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A Co-Ordinated BIM System to Track the Time and Cost of the Construction Projects

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Abstract
Now a day the construction industries are facing many **problems** due to improper planning and time and cost **overruns**. This has made to discuss how it could be improved. Many techniques have been raised in recent times one **of** them is Earned worth administration (EWA), which gives better administration of time and cost requirements. BIM is an approach where it improves the arrangement and improvement stages of a venture plan. Here the scheduling, quantity takeoff, representation module**,** and earned worth administration **platform play a** vital role in tracking the project as per the actual planning of the project and **avoiding** time delay and cost overrun, then with the final updated architectural model the 5D building architectural model with reference to the time and cost is setup and keeps on updating as the calendar of the project gets updated, by incorporating this tool of **the** integrated system properly into the construction practice the above said problems of cost and time overruns can be overcome.
Keywords: Building Information Modeling (BIM), Clash Detection, Visualization and Simulation, EWA (EARNED WORTH ADMINISTRATION), 5D BIM (Five-Dimensional Building Information Modeling)

Introduction

Building Information Modeling (BIM) is a digital representation of the physical and functional characteristics of a building or infrastructure. It involves creating a detailed 3D model that incorporates information about the building's geometry, spatial relationships, materials, quantities, and properties.

BIM enables architects, engineers, and construction professionals to collaborate and work more efficiently throughout the entire building lifecycle, from design and construction to operation and maintenance. The key components of BIM include:

3D Modeling: BIM software allows the creation of detailed 3D models that accurately represent the building's components and systems, including walls, floors, doors, windows, plumbing, electrical systems, and more.

Data Integration: BIM incorporates various data sources and formats, such as drawings, specifications, cost estimates, schedules, and performance data. This integration enables better decision-making and coordination among project stakeholders.

Parametric Design: BIM tools offer parametric capabilities, allowing users to create intelligent objects that are interconnected and update automatically when changes are made. For example, modifying the dimensions of a wall will automatically adjust the connected elements like doors, windows, and structural components.

Clash Detection: BIM software can identify clashes or conflicts between different building elements, such as pipes conflicting with structural components. Clash detection helps in the early

identification and resolution of issues, reducing construction errors and rework

Quantity Takeoff and Cost Estimation: BIM models contain information about materials, quantities, and properties, enabling automated quantity takeoff and cost estimation. This functionality enhances accuracy and efficiency in estimating project costs.

Visualization and Simulation: BIM allows realistic visualization of the building design, helping stakeholders understand the project better. Additionally, it supports simulation capabilities, such as energy analysis, lighting analysis, and structural analysis, which aid in optimizing design performance.

Facility Management: BIM models can be utilized for facility management during the operational phase of a building. Maintenance schedules, equipment information, and asset management data can be integrated into the BIM model, providing a comprehensive digital representation for ongoing facility management.

BIM has revolutionized the construction industry by improving collaboration, reducing errors, minimizing rework, and optimizing the overall construction process. It enables more efficient project delivery, cost savings, and better facility management throughout the lifecycle of a building or infrastructure project.

Building Information Modeling (BIM) is the way to create and oversee 3D building information during its progression. BIM is a multiphase complex procedure that accumulates contributions from associates to display the sections and tools that will be utilized during the progress to make a kind point of view of the structure procedure.

EWA (EARNED WORTH ADMINISTRATION)

Earned worth administration (EWA) is an industry-standard strategy for assessing a venture's progress at some arbitrary purpose of time, forestalling its fulfillment date and last expense, and dividing changes in the calendar and spending plan as the task continues. It contrasts the arranged measure of work and what has really been finished, to decide whether the cost, time, and work accomplished are progressing as per the prearrangement. As work is complete, it is considered "earned".

3D Building Information Modeling (BIM)

3Dimentional BIM is the best acquainted with - the way of making graphical and non-graphical data and sharing this data in a Common Data Environment (CDE). As the project life span advances the data turns out to be always well-off in detail until the time when the task information is given over to a client at fulfillment.

3D BIM (Building Information Modeling) refers to the use of three-dimensional modeling technology within the BIM process. BIM itself is a digital representation of the physical and functional characteristics of a building or infrastructure project, and 3D BIM takes it a step further by incorporating a three-dimensional visualization aspect.

In 3D BIM, a detailed and accurate three-dimensional model of a building or infrastructure project is created using specialized BIM software. This model encompasses the spatial relationships, geometry, and components of the project, including walls, floors, roofs, doors, windows, mechanical systems, electrical systems, and other elements.

The 3D BIM model allows stakeholders, including architects, engineers, contractors, and clients, to visualize the project in a realistic and immersive manner. It provides a comprehensive representation of the building's design, enabling better communication and understanding among project team members.

Benefits of 3D BIM include:

Visualization: The three-dimensional representation helps stakeholders visualize the project, facilitating better design comprehension and decision-making.

Clash Detection: 3D BIM models can be used to detect clashes or conflicts between different building elements, such as pipes intersecting with structural components. This allows for early identification and resolution of issues, reducing construction errors and rework.

Coordination and Collaboration: 3D BIM fosters better coordination and collaboration among project team members by providing a common platform for sharing and integrating design information. It enables multidisciplinary teams to work together more efficiently.

