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Estimation of Project Duration and Cost Using Building Information Modeling (BIM)

Ahmed Abdulameer Arab Al-Taie, Iraq
M.E/M.Tech, (Construction Engineering and Management)
Department of Civil Engineering
Osmania University
Ahmedarab731@gmail.com

Abstract

Building Information Modeling is a powerful tool in the construction industry. The use of BIM help in creation and use of a three - dimensional model (3D) virtual paradigm that assists the design, construction and operation of a building. BIM is a faster and more effective way for designing and construction management. It improves the quality of design and reduces rework during construction, which serves as the advantages according to the perception of AEC professionals. It can also help in controlling delays in relation to a planned schedule. BIM provides accurate quantity take-offs, improves scheduling time tables and consequently diminishing total project contingencies and costs. The building of the College of Administration and Economics in Iraq at Waset is considered as a case study to realize the actual uses and benefits of Building Information Modeling (BIM). A 3D model is developed in Revit Architecture software and estimate total project duration by using primavera P6 software and link with Navisworks to extracted 4D model and estimated the total project cost 5D.

Keywords: **Building Information Modeling 4D, 5D, BIM time and cost estimation.**

INTRODUCTION

The construction Industry is the backbone of any nation's economy and it is consider as a unit to measure the economic growth of the country by measurement of the development

of the infrastructure and construction sector. The construction industry is very complex industry which involves various parties in different processes and stages of project which work together to achieve the target success of any project. the construction sectors is widely affected by many problems such as cost overrun, time overrun and also the quality of end product which is not achieved due to various problem during the constructions stage of the project [1] . Building Information Modeling is one of the technologies helps control on problem. Computable information about a building projects this dependable digital methodology into three dimensional (3D) drawings in the three primary dimensional width, height and depth with the time as the fourth dimension (4D), cost as the fifth (5D). 4D model based scheduling simulation can be used to monitor the progress at site without being actually present there. It can also help in monitoring delays in relation to a planned schedule .5D model based estimating produces accurate quantities for the efficient estimation of architectural, structural and services components. These quantities can be extracted at various stages at concepts stage for generating budgets, at the end of design development stage for floating tenders. The BIM tool is to be helps for design, defining the building form and spaces, visualization to analyzing costs, time. it is a construction management (CM) tool useful for a real simulation process of the BIM is useful for increasing total quality, providing accurate quantity take-offs, improving scheduling timetables, consequently diminishing total project contingencies and cost.[2]

BIM VS. CAD

BIM provides many advantages over CAD. The key difference between BIM and CAD is that a traditional CAD system uses many separate 2D documents to explain a building these documents are created separately and have no intelligent connection between them. The possibility of uncoordinated data is very high. The change management created by CAD is a tiresome and error susceptible process. BIM takes a different approach it assembles all information into one location and cross – links that data among associated objects.by and large CAD is accurately a 2D technology with a specific need to output a collection of lines and text on a page these line have no meanings whether inside the computer or on the printed sheet . CAD drafting has efficiencies and advantages over pen and paper but is really just a simulation of the act of drafting. . Historically the designer drew a set of plans and then used those plans to manually derive sections elevations and details during the development of a project if any of those items changed the designer had to modify each of the other drawings that were affected to take the change into account. This is where BIM makes a significant departure from heritage CAD platforms. The beauty of BIM is that it manages change without having to change all drawings unlike CAD the intent of BIM is to let the computer take responsibility for redundant interactions and calculations providing the designer with more time to design and evaluate decisions [3].

LITERATURE REVIEW

The impact of BIM implementation on the traditional conventional building design methods. The BIM is extends this methodology into three dimensional (3D) drawings in the three primary dimensional width, height and depth with the time as the fourth dimension (4D) and cost as the fifth (5D). 4D model based scheduling simulation can be used to monitor the progress at site without being actually present there. It can also help in monitoring delays in relation to a planned schedule. 5D model based estimating produces accurate quantities for the efficient estimation of architectural, structural and services components. These quantities can be extracted at various stages: at concepts stage for generating budgets, at the end of design development stage for floating tenders, at GFC stage for verifying contractor bills. The BIM tools is to be helps for design, defining the building form and spaces, visualization to analyzing costs, time and energy performance. It is a construction management (CM) tool useful for a real simulation process of the ongoing building project. In the undertaken case study, BIM is useful for increasing total project quality, providing accurate quantity take-offs, improving scheduling timetables, consequently project contingencies and costs. The case study presented in this paper suggested contractual arrangement for the building project resulted in improved productivity, better coordination, reduced error and rework of construction [2].

