Project:

- Settings before Starting the Actual Work:
- Preparation of Work Breakdown Structure:
- Preparation of Resource Sheet:
- Resource Assigning:
- Extracting Final Duration and Cost & Reports:

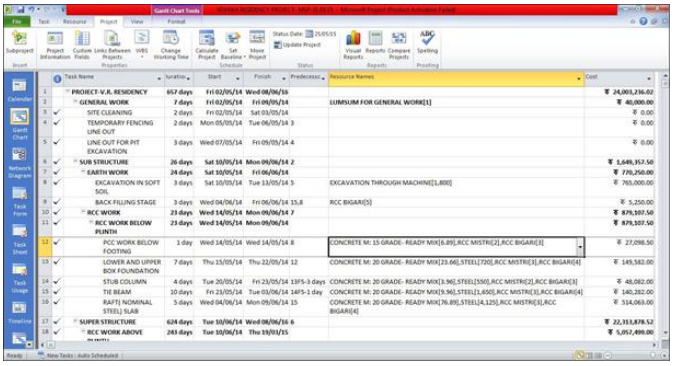

Figure 5: Total cost and duration workout in MSP

Exporting 3D Model and MSP Schedule to the Navisworks Manage:

Connecting Revit model, M.S. Project schedule and Gantt chart together. By choosing Column of Actual Start and Actual Finish in Time liner the project. So according to visual presentation the investor can get d idea of project actual

status. Like the project is in schedule, or lacking behind the schedule. So accordingly we can manage the project by rescheduling to avoid the time over run After providing the time liner we can extract the videos of construction process with activity sequence.

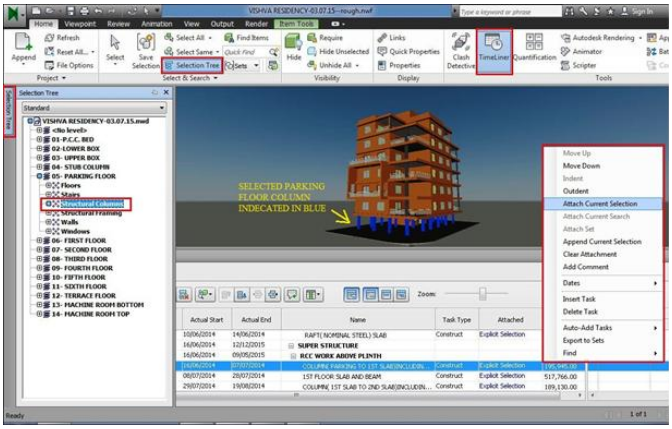

Figure 6 : Linking model to the time schedule

Results

To complete the project and obtain the objectives various software are used such as Revit is used for presentation, rendered views and quantification. For planning and scheduling the project Microsoft project is used, it is also used for resource allocation outputs in the form of graph and charts. Navisworks manage is used to trace the project planned vs actual. It is also used for clash detection in the project. The results obtained from this software's are discussed below

1. Revit 3D Model

Modeling the project in Revit helps to understand the project visually. It gives the idea of the project to all the stakeholders from the initially phase only. The applicability of Revit model is discussed below.

- Energy Analysis:By selecting the building site location, date and time the sun path on the site can be studied .It helps in analyzing the building shaded areas .Further the 6D i.e. Energy analysis can be performed for the building.

- Structural Analysis:The same model can be used for structural analysis. The model can be directly imported to structural analysis software like Staad - Pro etc. this reduces the time.

Quantity Takeoff:

Following are the quantities extracted from the Revit model.

