

Application of Building Information Modeling for an Institutional Building

Sam Joseph*, Rahul Sasikumar, Malavika Anil and Prasanna Venkatesan R

School of Civil Engineering (SCE), VIT University, Vellore, Tamilnadu, India

Abstract

Building Information Modeling (BIM) is widely seen as a catalyst for innovation and productivity in the construction industry. While BIM is increasingly being adopted in developed countries, implementations in the developing country context are rare. Research has established how construction firms struggle from several limitations having to do with the socio-economic and technological environment found in developing countries. Case studies shows that BIM does enhance the traditional scheduling and cost estimating methods with a more reliable and automated technology. Due to numerous steps of construction industry and its complicated and extensive structure, errors and reworks often might happen in this section. As such, BIM (Building Information Modeling) is regarded as a beneficial tool in minimizing the waste and improving the efficiency of building construction. This project is an application of Building Information Modeling which is an upcoming topic in the field of construction planning and management. We selected an institutional building to show the application of Building Information Modeling using software like Revit (2018) and Navisworks Manage (2018). We wanted to show the application of BIM which would make the construction of a humungous project like an educational institutional building to be more precise and well managed within the limited time frame. We collected data such as the floor plans and elevations of the new Gandhi Block (School of Architecture) in VIT, Vellore campus and created a 3-Dimensional model of the building using the Revit (2018) software. By creating a 3-D model we were able to give a real life representation of the building. We created the 3-D model according to the dimensions and specifications in the floor plan and elevation provided to us. We then transferred the model to the Navisworks Manage software for simulation the time constraint. As majority of the building construction was completed at the time of the project, we collected the actual start and finish dates of construction of different components and parts of the building. We created a CSV excel file with the time schedule of the entire construction process including start and finish dates of each process. The file was then added to Navisworks manage. We created sets for each building components like flooring, walls, windows, doors and ceiling for each floor. We then linked the sets to the activity and their respective dates to create the time constraint simulation. Creating this sort of a time constraint simulation will help us get a virtual idea or image of the completion of the entire project part by part and helps managing the construction more efficiently and precisely.

Keywords: Building Information Modeling (BIM) • Computer Aided Design (CAD) • Building Information Modelling (BIM) • Asset Information Model (AIM)

Introduction

Building Information Modeling (BIM) is a set of interacting policies, processes and technologies generating a "methodology to manage the essential building design and project data in digital format throughout the building's life-cycle". As a key part in the project lifecycle, contractors play an important role in making sure the project will be delivered on time and within the budget. This project will show how BIM technology will benefit for Architect, Engineer and contractors for Estimating & schedule and cost controls. It begins with a general introduction of BIM technology and the different ways it works compared with traditional CAD (Computer Aided Design) method, and continues with evaluation of BIM tools. It then explains the uses of Scheduling and Cost Estimating in BIM respectively and provides a case study to show how BIM can work for architect, engineer and contractor [1].

Building Information Modeling (BIM) is an emerging technology throughout the world in the Architecture, Engineering, and Construction (AEC) industries. BIM technology provides users with accurate and consistent building/project

data and information, accommodating the functions needed to model the building and provides a virtual view of it. Building information models are increasingly used, for several purposes by the diverse stakeholders during the different phases of the project and building lifecycle. BIM revolutionize the AEC industry, being not only a change between CAD and parametric modeling with 3D capabilities, but a change of workflows, methodologies, process, and relations. Basically it changes the way business is done throughout the industry. Although all of these changes may seem too much to be easily accepted by the industry, the benefits are much greater, making BIM the future for the industry. Nowadays, Construction and BIM technologies are built for the trailer and the office. To improve productivity and efficiency in construction, these technologies need to be built it for the field, where the work is done and money is spent. According to the Construction Industry Institute 75% of all construction dollars are spent in the field, however, 90% of the technology is made for the trailer and the office.

Literature Review

Building information modeling (BIM) is a process supported by various tools, technologies and contracts involving the generation and management of digital representations of physical and functional characteristics of places. Building information models (BIMs) are files (often but not always in proprietary formats and containing proprietary data) which can be extracted, exchanged or networked to support decision-making regarding a built asset. Current BIM software is used by individuals, businesses and government agencies that plan, design, construct, operate and maintain diverse physical infrastructures, such as water, refuse, electricity, gas, communication utilities, roads, railways, bridges, ports and tunnels.

***Address for Correspondence:** Sam Joseph, School of Civil Engineering (SCE), VIT University, Vellore, Tamilnadu, India, Tel: + 7092865559; E-mail: samjoseph0401@gmail.com

Copyright: © 2020 Joseph S, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Received 09 July, 2019; **Accepted** 16 July, 2020; **Published** 23 July, 2020

The US National Building Information Model Standard Project Committee has the following definition- Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition. The best tool to simulate the construction project within a virtual environment is BIM.

In past, blueprints and drawings were used to express information about a particular building plan. This 2D approach made it very difficult to visualize dimensions and requirements. BIM objects, the components that make up a BIM model, are intelligent, have geometry, and store data. If any element is changed, BIM software updates the model to reflect the change. This allows the model to remain consistent and coordinated throughout the entire process so that structural engineers, designers and architects can work in a more collaborative environment.

Many construction projects suffer from poor design and from inconsistent time and cost management. This situation has led rethinking of the industry's performance and how it could be improved. Technology is breaking through design and management practices. Earned Value Management (EVM) enables better management of time and cost constraints. Building Information Modelling (BIM) is recognized to improve the planning and realization of a construction project. BIM improves technical work at the design stage by creating 3-D models that integrate all building's features and it better represents the infrastructure's requirements. Those models can also be enhanced if linked with schedule or time (4-D) and costs (5-D); the construction can thus be better planned almost entirely at the design phase.

Time and cost controls are very important for any construction organization. In an effort to merge a time and cost management system with future construction best practices, the study objective was to develop an Integrated Time-Cost Management System (ITCMS) and to test it on a real-case scenario. The conceptual methodology revealed that this system would consist of four modules: time and cost estimating, scheduling, visualization, and EVM. A conceptual workflow was also presented and several tasks to be performed at the design and construction phases developed. Most of the work is to be performed with computer tools; pieces of software such as MS Project, Microsoft Excel, and Autodesk's Revit, Quantity Take off, and Navisworks were used.

The ITCMS has the potential to improve the actual construction practices. Multiple benefits are identified from applying it to the actual project such as ability to associate detailed time and cost values to each of the building model components during the design phase; facilitated estimating process with automated outputs; creation of a time and cost baseline that serves as a reference for EVM performance reporting at any time during the construction; visual tool fostering better comprehension among the project team, particularly with people that have less technical or management knowledge.

Like other industries, the construction companies benefit from a range of Information and Communication Technology (ICT) solutions when delivering their projects. It has been suggested that construction projects will be more effective and productive with ICT applications. One of these ICT applications is Building Information Modeling (BIM), which could have many benefits in supporting construction. In terms of more effectiveness and productivity, BIM yields advantages for scheduling, design, implementation, and facility management. From a stakeholder perspective, BIM helps owners, designers, contractors, and management teams to collaborate, visualize and manage construction work better. Consequently, BIM technology receives significant attention from practitioners. In the light of improvement, increasing the use of ICT could help to address some of the currently experienced challenges [2].

BIM finds elements of a building for example windows, doors, slabs, stairs, and walls by applying their attributes such as usage, structures, and functions as well as utilizing parametric technology; Moreover, it can reflect any alterations in the elements of building instantly into the information about the building configuration by distinguishing the connections between those

attributes. Accordingly, the building elements' specifications and their relative information can be gotten by using a simulation model, which provides it possible for making quick decisions pending a construction project. Additionally, BIM not only prepares foreseeable information with regard to amount, expenses, schedules, and materials but furthermore provides it possible to perform analyzing data that can depend on the structure and ambience.

BIM supports optimization of building designs in order to aid selection of alternative design elements and materials before they are actually constructed. The BIM model provides platform for information integration. It is helpful for design evaluation and assist designer to verify drawing correctness and consistency.

An application of Building Information Modeling is called Asset Information Model. Asset Information Model (AIM) is a model that compiles the data and information necessary to support asset management, that is, it provides all the data and information related to, or required for the operation of an asset. It might include information outlining the original design intent, details of ownership, survey work undertaken, operational performance details as well as 3D models developed on the project [3-5].

