



Implementation of 5D Building Information Modelling (BIM) Concept Using Autodesk Ecosystem

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Abstract. Increased needs and technology in the New Capital City (Nusantara) development project resulted in a demand for an increase in the quality of human resources. One of these quality improvements is the use of Building Information Modeling (BIM) in non-simple buildings with an area of 200 m² and above 2 floors. In this research, Building Information Modeling (BIM) uses the Autodesk ecosystem. The work process is carried out on Autodesk Revit software as the main software. In Autodesk Revit, 3D modeling is done by inputting data complete with element specifications. The data is then processed into quantity data. After the modeling is complete, the 3D model will be exported to support software such as Navisworks and Augin. In Autodesk Navisworks, the 3D model will be inputted with time data and parsed into a schedule. While in Augin, the 3D model will be simulated and placed according to the realistic picture of the field using Augmented Reality technology. So as to get a more varied output in the form of technical documents and visual products.

Keywords: Augin, Autodesk, Building Information Modeling, Navisworks, Revit

1 Introduction

Increased needs and technology in the New Capital City (Nusantara) development project resulted in a demand for improved quality of human resources, thus encouraging collaboration between the government, private sector and academia in human resource development [1]. This increase has resulted in market fluctuations in the construction field being hampered, especially in the private sector, this is due to the complex and many constructions demands, so that planners must meet multi-dimensional constraints [2]. Dimensional constraints are at least achieved up to the fifth dimension [3]. To reach this level, Gobesz argues that it is necessary to develop standards from Computer-Aided Design (CAD) to Building Information Modeling (BIM) standards. BIM itself can be defined as a tool that can store information on a project [4] (Parung, 2019). Meanwhile, according to Chen, BIM is one of the innovations in projects ranging from planning, design, implementation and maintenance [5]. More specifically, BIM has advantages in aspects such as design, scheduling, implementation and facility management [6].

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Compared to using CAD standards, BIM standards can increase planning time efficiency by about $\pm 50\%$, as well as reduce human resources by about $\pm 26.66\%$ and reduce personnel costs by about 52.25% [7].

One of the developers that provides BIM-based software is Autodesk. Kymmell highlighted Autodesk's role as one of the leaders in facilitating collaborative technology to improve project efficiency [8]. Slowly Autodesk emerged as an ecosystem with a level of coverage of the entire construction project. Autodesk emphasized that the Autodesk ecosystem is strengthened by the role of Revit and Navisworks in facilitating collaboration between disciplines [9]. Both are the foundation of Autodesk in the architecture, engineering and construction (AEC) industry. Both are interconnected and complementary but differ in their use and focus. Autodesk Revit plays a role in the application of BIM in the construction industry, due to its ability to integrate various disciplines in 3D models on one digital platform [10]. While Autodesk Navisworks plays a role in project coordination through simulation and clash detection, which makes it easier to detect errors in the construction phase [11, 12]. In addition, in its development, the two software can be displayed in the integration of Augmented Reality (AR) technology, which is used in project presentation and design review in real time [13].

However, as with any new technology development, there are significant challenges that need to be addressed, especially in the Autodesk ecosystem. Sacks et al. point out that Autodesk's extensive ecosystem can be confusing for users when fully integrating BIM workflows, users often struggle to integrate all tools to interact efficiently [14]. The lack of international standards regarding the best workflows exacerbates this problem. Therefore, this research aims to find out the cross-software workflow in the Autodesk ecosystem, especially Revit, Navisworks and Augin Plugin software on the PT. Sinar Wandiole Industrial Estate project.

2 Materials and Methods

2.1 Methods

This research uses a qualitative research methodology with a participant observation approach. Researchers used this method to find out team collaboration on cross-software workflows in the Autodesk ecosystem. For sampling collection, researchers use Purposive Sampling where sampling is based on certain considerations [15]. And prospective samples are taken based on permanent employees of CV. Sinwa Konstruksi Nusantara who have worked for at least 1 year.

The subject of this research is CV. Sinwa Konstruksi Nusantara where researchers will examine the workflow of the team. As for the object in this study in the form of the use of BIM standards used in the PT Sinar Wandiole Industrial Estate project. Data collection techniques are carried out by means of field notes and analysis of company documents. This research started from July 13, 2023 to April 12, 2024.

Observation data will be processed with Creswell data processing and analysis techniques, namely description, analysis and interpretation [16]. Description, the data will be conveyed chronologically along with the patterns and workflows of the research

subjects. Analysis, researchers will explain the benefits and obstacles to the object of research that refer to the results of the description. Interpretation, researchers interpret the data and then draw research conclusions.

