ANALYSIS OF THE IMPLEMENTATION OF BUILDING INFORMATION MODELING (BIM) IN THE ACCELERATION OF BUILDING CONSTRUCTION MANADO STUDENTS' DORMITORY

Fardi Kalumata [1], Jonie Tanijaya [2], Erni Rantebungin [3]

1Student of Civil Engineering Master's Program, Paulus Indonesian Christian University, Jl Perintis Independen K.M 13 Daya, Makassar, Email: ardhykalumata23@gmail.com 2.3 Lecturer in Civil Engineering Study Program, Paulus Indonesian Christian University, Jl Perintis Independen K.M 13 Daya Makassar.

ABSTRACT

The construction of the Manado Student Dormitory (AMN) is one of a lot of priority governments, the construction of which is based on PP No. 106 of 2021. The aim of building the AMN is so that students from various regions studying in North Sulawesi can interact with each other, and get to know and respect each other's culture. After the Pre Construction Meeting (PCM), the owner instructed that acceleration be made by shortening the implementation time. To implement these instructions, the contractor PT. Widya Satria implemented the BIM (building information modeling) system to accelerate the work, by modeling the construction phase starting from BIM 3D (modeling), BIM 4D (scheduling), and BIM 5D (quantity take off). Accelerating work is carried out by applying the fast track method so that any work that has a long critical path time can be shortened by overlapping work between one stage and another that can be done together. The implementation results simulate that the work can be completed faster than the contract time with the worker requirement of 296 people, 1 (one) tower crane unit, and 1 (one) mobile crane work unit, even after implementing BIM in the construction of AMN Manado, all stakeholders It is easy for the holder to coordinate and control work progress.

Keywords: building information modeling, fast track, navigation work simulation

1. Introduction

The Indonesian student dormitory construction project begins on December 27, 2023, with 247 calendar days (normal time). As time went by after the Pre Construction Meeting (PCM) was held, the service user instructed that an acceleration be made by shortening the implementation time from 247 calendar days to 217 calendar days. To implement the instructions mentioned above, the service provider PT. Widya Satria applies the BIM (Building information modeling) system to accelerate the work, by modeling the construction phase starting from 3D (modeling), 4D (scheduling), 5D (quantity take off)

The results of this modeling and simulation will be a sequence of work starting from structural, architectural, and MEP (mechanical, electrical, plumbing) work. The final output from the application of BIM is that it will be easier to see clash detection between structural elements, reduce excesses/deficiency in volume calculations due to calculation errors, and can also display the dependency of work items from one job to another. So it is hoped that by implementing a working system using BIM,

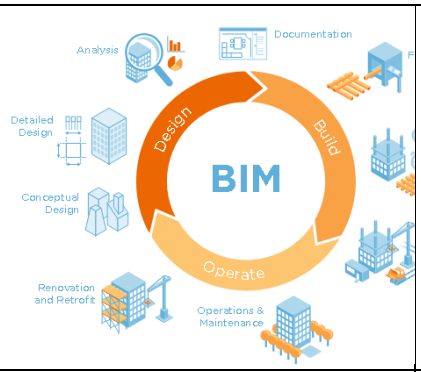
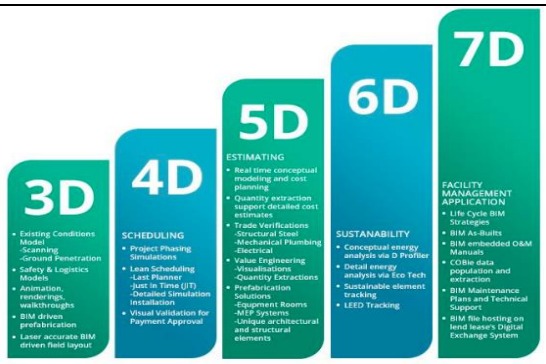
slack time, resulting from repetitive and not well-coordinated work, can be avoided and the work carried out can be accelerated more optimally.