Improved Design Accuracy: The detailed 3D model allows for more accurate design documentation, reducing design errors and minimizing discrepancies during construction.

Quantities and Cost Estimation: The 3D BIM model contains information about materials, quantities, and properties, enabling automated quantity takeoff and cost estimation. This functionality enhances accuracy and efficiency in estimating project costs.

Visualization of Construction Sequence: 3D BIM models can also be used to visualize the construction sequence and plan project phasing, aiding in project scheduling and logistics.

Generally, 3D BIM enhances the design, coordination, and communication processes in construction projects, leading to improved project outcomes, reduced risks, and increased efficiency.

4D Building Information Modeling (BIM)

4D BIM (Four-Dimensional Building Information Modeling) expands upon the concepts of 3D BIM by incorporating the element of time or scheduling into the building information model. It involves integrating the project's construction schedule with the 3D BIM model to create a visual representation of the project's progression over time.

In 4D BIM, the construction schedule is linked to the 3D model, associating specific tasks or activities with their respective locations within the model. This linkage enables the visualization of the project's construction sequence and provides insights into the timing and coordination of various construction activities.

By incorporating the time dimension into the BIM process, 4D BIM offers improved project visualization, coordination, and scheduling. It helps stakeholders gain a better understanding of the project's construction sequence and facilitates proactive management of construction activities, leading to improved efficiency and project outcomes.

5D Building Information Modeling (BIM)

5D BIM (Five-Dimensional Building Information Modeling) expands upon the concepts of 3D and 4D BIM by incorporating cost and estimating information into the building information model. It adds the element of cost or project economics to the 3D and 4D models, creating a comprehensive and dynamic representation of a construction project.

In 5D BIM, the cost data and estimating information are integrated with the 3D and 4D models, allowing for the analysis and visualization of cost-related aspects throughout the project lifecycle. The model incorporates quantities, costs, and other relevant financial data associated with the project components, enabling accurate cost estimation, tracking, and control.

By incorporating cost data into the BIM process, 5D BIM enhances the understanding, control, and analysis of project costs. It enables stakeholders to make informed decisions, optimize project value, and improve overall project performance

NAVISWORK

NAVISWORK is a project review software developed by Autodesk that is commonly used in the architecture, engineering, and construction (AEC) industry. It is designed to facilitate coordination, collaboration, and visualization of construction projects by integrating data from various sources and disciplines into a single, unified platform.

NAVISWORK is often used in conjunction with other software tools in the BIM workflow to enhance project coordination, clash detection, visualization, and collaboration. It helps project teams streamline their processes, reduce conflicts, improve decision-making, and ultimately deliver projects more efficiently.

Literature Review

Pooja Tripathi et al. (2018) in their studies aim to ponder the booking methods and development arrangement of work for multistory structures and to play out the use of Microsoft venture programming in arranging and booking a multistory RCC building development. To accomplish the above targets a theoretical RCC private G plus 4 building is considered. The complete arranging and booking of this structure are considered by the conventional strategy utilized by Architects, Engineers, and contractual workers and are looked at by the current programming strategy. For this methodology Microsoft venture programming is utilized for arranging furthermore, booking the RCC building. Perception reveals that Microsoft venture

programming fills in as a viable apparatus for producing a Gantt graph for the timetable of a development venture, what's more, gives the base length of development time by timetable crunching and undertaking smashing strategies in programming. The present work shows great data about the utilization of Microsoft venture programming for the arranging and planning of building development.

Roger Warburton et al. (2016) in their studies focused on Developing Standard Earned Value Management (EVM) conventions, the present way to deal with Earned Schedule (ES) is stretched out and formalized to build up its thorough, hypothetical establishment. An exact definition is accommodated what we term the venture's earned length, whose creation finishes the group of three arranged, real, and earned terms. The distributed ES equation rises as a straight estimation, yet is found to work with some non-linear cost profiles, and the situations under which it gives both right and inaccurate term evaluations are noted. In the few arranged and earned worth utilitarian profiles inspected, no estimates are required to determine a precise scientific articulation for the last length; most term recipes are direct and valuable. The dependability and exactness of the length equations are shown in a few instances of genuine, non-linear undertaking information that speaks to enormous classes of activities. We finish up with a functional direction for undertaking chiefs.

Suresh Kumar et al. (2015) focused studies on utilizing MSP Software as aprocedure that includes estimation, sequencing the exercises, assets allotment, and timing. The development planning is to finish the venture in time and match the assets with the assigned time. Booking utilizing MSP Software gives great control and a clear calendar to an undertaking. EV Analysis is a standard technique for estimating a venture's advancement at some random purpose of time, gauging its finishing date, and last expense, and investigating differences in the calendar and spending plan of the task. This task manages planning to utilize MSP and EV Analysis for a condo building. Consequently, procedure time and cost invade are stayed away from.

