ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 3, January 2018

4D INTEGRATED PROJECT BASED DELIVERY

JANAKARAJ M
Assistant Professor
Department of Civil Engineering
NMAM Institute of Technology, Nitte, Udupi, India
janakaraj@nitte.edu.in

LEKHA SHANKAR G R
PG Scholar, Construction Technology
Department of Civil Engineering
NMAM Institute of Technology, Nitte, Udupi, India
lekhashankar1995@gmail.com

ABSTRACT

A significant benefit of Integrated Project Delivery (IPD) is the opportunity to replace value engineering with target pricing or target value design processes (a form of estimated budgeting). Building Information Modeling (BIM) is the thriving technology in the present construction industry. The BIM is the documentation process consisting of information such as Design, Construction Planning, Facility Management and Operation. The Knowledge of labor productivity is essential for cost management and tracking of project activities. The integrated information in Building Information Modeling (BIM) includes physical component attributes (such as Geographical features of location) and managerial attributes (such as Resources), the of focusing on cost – time integrated tracking control theory have been sparse. Current advancement in 3D BIM applications have allowed for development of BIM based visual progress control systems. However, using 4D BIM helps in forecasting the resources required and tracking the project. This paper develops a field labor productivity data acquisition method by integrating a 3D model with Time schedule. To evaluate the proposed method, a case project case study on the Rural Health Centre at Nitte and field data were used to assess the 4D integration of information to assess the tracking.

Keywords— BIM, 4D Scheduling, Labor Productivity, Scheduling, IPD.

I. INTRODUCTION

Tracking is vital for successful management of construction projects. Construction progress can be characterized by the percent completed, which involves a complex measure of time and cost. In order to investigate the status of the work performed, data including quantities, time spent, and committed costs of resources for each activity or work package should be considered. A three-dimensional model linked to a database of project information, is one of the most powerful tools supporting Integrated Project Delivery (IPD) [6]. In progress control, it is time-consuming to both extract the quantities from construction drawings, schedules, and budget information and collect the required data [1]. The quality of progress control depends on the quality of the general contractor's paper-based daily progress report, which summarizes the subcontractors' daily reports. Advances in 3D–based integrated information modeling and visualization technologies have allowed managers to visually demonstrate construction progress [2]. The IPD project plan includes project metric values and reporting intervals to monitor progress of the project. Metrics include overall performance of the project as well as the traditional cost, schedule, and scope measurements. Meeting these metrics may also be tied to financial incentives for the parties [6].

Productivity can also be referred to as cost effectiveness because productivity is primarily measured based on cost. Productivity is given as a constant in-place value divided by some input, such as worker hours. it can be difficult to measure labor productivity on a job site due to the complexity of job descriptions and the time consuming process of tracking the productivity of workers. Moreover, it is challenging to identify the measured productivity for a designated activity at a particular quantity in order to produce the unit cost of the task. [4] discussed about Improved Particle Swarm Optimization. The fuzzy filter based on particle swarm optimization is used to remove the high density image impulse noise, which occur during the transmission, data acquisition and processing. The proposed system has a fuzzy filter which has the parallel fuzzy inference mechanism, fuzzy mean process, and a fuzzy composition process. In particular, by using no-reference Q metric, the particle swarm optimization learning is sufficient to optimize the parameter necessitated by the particle swarm optimization based fuzzy filter, therefore the proposed fuzzy filter can cope with particle situation where the assumption of existence of "ground-truth" reference does not hold. The merging of the particle swarm

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 3, January 2018

optimization with the fuzzy filter helps to build an auto tuning mechanism for the fuzzy filter without any prior knowledge regarding the noise and the true image. Thus the reference measures are not need for removing the noise and in restoring the image. The final output image (Restored image) confirm that the fuzzy filter based on particle swarm optimization attain the excellent quality of restored images in term of peak signal-to-noise ratio, mean absolute error and mean square error even when the noise rate is above 0.5 and without having any reference measures.

IFC (Industry Foundation Classes) provides an interoperability solution between different software applications. The format establishes international standards to import and export building objects and their properties. IFC improves communication, productivity, delivery time, and quality throughout the life cycle of a building. It reduces the loss of information during transmission from one application to another, with established standards for common objects in the building industry.

The objective of this research is to establish an advanced measurement method for productivity using building information modeling (BIM) and information integrated technology for the purposes of progress analysis and control. This research mainly focuses on a productivity tracking process based on visualized work progress and associated data for developing a productivity measurement system.

