

Building Information Modeling (BIM)-4D Visualization

Sonali Pandit¹, Er. Bhupinder Kaur², Er. Sandeep Salohtra³

¹Pursuing Master in Civil Engg. from Chandigarh University Punjab India

²Associate Professor in CSE Department at Chandigarh University Punjab India

³Head of Department in CE Department at Chandigarh University Punjab India

Abstract - Building Information Modelling is a technique which creates, manage or generate a model by taking physical and functional characteristics of building by using digital presentations. Term 4D means fourth dimension which represent time i.e. 3D work added with scheduling (time). 4D BIM gives new sight to the project i.e. 4th dimension BIM added time in computer with 3D CAD solid models [10]. BIM tools are used for analyzing or assessing the building performance also BIM evaluate thermal performance of buildings by using sensing data, analyzing heat of building and BIM database [14]. The 4D visualization is a technique who generalized reflective analytical activities and also cognitive activities of site management. 4D CAD model gives double efficiency with limited time resources. Also 4D models are helpful to speed up the construction process hence reduces the mistakes and remove them quickly [9]. Concerning with the safety aspects information of design phase and scheduling are properly calculate to formulate a 4 dimensional (4D) model, after that actual site monitoring data continuously compared with the 4D model between the construction process[1]. 4D CAD based upon the project planning, formalizing, scoping and synchronizing the structure. 4D-models identify schedule shortcomings and also detect delays for safety management using visualization. Therefore, the safety measures are properly visualized by 4D models by verifying cost.

Key Words: Building Information Modelling (BIM), Visualization, 4DCAD, thermal performance, scheduling, 3D.

1. INTRODUCTION

1.1 What is 4D BIM?

BIM 4D:- 4D BIM technique is widely used in CAD industry in which 3D CAD assemblies are intelligently linked with time scheduled informational work. Each component or assembly in a model gives all information about creation date of model it's possibly and destruction time. 4D visualization create beneficial aspect to overview or visualize entire duration of process properly and also display of progress through entire journey or lifetime of project [19]. The generations of thoughts are achievable by replacing ancient or long-established drawings with 3D models with additional information about the project. Model should represent well-designed parts of the structure beam, walls and windows, etc. Everything associated with number of properties and detailed work depending upon the component's type which create material schedules or help in creating the analytically models of the various structure [15].

Addition information create some gap but later on it can be used every function and all modification are visible properly in a model. In day today life 4D BIM provide best solution for construction work use of 2D project planning and scheduling with 4D visualization technique increases range of real time operation. 4D visualization has a potential to overview all details of project from start to finish. Automatically view project work and resources at a given time table without analyzing traditional Gantt charts and important design documents. Easy to check interoperability functions with CAD platforms to evaluate efficiency [2]. Provide quick and clear communication through immediate scheduling work updates with intelligent linking process. Immediately detect problem against space time clashes and overcome the problem early as possible.

1.2 HISTORY

Recently in last two year building information modeling (BIM) has been exposed in construction world but in reality the technologies and ideas behind BIM evolved more than 50 years. In 1957 BIM served their applications as computer aided mechanism (CAM), in 1963 used as CAD with graphical interface, in 1975 used as (BDS) Building Description System, in 1982 served as 2D CAD, In 1987 served as a ArchiCAD, later on in 1992 it is officially termed as Building Information Model, in 2000 used in Revit, in 2001 served as NavisWorks, in 2002 used as Autodesk buys Revit as well as in 2007 served as Autodesk buys NavisWorks. In 2008 served their function Parametricist Manifesto and in 2012 used as a formit program.

1.3 WHY WE ARE DOING THIS?

In 1998 4D BIM is discovered by Sir John Egan in his report "TECHNOLOGY AS A TOOL" there should be huge benefits achieved after eliminating rework and wastage of time. 4D BIM creates new dimension i.e. time to 3D CAD work every sequence of series or events are properly evaluated in a time line i.e. construction sequence can be properly reviewed by using 4D BIM[5]. 4D BIM or 4D Visualization is advanced construction management technique used by project work team or delivery team who work on large end projects. 4D BIM is commonly used in construction of tunnels, tall buildings, highways, bridges, hospital complexes, hydro electrical power generation plants which are associated with time and cost.