2. Building Information Modelling

Building Information Modeling (BIM) is a technology in the field of AEC (Architecture, Engineering and Construction) which is capable of simulating all the information in a development project into a 3-dimensional model. Building Information Modeling (BIM) technology is no longer foreign to the AEC industry in the world, including in Indonesia. Throughout its journey, BIM has received a positive response from the public considering the benefits offered in the AEC field. By implementing BIM in the world of construction, both developers, consultants and contractors will be able to save work time, costs incurred and the labor required.

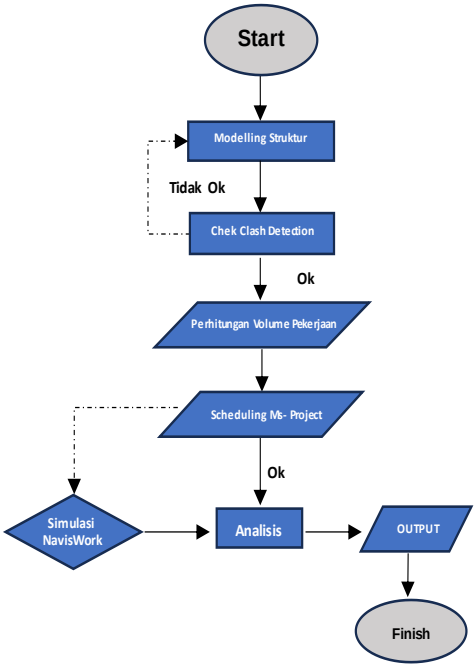
Literature Review

Professor Charles M. Eastman invented the term BIM in the 1970s, and it essentially means digital modeling of typical building construction.It is based on a procedure that organizes all information about accomplishments (Vignali et al., 2021). National Building Information Modelling Standard (NBIMS) defines BIM as "A BIM is a digital representation of physical and functional characteristicsof a facility. As such, it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward" (National Institute of Building Sciences., 2007). Compared to 3D design CAD, BIM is a three-dimensional representation and a model in which each entity has a specific role and information in the project (Vignali et al., 2021). BIM is not simply a piece of software but also a mechanism for gathering information about a construction project during the design and pre-construction stages. BIM is not only a tool for knowledge utilization and dissemination but also the process of the most recent construction approaches for information collected during the construction process (Samimpay & Saghatforoush, 2020), and it consists of:•3D: Three dimensions, including length, width, and heightparameters•4D: Three dimensions with the construction schedule•5D: Four dimensions with estimating constructioncost•6D: Five dimensions of the site, which require theintegration of geographical information systems and BIM.•With GIS integration, all of the cases available in the project•The site presentsdetailed information about the location.•7D: Facilities management in the project lifecycle

	
BIM Workflow *Source: Planon building Conection*	BIM Dimension *Source:* *https://superfffmk.live/product_details/50820588.html*

3. **Flowchart research**

Based concept for workflow research



Research Framework

Based on the background and referring to previous research, the steps to carry out an analysis of the application of Building Information Modeling (BIM) in accelerating the construction of the Manado Nusantara Student Dormitory Building are as follows:

1. Collect project data related to the matters needed in preparing this research.
2. Collect data such as detailed engineering designs from planning consultants, cost budget plans, and other requirements related to the Nusantara Manado Student Dormitory Building construction project

3. Carry out 3D modeling of the structural shape of the Nusantara Student Dormitory Building, this modeling is done very carefully so that the modeling created is in accordance with what was planned.
4. Check clash detection on each structural element.
5. Ensure that modeling using Revit software is complete, then calculate the Quantity Take Off (QTO) for each structural work item
6. After the Quantity Take Off (QTO) for each work item is obtained, continue by entering each work item based on the Sequence that has been created based on the planning version curve.
To create work sequences, assistance was made using MS-project software and NavisWork Manage 5D
7. Conduct a study of the needs for human resources, equipment and materials needed in the process of accelerating work, so that the needs for labor resources, equipment and materials are obtained
Make conclusions from the calculation results so that data is obtained on various resource requirements needed if the Dormitory Building Construction is accelerated for 1 month.