2.2 Materials

Building Information Modeling. Building Information Modeling (BIM) is a multi-level and diverse detailed model and digital management platform that effectively addresses construction challenges [17]. Hwang et al. stated that BIM can suppress the percentage of rework [18]. This can happen because BIM can display project-scale data in one model-based platform. So that users can make the right decisions. Similarly, Franz & Messner found that contractors who are involved since conceptual design and pre-design can produce costs plus costs that tend to be greater [19]. This can happen because BIM generates and manages data for a project, including building geometry, space relationships, geographic information, and the quantity and quality of building components [20].

Autodesk Revit. Autodesk Revit is a 3D model information program that provides facilities for sketching and allows architectural objects to be analyzed from all angles, levels and views which are then presented in the form of interconnected information and databases [21]. This makes it easy to track changes in 3D models and even 3D models related to other devices [22]. By utilizing cross-disciplines, it is easy for users to do detailing on each component. Each installed component contains specific data which will then be processed into other products such as quantity or simulation data.

Autodesk Navisworks. Autodesk Navisworks is one of the support software in the Autodesk ecosystem. Navisworks integrated with Autodesk Revit enables efficient and accurate scheduling with 3D visualization in construction projects [23]. One of Navisworks's flagship tools is Clash Detection, which detects problems and collisions in each element of the 3D model [24]. In addition, there is Lean Construction which focuses on reducing waste and maximizing value for customers in construction projects [25]. Both tools present complex project management in digital form.

Augin Plugin. Augin is an additional software that serves to expand or add features to the main software. Augin plugins represent 3D models with the real world [26], thus enriching the user's perception of the surrounding environment. 3D model representation is not only limited to architectural appearance but also structure and mep. The more complete the data input on the 3D model, the more complete the appearance displayed on the Augin visualization.

Barriers. Utomo & Rohman in their research revealed that the main obstacle according to BIM experts is the lack of understanding of the benefits of BIM so that the use of BIM is not optimal [27]. The desire of the project environment to change the way of

working from CAD to BIM also affects the utilization of BIM. In line with that, Hanifah concluded that the level of awareness is quite high for respondents who recognize BIM [28], but its use is still low. Meanwhile, in Indonesia, experts' understanding of BIM is still lacking. Ideally in every project there is a special division that handles the BIM process [29].

3 Results

PT. Sinar Wandiole's Industrial Estate project stands on 1.2 ha of land with extreme land elevation and is traversed by tributaries. This project aims to expand the business by increasing the scope of product capacity. The project scope of work consists of soil elevation modeling, construction of retaining walls, 10 function buildings and telford, which are then made into technical documents.

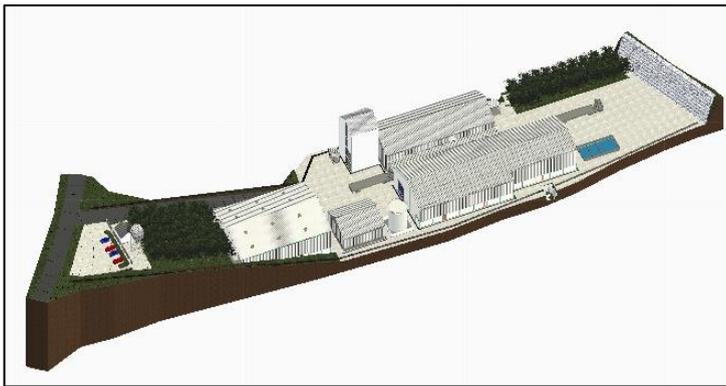


Fig. 1. 3D visualization of conceptual design design

3.1 Pra Construction

In the initial stage, data collection was carried out to define the scope of work. The owner provided some data in the form of building specifications, topographic data and land use right documents. As for the data obtained by themselves in the form of location maps and field documentation. Each data obtained is directly uploaded into the local network file so that each connected device can directly access the data that has been collected.

The next step is to create a Central Worksharing file in Revit by the architect. At this stage the architect will begin to describe the building specifications in accordance with the owner's request until a building model is formed. After that the architect division will start uploading the central file on the local server. After the file is uploaded, the structural and mep divisions will start creating local models on the central file so that each division can work on different parts simultaneously. After each part is complete, both the architect division that continues to the interior layout stage, the structural

division that inputs and analyzes the iron requirements and dimensions of each element and the mep division that designs the electrical and plumbing lines, then the local model will be synchronized with the central model to form a complex 3D model.

The complex 3D model is then exported to Navisworks for inspection of the entire 3D model and collision detection by the Site Manager. The Site Manager will mark-up elements that do not match or have collisions. After the inspection is complete, each relevant division will repair the problematic elements. By utilizing the switchback feature, each division can repair its parts through the local model, which will then be synchronized with the central model and re-export the repaired complex 3D model to Navisworks. Do the same until you get the right result.