Table no. 1 :Quantities of Building

Particulars	Quantity	Unit
Excavation upto 3.0m in soft soil	1800	Cum
PCC work below footing(RMC-M:15)	6.89	Cum
RCC column footing (RMC-M:20)	23.66	Cum
RCC column (RMC-M:20)	100.16	Cum
RCC beam (RMC-M:20)	343.00	Cum
RCC slab (RMC-M:20)		
RCC staircase waist slab/steps/landings (RMC-M:20)		
TOR & mild steel	101400	kg.
Ecolite AAC Block (625x240x150)	381.18	Cum
Cement plaster (external)18 mm	1245.33	sq. m.
Cement plaster (internal)15mm	5407.29	sq. m.
Plastic Paint (internal)	5407.30	sq. m.
Office ultima Paint (external)	1245.33	sq. m.
Flooring – Vitrified Tile	812.00	sq. m.
Flooring – Toilet Tile	138.00	
Flooring – Terrace Tile	315.00	
Flooring – Common Area Tile	159.00	
Toilet & kitchen dado	852.00	sq. m.
Vitrified skirting 75mm	462.00	rmt.
Terrace & toilet waterproofing	525.00	sq. m.
Top terrace waterproofing	93.00	sq. m.
Window sill (1:4)	76.00	rmt.
Quota tread	144.00	rmt.
Quota riser	151.00	rmt.
Sliding doors & windows	3012.80	sq. m.
Louvers	1829.20	sq. m.
Main door	9335.00	nos
Bed door	6031.00	nos
Toilet door	4575.00	nos
Duct door	2535.00	nos
OTIS Lift (5 person)	16 lakhs	
Toffen Glass Railing	2000.00	rmt.
WC	24.00	nos
Washbasin	24.00	nos
Sink	12.00	nos

2. Microsoft Project Results:

The work breakdown structure in Microsoft project find out 222 activities.

After assigning resources (material and labour):

Project Planned Start Date	02/05/2014
Project Planned Finish date	08/06/2016
Project construction cost	Rs.2, 40, 03, 236/-
Material and labour cost percentage	57% & 43% respectively

Various charts prepared represents the material and labour allocation and funds engaged with it for the project and budgeted capital required for smooth execution of project. Also the following charts we get for project management.

- Chart No 1 : Gantt chart
- Chart No.2 : Task Sheet
- Chart No.3 : Resource Sheet

Navisworks Manage Results:

From this software the visual results at intermediate date for planned and actual dates can be traced.

Tracing of project Planned Schedule and Actual Schedule on date 18/07/2014.

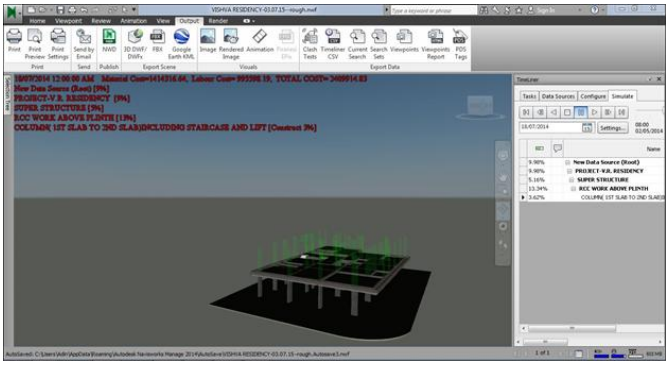

Figure 7: Planned Schedule on 18/07/2014.

According to planned schedule at 18/07/2014 the 1st floor slab and beam should be completed and RCC work of column (1st slab to 2nd slab)including lift and staircase should be in process but actually RCC work of column (parking to 1st slab) including lift and staircase is completed and RCC work of 1st floor slab and beam is in process.