RESULTS

As with other BIM software in general, in Autodesk Revit, before we model structural elements, we first have to model the grid and levels. This grid and level have different functions, the grid functions to determine the reference for the span or dimensions between structural elements, for example it is used to determine the distance from As to As of the column in the X direction and Y direction. The level functions to regulate the height of each floor to be modeled. Grids and levels are created with the initial step on the structure tab selecting grid, the results of the grid and levels that have been created can be seen in the image below:

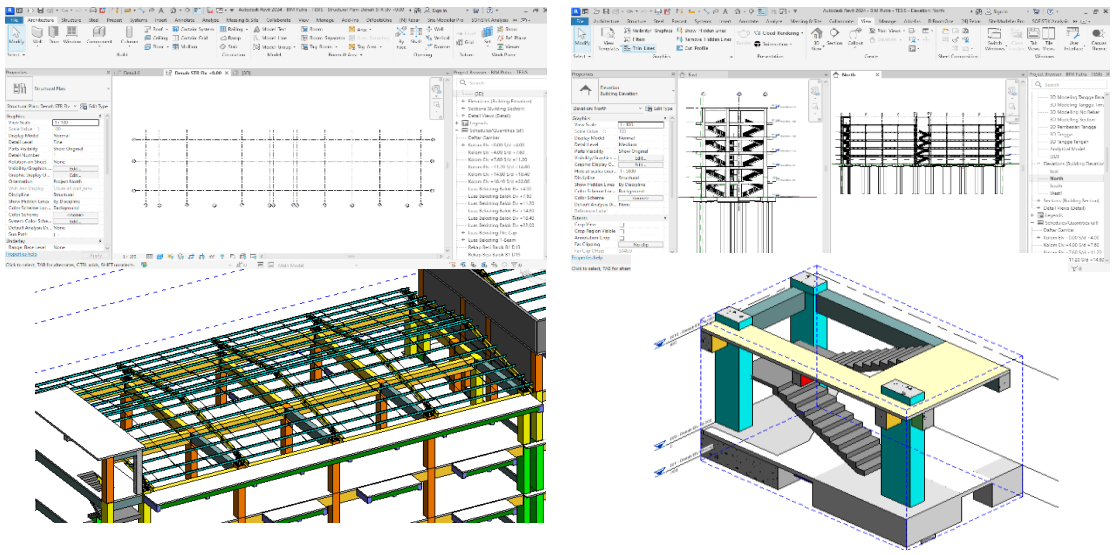


Image of modeling results with Autodesk Revit

After modeling has been carried out using Revit software, and an estimate of the duration of the work has been obtained, the next step is to summarize the labor requirements and implementation time for each work item. In the table below, a recapitulation of labor requirements and work implementation time is presented. After the labor requirements and implementation time have been completed, a structural work scheduling plan is then created using Microsoft Project software