1.4 WHY RESEARCHER ANALYSES 4D MODELING APPLICATIONS?

In construction project management work there are some difficulties arises visualizing the work progress as well as planning in space and also integrating information or strategies between stakeholders. Properly concentrate on time, cost and quality become harder for construction industry. 4D BIM gives improved version to plan, build, and design, maintain or create standardized information model which contain all appropriate information about life cycle of construction project [13]. According to researcher point of view 4D models connect, temporal, intimately aspects of project work allow users to visualized construction work and provide better schedule understanding, improved communication, create easier logistic management and detect error before execution [18]. 4D Modelling oftenly used colors for representing different construction states. It provide ideal color scheme for understanding model analysis.

1.5 MOTIVATION OF THE WORK

The biggest error or difficulties arises in 4D models is that in 4D visualization internal activities visualization is not possible only external activities or representation of visible activities are possible. In large scale interaction with 3D model generally discussed as compared to 4D visualization. 4D Models cannot be spread in wide scale until it is integrated by existing planning and also with some analytical tools that generate decision making automatically in construction industry. The lack of agreement in visualization standard and representation of building elements or activities create lots of problem in construction industry [1], [6], [16], [17]. The aim of this review paper is to face the challenges or solve the problem which relates with 4D visualization work and provide motivation to other researcher to analyze these kinds of problems.

2. LITERATURE REVIEW

2.1 PRESENT STATUS OF RESEARCH IN THIS AREA

According to survey conducted on BIM in all over the world the adoption of 4DBIM increases day by day. BIM become important or essential part of construction industry. It provides better communication, coordination and visualization etc. BIM application received at different levels is accepted in different countries. The country like US where BIM is not only accepted but became compulsion at large extent [11]. General Service administration initiates a rule in 2007 to produce 4D BIM model for making spatial program validation.