Ahmad Jrade et al. (2015) made an attempt to study Numerous development undertakings that experience the ill effects of poor planning and conflicting time and cost the executives. This circumstance has prompted reexamining of the industry's exhibition and how it can be improved. Earned worth the board (EVM) empowers improved administration of time and cost requirements. Building Information Modeling (BIM) is perceived to improve the arranging and acknowledgment of a development venture. The present paper proposes an incorporated time and cost the executives framework (ITCMS), where an EVM stage is utilized in a virtual situation during the arranging and development periods of a task. The ITCMS empowers early contribution what's more, venture coordination in addition to exhaustive time and cost the board. Theframework comprises four modules and thirteen unique procedures. The ITCMS is beneficial in the structure to arrange; development experts can match the structure model with time and cost parameters just as streamline it through a conflict identification process that outcomes in spending plan and calendar compressions at an early stage. The ITCMS is a valuable apparatus for developing and designing directors that endeavor to build activities' presentations. The creators show in this paper the legitimacy of utilizing the ITCMS through a real venture.

Hong Long Chen et al. (2015) investigated the Earned worth undertaking the executives (EVPM) is a successful apparatus for overseeing venture execution. In any case, most investigations on augmentations and utilizations of EVPM focus on improving last expense and span appraises as an alternative to enhancing the utilization of arranged worth (PV) to anticipate earned worth (EV) and real cost worth (AC). This examination suggests a clear displaying technique for improving the perceptive power of PV before executing an undertaking. By utilizing this displaying strategy, examination creates EV and AC gauging models for four case ventures. Out-of-test defining approval utilizing mean total rate mistake (MAPE) exhibits that the proposed strategy improves anticipating precision by a normal of 23.66% and 17.39%, individually, for EV and AC. This enhancement for PV's prescient power preceding undertaking execution gives the executives increasingly dependable prescient data about EV and AC execution, taking into account feasible proactive activity to guarantee great

results execution.

Jeroen Colin et al. (2015) reported Late writing on the venture the executives stressed the exertion spent by the administration group through the undertaking control process. In light of this exertion, a utilitarian refinement can be made between a top-down and a base-up task control approach. A top-down control approach refers to the utilization of a venture control framework that creates undertaking-based execution measurements to give a general review of the venture implementation. Activities are activated dependent on these general execution measurements, which need further examination to distinguish issues at the movement level. A base-up task control framework alludes to a framework wherein nitty gritty movement data should be accessible always during the undertaking control process, which requires more exertion. In this exploration, researcher propose two new venture control approaches, which consolidate components of both top-down and base-up control. To this end, researcher incorporate the earned worth administration/earned timetable (EVM/ES) strategy with numerous control focuses roused by basic chain/support the board (CC/BM). They showed how the EVM/ES control approach is corresponding with the idea of cradles and how they can improve the venture control process when shrewdly consolidated. These joined top-down procedures overcome a part of the downsides of normal EVM/ES referenced in the writing, while inconsequentially expanding the effort spent by the task chief. A massive computational analysis is set up to test the methodology against other control strategies inside an expansive scope of rebuilt dynamic task advance situations.

Research Gap

From the above study made following parameters are considered for further study. Earned worth administration is a helpful apparatus that empowers appropriate checking for controlling time and cost with respect to the undertaking. Coordination time-cost framework design. Building information modeling will help development administrations take essential choices during the construction phases of the task with a top to bottom time and cost tracking.

Importance Of The Study

The point of the investigation is to follow the time and cost of the real task through the BIM approach over conventional development practice by legitimate work breakdown structure, quantity take off, planning and budgetary examination by EWA, and costing approach associated with a model fuse the ability to easily watch costs in 3Dstructure.

Objectives:

- To study the sequence of work in construction.
- To study the scheduling techniques using the critical path method.
- To track and reduce the time and cost of the genuine endeavor through the BIM approach
- To analyze the conventional development practice versus the BIM approach through a real task.
- Budgetary investigation of the real venture through EWA (Earned worth administration).

Many development activities experience the problem of poor structure, conflicting time, and cost to the board. This situation has prompted reconsidering the business' exhibition and exactly how it might be improved. Innovation is getting through structure and the executives rehearse. Earned worth administration (EWA) enables better management of time-cost constraints. BIM is identified to improve the configuration and improvement stage of a construction project. The purpose of the paper is to coordinate a time-cost management system, where an EWA platform is used in a virtual environment during the planning and construction phases. The coordinated system permits project coordination and time-cost management. The framework consists of four modules. the coordinated time-cost management system is beneficial at the configuration and improvement stage to bind the building model with time and cost parameters as well as puts that results in budget and schedule compressions early on, this paper demonstrated the validity of using the coordinated time and cost management system through an actual project.

Methodology:

The main aim of this paper is to show how to implement the BIM approach to even low-budget

construction works, where in general we don't track scheduling in traditional construction practice for small-scale construction works, but this study has shown how to track time & cost of the small scale construction works so that we can track and overcome time and cost overrun during the construction process.

For the study purpose, we have selected a finished project that is "Model village development project" a school building which is of about 136.08 square meters, which is located in Bramasandra village, Sira, Tumkur, here only the architectural model is taken into consideration. First, an auto cad drawing is prepared and by exporting that drawing into Revit the 3D model is created. The data incorporated in this study are taken as per the information collected from the site engineers.