The aim of this study is to suggest the extended functions and the future directions for 4D CAD with several effective application cases of 4D CAD so that the application of that can be efficiently improved. Due to the growing interests in BIM, 4D CAD is being applied to a practical business of construction as a supporting tool for BIM.4D CAD is simply one of many tools for the successful implementation of construction projects including civil engineering projects; it is neither an essential technology nor a fix-it-all instrument for construction management. The application of 4D technology to construction sites will prove successful only when the tool is proactively leveraged in a way tailored to individual sites with its effects fully understood. Amid growing interest in BIM and the active discussion about its benefits, construction technicians and other stakeholders should develop and apply technologies and methodologies for the implementation of BIM.[5]

Methodology and Model Development

First conversion of Auto CAD data into Revit 3D then creating 3D Model in Revit Architecture For the creation of building levels are to be identified for each floor. These levels are then given in the elevation and are created. Next step depends on details in columns, beams, doors, windows

and the other details. Families are prepared which should be loaded in each step of project. After creating levels and families group start placing the walls, stairs, etc. as per tools in BIM.

Figure 1: Imported Auto CAD to Revit

Figure 2: Revit 3D, floors

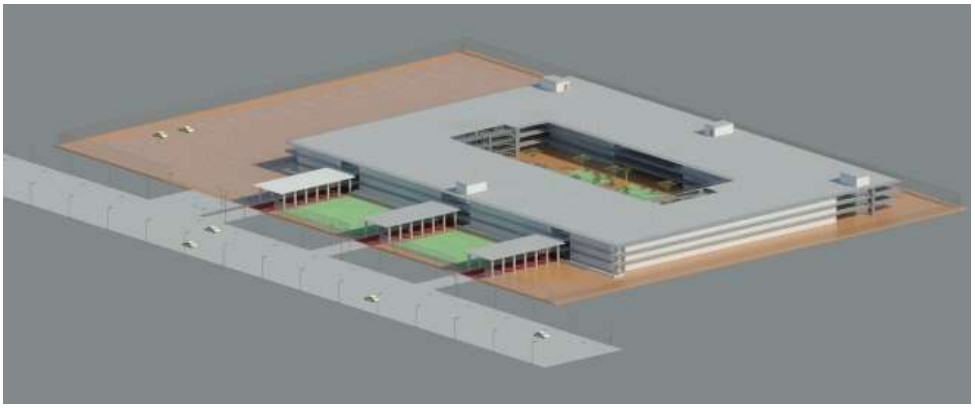

Figure 3: 3D Model of Final View for Building by rendering process

Planning and scheduling of the project

It helps in optimizing resource and space for the whole construction phase with (primavera p6) project can get of hand quickly. Before you know it, a simple building project becomes a collage of smaller projects, such as design, excavation, foundation work and marketing. You can have more control over your project by creating smaller projects.

4D Modeling

Revit to Navisworks

There is a Revit plugin to export a Navisworks file directly from Revit which maintains much of the data related to the Revit file. This function will save the file as a Navisworks, NWC file which can be open directly in Navisworks