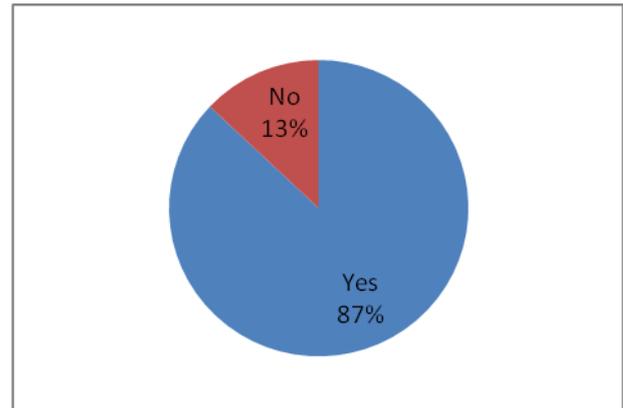


Fig.1. Interested in adopting 4D BIM

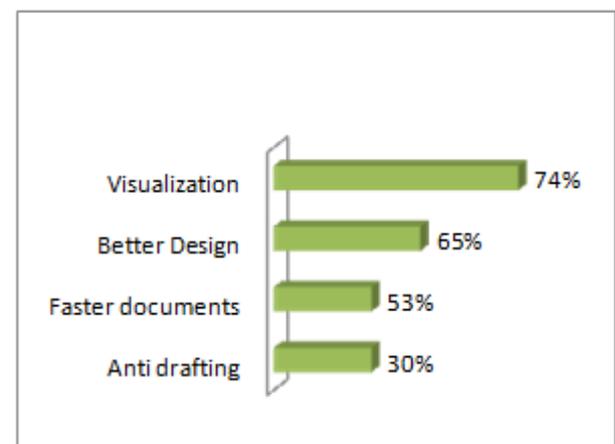


Fig. 2 Acceptance of BIM which appeals the most

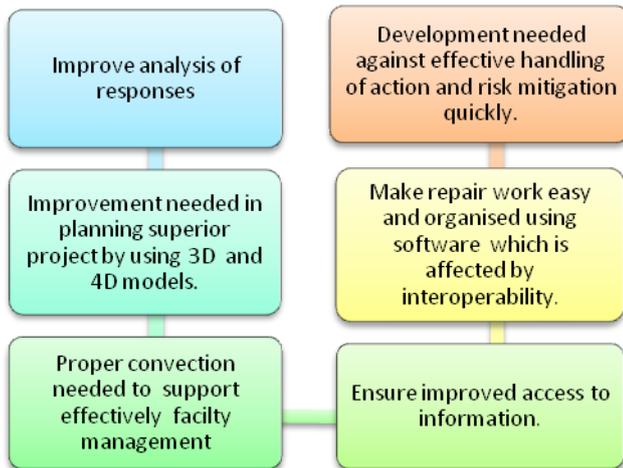
The two main objective of BIM is to calculate percentage of usage of BIM in AEC companies and the other is to record benefits obtain from BIM. These kind of survey identified the difficulties arises to understand the complexity of BIM and 4D Visualization. Lack of interest between contractors and clients generate problems in industry.

2.2 CODAL PROVISION

The IFC (Industry Foundation Classes) It is a basic platform which contain neutral format file with large open specifications, discovered by the building SMART. The main objective is to create data model which are able to achieve lot of information about building infrastructure as much as possible. The IFC standards are registered under ISO and these are official International Standard written as ISO 16739:2017, Each BIM software being capable to read properly and write such type of file format. The framework of an IFC file is totally made on the basic of entity-relationship models. It is generally analyzed or imagined the concept of relative database, in which each and every entity is joined with each other by various relations. All attachments are very important; therefore collecting such type of basic information about every node it is important to evaluate geometry and location of the structure, the possibility to gain extra knowledge about materials,

connections and manufacturers with other components (e.g. connection between walls and beam), etc. It is very critical to analyze that these characteristics are not similar to the arrangement of number of properties attached to each component or element. Further these attachments are the part of references attain by other entities [8].

2.3 RESEARCH GAP



2.4 CURRENT RESEARCH DONE BY RESEARCHER

1. **Author Name:** Chau et al.

Research Paper: 4D Dynamic construction management and visualization software: Site

Year: 2004

Conclusion: 4D simulations program can be used strategically at site work for evaluating progress of visualization, utilization, allocation and estimating quantities by using 4D simulation applications.

2. **Author Name:** Chau M. et al.

Research Paper: 4D Dynamic construction management and visualization software Development

Year: 2004

Conclusion: Use of 4DSMM powerful information platform system 4D GCPSU has been fully developed.

3. **Author Name:** Wang L. et al.

Research Paper: 4D modeling to advance construction visualization in engg. education.

Year: 2007

Conclusion: Virtual construction simulator prototype with 4D CAD generated interfaces which allow user for developing a construction program by selecting objects of 4D CAD Models.

4. **Author Name:** Zhou et al.

Research Paper: Application of 4D visualization technology for safety management in metro construction.

Year: 2012

Conclusion: In case of safety management and risk rate judgment use of visualization technology implementation in metro construction area provide the real time monitoring data in 3D visuals.

5. **Author Name:** Zanen et al.

Research Paper: Using 4D CAD to visualize the impacts of highway construction on the public.

Year: 2013

Conclusion: By applying color coding on the surfaces were pretty much helpful for designing 3D objects. These methods also visualized different types of impacts and magnitudes on highway projects work.

6. **Author Name:** Trebbe et al.

Research Paper: 4D CAD models to support the coordination of construction activities between contractors.

Year: 2014

Conclusion: 4D CAD model very much helpful to aligned the different co builders design with their advanced construction operations and planned construction schedules.

7. **Author Name:** Han et al.

Johansson et al.

Leon L. et al.

Research Paper: Appearance based material classification for monitoring of operation level construction progress using 4D.

Year: 2015

Conclusion: Point cloud models generated eventually at the construction site by using SFM and MVS images which are based on 3D reconstruction methods.

8. **Author Name:** Jupp et al.