WBS (WORK BREAKDOWN STRUCTURE):

WBS is characterized as deliverable-engaged, various leveled gathering of the undertaking, what's more, characterizes the complete undertaking degree. Expectations are substantial, quantifiable pieces of a venture which can't be additionally separated task isn't a WBS component however a lot of assignments produce a deliverable. The expressions and their criteria in WBS have appeared in Table 3.1.

Table 3.1: Stages and criteria in WBS

Description	Criteria
Subproject stage	A self-determining, deliverable end product requiring processing of multitasking having a large volume of work
Task stage	A recognizable and deliverable major work comprising one or more work packages.
Work package stage	The sizeable, recognizable, measured, cost able and manageable work item/package of activities
Activity stage	Recognizable lower-level jobs, operations, or processes, which consume time and resources
Operation stage	The lowest day-to-day tasks, or processes which are part of an activity

Coordinated Time-Cost The Executive's Framework

The framework shown below consists of 4 modules as shown in Figure 3.2

1. Representation module. 2. Time-cost assessing module.
3. Planning module. 4. Earned worth administration module

Incorporated Time Cost The Executives' Framework

- The work breaks down the structure of the proposed work is made ready.
- In this framework process, the 3D building architecture model has been created in accordance with the WBS as shown in Figure 3.3
- Performed the quantity takeoff for the created 3D building architectural model in Revit.
- To the obtained quantity takeoff from the above step, time and cost are gauged for every single architecture building component.
- According to the gauged time and cost of every component of the architectural building, planning of the work is done in the Microsoft project.
- After planning the project, the earned worth administration platform is set up and to that, a baseline is also created.
- Here 3D building architectural model is used as a perception device, if there are any changes in the model changes are made and a 5D building model with reference to the time and cost is created.
- After complete changes update the model and incorporate it into the development stage
- Here in the development stage, project progress is tracked, and have updated the costs of the undertaking.
- Then as the development stage progresses the work routine is updated similarly the earned worth administration stage is also updated.