II. REVIEW OF LITERATURES

Building Information Modeling (BIM) is one of the most promising developments in the architecture, engineering, and construction (AEC) industries. Eastman defined BIM as a digital representation of the building process to facilitate the exchange and interoperability of information in a digital format [3]. Eastman also describes six important applications of BIM that apply to contractors as follows.

- Clash detection
- Quantity takeoff and cost estimation
- Construction analysis and planning
- Integration with cost and schedule control and other management functions
- Offsite fabrication
- Verification, guidance, and tracking of construction activities

One of the most commonly used software programs for BIM is Revit by Autodesk. Parametric 3D objects called 'families' in Revit are created to represent intelligent 3D model-based designs, coordinated models and documentation, point cloud viewing and editing, energy-efficient building simulation, and construction modeling. Estimators can extract material quantities automatically from the BIM and use this information in downstream cost estimation applications. Hartmann et al. (2012) indicated that BIM-based tools need to satisfy various requirements including: 1) the detail estimate generation, 2) quantity takeoff for each of the items defined in work breakdown structure (WBS). The implications of implementing BIM are: 1) the use of BIM-based tools, which saves estimators time during quantity takeoff, and 2) the automatic incorporation of design changes into the estimate, which allows for a reduction in estimated hours.

Project based delivery methods continue to take hold in construction industry, an intriguing and sophisticated modeling technique has begun. It is often referred to as 4D BIM or Simulation Based Modeling and relies on integrating components of the 3D BIM with time or schedule related information. The use of the term 4D is intended to refer to the 4th dimension: time. The process of creating a 4D model can be relatively straightforward so long as the BIM models have been developed with sufficient granularity. Real – time navigation through the modeled environment is supported during the simulations to enhance exploration [5].

The animated simulation of the 4D model can be played back to visualize the actual occurrence of events in the proper chronological sequence. The ability to visualize the construction sequence in the context of the actual project site provides the design team, owners, contractors, municipalities, regulatory agencies, and other interested parties with a bird's-eye view of the process, simplifying their understanding of the events to occur [5].

One of the main potential benefits of IPD is the reduction of construction time due to the extensive planning and changes to project processes. This benefit is a common determinant in selecting IPD as a preferred process by owners. The ability to link schedule, phasing and detailed construction sequencing during design will provide efficiencies in material procurement [6].

IFC (Industry Foundation Classes) is an open and standardized data model intended to enable interoperability between building information modeling software applications in the AEC/FM industry. [7]. The Industry Foundation Classes (IFC) file format was developed by the International Alliance of Interoperability

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 3, January 2018

(IAI). In accordance with that, several industries related efforts targeting specific modelling extensions for the next IFC Release have been started recently by the IAI [8].

III. METHODOLOGY

Activity duration estimation

Activity duration estimating in the project for estimating the number of work periods that will be needed to perform each activity. Duration can be estimated in units being freely defined by the project and the duration often influenced by the power of the resources availability. Therefore, resource estimating and duration estimating are interdependent.

The estimation of duration for each activity can be carried out in simple three ways:1. Expert Judgment 2. Analogous estimating 3. Parametric estimating 4. Three point estimates

Parametric estimating uses a statistical relationship between historical data and other variables for calculating the estimate for activity such as cost, budget and duration. Activity duration was parametrically determined by multiplying the quantity of work to be performed by labor hours per unit of work.

Activity duration in days = Quantity of work / Resource output per day (1)

Total labour hours = Quantity of work x Productivity rate (2)

Activity Duration = Total labour hours / Number of persons (3)