Tabel 1 Recapitulation of Volume, Manpower, and Implementation Time

No	Uraian Pekerjaan	Volume	Satuan	Estimasi Tenaga Kerja	Waktu (Hari)
1	1 Mobilisasi peralatan				7.0
	2 Mobilisasi Material				7.0
	3 Mobilisasi Personil				3.0
2	**Pekerjaan Tanah**				
	1 Pekerjaan Cut and Fill				7.0
	2 Pekerjaan Pengeboran dan Pembuangan Lumpur				35
3	**Pekerjaan Pondasi Bore Pile**				
	1 Pembesian Pondasi Bore Pile	64,332.73	Kg	12	38.0
	2 Pemasangan Besi kedalam Lubang	69	Titik		38.0
	3 Pengecoran Pondasi Bore Pile	69	Titik		38.0
	4 Pemotongan Kepala Tiang	69	Titik		38.0
4	**Pekerjaan Pilecap, T-Beam dan Lantai Basement**				
	1 Pekerjaan Urugan Pasir di bawah PileCap	39.62	m^3	5	3.0
	2 Pekerjaan Cor Lantai kerja di bawah Pilecap	19.81	m^3	10	3.0
	3 Pembesian Pilecap	43681.54	kg	12	26.0
	4 Pekerjaan Bekisting Pilecap	501.57	m^2	12	22.0
	5 Pekerjaan Urugan Pasir di bawah T-Beam	8.581	m^3	5	1.0
	6 Pekerjaan Cor Lantai kerja di bawah T-Beam	4.29	m^3	5	2.0
	7 Pembesian T- Beam	39626.66	kg	12	24.0
	8 Pekerjaan Bekisting T- Beam	426.79	m^2	10	12.0
	9 Pekerjaan Pengecoran Pilecap	429.82	m^3	10	18.0
	10 Pekerjaan Pengecoran T-Beam	60.071	m^3	6	5.0
	11 Pembesian Pelat Lantai Basement	14036.59	kg	8	13.0
	12 Pengecoran Pelat Lantai Basement	639.37	m^3	10	26.0
5	**Pekerjaan Kolom Lantai Dasar**				
	1 Pekerjaan Pembesian Kolom Lantai Dasar	31600.8108	kg	8	28.0
	2 Pekerjaan Bekisting Kolom Lantai Dasar	480	m^2	12	27.0
	3 Pekerjaan Pengecoran Kolom Lantai Dasar	73.63	m^3	10	3.0
	4 Pekerjaan Tangga Bekisting, Besi, Pengecoran				7.0
6	**Pekerjaan Struktur Lantai 1**				
	1 Pekerjaan Bekisting Balok Lantai 1	1238.13	m^2	10	33.0
	2 Pekerjaan Bekisting Pelat Lantai 1	1151.524	m^2	20	39.0
	3 Pekerjaan Pembesian Balok 1	41104.2	kg	10	29.0
	4 Pekerjaan Pembesian Pelat Lantai 1	13780.38	kg	10	10.0
	5 Pekerjaan Pengecoran Balok dan Pelat Lantai 1	244.225	m^3	20	5.0
	6 Pekerjaan Pembesian Kolom Lantai 1	23,368.29	kg	10	17.0
	7 Pekerjaan Bekisting Kolom Lantai 1	332.64	m^2	12	19.0
	8 Pekerjaan Pengecoran Kolom Lantai 1	48.96	m^3	10	2.0
	9 Pekerjaan Tangga Bekisting, Besi, Pengecoran				7.0