The AIM is used by clients, and users and facility managers as a building enters the operation and in use phases of the project lifecycle. Building owners/occupiers will use the data and information contained in the AIM to answer the Organizational Information Requirement (OIR) to support business operations. Asset Management suppliers will use the data contained in the AIM to manage their activities effectively. The AIM should deliver a fully-populated asset data set that can, if required, be used by computer-aided facility management systems (CAFM). This software allows facility managers to plan, execute and monitor activities required to deliver proactive and reactive maintenance, explore space configuration and manage moves.

Autodesk Revit is a building information modeling software for architects, landscape architects, structural engineers, mechanical, electrical, and plumbing (MEP) engineers, designers and contractors. The original software was developed by Charles River Software, founded in 1997, renamed Revit Technology Corporation in 2000, and acquired by Autodesk in 2002. The software allows users to design a building and structure and its components in 3-D, annotate the model with 2-D drafting elements, and access building information from the building model's database. Revit is 4-D building information modeling capable with tools to plan and track various stages in the building's lifecycle, from concept to construction and later maintenance and/or demolition. Autodesk Revit is a building information modeling software for architects, landscape architects, structural engineers, mechanical, electrical, and plumbing (MEP) engineers, designers and contractors. The software allows users to design a building and structure and its components in 3-D, annotate the model with 2-D drafting elements, and access building information from the building model's database. Revit is 4-D building information modeling capable with tools to plan and track various stages in the building's lifecycle, from concept to construction and later maintenance and/or demolition [6].

Navisworks (known for a while as Jet-Stream) is a 3D design review package for Microsoft Windows. Used primarily in construction industries to complement 3D design packages (such as Autodesk Revit, AutoCAD, and Micro-Station) Navisworks allows users to open and combine 3D models, navigate around them in real-time (without the WASD possibility) and review the model using a set of tools including comments, redlining, viewpoint, and measurements. A selection of plug-ins enhances the package adding interference detection, 4D time simulation, photorealistic rendering and PDF-like publishing.

Objectives

1. To create a 3-D Building Information Model of the infrastructure asset.

Computer software such as Revit was used for making a virtual 3-dimensional model of the selected institutional building according to the data collected (floor plans, elevations, section views, etc.)

- To simulate time constraints of the building using 4-D modelling technique.

Navisworks Manage software was used to add the fourth dimension – time constraint to the model. Simulation of the entire construction schedule was created virtually.

- To recommend measure for effective application of Building Information Modelling in infrastructure construction.

Effective application methods are suggested to improve construction process by effective use of valuable resources and reduced wastage of resources [7].

Motivation

The motivation for doing this project was mainly an interest in undertaking a challenging project in an interesting area of construction planning and management. It was an opportunity to learn and expand our knowledge with the use of this software used for planning, design and maintenance of structures. We recognized and understood the importance of software, and the role it plays to anchor various stages of Construction. We selected this field of study as it was not covered in our university lectures. The software was new to us and our fascination towards the growth and improvement in the field of construction with the help of modern technology led us to select this topic. Living in an era immensely influenced by computers and modern technology, we wanted to learn the application of modern technology in our field. Being an aspiring civil engineer, we wanted find modern solutions to the problems faced in the area of construction planning and management. Especially huge construction projects that require a lot of time and resources need precise planning and execution and we believe Building Information Modeling would help us achieve the targets efficiently.

Background

In this project, we are planning to use make use of 'Revit' software to create a detailed 3-dimensional Building Information Model (BIM) of the Infrastructure (MAHATMA GANDHI BLOCK-VSPARC) and then exporting the 'Revit' model to 'Navisworks Manage' to perform time constraint simulation of the project. The infrastructure selected here is an educational institution building consisting of five floors (G+4). The building was selected as it was completed recently and was a huge project. The resources we needed for the project was easily available. The project emphasizes on the application of Building Information Modeling in the construction project of huge projects like these where efficient use of time and resources would help us achieve better results than expected. It also shows the easiness attained by using modern technologies and computer software.

Project Description and Goals

Our project deals with the application of Building Information Modeling in the construction of an educational institutional building, namely Mahatma Gandhi Block (VSPARC) in VIT University, Vellore. It is a building consisting of 5 floors (G+4), with a green architectural design. Being a multi-storey building spread across a vast area of land, the construction of the building would require detailed planning and management in order to achieve the best of use of all kinds of resources to produce the best result expected. This can be achieved with the help of Building Information Modeling where a virtual model and simulation would help the builders and the client to select the most suitable resources required for each component or stage of construction.

Creating a virtual 3-dimensional model of the building using Revit software would give a realistic image of the building after the construction. Linking the time schedules charted by the builder virtually with the 3-D model using Navisworks Manage software would give us a virtual simulation of the building through each stage of construction from the beginning to the end. This would help us make changes to the building through each stage of construction and also help us manage time very efficiently through construction. The 3-D model can also be linked to the cost of construction for each stage or component with the help of Navisworks Manage software. This model simulation consisting of five dimensions, namely three dimensions of measurement, time and cost would help us use all resources such as building materials, raw materials, time and money in the most efficient way.

Particularly linking time schedule and cost of each stage of construction to the model would help us determine the fastest and most cost efficient way of construction by simple simulation of the building construction using the software. In the world where computers have so much influence in almost everything we do in our daily lives, this could be an efficient application of computers and software in our construction industry. Such software is used for basic activities such as sketching the plan for the building. Now with the increased influence of software, we can get a complete virtual simulation of the entire construction process which will help us rectify mistakes that could take place during construction and make improvements in construction well in advance. Application of modern technology in such a way will help us save a lot of time and money, which are considered to be two of the most important resources in today's world. If saving such precious resources with the help of computers and software is possible, we can achieve greater goals in this industry which is considered to be the base stone of life on earth. Our goal is to show that Building Information Modeling with the help of such software will help us achieve efficient and precise results in the construction industry that contributes to huge proportion of our countries economy.

Technical Specifications

We used two Autodesk software for our project, namely – Revit (2018) and Navisworks Manage (2018). We were able to access the software with the help of student licenses. The Revit software was used to make the 3-dimensional model of the building according to the dimensions specified in the data collected. The Navisworks Manage software was used for the time constraint simulation according to the schedule collected.

Some of the tools and basic functions used in Revit software were:-

- Units** – We set the dimensional unit as milli-meters (mm).
- Grids** – It is a function mainly used to draw a grid for reference while drawing walls so that each floor is aligned correctly above each other respectively.
- Walls** – We used basic wall command to draw a layout of the floor plan for each floor. The height and width of the inner walls and outer walls were done according to the plan.
- Floor** – We used floor option for flooring and selected the thickness according to the plan.
- Window** – The windows were done with the most suitable design offered in the Autodesk Material Library.
- Doors** – The doors were selected from the available Autodesk Materials Library.
- Ceiling** - A similar function to flooring was selected according to specification in the plan provided.
- 3-D View** – It is a function used to the building as a 3-D model.
- External Tools** – It is a tool used to transfer the Revit file (.rvt) to a Navisworks Manage file (.nwc).
- Project Browser** – It is a window that shows each component of the building.

Some of the tools and basic functions used in the Navisworks Manage software were:-

- Sets** – It is function used to select each component of the model like wall, floor, etc.
- Selection Tree** – It is window showing each component or part of the transferred Revit 3-D model.
- Timeliner** – It is a window used to link the task and each set and for simulation.
- Csv File** – CSV format files are used to transfer task schedules to the software for simulation. It is similar to MS Excel.

- **Rebuild Task Hierarchy** – It is a command used to extract the task and schedule from the CSV file into the software.
- **Simulate** – It is a command used to simulate the entire construction process or part of it with respect to the time constraint.

Methodology

The methodology used here is direct application of Revit software and Navisworks Manage software. The main application of Revit software is of creating the 3-dimensional model of the building and all its components structure to even the furniture.

We first made grid lines that could be used as reference while drawing the floor plan of each floor. The grid line mainly outlines the outer walls of the ground floor. This helps us use a reference point in the space dimension to find the exact position of walls in the higher levels. These grid lines are reference points and do not have direct involvement in the 3-D model description. The grid line is used only as reference for two dimensions such as length of the room and width or breadth of the room. It does not become a reference for height of the floor or room.