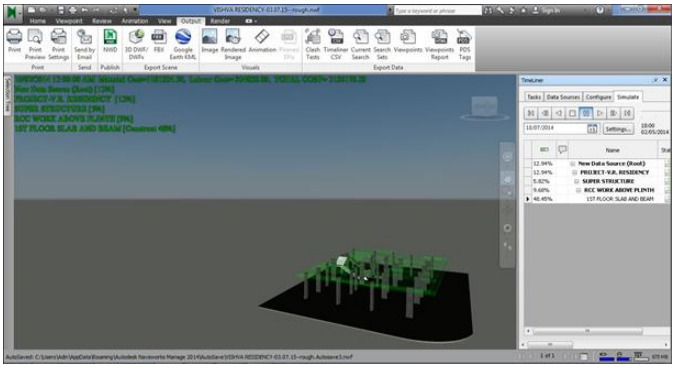

Figure 8: Actual progress till date 18/07/2014

Tracing of project Planned Schedule and Actual Schedule on date 05/03/2015

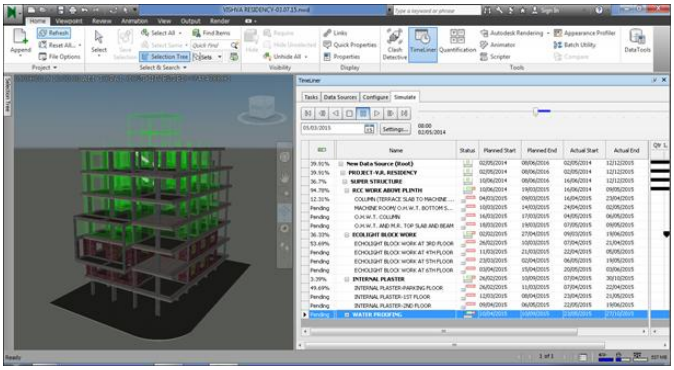

Figure 9 : Planned Schedule on 05/03/2015

According to planned schedule at 05/03/2015 the RCC work is completed and Ecolight Block Work at 2nd floor should be completed and block work at 3rd floor level should be in process but actually RCC work of till column (5th slab to 6th slab) including lift and staircase is completed and RCC work of 6th floor slab and beam is in process.

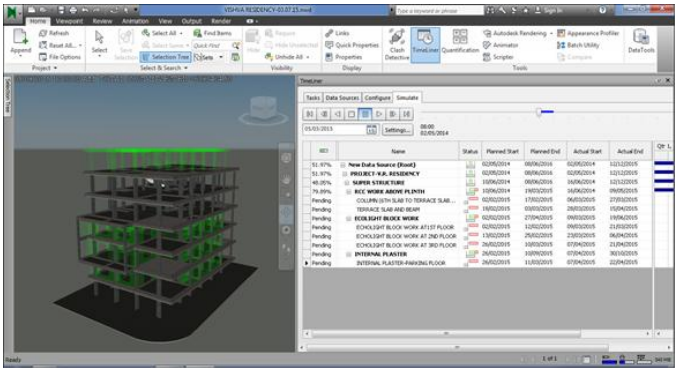

Figure 10 : Actual progress till date 05/03/2015

Clash Detection in Navisworks Manage

Clash Detected No.1

Clash location: First floor, Third floor, Fifth floor.

Clash between: Structural Column (S C30A 230X600) & Window –1800x1500

Resolving solution: Need to shift the window at corner of the room.

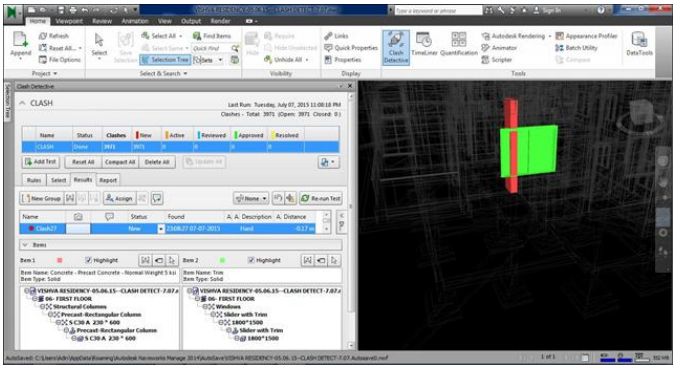

Figure 11: Clash between Structural column & Window

Clash Detected No. 2

Clash location : Machine Room .

Clash between : Terrace Window (1370x1500) & M.R. Structural Framing (150X450)

Resolving solution : Need to reduce the beam depth and increase the width of beam.

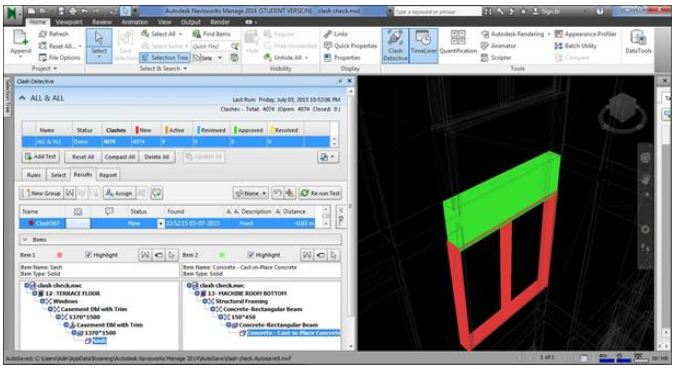

Figure 12: Clash between Structural Beam &Window

Clash Detected No.3

Clash location: First Floor to Sixth Floor each Toilet

Clash between: Plumbing Pipe (Soil Waste Pipe) & Structural Framing (150x450)
Resolving solution: Need to flush the structural framing top to sunk slab top