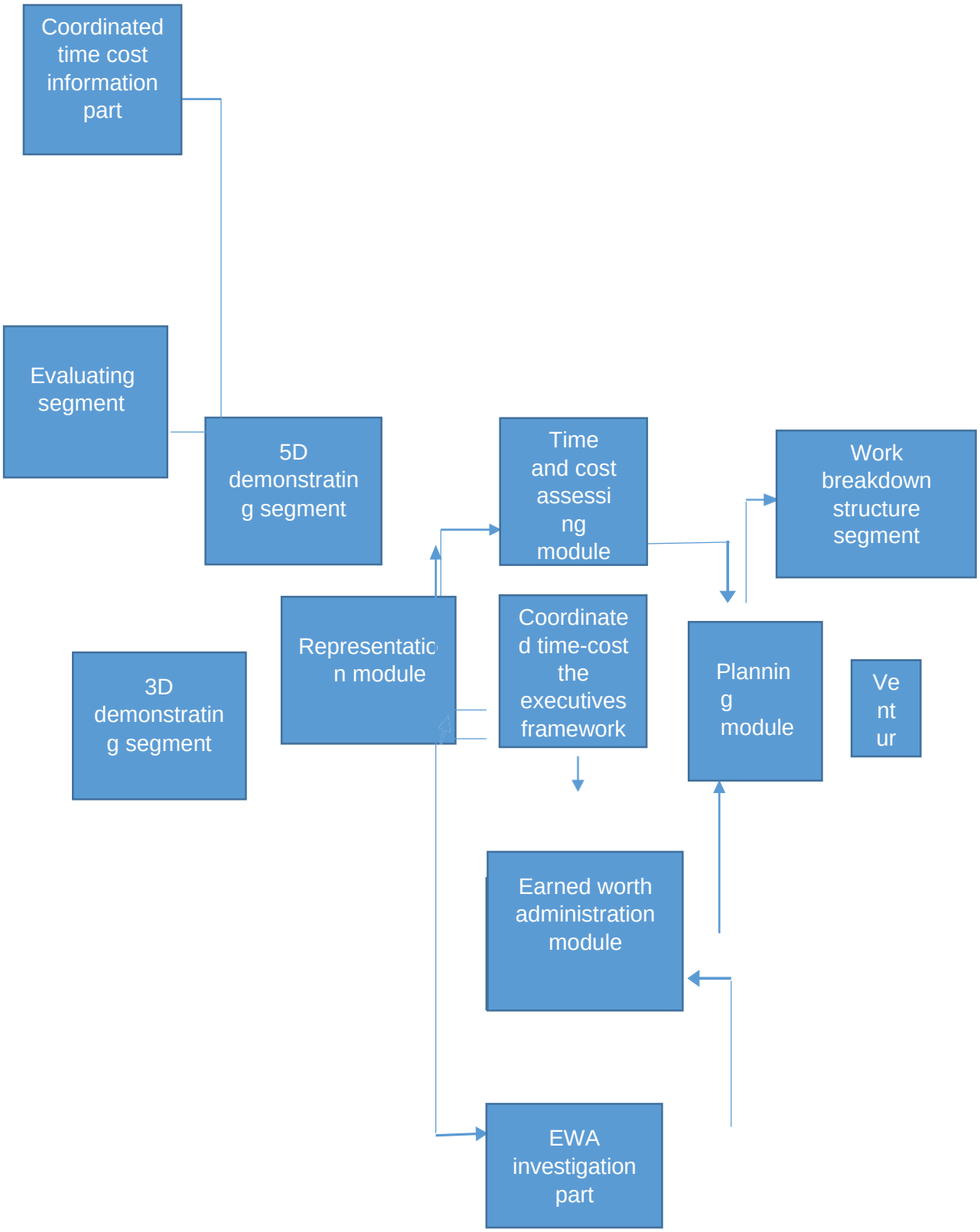


Fig. 3.1: Coordinated time-cost executive's framework modules & part

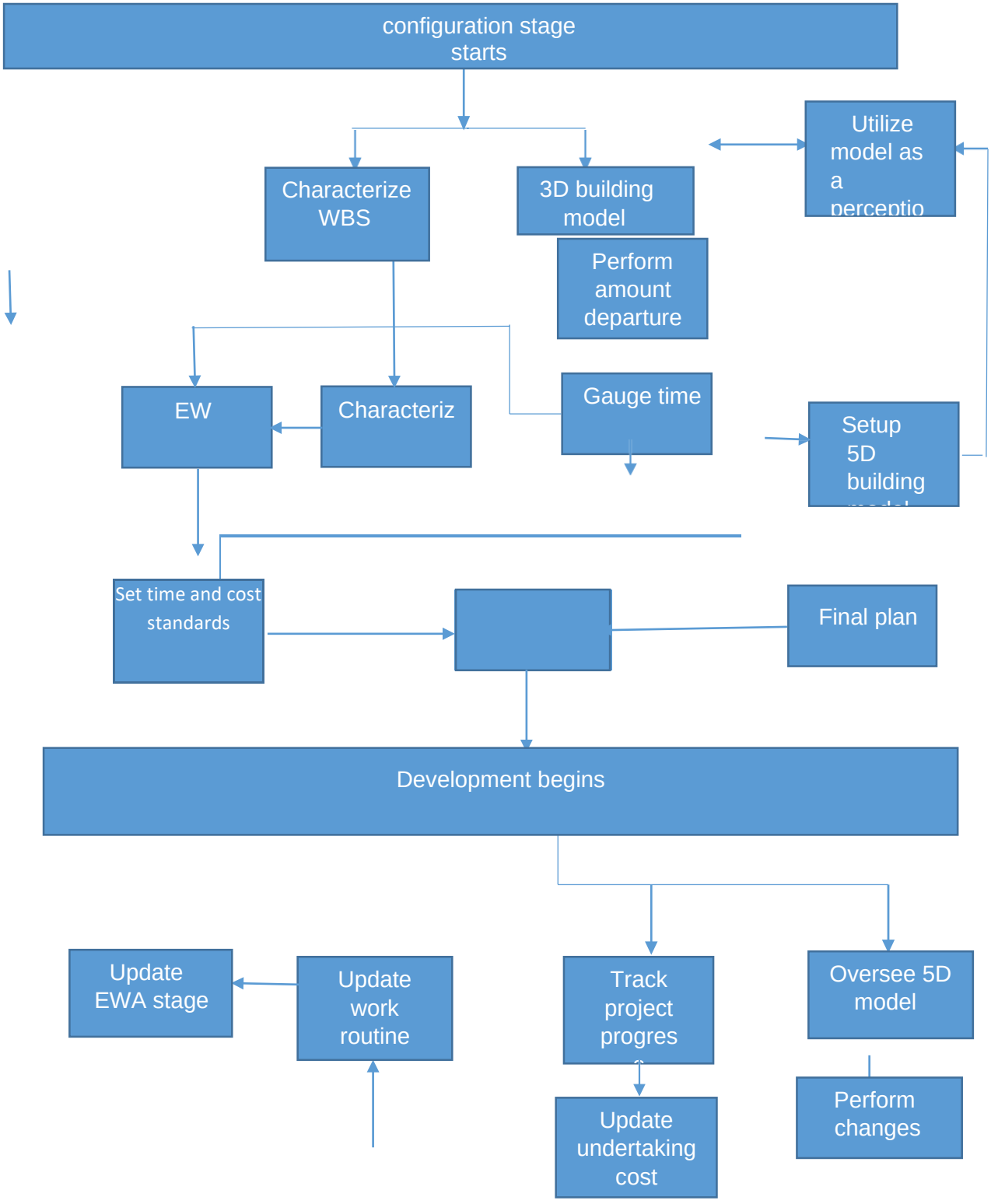


Fig. 3.2: Incorporated time cost the executives framework workflow

EWA (EARNED WORTH ADMINISTRATION)

Calculating Earnings worth administration measures progress against a baseline. It involves calculating three values for each activity in the WBS: a) The Planned Value (PV), b) The Actual Cost (AC), c) The Earned Value (EV), These three values are combined to determine at that point in time whether or not work is being accomplished as planned.

The commonly used measures are the cost variance: Cost Variance (CV) = EV – AC, Schedule Variance (SV) = EV – PV. The cost performance index (CPI). It is calculated thus: CPI = EV / AC. The schedule performance index (SPI), is calculated thus: SPI = EV / PV. A negative schedule variance (SV) calculated at a given point in time means the project is behind schedule, while a negative cost variance (CV) means the project is over budget.