After the 3D model is correct, the Site Manager adds the project schedule to the 3D model. Using the timeliner feature, the Site Manager categorizes each element into coherent work items. Then each work item is given a name and duration in units of time. Then the work item is input into the timeliner panel. In this timeliner panel, each work item will start to be set for the start date and completion date. After this, the 3D model is ready to be simulated to visualize the sequence of activities and project progress. At the same time as the Site Manager is working on the 4D model, each division begins to prepare technical documents using Revit's sheets feature. Some of the things that need to be done at this stage are 1). Creating etiquette using title blocks, this is done by the site manager before working on the 4D model to harmonize between divisions; 2). Adding the views that you want to add to the sheet (for example, Floor Plans, Elevations or Sections); 3). Add notations using the text or material not feature; 4). Add shading using the region feature; 5). Inserting details using the callout feature. After the drafting is complete, each division synchronizes with the central model.

After the preparation of technical documents is complete, then each division makes a cost estimate using Revit. The following are the stages of working on cost estimation in Revit, 1). Create a material takeoff according to the work item category; 2). Add the unit cost parameter, to input the price; 3). Add the Total cost parameter, using the Calculated Value feature so that it can input the calculation formula; 4). Arrange the Schedule on the Sheet. Perform the above workflow on the entire building. After all building and land modeling is completed, the site manager will unite all central models into one using the Revit link feature. This feature allows Revit to display a complete visual representation, allowing stakeholders to see all aspects of the design simultaneously so that it becomes a basis for decision making.

3.2 Construction

At this stage, the Site Manager and Project Manager discussed the selection of sub-contractors. In this project, the main contractor provided requirements for the use of BIM for collaboration and project coordination. Sub-contractors are required to access the BIM model to ensure their work is in accordance with the agreed digital model. The sub-contractor who agreed was CV. Surya Jaya Konstruksi.

Furthermore, sub-contractors are given access to BIM 360 to access construction documents and data. The construction data in question is in the form of 3D and 4D models and soil modeling while for documents in the form of technical specifications,

topographic data and contract values. After all the data is received, the sub-contractor can start the implementation of work in the field. Furthermore, the main contractor submits a request for the installation of the reference tracker point plugin augin at the construction site. This makes it possible to access the 3D model in real-time. After all points are installed the main contractor reviews the construction site to ensure the work is in accordance with the plan and if there are changes the sub-contractor can immediately access the change model.

As construction progresses sub-contractors can submit contract change orders and Request for Information documents digitally. These requests will be studied by the main contractor before a coordination meeting is held. In this project the sub-contractor submitted a contract change order document, the sub-contractor assessed that there were several elements that needed additional volume. The most noticeable volume differences are in the volume of iron and cement cubication. This was due to the volume of iron in the 3D planning model not including the addition of overstaffing, while for cement cubication the 3D model did not take into account the reduction in volume left behind during the distribution process.

After the construction is in the completion stage the sub-contractor is required to complete the necessary documents. Once all documents are completed the main contractor will inspect and approve the work. The main contractor then compiles documents, visuals and presentations for submission to the owner. The main contractor will explain all the changes that occurred during construction and provide access to all information about the building systems, making it easier for the owner to perform future maintenance and management of the facility.

3.3 Supervision

During construction the main contractor will act as a supervisor, at this stage the team is divided into a document team and a field team. The document team is tasked with completing work related to documents, both documents required by the owner and documents required by sub-contractors. While the field team is tasked with completing the field data required by the document team.

In the initial stage of construction, the document team began uploading planning construction documents into BIM 360 so that they could be accessed by sub-contractors and owners. Then the document team will explain the scope of work, quality standards and scheduling. All these documents will form the basis of the main contractor's supervision of sub-contractors during construction. Meanwhile, the field team ensures that sub-contractors can access all the necessary documents.

After the document access is granted and the sub-contractor understands the project outline, construction can begin. At this stage the site team will start conducting regular inspections and monitoring in the field, to report on construction progress. From the results of this monitoring the site team will create a daily report, which is then uploaded into BIM 360. The results of the daily report will be used by the document team to input the start and completion dates of work items into Navisworks to display the deviation value between plan and realization.

Until the final inspection stage, the field team and the owner ensure that all work is in accordance with the specifications and quality standards set. The field team will explain to the owner about all work items assisted by Augmented Reality Augin to assess the conformity between the built building and the planned 3D model. After that, the document team will start collecting documents from sub-contractors and main contractors to be submitted to the owner.

3.4 Analysis of Benefits and Barriers

Building Information Modeling (BIM) is a new work standard that can accommodate all stages of construction. The use of BIM with all the features that serve to facilitate work there are several obstacles faced in its application.