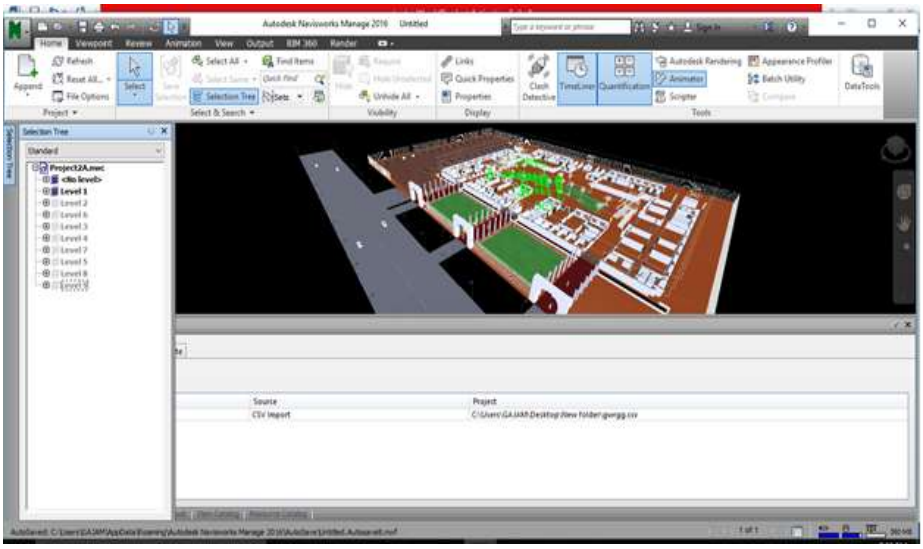

Figure 4: Selection Tree level - 1

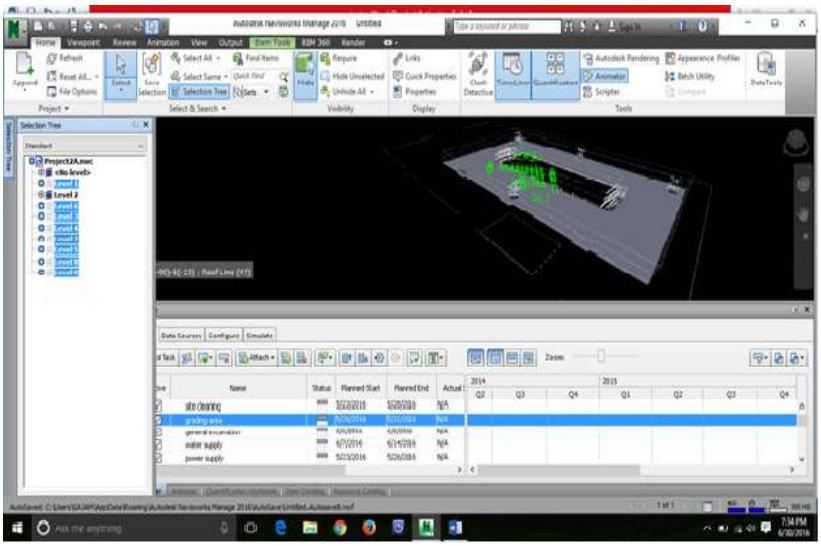

Figure 5: Selection Tree level - 2

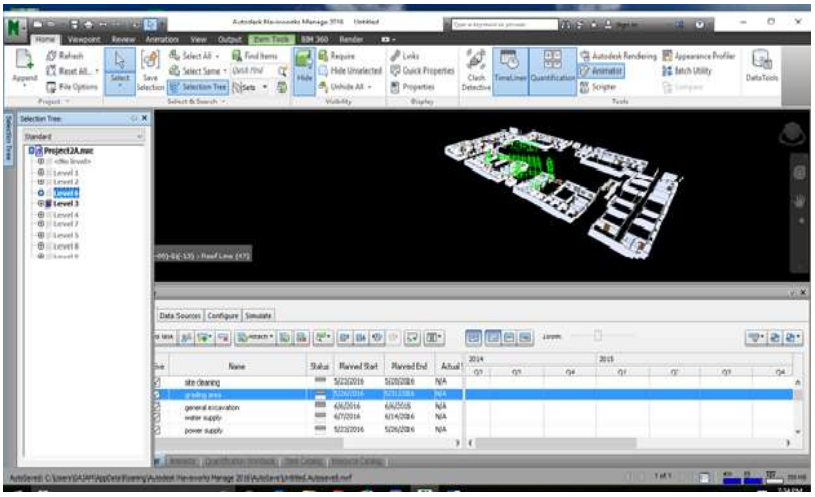

Figure 6: Selection Tree level - 3

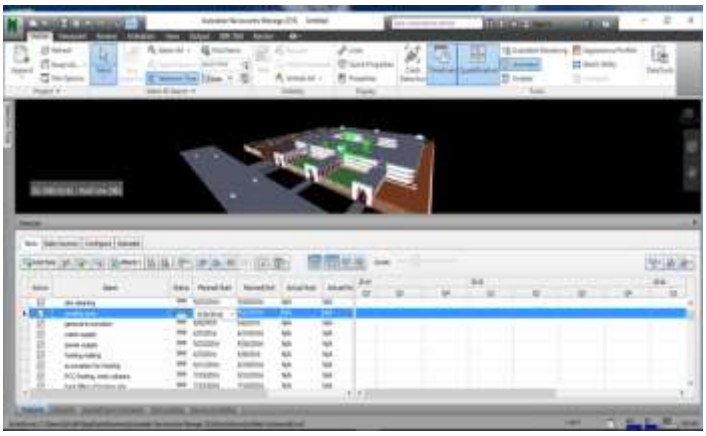

Figure 7: 4D scheduling of the Project in Navisworks Time liner

Quantity Take- Offs (QTO) and Cost Estimating 5D

A process in which Building Information Modeling (BIM) can be used to assist in the generation of accurate quantity take-offs and cost estimates throughout the lifecycle of a project. This process allows the project team to see the cost effects of their changes, during all phases of the project, which can help curb excessive budget overruns due to project modifications. Specifically, BIM can provide cost effects of additions and modifications, with potential to save time and money and is most beneficial in the early design stages of a project.

Results

Building information modeling 5D cost estimation for 3D prototype

Type	Cost (Rs.)	Height	Volume (m^3)	Total
.25*.7	4200	10	0.16	682.84
.25*.7	4200	10	0.16	682.84

.25*.7	4200	10	0.16	682.84
.25*.7	4200	10	0.16	682.84
.25*.7	4200	10	0.16	682.84
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.25*.7	4200	10	0.16	682.84
.25*.7	4200	10	0.16	682.84
.25*.7	4200	10	0.16	682.84
.25*.7	4200	10	0.16	682.84
.60*60	4200	10	0.33	1404.69
.60*60	4200	10	0.33	1404.69