Kim et al.

Murguiaa et al

Natephra et al.

Research paper: Integrating 4D Thermal Information with BIM for Building

Envelope Thermal Performance

Analysis and Thermal Comfort

Year: 2017

Conclusion: 4d construction scheduling creates better environmental planning which is integrated properly during construction of 3D and 4D Models.

Use of immersive VR technique provide better design visualization

CBA methods when combined with the 4D models for achieving better construction goal create flow integrating BIM model which provide 4D thermal information automatically.

2.5 SOFTWARE USED IN BIM 4D VISUALIZATION

The 4D Models are prepared in Autodesk NavisWorks. The creation of BIM model starts with collecting important data from Revit model. Next step is to assign each and every component at its place. The process is divided into some categories. These Categories are divided in three level i.e. creating, destructing and temporary levels. After assigning Revit's creation and destruction levels next step is to attached components with them, now only procedure left is to set up the starting and the ending data of each task. By setting up all of them in sequence it is very easy now to create 4D Visualization model of any structure [5],[8],[10],[21]. Setting of Visual of materials is simultaneously copied from Revit, therefore if everything set at its place properly than there is no need of any work. Also for number of building services different software are used for creating 4D models:-

- 1) Tekla Structures and Robot Structural Analysis software are used for structural engineering purposes.
- 2) Revit MEP and Magi CAD, NAVIS Software are used for building service purposes.
- 3) Synchro vico and BIM Measure are used for project management purpose.
- 4) Bentley Facilities and Arts A. are applicable to check sustainability analysis i.e. 4D Building Studio with Design Builder are used for facilities management.

3 METHODOLOGY

1) Selection of academic publications

Selection process of academic publications used in this study is derived from the methodology which is adopted from different review articles. The commonly followed literature adoption processes in review paper include number of steps, which are told about from where researcher collect literature database, preliminary data, search rules and double-check screening. According to the principal, this study only provides reviews journal articles which are based

on 4D BIM. This process generally graved to collect preliminary search data and literature filtration views, therefore identifying the articles related to 4D BIM is most relevant [6],[7],[9].

Step 1: Select target journals.

Step 2: Perform adequate research on BIM-related studies.

Step 3: Identify the relevant BIM applications on building structure based on the knowledge of 4D BIM.

2) Data Collection

Analyze different kind of environmental data based on air temperature, air-flow, solar radiation patterns, lighting levels and humidity can be collected properly [6]. According to current survey air temperature and humidity of the building can be easily evaluated by using sensors at regular intervals. Collection of raw data contains numerical values of dry-bulb temperature, timestamp, relative humidity etc.

3) Selection of BIM software used

According to academic studies standardization, this study gives review about current BIM software's and their applications which are developed to enhance the sustainability as well as performance of building throughout the lifecycle process. Based on the behavior of 4D BIM according to definition 12 kind of popular BIM software are specially designed and developed to analyze infrastructure of sustainable buildings and smoothly solved problems by choosing from 4D BIM Tools Matrix.(Tekla Structures and Robot Structural Analysis) for structure engineering programs, (Revit MEP and Magi CAD, NAVIS Software) for building programs[8],[10], Synchro vico and BIM Measure used for project management, Bentley Facilities and Arts A. for sustainability analysis used by Building Studio and Design builder work.

4) Analyze review methods and the development of "4D VISUALIZATION" program

The outcome coming from this review process is to develop "4D VISUALIZATION" model which creates connections between BIM as well as structures which are bonded together in to a main framework [6],[9] and [17]. There are four-step methods which are generally used to develop the "4D VISUALIZATION" program which are written as under:

Step1: Specify the field of objects related to the subject which are classified properly after reviewing it.

Step2: Properly define and analyze the important properties of objects.

