

Making a Construction Project More Efficient using Clash Detection Tool of Building Information Modeling

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Abstract - This review paper summarizes how Building Information Modeling (BIM) has emerged as a highly efficient solution for information management in the Architecture, Engineering, and Construction (AEC) industry. In the Indian construction scenario, most of the projects are still using a 2D CAD drawing for their design and execution purpose. These 2D drawings have a lot of limitations during execution like miscommunication, misunderstanding, and time-consuming, etc., This type of errors will be reduced while using BIM process. Clash detection tool is an application of BIM which is used for the coordination of building systems within 3D building models. This review paper gives a brief idea about how effective clash detection in BIM is and it focuses on the methodology involved in conducting clash detection analysis using Building Information Modeling software. Also, this tool is used in foreign countries due to its efficiency in improving the construction work. This work also involves finding out, how this clash detection tool helps to optimize the cost and time for the construction using BIM Coordination. The benefits and drawbacks of 4D BIM model were discussed. In this study, commercial software such as Autodesk Revit 2018, Autodesk Navisworks Manage 2019 are used. It also focuses on the process of simplifying and standardizing the process of Clash Detection using Autodesk Navisworks. The researchers have unanimously found that total cost of the project will not be increased and surety of completion of the project on time avoids overruns by using clash detection.

Key Words: AEC Industry, Building Information Modelling, Clash Detection, Autodesk Navisworks, Autodesk Revit.

1. INTRODUCTION

For the last few years in the construction industry, the complexity of modern-day construction projects has increased. And no significant improvement in the productivity of the construction industry has been observed. The productivity of the construction industry has traditionally been much lower than that of other industries because the main reason for this shows to be the incapability of new technologies. As other industries have improved their productivity by using new modified methods and techniques. The construction industry is also applying new technology such as Building Information Modelling (BIM) to assist better the productivity of Construction Project Management.

A BIM consists of 3D models of the project with links to all the required information connected with the projects planning and construction or operation. BIM is a 3D modelling which involves 4th dimension as time (4D), 5th dimension as cost (5D) and information database of the project, 6th dimension is related to Energy, Efficiency, Sustainability (6D) & 7th dimension is related to Facilities Management (FM)(7D).

The National Building Information Modelling Standards (NBIMS) committee of US defines BIM as, "a digital representation of physical and functional characteristics of the facility. A basic premise of BIM is the collaboration by different stakeholders at different phases of the life cycle of a facility to insert extract, update or modify information in BIM to support and reflect the roles of that stakeholder".



Fig -1: Clash detected between a beam and HVAC duct.

2. CLASH DETECTION

Clash detection remains the primary requirement of any multidisciplinary project wherein composite design needs to be inspected for the identification of clashes. Clash Detection is the method of inspecting and identifying the various interferences which frequently occur in the coordinating process of 3D models created in different modern softwares like Revit Architecture, Revit Structure & Revit MEP. In BIM, 3D models of different types such as Structural, Civil, Architectural & MEP (Mechanical, Electrical & Plumbing) are produced. After combining all these different types of models to create a complete BIM model there will be chances of clash between these elements.

In clash detection test it detects the conflicts between different elements within 3D Building Information Model before actual construction starts, and therefore time optimization in the construction schedule, reduce costs and

change orders. By using clash detection application in AEC industry increase the productivity of design and construction project.

There are 3 main types of clashes:

1. **Hard clash:** This type of clash occurs with two objects are taking up the same space. Such as pipes passing through walls, lower ceiling height. This type of information is entered in the BIM modeling objects and hard clash provides the detection based on the geometrical as well as on semantic and rule-based algorithms.
2. **Soft Clash/Clearance Clash:** Soft clash detects clashes that occur when the object needs more positive spatial or geometric tolerances, spaces, and buffers within their buffer zone for improved accessibility, insulation, maintenance, and safety. For example, an air conditioning component may require certain clearances to allow for maintenance, access, or safety that a steel beam would negate.
3. **4D/Workflow Clash:** This type of clash might involve the scheduling of contractors, the delivery of equipment i.e., cranes, bulldozers, and materials, and general timeline conflicts. For example, work crews arriving when there is no equipment on site. Since these objects are frequently scheduled as temporary, demolished, or other schedules so link them for clash detection to make sure they do not affect to project.

3. BIM SOFTWARE AVAILABLE FOR CLASH DETECTION

There are several companies that offer clash detection software for the AEC industry. Following are some softwares which are used for clash detection in BIM

1. **Revit:** Revit is database structure and objects definition modeling, which is an effective modeling software. The preferable work practice is of course when all the modeling is performed internally within Revit. In order to satisfy the specific needs of the diverse types of specialists for Revit, Autodesk distributed the product into three types – Revit Architecture, Revit Structure, and Revit MEP. Revit software gives clash detection abilities where objects clash with each other are highlighted for improvement. This capability is, however, limited in that it does not develop reports, trace Clashes, Clash Status, Set Rules, Custom Clash Test, Clearance Tests, Time Based Clashing, or track changes.