Table 1. Benefits and barriers on work pattern and workflow’s chronologies

The Planning Stage				
No	The chronology	Benefits	Results Barriers	Notes
1.	Planners are not using BIM 360 as a database	-	<ul style="list-style-type: none"> • Subscription fee • Limited location 	Due to subscription costs, planners use alternative methods as databases but are limited to one location.
2.	Each division works at the same time	<ul style="list-style-type: none"> • Faster and more effective processing • Better design • Enables faster changes • Monitoring progress between divisions 	<ul style="list-style-type: none"> • Generates a lot of collision 	The process can be faster and more accurate and is done by experts in the field, but working simultaneously results in small collisions that are difficult to detect.
3.	Revit and Navisworks synchronization using manual method		<ul style="list-style-type: none"> • Unable to make changes automatically 	Due to the high cost of BIM 360 subscriptions, planners use alternative ways to synchronize data.
4.	Utilization of the collision detection feature in Navisworks	<ul style="list-style-type: none"> • Faster and more accurate collision detection 		This feature covers the shortcomings of concurrent work.
5.	Inputting a work schedule using the Timeliner Feature in Navisworks	<ul style="list-style-type: none"> • Visualize the work schedule 	<ul style="list-style-type: none"> • Requires more time 	The more specific the division of work items on the timeliner, the more accurate the information generated, so it often takes a lot of time and effort.
6.	Preparation of plan drawings	<ul style="list-style-type: none"> • Faster processing 	-	The sheet feature will always be synchronized with the view

The Planning Stage				
No	The chronology	Results		Notes
		Benefits	Barriers	
7.	with the Sheet feature in Revit Calculate cost estimates using the schedule or material take off feature	<ul style="list-style-type: none"> • Synchronized with each other • Faster processing 	<ul style="list-style-type: none"> • Complexity in document preparation 	<p>so that the update process is faster.</p> <p>Volume calculation is done automatically so that the process is faster but it is difficult to compile the results into a document.</p>
The Construction Stage				
8.	Implementers use BIM 360 as a database	<ul style="list-style-type: none"> • Better coordination • Fast updates 	-	Main contractors, sub-contractors and owners can access information data quickly.
9.	Main contractor addresses work items using Augmented Reality technology Augin	<ul style="list-style-type: none"> • Display visualization of work • Better understanding 	<ul style="list-style-type: none"> • Requires a smartphone with high specifications 	This technology makes it easier to visualize work items so that there are no misperceptions, but the more complex the 3D model, the higher the smartphone specifications required.
10.	Sub-contractors use Revit 3D models as a reference for work	<ul style="list-style-type: none"> • Reduce detailing time 	-	In contrast to Autocad, Revit provides more complex 3D modeling from the planning stage.
11.	The Main Contractor provides a schedule of works using the Timeliner Feature in Navisworks.	<ul style="list-style-type: none"> • Better site management • Better logistics management • Helps decision makers 	<ul style="list-style-type: none"> • Requires expert guidance for operation 	This feature helps sub-contractors for construction management in the field, but there are still few people who understand its operation.
Supervision Stage				
12.	Supervisors use BIM 360 as a database	<ul style="list-style-type: none"> • Easy access to data sources • Easy to do field documentation results • Make it easy to make weekly reports 	-	BIM 360 as a database makes it easy for supervisors to upload or view field data.
13.	The inspection stage utilizes Augmented Reality as a reference	<ul style="list-style-type: none"> • Helps to detect work errors 	-	This makes supervisors no longer need to see 2D images, just scan the barcode and a 3D model will appear that is directly connected to the field.

The Planning Stage				
No	The chronology	Benefits	Results Barriers	Notes
14.	The document team uses the timeliner feature in Navisworks to create weekly reports	<ul style="list-style-type: none"> Simplify monitoring progress 		Navisworks's timeliner feature can generate information in the form of deviation values between plan and realization.

4 Research Limitations

This research has several limitations that require in-depth understanding to generalize the findings. Firstly, this study focuses more on large-scale projects, so the conclusions drawn are less relevant for small construction projects that have limited resources. Secondly, the findings of this study are highly influenced by the social context of the construction project sites studied. Therefore, the results obtained are not fully applicable to all locations or projects that have different social dynamics.

5 Conclusions

Based on the research results, the following conclusions can be formulated that this research shows that Building Information Modeling (BIM) has influenced patterns and workflows in the construction industry, by creating a more collaborative, transparent and data-driven process. BIM introduces a new way of designing, managing and coordinating projects, where all disciplines are forced to work within one integrated model. This in turn changes the working dynamics from silo-based (separate per discipline), to more connected and synchronized. However, the research also highlighted several barriers to adapting to these new workflows and patterns. Resistance to change is one of the biggest barriers, especially among implementers who are used to conventional working methods. The use of BIM demands a skills update and a change in communication flow, where everyone has to get used to the complex digital platform. This research also found that although BIM improved efficiency and accuracy in modeling project designs, the project's new adaptation to BIM resulted in an extension of time on the project, due to the need to guide some stakeholders who still lacked understanding of the operation of the BIM software used.

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