Visualization and Implementation of 4D CAD Modeling for Planning & Scheduling for a Residential Building Construction Project

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ABSTRACT

This study presents a Visualization and implementation of 4D CAD Modeling for Planning & Scheduling. The current planning process is largely manual and time-consuming. There are number of traditional methods for planning and scheduling of construction projects like Bar chart, CPM network technique. One of the technologies developed to improve the coordination, communication of data, design, planning and visualization of construction projects is "Four Dimensional Computer Aided Design (4D CAD)". 4D CAD model is a computer generated model of structure. 4D models can give a clear picture of project & idea to future possible impact while planning which will occur during construction. 4D model is the promising tool for construction planning. If only converting this 2D drawing is a tedious task, combining these 2D drawings with safety. Planning creates more difficult tasks. In order to address the problems, this paper discusses our research in integrating construction scheduling and safety planning in a 4D environment. Use of 4D Model contributed in time saving and ultimately cost of construction by reducing the delay. 4D models help to improve construction plans as compared to traditional planning tools.

Keywords: 2D CAD Drawing, 4D CAD Model, Construction Planning and Schedule, MSP.

I. INTRODUCTION

In construction industry planning & scheduling contributes the important part of management of any construction project. For completion of the project successfully, efficient planning is required. Nowadays, construction projects are becoming more and more complicated in nature. The current planning process is largely manual and time-consuming. There are number of traditional methods for planning and scheduling of construction projects like Bar chart, CPM network technique. No methods can give the modeling and visualization of the sequence of execution of construction activities as well as proper workspace logistics.

II. ISSUE IN CONSTRUCTION PLANNING AND 4D CAD MODEL

"Plan your work and work your plan." (Vince Lombardi)

A. Planning-

Planning is the first step of project management philosophy of planning, organizing and controlling the execution of the projects. Project planning and project scheduling is two separate and distinct function of the project management. Construction planning is playing an important role within the development of construction industry. An efficient and effective planning method is intensively needed to enhance the project performance and to minimize the risk of cost overrunning and delays.
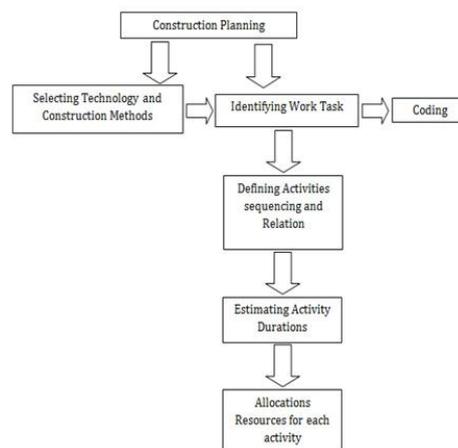
Figure 1: Construction Planning Process

B. 4D Cad Model-

A aims to study different aspect of 4D cad modeling and to find out its impact on the construction planning process, and how to benefit most from this technology. Construction planning is a challenging and essential activity in the execution and management of construction projects. In addition, 4D modeling contributes in achieving detailed and accurate work plans, planning of temporary structures, quantity takeoffs and managing site logistics. In order to get diagrammatic presentation of scheduling, the four dimensional computer process aided design models will be an effective solution. The industry must have systems in place to improve documentation, co-ordination and communication both in the planning stages and in the field. One of the technologies developed to improve the coordination, communication of data, design, planning and visualization of construction projects is "Four Dimensional Computer Aided Design (4D CAD)". 4D CAD model is a computer generated model of structure. Therefore it is used to stimulate graphically.

4D models can give a clear visualization picture of project & idea to future possible impact while planning which will occur during construction. The findings confirm that the 4D model is more rational, more convenient and efficient than the 2D model regarding all results of statistical and multi criteria analysis. 4D CAD minimize the cost overrunning & delays. 4D model is the promising tool for construction planning. If only converting this 2D

drawing is a tedious task, combining these 2D drawings with safety. Planning creates more difficult tasks. In order to address the problems, this paper discusses our research in integrating construction scheduling and safety planning in a 4D environment. This method helps to measure level of application of constructability principles using 4D CAD on construction design. 4D models are linked with each design units with corresponding time schedule. The fourth dimension in the 4D CAD model is the time schedule. They must allocate right resources and adjust the schedule more effectively. Incorporating this rationale, a prototype system named 4DX has been developed as a distributed collaborative 4D based planning environment and used for the verification testing of the method. The findings of the preliminary testing shows the proposed approach and prototype achieves distributed real-time collaborative 4D construction planning, and can subsequently achieve a robust plan and full 4D CAD simulation. Use of 4D Model contributed in time saving and ultimately cost of construction by reducing the delay. 4D models help to improve construction plans as compared to traditional planning tools. For which planner needs to estimate the location, timing & intensity of the impact that are caused by planned construction work. By implementing this model in actual practice, results were obtained and from these results they set conclusion.
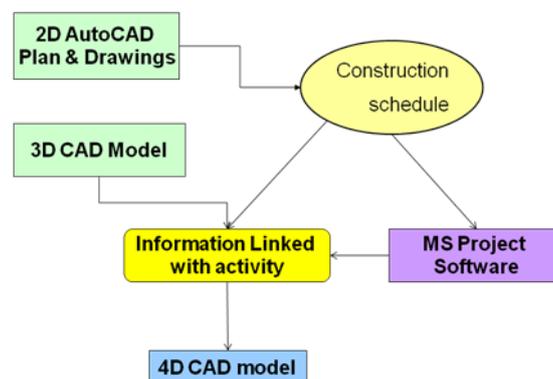

Figure 2: Generation of 4D CAD Model.