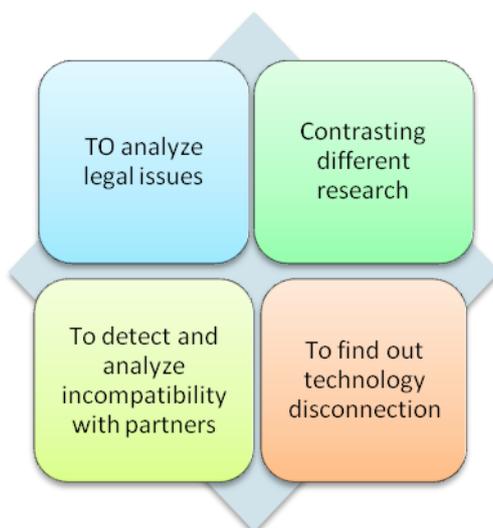
Step3: Evaluate the similarities and differences generated in different review papers by analyzing them. Especially BIM software based on the structure attributes and project phases.

Step4: Determine properly whether considering reviewed papers and their applications display similarity to the authority task in a common ground or not.

5) Create Building Model

Firstly draw a building model in Autodesk Revit 2015 which is very intuitive. After that the main thing is to do is import all DWG files into Revit software. This criterion is very easy to install. Now proceed with the creation of levels in each story. It may be also helpful to draw levels for each stair landings. Next step is to analyze seriously the types of components which we want to construct like walls, floors, slabs, beam stairs etc. There is complete freedom given to create number of partition layers. Only one thing is to remember in your mind is to choose standard materials, not according to your choice. After this the process of creation of the model is to be started. At first stage, the existing condition of the structure should be evaluated. Then next step is to copy all important components into design options. After doing this the modelling of alternatives realizations should be followed. At the first stage starting phases should be properly set up, than later on each element should be created. Now assign the optional and destruction phase. Emerges of few obstacles are normal during creation of model process [8],[10],[16],[18]. Therefore when some of the component needs cutting in the opening of the wall in every stage, the opening should be clearly visible in designed model during the moment of construction of the wall. It creates huge distraction in the program. The journey of creation of model managed easily and verified properly by reviewing 3D view.

4. Objective



5. Conclusion

BIM 4D Visualization technologies provide highly advanced or construction or industrial management skills to monitoring environment, in project scheduling and also used by project team for project control [6]. The given task

properly executed with planned and accurate dates are defined by Gantt chart Performa. Comparing with each other plans and dates the given status bar shows progress of work to the project team in a simplest form. 4D BIM gave actual representation of construction work and also provide information about construction plan. 4D model include all construction activities and also provide safety measurement against risk mitigation or actions [5]. Design of 4D modelling software i.e. Autodesk Navisworks 2017 found very easy to adopt or learn which help AEC and construction industry for better outcome of construction project [8],[10]. Duration of case study also create few shortcomings for e.g. it required adequate training staff, highly skilled people, software's cost and also cost of software training program. Therefore, this review paper implements that 4D BIM model act as a promising tool in construction industry. The main aim of BIM 4D models is to provide better visualization at construction site, it is also helpful achieving accurate work plan, details, increased planning efficiency, provide communication between project and project team and also improved safety aspects [7],[12],[18],[20].

6. ACKNOLEGEMENT

This review paper was supported by Chandigarh University, Punjab India and also Department of Civil Engineering. I love to thank my guide Associate professor Er. Bhupinder kaur Department of computer science engineering and my Co guide Er. Sandeep Salohtra Department of civil engineering who provide insight and expertise that greatly helps me to continue this research and write this review paper.

7. REFERENCES

[1] Botton, C., Kubicki, S., Halin, G. (2013). Designing adapted visualization for collaborative 4D applications. *Applied Energy* 134 (2013) 531-549. Doi: 10.1016 / 0003-4916(63)90068-X.

[2] Chau, K.W., Anson, M., De, D.D. (2004). *Sar4D dynamic construction management and visualization software: 2. Site trial* (2004). *Proceedings of the IEEE ICRA, Karlsruhe*.

[3] Chau, K.W., Anson, M., Zhang, J.P. (2004). *4D dynamic construction management and visualization software: 1. Development* *Computing in Civil Engineering* 27 (2013) 645-656. doi: 10.1061/ (ASCE)CP.1943-5487.0000273.