.60*60	4200	10	0.33	1404.69
.60*60	4200	10	0.33	1404.69
24"	450	10	0.27	121.24
24"	450	10	0.27	121.24
24"	450	10	0.27	121.24
24" 2	450	7.43	0.20	90.08
24" 2	450	7.43	0.20	90.08
24" 2	450	7.43	0.20	90.08
24" 2	450	7.43	0.20	90.08
24" 2	450	7.43	0.20	90.08
24" 2	450	7.43	0.20	90.08
Grand total				
702	2598120			623632.96

Door Schedule

Type	Height	Width	Cost (Rs)	Total
D3	1.981	1.829	950	3442
30" x 80"	2.032	0.762	950	1471
30" x 80"	2.032	0.762	950	1471
30" x 80"	2.032	0.762	950	1471
D1	2.134	1	950	2027
34" x 84"	2.134	0.864	950	1750
36" x 84"	2.134	0.914	950	1853
D4	2.4	1.6	950	3648
D1	2.134	1	950	2027
D1	2.134	1	950	2027
Grand total				
499			468050	1046127

Floor Schedule			
Type	Volume	Cost (Rs)	Total
Generic - 12" 2	112.39	2160	1614098
Generic - 12" 2	82.03	2160	1178026
Generic - 12" 2	1.52	2160	21800
Generic - 12" 2	25.41	2160	364925
Generic - 12" 2	60.05	2160	862394
Generic - 12" 2	2.36	2160	33861
Generic - 12" 2	20.82	2160	298966
Generic - 12" 2	1.43	2160	20475
Generic - 12" 2	57.80	2160	830091
Grand total: 33		61020	51460560

Railing Schedule

Type	Length	Cost (Rs)	Total
Handrail - Rectangular	7.618	400	3047.154
Handrail - Rectangular	13.78	400	5512.166
Handrail - Rectangular	7.618	400	3047.154
Handrail - Rectangular	13.78	400	5512.166
Handrail - Rectangular	13.783	400	5513.181
Handrail - Rectangular	7.618	400	3047.154
Handrail - Rectangular	13.78	400	5512.166
Handrail - Rectangular	39.574	400	15829.577