Once the grid lines were made exactly according to the dimensions of the outer walls of the ground floor, we start to make a 2-dimensional floor plan using walls function. We draw the exact dimensions as mentioned in the floor plan and complete the floor plan for each floor by also maintaining the reference grid lines. These grid lines need to be maintained in order to get each floor aligned correctly as there is no structural component provided for our project. The grid lines act as a substituent to the points where the columns would come into existence in real life.

On completion of the floor plans of each floor, we aligned the sectional view and elevation view of the building by entering the correct dimensions of wall height for each floor. The 3-D model then comes into picture as we complete the final dimension of height of each floor and align each floor correctly. Now we added windows and doors to each room at their respective position. Once the windows and doors were fixed, the stairs were aligned and designed. The stairs had to be aligned for all floors from ground floor to 4th floor uniformly. Stairs need to be designed separately with the correct number of stairs, width and inclination and then later fixed into place within the 3-D model.

Now we added flooring and ceiling to each floor according to plan and also provided roofing for the topmost floor. This completes the 3-D model. The final 3-D model is then transferred to Navisworks Manage by using external tools in Revit and saving it as .nwc file rather than .rvt file.

On opening the 3-D model in Navisworks Manage software, we first provide sets to the model. This is done by creating sets in such a way in which we would like to link each stage or component of construction to their respective task consisting of the time constraint. We selected components like flooring, walls, doors, windows and ceilings of each floor as a set from the selection tree. We created a total of 26 sets that includes various components of the building.

We also created a MS Excel workbook consisting of the entire schedule task by task and also with their planned start and finish date, actual start and finish date, duration, cost and IDs. These are arranged chronologically from start to finish of the entire construction of the building.

Now we convert the schedule into an MS Excel worksheet and then saved it as a CSV file. This CSV file is opened in Navisworks Manage by adding it through the data source option. Then we rebuilt the task hierarchy shown in the schedule which transfers the entire schedule and tasks with their respective start and finish dates into the software. Each task is then linked to its respective sets with the help of attachments. Once each task was linked to their respective set correctly the task type was set to construct.

We now simulate the entire model with respective to time to show how the construction would take place stage by stage as mentioned in the schedule in a short period of time. We set the interval size as 15% and playback duration for

20 seconds. On beginning the simulation, the entire construction of the building will be shown advancing virtually stage by stage with respect to time (Figure 1).

Schedule, Tasks and Milestones

December 2019

We decided on the topic and selected our building to be the Mahatma Gandhi Block (School of Architecture, VSPARC) in VIT University, Vellore. Collected data such as floor plans, elevation plans, sketches, sectional plans, budget details of the entire project, construction schedule of the entire project and all relevant information required. We broke down the complex drawings into simpler drawings for ease of reference and understanding. We made the dimensions more readable and convenient for reference. Installed Revit (2018) and Navisworks Manage (2018) software.

January 2020

We started drawing floor plans according to the plan and dimensioned each component according to the dimensions provided. Each floor plan was done individually and then later aligned with the help of grid lines. All three dimensions were corrected, aligned and checked for precision. The 3-dimensional model was completed.

February 2020

The final portions of the 3-dimensional model that include various components within the building such as flooring, ceiling, doors, windows and staircase was completed. The staircase was done separately according to measurements and aligned for each floor. Doors and windows were fixed. Flooring and ceiling was completed. The Revit file (.rvt) was transferred to Navisworks. The MS Excel file was prepared according work schedule and converted to required CSV format.

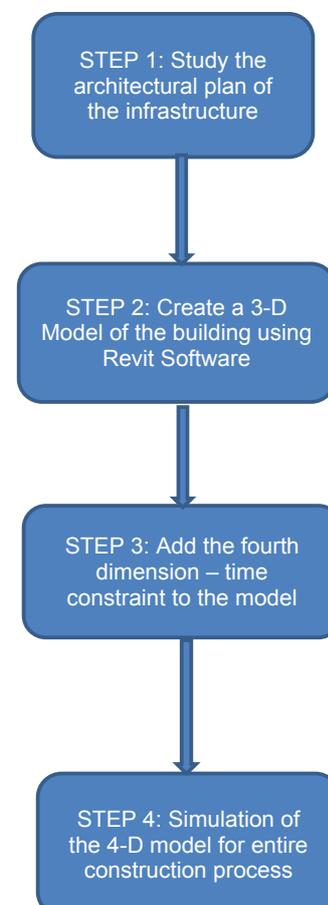


Figure 1. Steps illustrating application of a 4-dimensional modeling of an institutional infrastructure.

May 2020

The sets were created and named for each component of the building from the selection tree. The schedule was transferred to Navisworks Manage and the task hierarchy was rebuilt. Each set was then linked to their respective tasks and start and finish dates. The simulation was carried out for the entire construction process from start to finish and evaluated. The 3-D Revit model and its fourth dimension, time constraint was simulated.

Project Demonstration

We have carried out the entire program using computer software and programs. Screenshots were taken at each stage of the project for demonstration. We used the Revit software to create the 3-dimensional model of the building (Figures 2-9).

We then transferred the 3-D model from Revit software to Navisworks Manage software for linking the time constraints and its simulation (Figure 10).

We then transferred the MS Excel file consisting of the construction schedule; tasks and their respective details such as start and finish dates in the CSV file format (Figure 11).

Sets are created by selecting each component from the selection tree. Sets are created for an ease of linking each component to their respective task and dates. Sets are also created for the ease of searching a component quickly. It would be difficult to find small components in a huge construction project, so creation of sets will gather components of similar properties and group them. This makes it easier to link them to a schedule or search for them (Figure 12).

We then rebuilt the task hierarchy into Navisworks Manage which means transferring the schedule from the CSV file to the software. Then they are linked to the respective sets created earlier for simulation. The task type is set as construct (Figure 13).

The simulation is carried out after linking each set with their respective

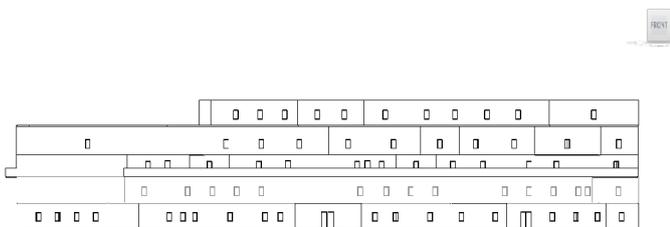


Figure 2. Front View of 3-dimensional model of the building.

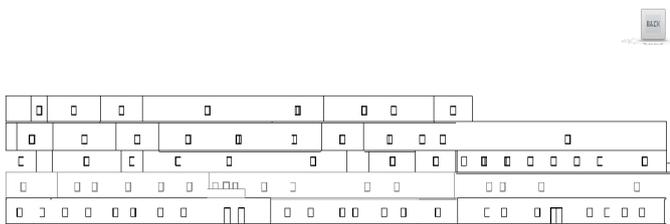


Figure 3. Back View of 3-dimensional model of the building

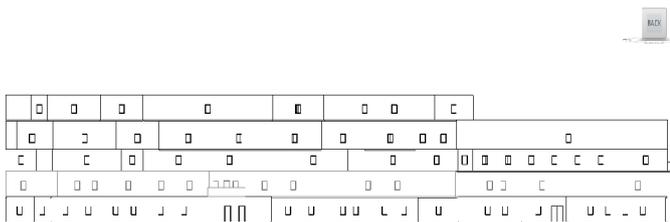


Figure 4. Left Side View of 3-dimensional model of the building.

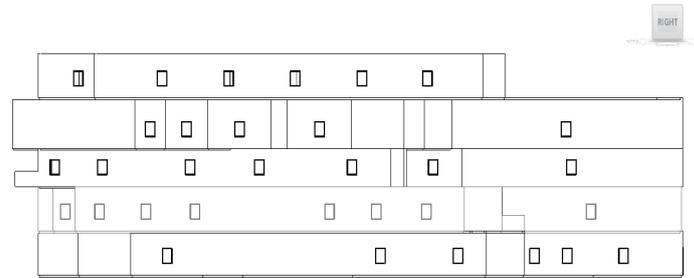


Figure 5. Right Side View of 3-dimensional model of the building.