[4] Garrido, A.C., Calcedo, J.C.S., Rodríguez, A.M.R. (2017). A quantitative analysis on the feasibility of 4D Planning Graphic Systems versus Conventional Systems in building projects *Automation in Construction* 43 (2017).

[5] Han, K.K., Golparvar, Fard, M. (2013). Appearance-based material classification for monitoring of operation-level construction progress using 4D BIM and site photo logs. *Proceedings of the CIB W78 International Conference, Beijing, China, 2013*.

- [6] Jupp.J (2017). 4D BIM for Environmental Planning and Management. Infrared method (1999).
- [7] Johansson.M, Roupé.M, Sijtsema.P.B (2015). Real-time visualization of building information models (BIM) ASHRAE Journal (2000)5. 51.
- [8]Kacprzyka.Z, T.K.p (2014). Building Information Modelling- 4D Modeling Technology on the example of the reconstruction stairwell.Computer Society doi:10.3389/fmicb.2011.00006. s
- [9] Kim.C, Kim.B, Kim.H (2012).Automatic 4D CAD model updating methodology. <http://buildingsdatabook.eren.doe.gov/DataBooks.aspx;2012> [accessed 13.05.3].
- [10] Kacprzyka.Z, T.K.p (2014). Building Information Modelling- 4D Modeling Technology on the example of the reconstruction stairwell.Computer Society doi:10.3389/fmicb.2011.00006.
- [11]Kumar.J.V, Mukherjee.M (2009). Scope of building information modeling (BIM) in India. Dept. of IIT Roorkee India.
- [12] Leon L. olde Scholtenhuis, Timo Hartmann, Andre G. (2015) 4D visualization used in highway projects.
- [13] Moon.H.S, Dawood.N, Kang,L (2014). Development of workspace conflict visualization system using 4D object of work schedule automation in Construction 43 (2014) 73–83. 15
- [14] Murguiaa.D, Brioso.X(2017) .Using “Choosing by Advantages” and 4D Models to Select the Best Construction-Flow Option in a Residential Building proceeding of the IEEE ICRA, Karlsruhe, 2017.
- [15] Natephra.W, Motamedi.A, Yabuki.N, Fukuda.T (2017). Thermal Information with BIM for Building Envelope Thermal Performance Analysis and Thermal Comfort Evaluation in Naturally Ventilated Environments Proceedings of IBPSA, Eindhoven, Netherlands, 2003
- [16] Reizgevičiusa.M, Ustinovičiusb.L, (2013). Romas Rasiulisc Efficiency Evaluation of 4D CAD Model proceedings of the Annual ACM Conference on Human Factors in Computing Systems, Seoul Korea, 2013.
- [17] Scholtenhuis.L.L.O, Hartmann.T, Dorée.D (2015).4D CAD Based Method for Supporting Coordination of Urban Subsurface Utility Projects. Revit API, Informs de la Construction 66 (536). doi:10.3989/ic.13.151.
- [18] Trebbe.M, Hartmann.T, Dorée.A (2014). 4D CAD models to support the coordination of construction activities between contractors Bordeaux, France, 2014. Doi: 10.21611qirt.2014.133.
- [19] Zanen.P.P.A, Hartmann.T, S.H.S. Jibouri.AL, Heijmans.H.W.N (2013). Proceedings of the PLEA2012 International Conference, Lima, Per, 2013.
- [20] Zhou.Y, Ding.L.Y, Chen.L.J (2012). Application of 4D visualization technology for safety management in metro construction appropriate building construction in tropical and subtropical regions, SKAT, 199.s
- [21] Zmrhal. V, Hansen J, and Drkal F (2003). Modeling and simulation of a room with a radiant cooling ceiling, in: Proceedings of IBPSA, Eindhoven, Netherlands, 2003.s
- [22] Zrijal. H, Humphreys. M, and Nicol. F. (2015) Adaptive thermal comfort in Japanese houses during the summer season: Behavioral adaptation and the effect of humidity, Buildings, Buildings 5 (2015)1037–1054. Doi: 10.3390/buildngs503103