Grand total			
48		19200	1309214.875

Ramp Schedule			
Family	Type	Width	Cost (Rs)
Ramp	15.555*1.799	1	49500
Ramp	15.555*1.799	1	49500
Ramp	15.555*1.799	1	49500
Ramp	15.555*1.799	1	49500
Ramp	15.555*1.799	1	49500
Ramp	15.555*1.799	1	49500
Grand total			
6			297000

Roof Schedule			
Type	Volume	Cost (Rs)	Total

6"	1295.82	2610	22192136
6"	1295.61	2610	22188652
6"	1290.99	2610	22109493
Generic - 12"	7.11	2610	60844
Generic - 12"	6.37	2610	54544
Generic - 12"	6.81	2610	58332
Generic - 12"	7.11	2610	60844
6"	36.61	2610	627026
6"	36.61	2610	627026
6"	36.61	2610	627026
Grand total: 10			68605923

Stair Schedule		
Type	Width	Cost
7" max riser 11" tread	1.43	37000
7" max riser11"tread	1.43	37000
7" max riser 11" tread	1.43	37000
7" max riser 11"	1.43	37000

tread		
7" max riser 11" tread	1.43	37000
7" max riser 11" tread	1.43	37000
7" max riser 11" tread	1.43	37000
7" max riser 11" tread	1.43	37000
7" max riser 11" tread	1.43	37000
Grand total: 12		444000

Structural Framing Schedule				
Type	Length	Volume	Cost (Rs)	Total
.6*.4	7.405	1.83	2880	5256.36
.6*.4	7.375	1.87	2880	5374.08
.6*.4	7.675	1.89	2880	5443.20
.6*.4	6.233	1.59	2880	4584.44
.6*.4	6.385	1.48	2880	4275.07

.6*.4	6.09	1.56	2880	4485.56
.6*.4	7.375	1.77	2880	5097.60
.6*.4	7.094	1.75	2880	5041.62
.6*.4	8.25	1.98	2880	5702.63
.6*.4	7.375	1.77	2880	5097.60
.6*.4	7.275	1.65	2880	4752.00
.6*.4	6.918	1.61	2880	4643.19
.6*.4	8.719	2.09	2880	6026.30
Grand total				
585		1684800	2930698.30	

Window Schedule				
Height	Width	Sill Height	Cost (Rs)	Total
1.829	1.198	0.305	675	1479
1.829	1.2	0.305	675	1481

1.5	2	0.914	675	2025
1.5	2	0.914	675	2025
2	2	0.305	675	2700
2	2	0.305	675	2700
0.5	1.198	1.067	675	404
0.5	1.198	1.067	675	404
1.5	2	1.052	675	2025
Grand total				
Count492		332100 Rs.		955560 m²

Wall Schedule						
Type	Area (m2)	Cost	Brick wall	Putty	Putty paint	Total wall
0.25	18	1215	22401	495	9126	31528
0.25	16	1215	18886	495	7694	26580
0.25	7	1215	7989	495	3255	11243
0.25	7	1215	8538	495	3478	12016
0.25	15	1215	18514	495	7543	26056
0.25	8	1215	9814	495	3998	13812
0.25	17	1215	20572	495	8381	28953

0.25	11	1215	13332	495	5432	18763
0.4	3	1485	4421	495	1474	5895
0.4	4	1485	5364	495	1788	7152
0.27	2	1260	2106	495	828	2934
0.27	13	1260	16885	495	6633	23518
0.27	23	1260	29387	495	11545	40931
Grand total						
Count 1462						30475121

Conclusion

- 3D BIM (building information modeling) model has been developed by integrating 2D AutoCAD drawing and 3D visualization using Revit Architecture software.
- 4D planning by linking the baseline plan from Primavera with the developed 3D model using Navisworks helped effectively in visualizing the sequence of the activities. This will result in accurate plans and will minimize planning errors to a large degree.
- 5D model has been developed by generating the cost estimates of each component of the model. Cost estimation model is connected to the 3D model so that any change in the design would be immediately reflected in total cost estimation of the developed model.

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