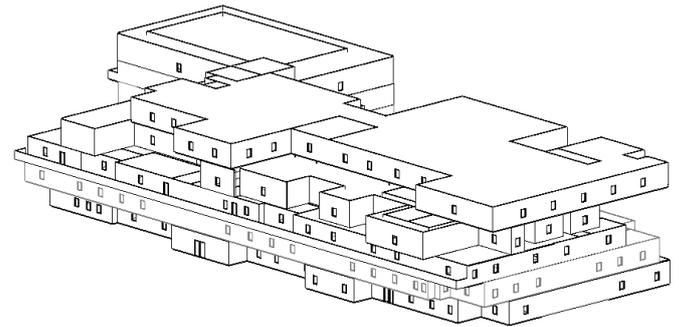


Figure 6. Aerial Front View of 3-dimensional model of the building.

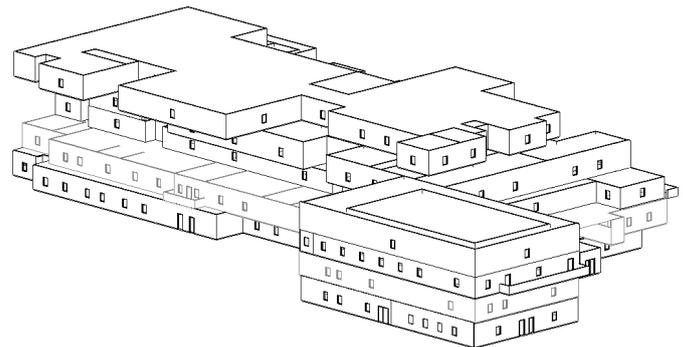


Figure 7. Aerial Back View of 3-dimensional model of the building.

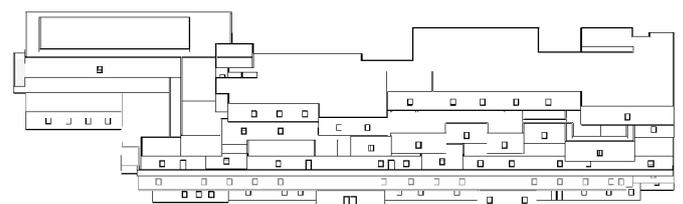


Figure 8. Top Front View of 3-dimensional model of the building.

tasks according to the following settings where playback duration is 20 seconds and interval size as 15% (Figure 14).

Once the settings are fixed according to choice the simulation is carried out. The interval size denotes the time period for the next activity to start. This can be set according to different units such as percent, days, hours, minutes or seconds (Figure 15).

The above figure shows the simulation of the construction after the completion of the ground floor of the building. The green components are the components next in queue for construction after the completion of the current component (Figure 16).

As shown in the above figure, the white components are the ones that are under construction at the given point of time and ones shown in their original color format are completed (Figures 17-19).



Figure 9. Floor Plans of 3-dimensional model of the building.

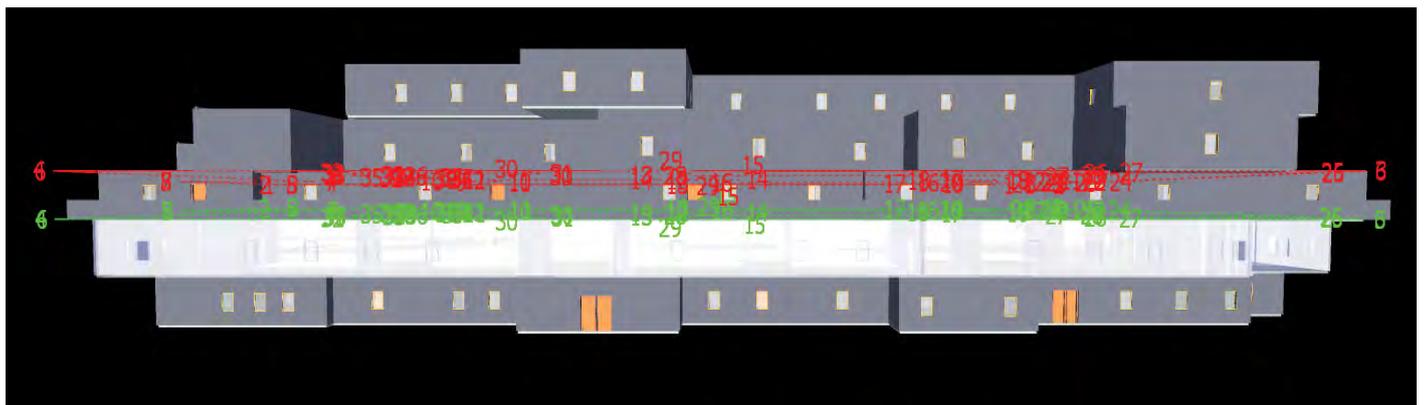


Figure 10. After transferring the 3-D model from Revit software to Navisworks Manage software for linking the time constraints and its simulation.

The above figure shows the final image of the whole building once the whole construction process is completed according to schedule. We can compare simulation of planned as well as actual schedules of construction and compare them for improvements in construction and time management for upcoming projects of similar capacity and volume. This helps us use the available resources in the most effective way and hence help us create sustainability and maximum productive without compromising the quality and standards of construction (Figure 20).

Figure 21 gives us a glimpse of the construction process in progress for a

different viewing angle as that shown in Figure 16. In such a manner we can view the entire construction process virtually from any angle of choice and thereby evaluate the process of construction of each component or stage in detail. This helps us reduce errors or disasters that could happen in real life.

Figure 22 shows us a different viewing angle of the completed building similar to the image shown in Figure 18. We can view the building from any angle of choice in the provided three dimensions and evaluate the construction process. This helps us evaluate each component or stage of construction of the infrastructure in detail from every angle and help us make necessary changes

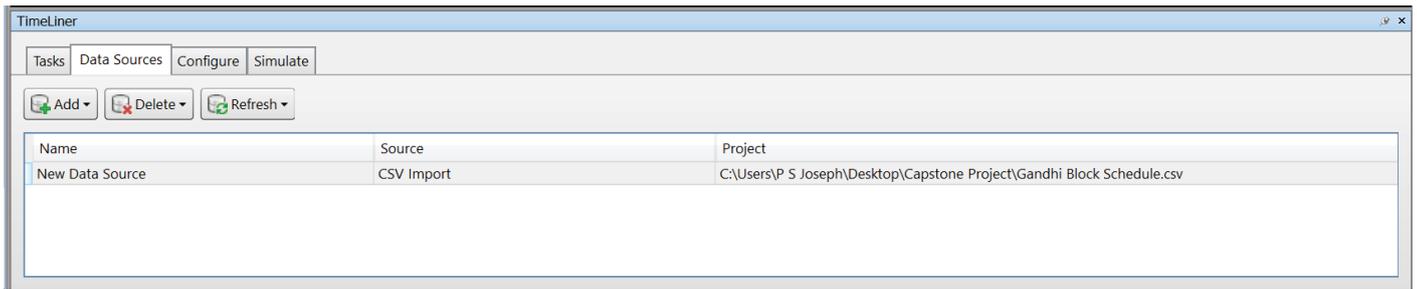


Figure 11. After transferring the MS Excel file consisting of the construction schedule, tasks and their respective details such as start and finish dates in the CSV file format.

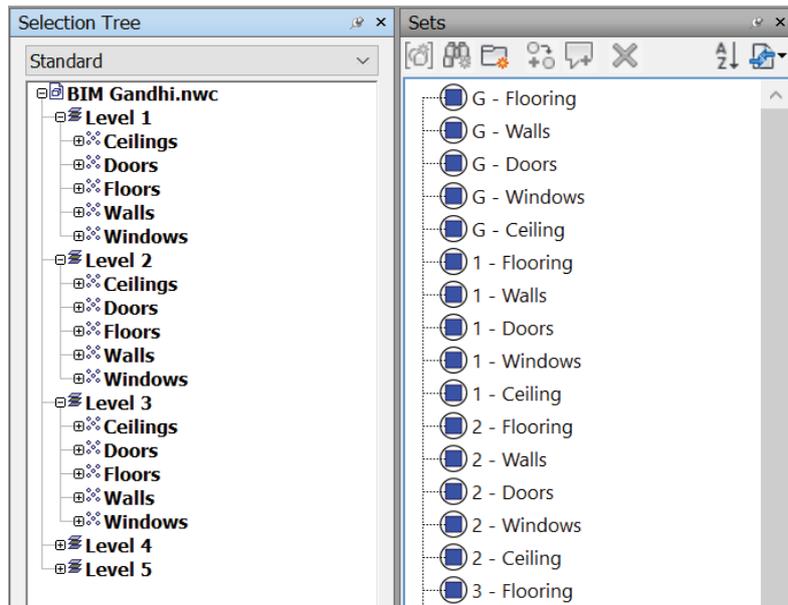


Figure 12. Transferring the schedule from the CSV file to the software.