Results And Discussions

The venture development span is determined to be 76 days, which is less than the scheduling planned for the site, that is in this project they have not prepared and followed any schedule, it's a regular traditional construction practice they had carried out in which they took approximately 125 days which is as per information collected from engineers of that site. When the general conditions and the executive's expenses are Excluded, the venture cost is assessed to be **"₹ 530,431.95**" (only for the architectural part for which the quantities have been taken) as shown in Figure 4.4. which is less than the estimation which has been obtained from the site, an estimation on the fifteenth and the last date of every month would be adequate to perform precise earned worth the board which is as shown in figure 4.5. A negative schedule variance (SV) calculated at a given point in time means the project is behind schedule, while a negative cost variance (CV) means the project is over budget,

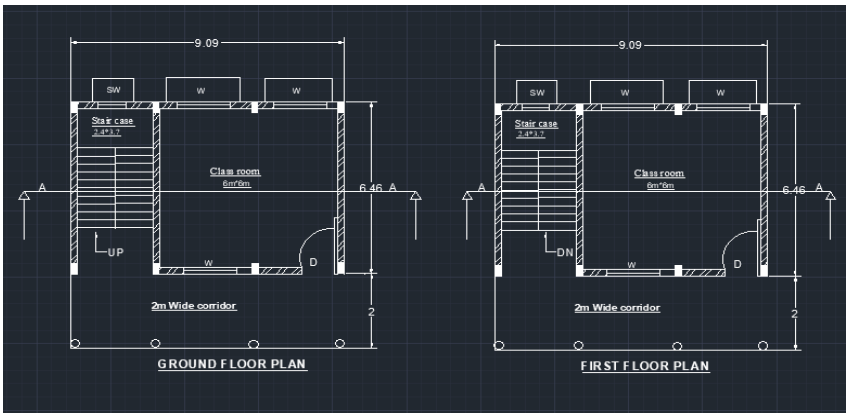


Fig.4.1: Auto CAD drawing of proposed work

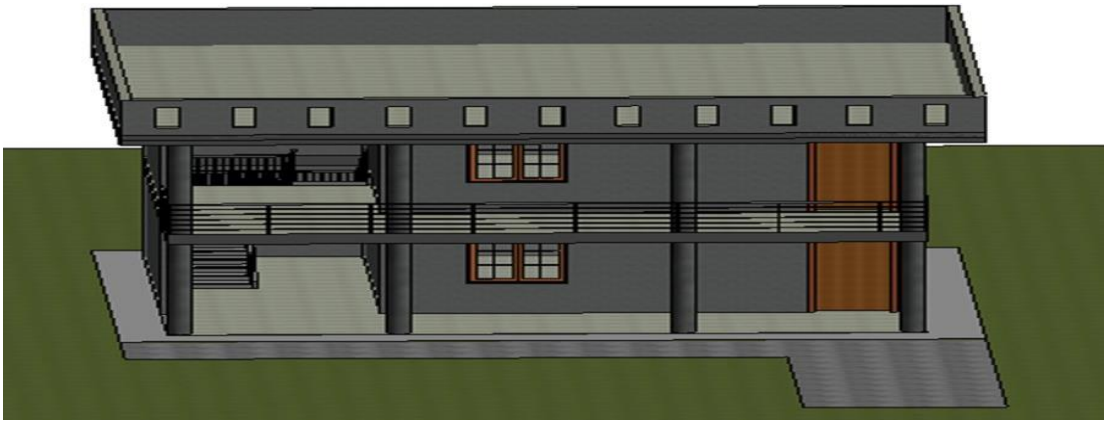
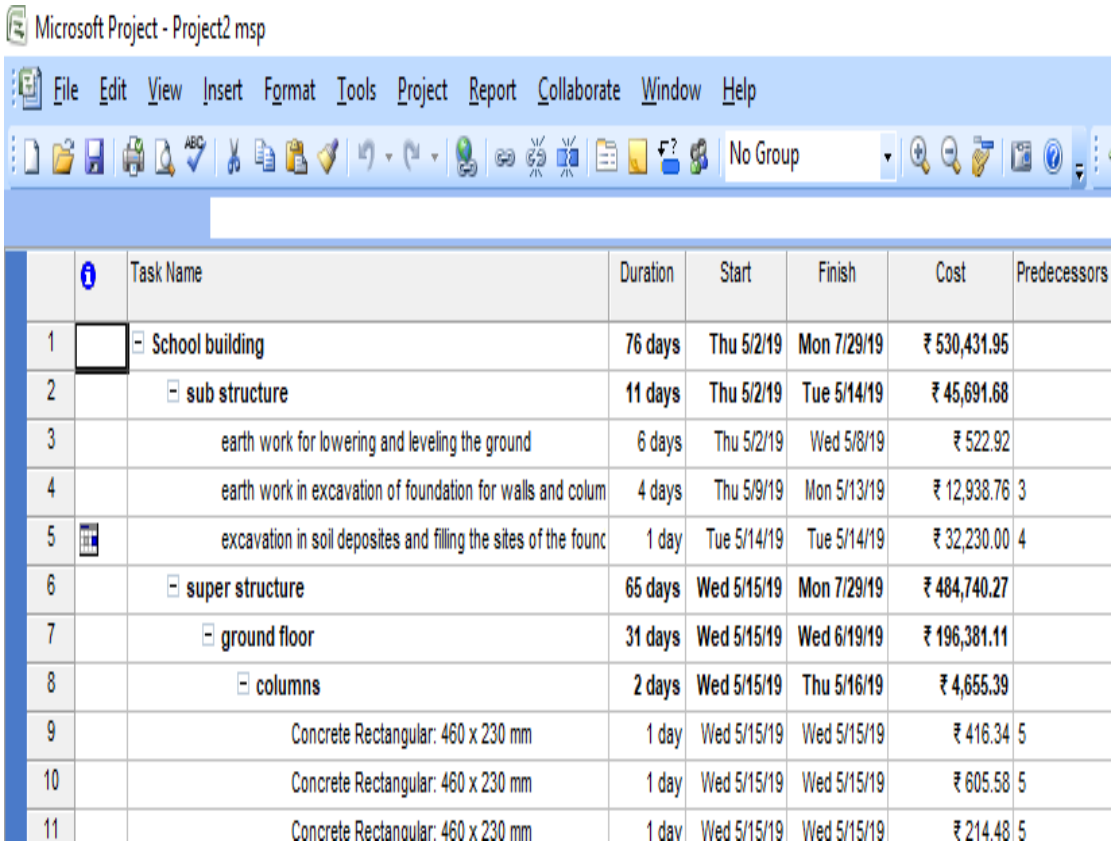