Activity ID	Activity Name	Total man days	Total No. of Persons	Duration	Mate	Mazdoor	Bhisti	mixer operator	mixer	vibrator	Mason	Carpenter
NITTE.xml												
NITTE RURAL HEALTH CENTRE												
BASEMENT FLOOR				Total labour hrs			Quantity of work x Productivity rate					
FABRICATION				Activity Duration			Total labour hours/Number of persons					
4	REBAR											
5	MS WINDOW GRILLS			Total labour hrs			8 hr/day					
6	STAIRCASE RAILING											
7	MS ROLLING SHUTTER											
7	FORMWORK FABRICATION											
CIVIL STRUCTURE												
9	EXCAVATION	165.42	14	11.82	1.24	12.76						
10	PCC BED AND MARKING	51.16	15	3.41	0.67	11.19						
11	FOOTING PEDESTAL COLI	28.88	12	2.41	0.62	7.32	3.29268	0.26	0.26	0.26		
13	BACKFILLING AND PLINTI	131.46	10	13.15	0.43	4.68	0.42553	1.49	1.49	1.49		
14	PLINTH BEAM	45.97	15	3.06	0.68	10.23	3.06818	0.34	0.34	0.34		
15	COLUMNS	54.30	15	3.62	0.70	10.65	2.73834	0.30	0.30	0.30		
16	BEAMS	107.15	30	3.57	1.36	20.45	6.13636	0.68	0.68	0.68		
17	SLABS (INCLUDING WAIS	138.59	30	4.62	1.87	19.48	7.01299	0.55	0.55	0.55		
18	STAIRCASE (STEPS)	4.45	4	1.11	0.21	3.01	0.63047	0.05	0.05	0.05		
19	SHADES, LOFTS AND DRC	64.80	25	2.59	1.50	17.50	4.5	0.50	0.50	0.50		
BLOCK WORK												
20	BLOCK WORK 9" THICK	132.62	10	13.26	0.00	6.12	0.68027	0.00	0.00	0.00	3.20	
21	BLOCK WORK 4" THICK	116.98	10	11.70	0.00	5.33	1.33333	0.00	0.00	0.00	3.33	
22	DPC FOR SILL	1.76	5	0.35	0.00	2.38	0.2381	0.00	0.00	0.00	2.38	
23	LINTELS	1.42	5	0.28	0.00	3.50	0.9	0.10	0.10	0.10	0.30	
CIVIL FINISHES												
PLASTERING												
28	CEILING PLASTERING	102.75	8	12.84	0.00	2.86	2.85714	0.00	0.00	0.00	2.29	
29	WALL PLASTERING (INTEI	182.92	10	18.29	0.00	3.57	3.57143	0.00	0.00	0.00	2.86	
FLOORING AND TILING WORKS												

Figure 1: Labor estimation and activity duration estimation using MS Excel

Simulation of 4D model

- One of the best applications for IPD is Autodesk, since it all for the hierarchical grouping of the elements so that they are easier to link. We can also use Revit and export the file to a Navisworks file.
- Develop a CPM schedule for the project in a compatible application. MS Project for the development of the schedule, but the linking of the database is a bit more challenging using Primavera.
- Link the 3D objects to the activities by selecting the objects in the 'Selection Tree' window and then right clicking on the activity which you would like the object to be linked to and select 'Attached selected'. This will link the schedule activity to the 3D objects.
- After linking the entire object, can review the simulation in the 'Simulate' tab of Timeliner, and can revise the playback settings in the 'Configure' tab of Timeliner.

Building information models developed with Revit Architecture are saved to the RVT file format. We can export the building model using the IFC format to an IFC certified application that does not use the RVT file format. The drawing can be opened and worked on in the non-native application. Revit serves the good interface for the 3D modeling here the levels are created and the model can be added separately for each level and can be modify easily. The revit has inbuilt templates for the door, windows, staircase etc. The model generated in the revit is saved in .rvt file however, file saved in the .ifc format is better for the collaboration. The

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 3, January 2018

industry foundation classes have developed this link for the exchange of information between models from one platform to another.

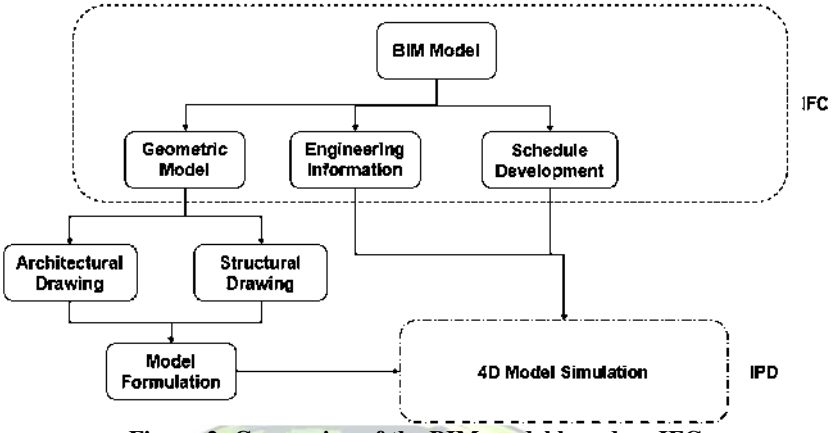

Figure 2: Conversion of the BIM model based on IFC

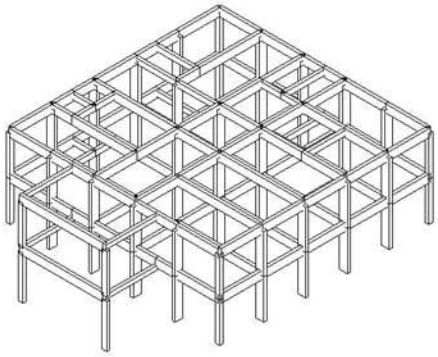

Figure 3: Structural model in Revit

Figure 4: 3D model in Revit

IV. DISCUSSION

4D IPD Models provides construction project visualization, CPM scheduling, supply chain management, cost management, risk management, interoperability with 3D CAD and industry standard project management software all focused on virtual construction engineering simulation.