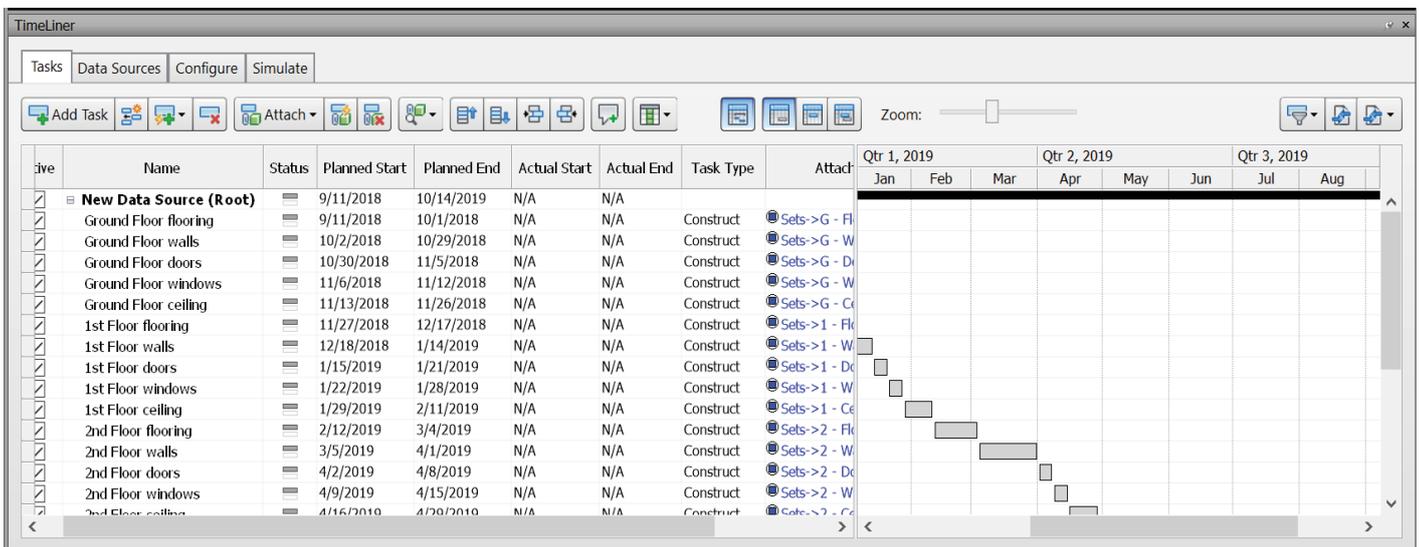


Figure 13. Simulation is carried out after linking each set with their respective tasks.

to improve the quality, save time and also to avoid mistakes that could happen. Hence building information modeling is an essential topic of further studies that could provide ease of management of huge construction process like these.

Results and Discussion

The project shows an application of a 4-dimensional modeling of an institutional infrastructure. The building selected here is Mahatma Gandhi

Block (School of Architecture, VSPARC) located within VIT University, Vellore campus. The building is a multi-storey infrastructure spread over a vast area of land. The project shows the ease of construction planning and management of huge construction projects like these.

A 3-dimensional model of the building was created according to specifications as shown in Figures 1-8 above. The virtual model gives us a glimpse of the image of the building after construction. Such a view of the building helps us select various materials and components that are best suited

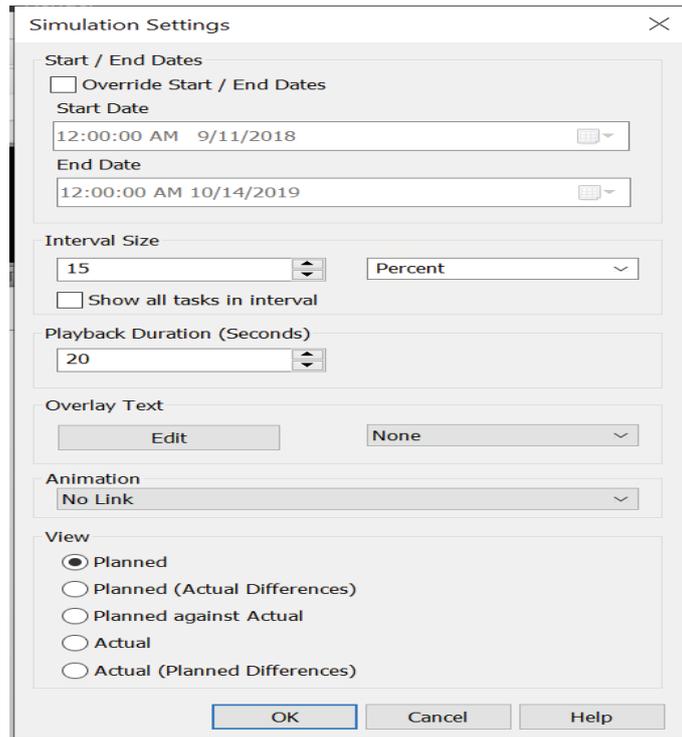


Figure 14. Simulation setting.

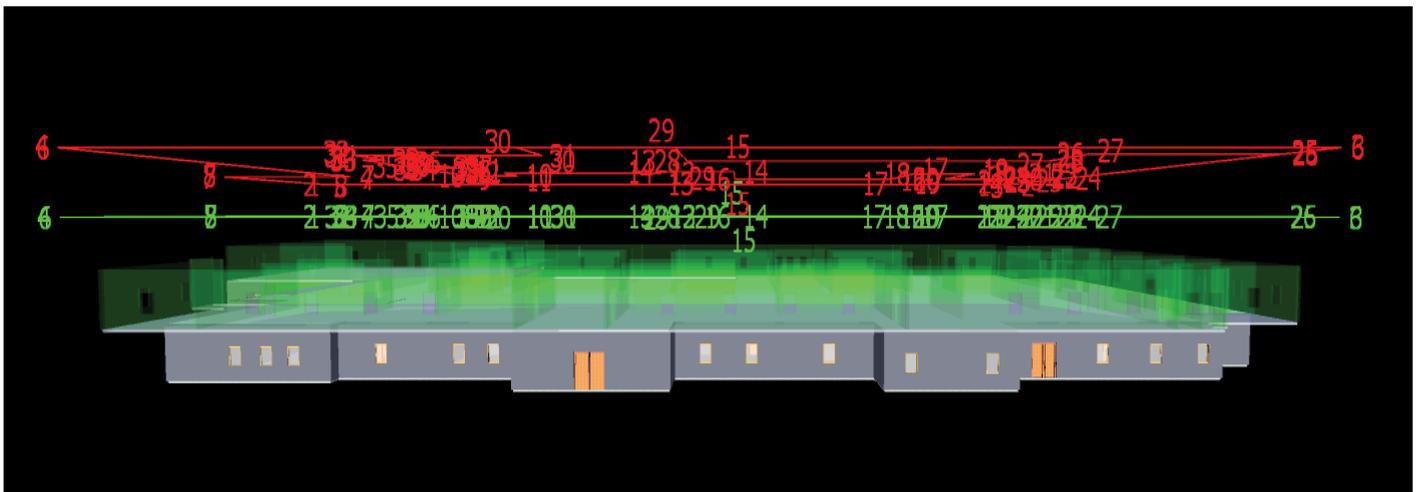


Figure 15. Simulation of the construction after the completion of the ground floor of the building.