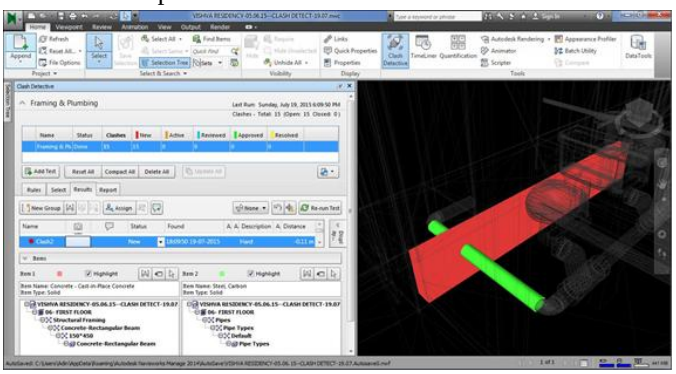

Figure 13: Clash between Structural Beam &Soil water pipe

Clash Detected No.4
Clash location: First Floor to Sixth Floor each Toilet
Clash between: Waste water pipe & Soil water pipe
Resolving solution: Need to keep difference in Waste water pipe & Soil water pipe.

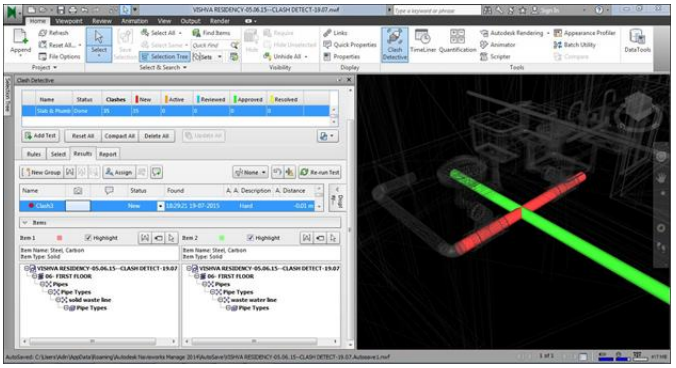

Figure 14 : Clash between Waste water pipe & Soil water pipe

Discussion

The building to be constructed when presented in the form of 3D model it is easy to understand and even non-technical person can imagine what is going to construct.

For this case study BIM concept is formulated with the help of Revit, M.S. Project and Naviswork Manage.

By creating a model in Revit various views(plans, section and elevation) are automatically created and changes in any view ,other views get updated according to it .It has reduced manual editing work and errors which saves the time. Revit model provides quantity take off in customize way and in systematic format. Revit is plug –in that directly allows the model to be exported to Naviswork. Revit 3D model can be used for analysis purpose like structural analysis, energy analysis, space planning etc. Rendering and walkthrough of building through Revit can be used for the presentation of the project.

Use of MSP provides scheduling and costing of the project. MSP helps in interconnecting of the project activities, assigning resources and cost of resources to each activity and finding out cost of each activity and the whole project cost. MSP helps to monitor the project progress by time to time updating the schedule. Reports generated from MSP helped in interpreting the statistics of the building. It works very well when the MS Project file is linked to the model since this can be modified anytime and linked again to the Navisworks file. Improved resource management will lead to a reduction in spending time and will also lead to more environmental friendly practices.

In Navisworks Manage 3D model of Revit and schedule prepared in MSP are imported. This allows linking the schedule to the actual building element. This makes easier to understand the time schedule as visual simulation can be created in the Navisworks Manage. Naviswork provides visual results of the actual and planned schedule of the project. The Navisworks model makes it easy the (3Dimensional interface) to discuss or solve problems. Advanced and improved planning analysis through BIM clash detection and 4D Planning will lead to lesser uncertainty during the construction execution stage.There is switch back facility in navis work with the help of the clash occurs we can correct that model by this facility and resolve the clash.