With the help of better visualization and communication, the planners, project team and client can accomplish a better and common understanding of the project scope and objectives, which can ameliorate the construction planning and execution process significantly leading to the project success.

OBJECTIVE:
1. To study the importance 4D CAD Modeling in construction projects.
2. It gives the co-ordination and interconnection of contractor's schedule of activities running at site.
3. It shows the status and progressive construction activity at any all time in the project.
4. 4D CAD model gives the better visualization to the personnel's work experience on the project.
5. It helps to better control and showing execution of activity of project.
6. To study the impact of 4D CAD model on planning and scheduling of the construction projects.

III. RESEARCH METHODOLIGY

The research methodology includes the study of literature survey and Development of model. The study of various papers, Journals of national and international project management and some points of concepts learned from websites, from these literatures review the concepts of generation and development 4D CAD model is understood.

3.1 LITRATURE REVIEW:

3.1.1 4D CAD Model:

Mr. Abhimanyu Basu PE PSP studied 4D scheduling- A case study. He addresses 4D scheduling indicates focus on certain areas such as visualization, communication, preconstruction planning, collaboration, planning, scheduling and constructability. 4D models can to help and giving a clear picture of project & idea to future possible impact while planning which will occur during construction. It appears that the benefits of 4D scheduling that saving in cost and schedule, risk reduction, improved quality, and the claim on the models to communicate project parameters [1].

Sangyoon Chin, et.al studied Real-time 4D Cad + RFID for project progress management. They addressed applied 4D Cad in process of RFID (Radio Frequency IDentification) such as status of ording, delivery, receiving and erection of building element [20].

Sai Yerrapathruni, John I. Messner, et al., studied the improvement in planning by using the 4D CAD and immersive virtual environment (IVE). They investigated the feasibility of using an immersive, 3D virtual environment to view and generate the 4D models to improve the construction project [19].

Wei Zhou, et.al studied An Interactive Approach to Collaborative 4D Construction Planning. They addressed the planning process by providing a unique 3D model input, which can be manipulated in effective user system interaction leading to compressive simulation. A prototype system named 4DX which developed as a distributed 4D based planning environment and user verification: testing of the method. [24].

Jan Tulke and Hanff Jochen studied the sequence planning for 4D construction. For that they suggested a solution for creating the time schedule and 4D simulation based on data stored in building model. In this paper they studied how to reduce the time for creating the 4D models. This paper deals with the current practice of creating 4D CAD model and the model created with the help of data stored in a building model, i.e. new approach for development 4D CAD model. This new approach consists of 3D geometrical model with schedule which is created at the time of calculation of quantities. Due to this, the scheduling is done with more precision and Bill of quantity is connected with the Building information model. They tested their new simulation approach on a high rise building in Germany which was a corporate office building involving number of activities [10].

3.1.2 Application on Construction Project:

Rahul B. Manchare, and Prof. Hemant H. Salunkhe (2015) studied applicability of 4d cad modeling in construction projects. They stated that 4D CAD model can save valuable resources such as time and money for a project having considerable difficulty and complexity [32].

Mohammad Rohani, et.al (2016) studied Operation Planning of Concrete Box Girder Bridge by 4D CAD Visualization Techniques. They addressed that this project simulates operational assembly-line for Box Girder Concrete Bridges can able to optimize the sequence and interaction of project activities and provides an efficient technology for reducing time and cost through planning and controlling resources, machines and materials [36].

Changyoon Kim, et.al. Applicability of 4D CAD in Civil Engineering Construction: Case Study of a Cable-Stayed Bridge Project. They addressed that a case study of cable stayed bridge project construction was analyzed and modeled using the 4D graphic simulation and developed three different levels such as activity, discrete operation, and continuous operation and result are presented for the cable stayed bridge construction [26].

Marcel Broekmaat and Bauke de Vries studied Implementation Scenarios for 4D CAD in Practice. They introduced proposed development of the software which wills effective on more cooperative and integrated work and name of software is SAP which might be widely implementation for new complexity work [15].

3.2 DEVELOPMENT OF MODEL:

4D CAD models are developed for RCC frame structure. Model is a G+5 residential apartment building. Conclusions will be evaluated on the basis of worthiness, for the time required to develop the 4D CAD model of different structures on the level of its difficulty and its use on actual site.