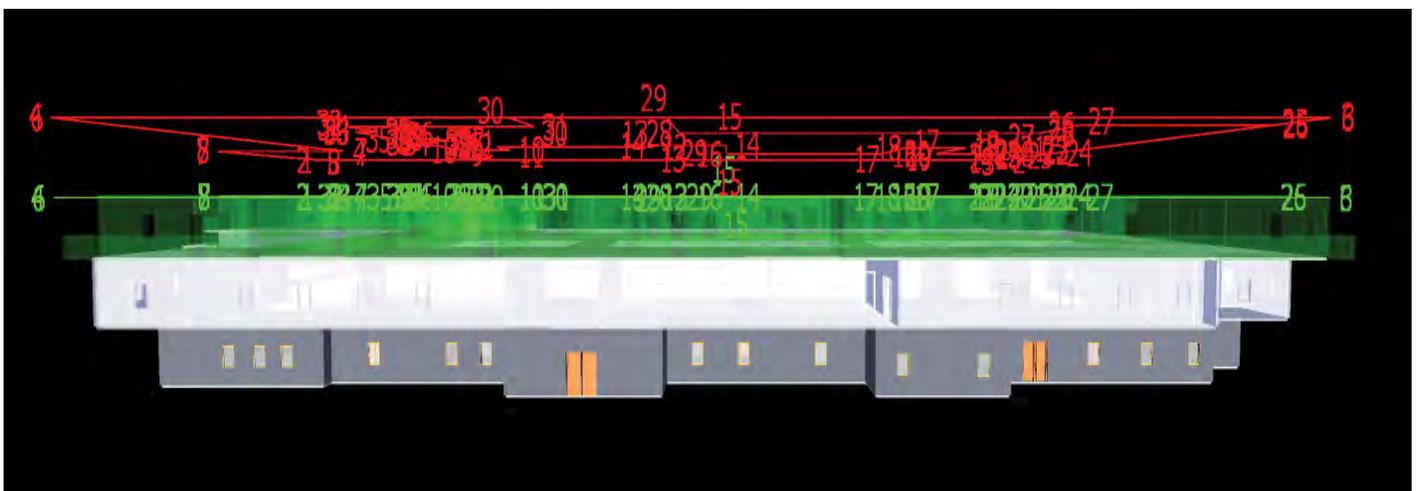


Figure 16. White components are the ones that are under construction at the given point of time and ones shown in their original color format are completed.

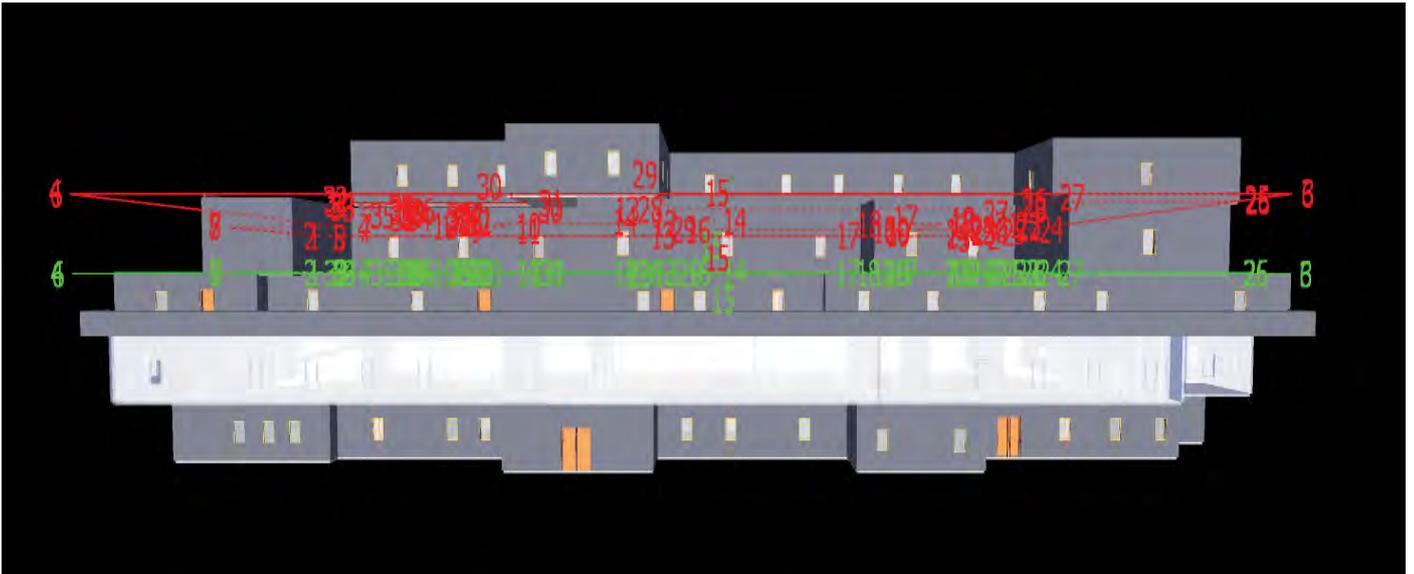


Figure 17. Shows the construction of the third floor and shows green faded components on the fourth floor that are in queue for construction after the completion of the current. In such a way the entire construction process can be visualized virtually from start to finish and time schedules can be revised for improvements that help in optimized and effective usage of resources available for construction.

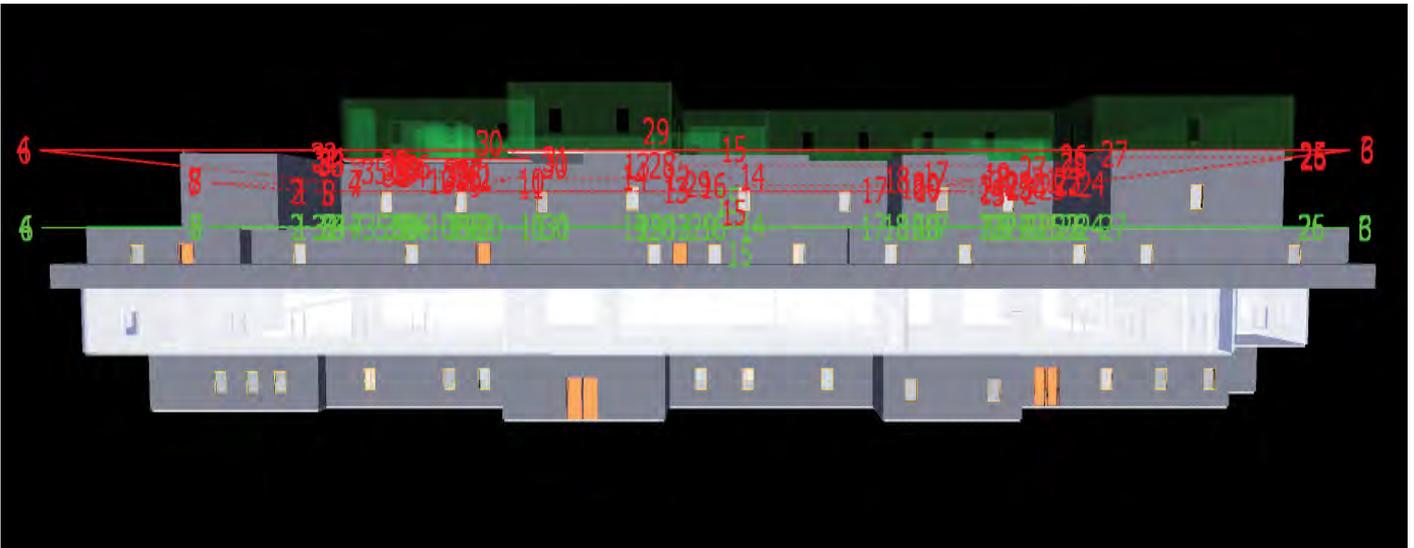


Figure 18. Queue components of the top-most floor that is to be constructed as soon as the current construction process of third floor is completed.