4D BIM enables construction product development, collaborative and transparent project implementation, partnering with the supply chain and production of components. The aim of 4D Model is clearly to deliver technology which supports the construction delivery team and survives the dynamics and demands of the construction industry. If construction is a series of problems to be solved, then 4D Models are the tool of choice to meet that challenge—enabling users to explore options, manage solutions and optimize results.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 3, January 2018

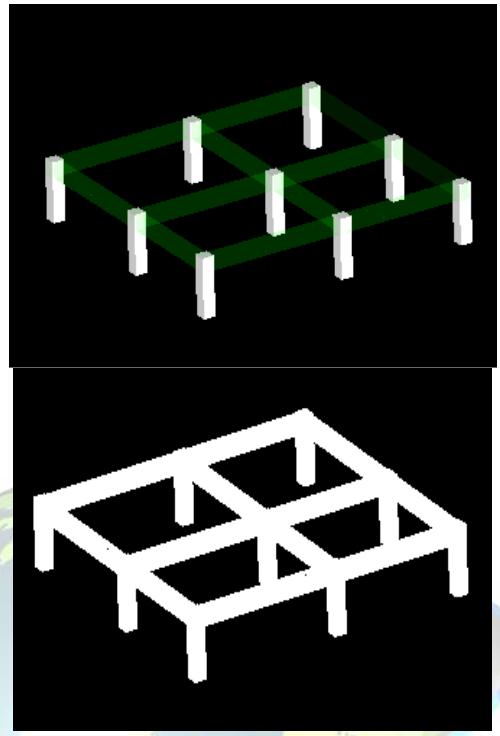

Figure 5: Simulation of 4D model in Navisworks

V. CONCLUSION

This paper helps to analyze daily construction labor productivity using a BIM 4D model and associated properties. This research found that productivity information is an essential ingredient of construction progress monitoring and control. This paper discussed the process of 4D BIM modeling, productivity and analysis.

a) It is possible to represent productivity using visual progress via a 4D BIM model. Productivity has a cost-time compound measure that considers the manpower required and the quantities being produced.
b) This research is limited to IS 7272 based productivity analysis regarding work packages of construction.
c) 4D IPD models helps to visualize the work, tracking the project work would be manageable.
d) The construction of the 4D models enables the AEC personals to visualize the entire duration of a series of events and display the progress of construction activities through the life time of the project
e) This approach towards project management technique has a very high potential to improve the project management and delivery of construction project, of any size or complexity

REFERENCES

[1] R. Navon, Research in automated measurement of project performance indicators, Autom. Constr. 16 (2) (2007) 176–188.
[2] R.J. Scherer, S.-E. Schapke, A distributed multi-model-based Management Information System for simulation and decision-making on construction projects, Adv. Eng. Inform. 25 (4) (2011) 582–599.
[3] C. Eastman, P. Teicholz, R. Sacks, K. Liston, BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors, John Wiley & Sons Inc., 2008.
[4] Christo Ananth, Vivek.T, Selvakumar.S., Sakthi Kannan.S., Sankara Narayanan.D, "Impulse Noise Removal using Improved Particle Swarm Optimization", International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), Volume 3, Issue 4, April 2014,pp 366-370
[5] Jim Jacobi, P.E, 4D BIM or Simulation based modeling, Insights, STRUCTURE magazine, pp 17 – 18, April 2011.
[6] American Institute of Architects, Integrated Project Delivery: A Guide, 2007
[7] Mikael Laakso, The IFC Standard - A Review of History, Development, And Standardization, Journal of Information Technology in Construction – ISSN 1874-4753, Vol 17 (2012) pp 135 – 161.
[8] IAI (1999). An Introduction to the International Alliance for Interoperability and the Industry Foundation Classes. Ed. Wix J and See R. International Alliance of Interoperability (IAI). Specification Task Force, pp. 21