A. Creating 2D drawings.

Auto CAD is used for creating 2D drawings. Then 2D drawing is imported into the Auto CAD 3D for creating 3D model. Schedule of construction activities are created by using Microsoft project and finally construction schedule is linked to the 3D model with the help of Autodesk Naviswork manage.
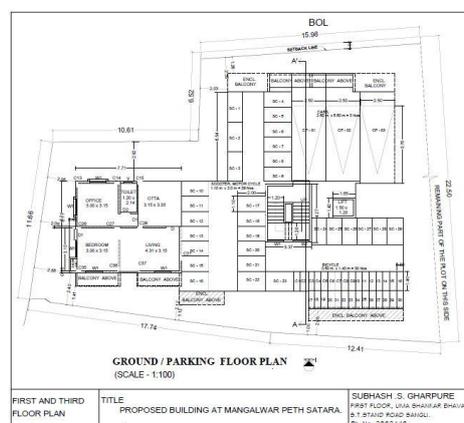

Figure 4: Ground / Parking Floor Plan
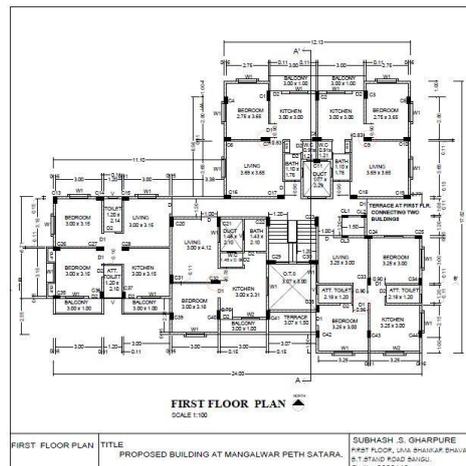
Figure 3: First Floor Plan

B. Procedure for developing 4D CAD model:

Development of 4D CAD model is nothing but attaching the construction schedule to the 3D geometrical model, both created by using various software tools. In this study the software tools used for creating model are, Auto CAD, MS project and Autodesk Naviswork manage.

MODEL:

The model is the construction of residential buildings of G+5 at Satara. There are 1BHK and 2BHK flats on each floor. The building consists of parking at ground floor, overhead water tank and lift. The RCC framework is taken into consideration for developing 4D model. i.e., beams, columns, and slab at each floor. The construction schedule is made with the help of Planning Engineer on that project. Total 8 working days are utilized for development of model from 2D to 4D.
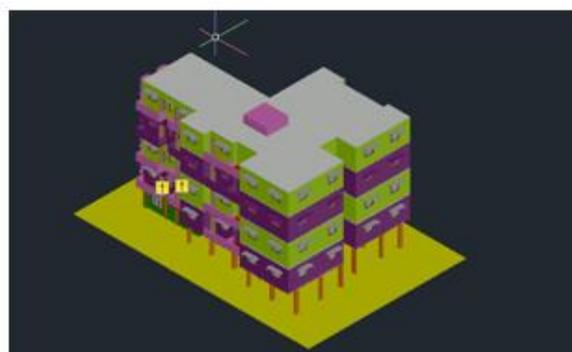

3D Model
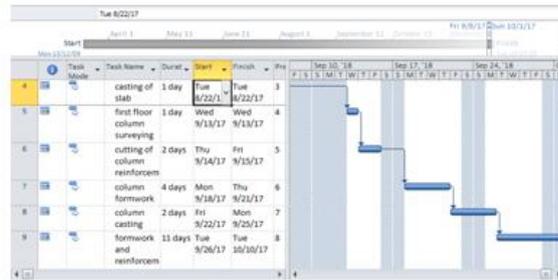
Construction schedule
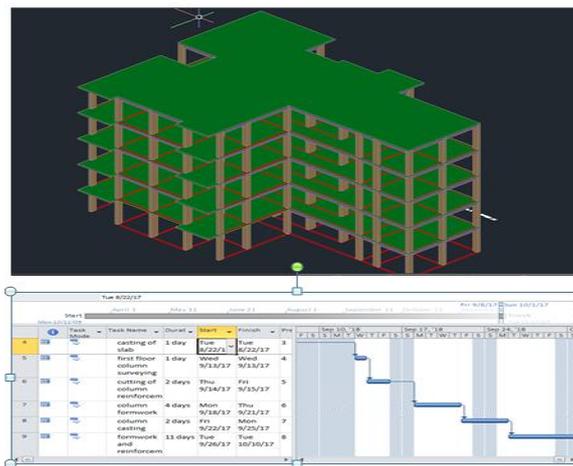
4D Model

Figure 5: 3D Model, Construction Schedule, 4D CAD model for Residential building.

IV. CONCLUSION

The current planning process is largely manual and time-consuming. 4D models can give a clear picture of project & idea to future possible impact while planning which will occur during construction. 4D model is the promising tool for construction planning. 4D models are linked with each design units with corresponding time schedule in MS project. The use of the 4D CAD model has twice reduced the occurrence of mistakes in the construction process and helped the participants with faster detecting and fixing the errors.

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