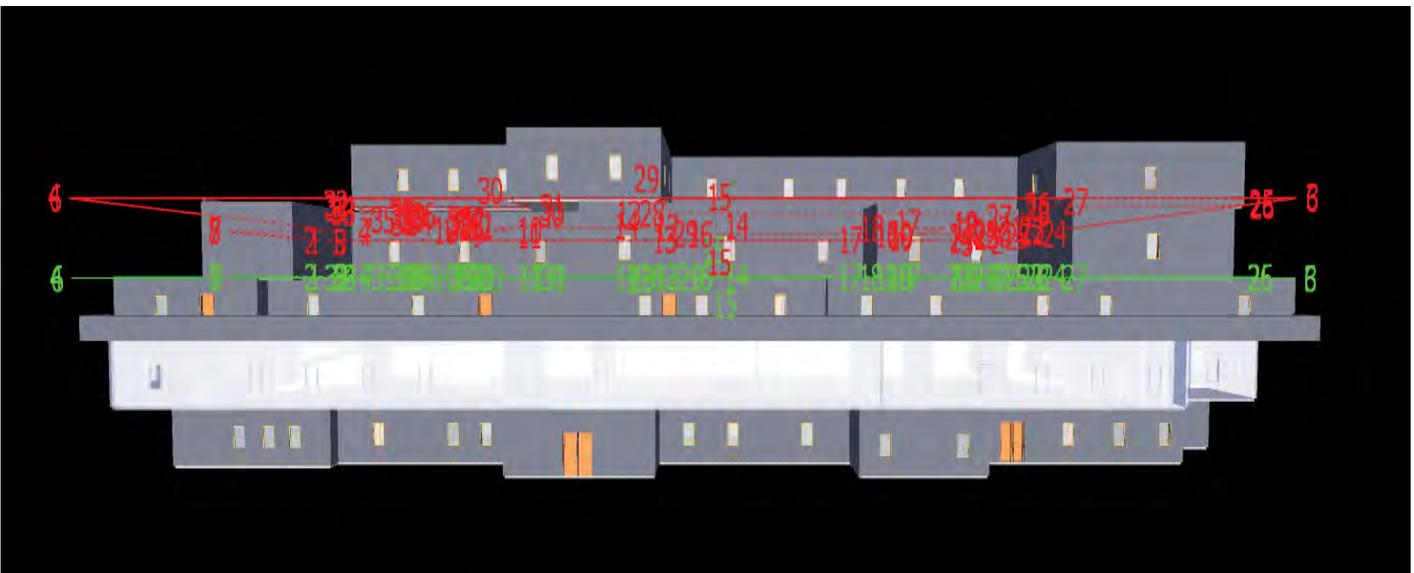


Figure 19. The final image of the whole building once the whole construction process is completed according to schedule.

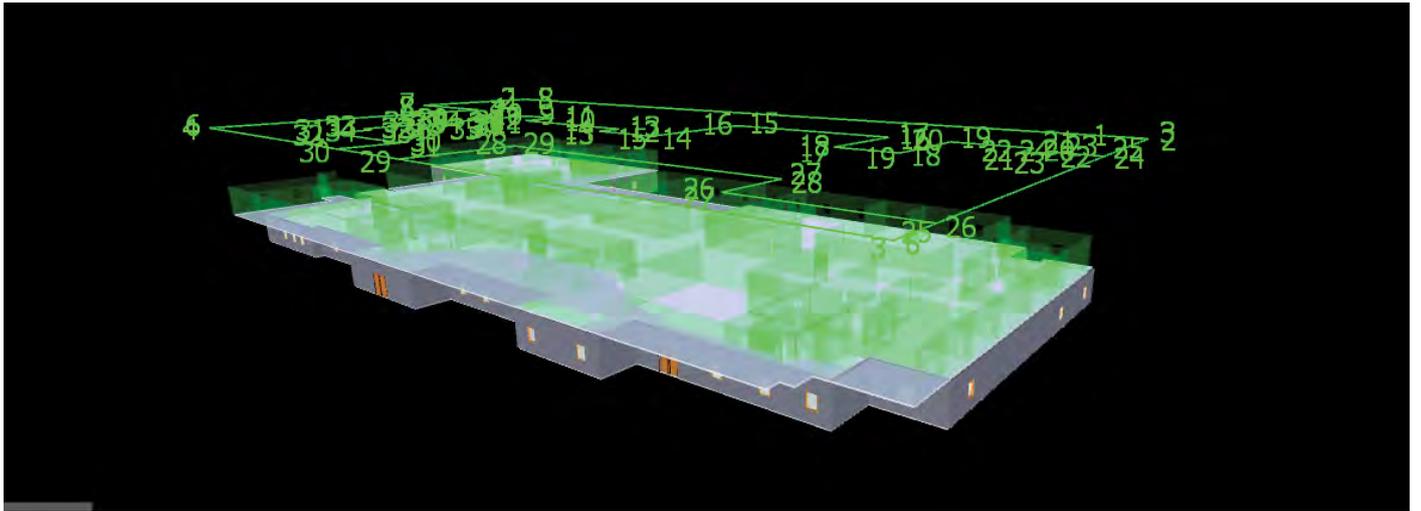


Figure 20. The construction process in progress from another angle of view as shown in Figure 11 above. The building can be viewed from any angle of choice at any given point of time frame during the simulation.

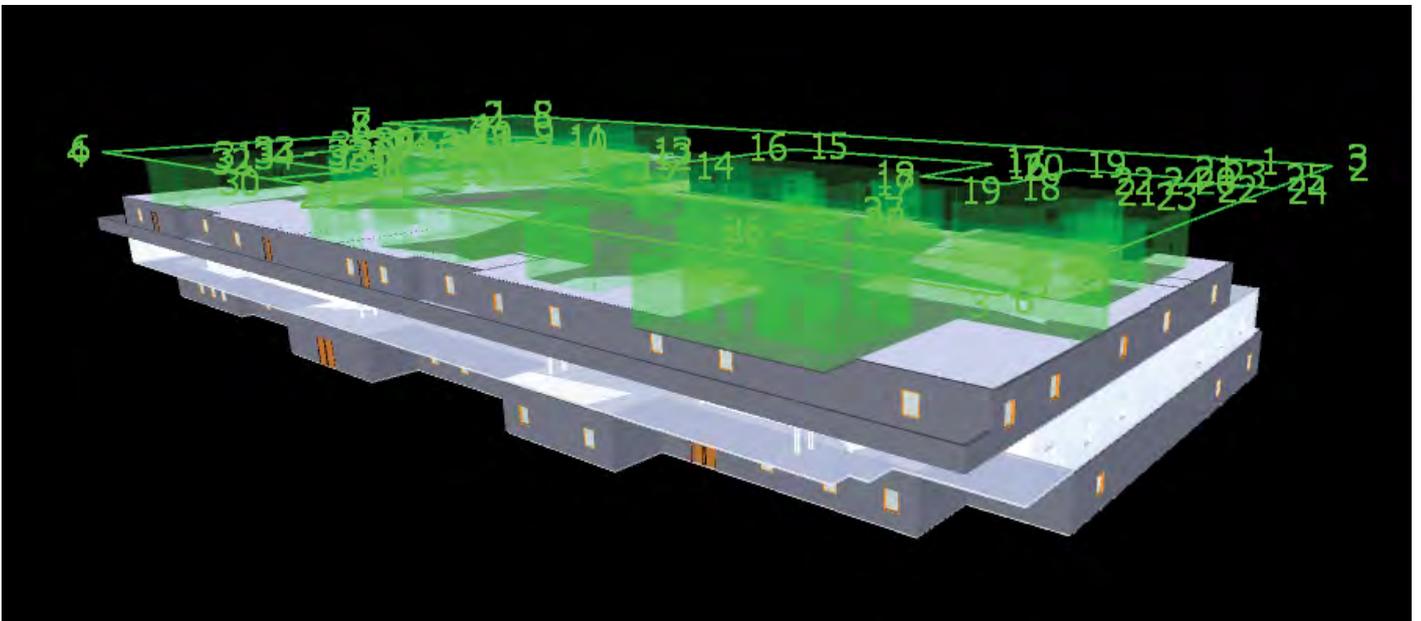


Figure 21. Glimpse of the construction process in progress for a different viewing angle.