Overall the tools like Revit, MSP and Navisworks Manage helped in better understanding of the building design ,construction sequence, effective resource management and timely completion of the project activities as per requires standards. Results in are useful efficient and timely delivery of the project.

Conclusion

Project management plays an important role for the smooth completion of project. Now a days selecting proper project management tool for the project is key of success to complete the project in stipulated time and in standard manner. Building Information modeling has provided a new approach towards project management. It is an emerging tool for project management which makes use of various tools for visualization, 3D coordination, quantification, cost linking, resource allocation, construction planning and monitoring these tools results in to expediting the construction process, effective resource management,4D visualization of the construction schedule, identification of unforeseen conditions and the resultant cost and securing more profit. These benefits made BIM a successful project management tool.

These tools definitely enhance each phase of the construction project. In this case study the concept of BIM is simulated through 3D modeling, scheduling and cost estimation using BIM supporting software such as Revit, Microsoft Project and Navisworks Manage. Following are outcomes of the current project which results in time and cost overrun zero.

1. Benefits of BIM to reduce time and make time overrun zero:

1)The 3D aspect of the BIM makes it a very effective method of communicating between the architect, MEP consultant, contractors and the other project participants. It benefits to communicate problem, its better understanding & resolving the problem. it saves time and effort spend in traditional way of communication.

2)Communication or coordination issues between components like the building structure, MEP can be effectively managed through the Clash Detective application in Navisworks Manage.

3)BIM model is effective in Material management. A proper resource management benefit in timely procurement of material .It reduces wastage of time (Quality and Quantity control of material) .as we can extract the quantities as per our requirement. When material management is achieved effectively using BIM it can lead to saving of loading transportation costs and time which will contribute to a more sustainable construction process.

4)The 4D model visualization of the construction schedule-helps to understand the sequence of the construction. It is a very effective means of communicating the construction sequencing process which helps identifying critical activities, identification of unforeseen conditions and the resultant cost to all the stakeholders.

5)The movie clips of the construction sequence from navis work and saved viewpoints in the model helped stack holders to communicate their ideas faster by reducing the navigation time.

6)The nature of the BIM process itself is such that it eliminates uncertainties in construction processes and reduces complexity. Some unforeseen conditions could be clashes between components, time-space conflicts. The Clash detection function may reveal some unexpected clashes between components which can be modified and updated in the model. Time-space conflicts between tasks on the schedule can be observed and corrected.

7)The BIM process minimizes unforeseen conditions and resulting cost. It prepares bid packages, measure of its value against cost.

8)BIM strengthens the capability and output of each phase and stakeholder of the project. It helps each player of project in conceptual design, visualization, cost estimation, clash detection, time management, scheduling, environmental analysis, spatial analysis, fabrication, quality assessment, facility management and maintenance.

9)For faster and better execution of project accurate and comprehensive information is required. Using software like Revit, Navisworks Manage, Microsoft Project, it is possible to extract accurate and reliable data as and when required and could be updated and modified as project progresses which results in better control and efficiency of the project.

10)Overall BIM helps in reducing labour hour in extracting data, increasing productivity,

Predicting future problems, early decision making etc. BIM is a revolutionary concept

which needs acceptance at all levels of the construction industry to utilize its full potential.

2. Benefits of BIM to reduce cost and make cost overrun zero:

1)Effective communication results in to completion of project in stipulated time. Though the project is completed in time no liquidated charges / penalty charges are charged .Also we could demand for increasing cost of star rated material such as steel, cement, sand etc.so no increased material rate is charged from your pocket

2)Effective material management reduces excessive procurement and wastage of material also reduces excessive Transportation cost.

3)Through 3D coordination model the concept of execution of project is clear to all stakeholders, and GFC (Good For Construction) drawing for execution reduces the rework and it results in reduce the over work of cost.

Hence BIM is effective project management tool. So it is getting popular day by day in construction industry. It acts as a collaborative tool for construction industry. It is helpful to complete the project in stipulated time and specified standard.

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