2. **Autodesk Navisworks:** The Autodesk Navisworks products help architecture, engineering, and construction teams to develop better control over the outcome of their projects. With Navisworks solutions, detailed design models can be combined and reviewed by all project stakeholders, serving users to benefit from the competitive advantages of building information modeling (BIM) workflows. The Autodesk Navisworks software provides a Clash Detection module that checks the BIM model and shows any areas where items interfere, or “clash”, with each other. This BIM tool allows to set up the rules, identify clashes, Generate Reports, Trace

Clashes, Status Clashes, Manage Clashes, Set Rules, Custom Clash Test, Clearance Tests, Time Based Clashing. The Autodesk Navisworks software family offers three products (Autodesk Navisworks Manage, Autodesk Navisworks Simulate, Autodesk Navisworks Freedom) to provide project stakeholders with the right tools to help collaborate, coordinate, and communicate more effectively.

4. LITERATURE REVIEW

1. Ravindra SSK Medicharla, in his paper titled “Bim Usage in Construction Industry: An Application of a Modal Integration and Clash Detection Tool in Building Design”, published in July 2020, observes that BIM (Building Information and Modeling) is one of the most popular applications in modern construction industries. BIM is used to manipulate and facilitates coordination among project managers and stakeholders, and also to make better time efficient and economics of the projects. This paper is mainly focus on modal integration and clash detection of a residential building. It says that without the integration of basic Architectural plan, Structural plan, and MEP (Mechanical, Electrical, Piping) planning it is unable to find the clash detection. Here it is thoroughly explained, how the clash detection occurs in planning before being construction started, if there is no proper planning (like integration of architecture plan, Mechanical, Electrical, Piping (MEP) planning there may get clashes, and if we construct without the integration of the plans in projects that may leads to destruction at the clashes site or rearrange of the construction parts and also time-consuming process. The softwares that are used for BIM application are Auto Cad 2019, Revit2017, Navisworks Manage 2018 (BIM 360).

Also, this paper focuses on a McKinsey report regarding usage of BIM software. In that report, one study found that 75% of companies that have adopted BIM reported positive returns on their investment with shorter project life cycles and savings on paper work and material costs. Because of these benefits, various governments like Britain, Finland, and Singapore, mandate the use of BIM for public infrastructure projects. In small specialty studies, BIM appears to be increasing productivity in labor. Also mentioned in a study involving a small contracting enterprise, the impact of BIM on labour productivity was quantified and findings demonstrated a 75% to 240% increase in labour productivity for modelled and prefabricated areas. For the professionals (architects, surveyors, engineers) involved in an infrastructure project, BIM allows for a virtual information model to be communicated from the design team to the main contractor and subcontractors and then to the owner/operator with each specific professional adding specific data to the single-shared model. The whole system is designed to reduce information losses that traditionally occur especially when a new team takes over a project. Finally, this paper concludingly states that, utilizing building information modelling solutions in the construction sector resulted to higher quality work, greater speed and productivity, and lower

costs for building professionals in terms of design, construction, and operation of buildings.

2. Mr. Swapnesh.P. Raut and Dr.S.S. Valunekar, in their paper titled "Improve the Productivity of Building Construction Project Using Clash Detection Application in Building Information Modeling", published in March 2017, observes that in the 21st century, BIM has brought a revolutionary concept in the Architecture, Engineering and Construction (AEC) industry. This allows constructing a building virtually before it is built on construction field. The starting of implementation of BIM at different levels in various developed countries like USA, Australia and UK are implementing BIM to a greater level where in India, it is in total contrast to status in developed countries. The Clash Detection tool is one of the most useful application of BIM, which is useful for the coordination of systems to make the projects time efficient and economical. In this paper we focus the methodology involved conducting clash detection analysis using building information modeling software. Their research also involves the concept of BIM, status of BIM in India. As such, it is case study of a residential building which consists of an architectural, structural and Mechanical, Electrical and Plumbing (MEP) BIM models and their consequent clash detection. In their case study, commercial software such as Autodesk Revit 2016, Autodesk Navisworks Manage 2016 were used and also focused on simplifying and standardizing the process of BIM coordination using Autodesk Navisworks software.
3. Aryani Ahmad Latiffi, et al, in their paper entitled "Building Information Modeling: Challenges and Barriers in Implement of Bim for Interior Design Industry in Malaysia", published in January 2013, decodes the challenges faced by the Malaysian Interior Design Industry, as the title states. A literature review was done to explore previous BIM studies on definitions and history of BIM, construction issues, application of BIM and BIM tools in construction projects as well as benefits of BIM. Malaysian government encourages construction players to apply BIM to construction projects because it can overcome construction project problems such as delay, clash of design by different professionals and construction cost overrun. Autodesk tools have been suggested by the government as a BIM tool platform. Other tools include Revit Architecture, Revit Structural, Revit MEP, Navisworks and Cost-X. It is crucial for construction players to be aware of the importance of BIM application in construction projects. This is because BIM can be one of the conditions required of a company to qualify for government and private projects, similar to what is practiced in some other countries. Moreover, BIM helps to increase construction project efficiency and effectiveness. It can also be implemented to improve communication and collaboration between construction players. The implementation of BIM technology is expected to become more widespread in Malaysian construction industry because of the government's efforts in promoting BIM.