Fig. 4.2: Revit 3D model of the proposed work

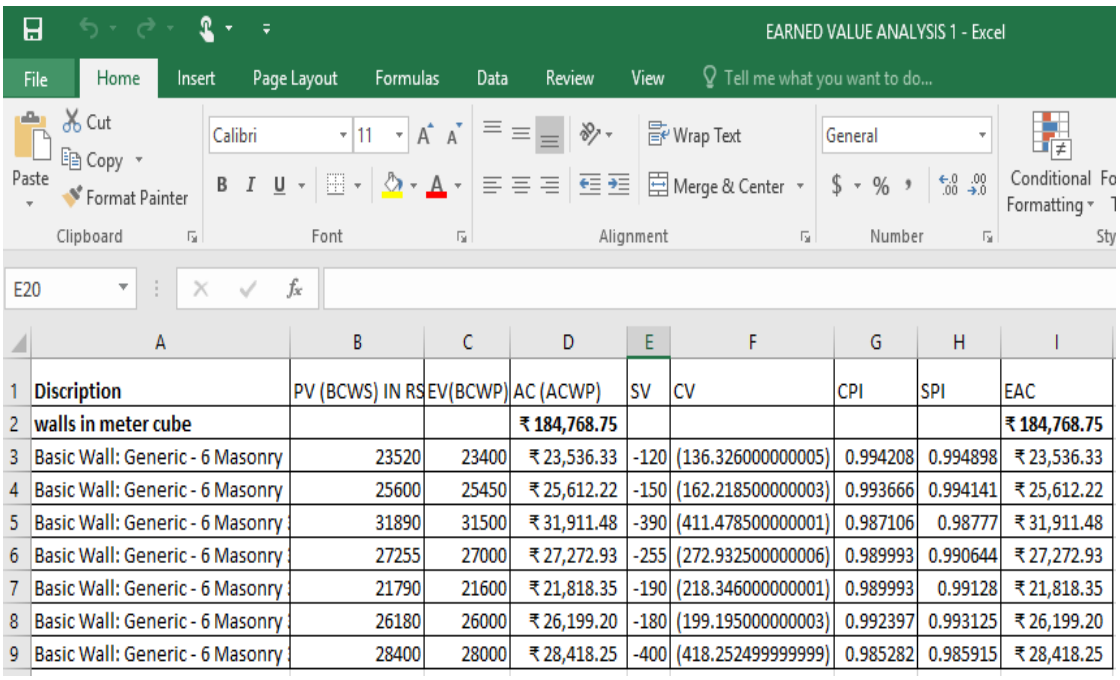
Discription	Material area	Material cost	Total cost
sub structure in meter square			
earth work for lowering and leveling the ground	7.69	68	522.92
earth work in excavation of foundation for walls and columns	45.72	283	12938.76
excavation in soil deposites and filling the sites of the foundation	29.3	1100	32230
super structure			
ground floor			
columns in square meters			
Concrete Rectangular: 460 x 230 mm	3.0658	135.8	416.33564
Concrete Rectangular: 460 x 230 mm	4.45935	135.8	605.57973
Concrete Rectangular: 460 x 230 mm	1.57935	135.8	214.47573
Concrete Rectangular: 460 x 230 mm	1.76516	135.8	239.70873
Concrete Round: 300 mm Dia	5.85289	135.8	794.82246
Concrete Round: 300 mm Dia	5.85289	135.8	794.82246
Concrete Round: 300 mm Dia	5.85289	135.8	794.82246
Concrete Round: 300 mm Dia	5.85289	135.8	794.82246