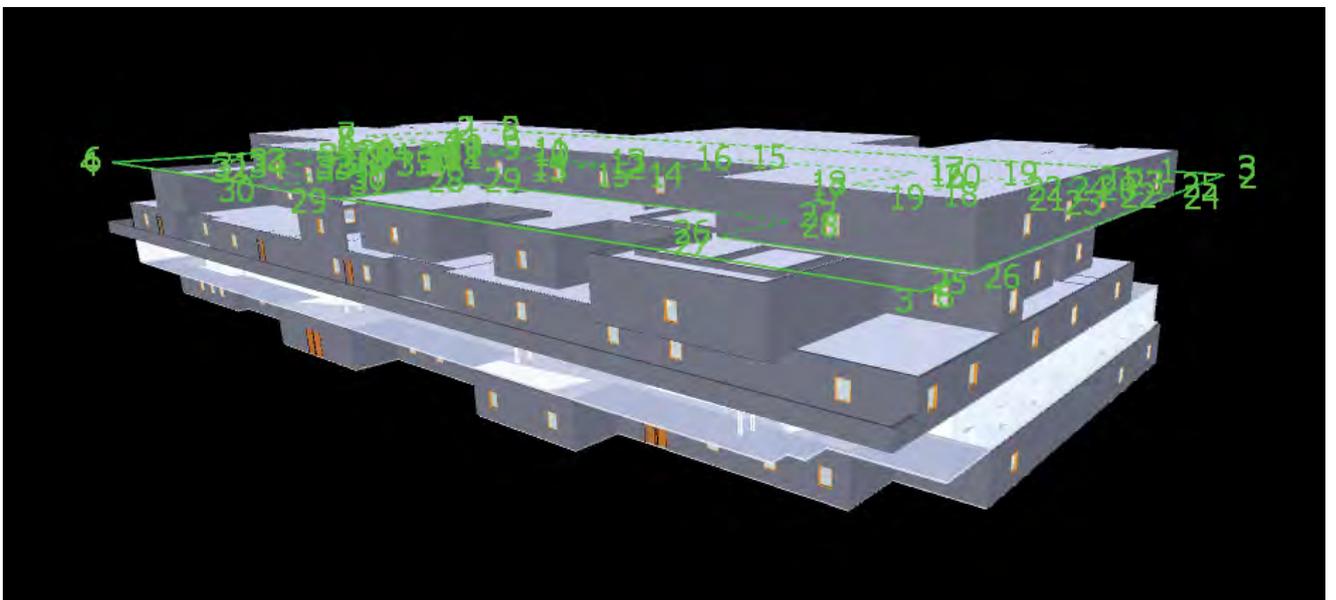


Figure 22. Different viewing angle of the completed building.

by repeated trial and combinations such as wall paint color, tiles furniture, management of space within the building, etc. Some parameters added to the 3-D model are walls, flooring, ceiling, doors, windows and roofing.

The 3-D model is then given its fourth dimension as time constraints. The fourth dimension, namely time constraint consists of task and its corresponding start and finish dates. A total of 27 activities were selected to show the construction process floor by floor. On simulation of the fourth dimension through Navisworks Manage software, we can virtually assess the entire construction project from start to finish. This helps us make improvements in time management for the project. It also helps us make improvements in various components or stages of construction for better and efficient use of valuable resources.

BIM can be used by engineers, architects, project managers, etc. in order to achieve these goals : To decrease design errors, To reduce clash detection, To boost the integration of cost and time, To improve the integration of design and construction phase, To increase the collaboration between different construction sections and finally to improve recycling.

BIM platform is not only providing the visualized 3-dimensional graph previous for participants but also including series of construction information. It promotes interactive communication and feedback for the design results. The point is the building project plan; design, construction and operation are carried out in a visual state. The BIM is implemented because the construction project demand sustainable, efficiency and cost improvements throughout project life cycle. Many of the 3-D visualization display are only for rendering in the earlier stage. The communication gap existed in construction parties, because the traditional drawing contained limited information lead to difficulty to execute in construction stage.

The BIM model is not only integration of the component information, but also provides a three-dimensional communication platform. The traditional construction work schedule management is based on 2D drawing which has poor visibility problems. It leads to communication difficulty between different participants. As a result, the actual construction progress often deviated from the work schedule plan. The BIM visualization technology simulate the project construction work process and establish the 4D management system, such as monitoring the entry time of construction manpower, material, equipment and other resources. The BIM 4D function guide the each section work sequence in the construction period. This method is modeled as a powerful visualization and communication tool provide the project construction implementation details to the project participants [8].

BIM helps in visualizing the sequence of creation building elements leading to save time and cost over the project life-cycle and visualizing construction sequence. Models of Building information are dramatically increasing to be popular with the tasks of facilities management (FM). The ability of BIM for containing vast visual information quantities has absorbed a huge amount of interest from units of facilities managers, operations and maintenance. The advantages are homogeneous to those listed for the other project stages. It can be frequently simpler for managing the tasks visually; utilizing the three dimensional (3D) model, to enable to view definite features of management, helps one in visualizing it oneself, and to connect it to others.

Limited attention is given to BIM implementations in infrastructure and facilities projects in developing countries. Revit works exactly opposite to AutoCAD. In Revit first to create direct 3D model and then get directly 2D drawing with material quantity and many more which is essential to manage construction of building. In an effort to merge a time and cost management system with future construction best practices, the study objective was to develop an integrated time-cost management system (ITCMS) and to test it on a real-case scenario.

The core purpose of BIM is to solve the problem of information creation, information management and information sharing in the whole life cycle of construction engineering. It embodies the idea of digital design information management and sharing. BIM uses virtual prototype technology as the key technology, establishment of the information sharing model of the whole life cycle of construction project.

BIM is a field in civil engineering that is still not known to many around the world and is also a topic or area for further research and studies that will help improve construction planning and management. As shown in the project, BIM will create an ease of construction process as we can see the construction process happen virtually according to schedule and make improvements in them. In such a way huge construction projects that require a lot of time, money, resources and manpower can be done in a very organized and efficient way with the help of BIM.

The whole process of Building Information Modeling consumes lesser time and resources as compared to the consumption of time and resource in the correction or improvement would take. BIM also helps asset management after occupancy of the building that will help us drastically reduce the expense of maintenance. BIM also has various applications in the building maintenance such as energy consumption and asset information. Energy consumption of the infrastructure can also be calculated using BIM. The asset information of all assets within the building can also be visualized and maintained using BIM applications. Hence, Asset Information Modeling is a field within BIM that has a major application in construction and real estate field that also opens a wide window for further study and research [9].

Conclusion

Our motivation to do this project was to show the advantages of involving modern technology and computer software in the field of construction planning and management. Being in a world where time and money are considered as the most valuable resources, we have to use them efficiently in a reduced manner as much as possible. In order to save time and money we can use computer software to help us virtually. It also helps us rectify mistakes or make the construction process more easily sorted. We took an educational institution building as an example for Building Information Modeling. The building consists of five floors. Our first step was to create a 3-dimensional model of the building with the help of the Revit software. We created the 3-D model with reference from floor plans, elevation plans and sectional plans collected as raw data. The 3-D model was dimensioned according to the plan. Each basic components of the building such as flooring, walls, doors, windows, ceiling and roofing was created within the 3-D model.

On completion of the 3-D model, we dealt with the fourth dimension in Building Information Modeling – time constraints. This was achieved with the help of Navisworks Manage software. A task schedule was created which consisted of various stages of construction of the building along with their start and finish dates respectively. We linked these tasks and dates with each of their respective stage or component of construction with the help of the software. As a result, a simulation of the entire construction process from start to end was virtually created as a function of time. This virtual simulation of the construction project will help us manage time and cost of each stage or component of construction efficiently and choices of selection can also be improved. This in return would help us save and efficiently use valuable resources such as time and money. Overall, the project shows the application of Building Information Modeling of an educational institution building using computer software such as Revit and Navisworks Manage.

References

1. Bhuskade, Shrikant. "Building Information Modeling (BIM)" 2 (2015).
2. Bui, Nam, Christoph Merschbrock and Bjørn Erik Munkvold. "A Review of Building Information Modelling for Construction in Developing Countries" *Procedia Engineering* 164 (2016): 487-494.
3. Jade, Ahmad and Julien Lessard. "An Integrated BIM System to Track the Time and Cost of Construction Projects: A Case Study" 2015.
4. Rui, Yin. "Review of Building Information Modeling (BIM)" *Application in Construction Industry* 8 (2019).
5. Yang, Tianqi and Lihui Liao. "Research on Building Information Model (BIM) Technology" *World architecture* 5 (2016).

6. Soltani, Sahar. "The Contributions of Building Information Modelling to Sustainable Construction" *World Journal of Engineering and Technology* 4 (2016): 1-7.
7. Sampaio, Alcínia Zita. "BIM as a Computer-Aided Design Methodology in Civil Engineering" *Journal of Software Engineering and Applications* 10 (2017).
8. Zhang, Cheng, Tarek Zayed, Wissam Hijazi and Sabah Alkass. "Quantitative Assessment of Building Constructability Using BIM and 4D Simulation" *Open Journal of Civil Engineering* 6 (2016): 1-20.
9. Seo, Myoungbae and Jinuk Kim. "Analysis of Awareness and Utilization of BIM in Civil Engineering" *Open Journal of Applied Sciences* (2012).

How to cite this article: Joseph, Sam, Rahul Sasikumar, Malavika Anil and Prasanna Venkatesan R. "Application of Building Information Modeling for an Institutional Building" *Civil Environ Eng* 10 (2020): 351 doi: 10.37421/jcce.2020.10.351