4. Abdi Suryadinata Telaga, in his paper entitled "A Review of Bim (Building Information Modeling) Implementation in Indonesian Construction Industry", published in May 2018, observes that Construction projects in Indonesia have been growing rapidly in the last three years. Therefore, construction management is very important to ensure completion of construction projects are within schedule and budget. Utilization of building information modeling (BIM) can increase the efficiency of a construction project. Their paper is intended to review the implementation of BIM in Indonesia through literature analysis. Based on various number of articles, the results showed that BIM research in Indonesia is still in a dearth. Building information modeling (BIM) has been widely known for having many benefits for the construction industry. Improvement of project cost control and conflict reduction are among the benefits associated with BIM. Therefore, BIM has been widely adopted in many countries to increase the productivity of construction projects. However, level of BIM utilization in construction industry varies among countries. While developed countries are among the early implementer of BIM, BIM implementation in developing countries still poses many challenges. Construction companies in Indonesia have used computer-aided design (CAD) to draw 2-D design and construction work. The 2-D drawing becomes the source of conflict during the construction phase as misinterpretation among designer and contractor frequently occurred.

To solve the conflict, designer and contractor have to clarify and change the drawing.

5. METHODOLOGY

After grasping the methodologies of various research papers, which were mainly focused on the Clash Detection Tool, the following steps explain the sequences of Clash Detection.

1. Drafting 3D model of a Residential apartment in Revit Architecture.
2. Designing structural elements like Beam, Columns, etc. in Revit Structure.
3. Introducing Mechanical, Electrical, and Plumbing Facilities in Revit MEP.
4. Exporting all three files through Autodesk Revit software as NWC file type.
5. Opening all of these files in Autodesk Navisworks Manage Software and combining/merging them to form one whole model.
6. This BIM model is used to perform "Clash tests". For this, the model is to be selected and clash type is to be mentioned, for which the clashes are to be detected.
7. After the clash tests performed, a list of all the clashes appears. Note: Clashes are generally the geometrical irregularities (for hard clashes).
8. Now, these clashes can be resolved/rectified by changing the position of the particular clashing element.
9. Conclusion: More efficient model worked out.
10. This model can save time and cost of the construction project.

6. RESULTS AND DISCUSSION

1. In the first paper we saw, how working with BIM tools helps a project efficiently. Also, these advance tools are easy to use and needs a very low expertise to work out with them.
2. Also, in a McKinsey report there were positive returns for 75% companies who had invested in BIM Tools. And a surging 75% to 240% labour productivity after the implementation of labour management tools using BIM.
3. In the second paper we can get an elaborative response towards improvement in our traditional methods of construction projects. We can see developed countries like USA, UK, and Australia are already implementing BIM in construction projects.
4. In the third paper we can observe that how early have BIM tools been implemented and mandated by Malaysian Interior Designing Industry. This shows our country lacking behind in productivity growth.
5. In the fourth paper we can see Indonesian author expressing his thoughts about the lack of knowledge and awareness about BIM in his country. We can learn not to attempt that mistake.
6. Also, the methodologies used and studied in these papers are effective and productive. And making a project effective in terms of cost, time, etc. is a potential sign of growth.
7. We have seen a heavy growth in use of BIM in Foreign Countries while setting new benchmarks.. It motivates us to use of BIM in our country as well.
8. BIM tools can make a project far more efficient. And also help in saving time and cost of a project. This may end up in good profits to everybody.
9. Autodesk Navisworks makes the clash detection process faster and easier along with completely reducing the scope of human errors during its execution. Design clashes that occur between building elements are successfully identified by Navisworks and they are timely solved.
10. Hence complete elimination of design errors, optimize time and cost is very important for AEC industry before actual construction starts on jobsite.

7. CONCLUSION

The traditional methods can no longer satisfy the work efficiency needed in this rapidly growing digital world. Building Information Modeling (BIM) is a boost within the AEC industry where its current implementation shows great effects on projects in terms of performance, time and cost. Therefore, adapting the modern-day BIM tools is an ultimate conclusion.

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