Fig. 4.3: Quantity take-off performed for the proposed model



	Task Name	Duration	Start	Finish	Cost	Predecessors
1	School building	76 days	Thu 5/2/19	Mon 7/29/19	₹ 530,431.95	
2	sub structure	11 days	Thu 5/2/19	Tue 5/14/19	₹ 45,691.68	
3	earth work for lowering and leveling the ground	6 days	Thu 5/2/19	Wed 5/8/19	₹ 522.92	
4	earth work in excavation of foundation for walls and colum	4 days	Thu 5/9/19	Mon 5/13/19	₹ 12,938.76	3
5	excavation in soil deposites and filling the sites of the founc	1 day	Tue 5/14/19	Tue 5/14/19	₹ 32,230.00	4
6	super structure	65 days	Wed 5/15/19	Mon 7/29/19	₹ 484,740.27	
7	ground floor	31 days	Wed 5/15/19	Wed 6/19/19	₹ 196,381.11	
8	columns	2 days	Wed 5/15/19	Thu 5/16/19	₹ 4,655.39	
9	Concrete Rectangular: 460 x 230 mm	1 day	Wed 5/15/19	Wed 5/15/19	₹ 416.34	5
10	Concrete Rectangular: 460 x 230 mm	1 day	Wed 5/15/19	Wed 5/15/19	₹ 605.58	5
11	Concrete Rectangular: 460 x 230 mm	1 day	Wed 5/15/19	Wed 5/15/19	₹ 214.48	5

Fig. 4.4: scheduling of the proposed work in MSP



	A	B	C	D	E	F	G	H	I
1	**Discription**	PV (BCWS) IN RS	EV(BCWP)	AC (ACWP)	SV	CV	CPI	SPI	EAC
2	**walls in meter cube**			**₹ 184,768.75**					**₹ 184,768.75**
3	Basic Wall: Generic - 6 Masonry	23520	23400	₹ 23,536.33	-120	(136.326000000005)	0.994208	0.994898	₹ 23,536.33
4	Basic Wall: Generic - 6 Masonry	25600	25450	₹ 25,612.22	-150	(162.218500000003)	0.993666	0.994141	₹ 25,612.22
5	Basic Wall: Generic - 6 Masonry	31890	31500	₹ 31,911.48	-390	(411.478500000001)	0.987106	0.98777	₹ 31,911.48
6	Basic Wall: Generic - 6 Masonry	27255	27000	₹ 27,272.93	-255	(272.932500000006)	0.989993	0.990644	₹ 27,272.93
7	Basic Wall: Generic - 6 Masonry	21790	21600	₹ 21,818.35	-190	(218.346000000001)	0.989993	0.99128	₹ 21,818.35
8	Basic Wall: Generic - 6 Masonry	26180	26000	₹ 26,199.20	-180	(199.195000000003)	0.992397	0.993125	₹ 26,199.20
9	Basic Wall: Generic - 6 Masonry	28400	28000	₹ 28,418.25	-400	(418.252499999999)	0.985282	0.985915	₹ 28,418.25

Fig. 4.5: Earned value analysis performed in Microsoft Excel

Conclusions:

The various problems faced by the construction industries due to not planning projects well and time and cost overrun are known by the comprehensive literature survey, the incorporated time-cost executives' framework is developed, then WBS is created in coordination with the 3D building architectural model.

The quantity takeoff is performed to the 3D building architectural model, then the obtained quantity cost is gauged and by the above all data the project planning is done, after planning the project calendar the earned worth administration platform is set up and to that baseline is also setup and the changes occurred during the construction process, the model is updated to that changes and 5D building architectural model with reference to the time- cost is setup after the 5D building architectural model is incorporated into the development stage and here the project progress is tracked and have updated the undertaking costs, work routine and earned worth administration.

Overall from this Building information modeling approach, we came to know that by incorporating time-cost the executives' framework process is not only used for large-scale construction works but even small-scale budget construction works can be carried out through this process as shown in this study, it was also noted that during the construction process of this project, there were time delays because the planned calendar was not followed properly. This was experienced when performing earned worth administration and later it has been corrected by performing earned worth administration at regular intervals of 15 days every month and objective of the paper was achieved successfully which kept track of the time and cost coordination.

In order to control time and cost overrun factors during the development stage the following factors should be considered which are as follows:

- Poor site the executives and supervision, for time delays receive clear data and correspondence channel and for cost invade create equipped groups for executing works.
- Inadequate planning, for time delays in picking experienced sub-contractual workers with great notoriety, for cost invade improvement of an appropriate arrangement of the site the board and administers.
- Incompetents subcontractors, for time defer select experienced and able subcontractors and for cost invade money related capacity to consider as a part of the qualification.
- Poor venture the board, maintain a strategic distance from incessant structure changes.

- Schedule delay, embrace powerful and proficient material obtainment frameworks
- Mistakes during the development, employ skillful labor
- Cash stream and monetary challenges looked at by the temporary workers, stream the calendar appropriately.
- Delay installment to provider/subcontractor, advance installment to contractual workers ought to be streamed by timetable.

Future Scope Of The Study:

- Risk and quality parameters can be added to this framework.
- We can work on the Sixth dimension which is facility management.

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