Source: Results of project data processing

Table 2 Continued Recapitulation of labor and working time

No	Uraian Pekerjaan	Volume	Satuan	Estimasi Tenaga Kerja	Waktu (Hari)
7	**Pekerjaan Struktur Lantai 2**				
	1 Pekerjaan Bekisting Balok Lantai 2	1238.13	m2	10	33.0
	2 Pekerjaan Bekisting Pelat Lantai 2	1151.524	m2	20	39.0
	3 Pekerjaan Pembesian Balok 2	41104.2	kg	10	29.0
	4 Pekerjaan Pembesian Pelat Lantai 2	13780.38	kg	10	10.0
	5 Pekerjaan Pengecoran Balok dan Pelat Lantai 2	244.225	m3	20	5.0
	6 Pekerjaan Pembesian Kolom Lantai 2	23368.2944	kg	10	17.0
	7 Pekerjaan Bekisting Kolom Lantai 2	332.64	m2	12	19.0
	8 Pekerjaan Pengecoran Lantai 2	48.96	m3	10	2.0
	9 Pekerjaan Tangga Bekisting, Besi, Pengecoran				7.0
8	**Pekerjaan Struktur Lantai 3**				
	1 Pekerjaan Bekisting Balok Lantai 3	1238.13	m2	10	33.0
	2 Pekerjaan Bekisting Pelat Lantai 3	1151.524	m2	20	39.0
	3 Pekerjaan Pembesian Balok 3	41104.2	kg	10	29.0
	4 Pekerjaan Pembesian Pelat Lantai 3	13780.38	kg	10	10.0
	5 Pekerjaan Pengecoran Balok dan Pelat Lantai 3	244.225	m3	20	5.0
	6 Pekerjaan Pembesian Kolom Lantai 3	23368.2944	kg	10	17.0
	7 Pekerjaan Bekisting Kolom Lantai 3	332.64	m2	12	19.0
	8 Pekerjaan Pengecoran Kolom Lantai 3	48.96	m3	10	2.0
	9 Pekerjaan Tangga Bekisting, Besi, Pengecoran				7.0
9	**Pekerjaan Struktur Lantai 4**				
	1 Pekerjaan Bekisting Balok Lantai 4	1238.13	m2	10	33.0
	2 Pekerjaan Bekisting Pelat Lantai 4	1151.524	m2	20	39.0
	3 Pekerjaan Pembesian Balok 4	41104.2	kg	10	29.0
	4 Pekerjaan Pembesian Pelat Lantai 4	13780.38	kg	10	10.0
	5 Pekerjaan Pengecoran Balok dan Pelat Lantai 4	244.225	m3	20	5.0
	6 Pekerjaan Pembesian Kolom Lantai 4	23368.2944	kg	10	17.0
	7 Pekerjaan Bekisting Kolom Lantai 4	332.64	m2	12	19.0
	8 Pekerjaan Pengecoran Kolom Lantai 4	48.96	m3	10	2.0
	9 Pekerjaan Tangga Bekisting, Besi, Pengecoran				7.0
10	**Pekerjaan Struktur Lantai 5**				
	1 Pekerjaan Bekisting Balok Lantai 5	1238.13	m2	10	33.0
	2 Pekerjaan Bekisting Pelat Lantai 5	1151.524	m2	20	39.0
	3 Pekerjaan Pembesian Balok 5	41104.2	kg	10	29.0
	4 Pekerjaan Pembesian Pelat Lantai 5	13780.38	kg	10	10.0
	5 Pekerjaan Pengecoran Balok dan Pelat Lantai 5	244.225	m3	20	5.0
	6 Pekerjaan Pembesian Kolom Lantai 5	23368.2944	kg	10	17.0
	7 Pekerjaan Bekisting Kolom Lantai 5	332.64	m2	12	19.0
	8 Pekerjaan Pengecoran Kolom Lantai 5	48.96	m3	10	2.0
	9 Pekerjaan Tangga Bekisting, Besi, Pengecoran				7.0
11	**Pekerjaan Struktur Lantai DAK**				
	1 Pekerjaan Bekisting Balok Dak	190.7545	m2	12	5.0
	2 Pekerjaan Bekisting Pelat Lantai Dak	546.718	m2	12	31.0
	3 Pekerjaan Pembesian Balok Dak	6930.64	kg	10	5.0
	4 Pekerjaan Pembesian Pelat Lantai Dak	6585.16	kg	10	5.0
	5 Pekerjaan Pengecoran Balok dan Pelat Lantai Dak	38.3606	m3	10	2.0

Source: Results of project data processing

To accelerate using the fast track method, you can do the following steps:

1. Determine the critical path

The critical path can be determined and can be seen with the help of MS-Project software. In the fast track method, work items that can be shifted/changed are only on the critical path. The steps taken are to display the critical path in the scheduling plan that has been prepared. To see the critical path using MS-project, you can do this by right clicking on the gantt

chart then clicking Show / Hide Bar Styles - Critical Task as shown in the image below:

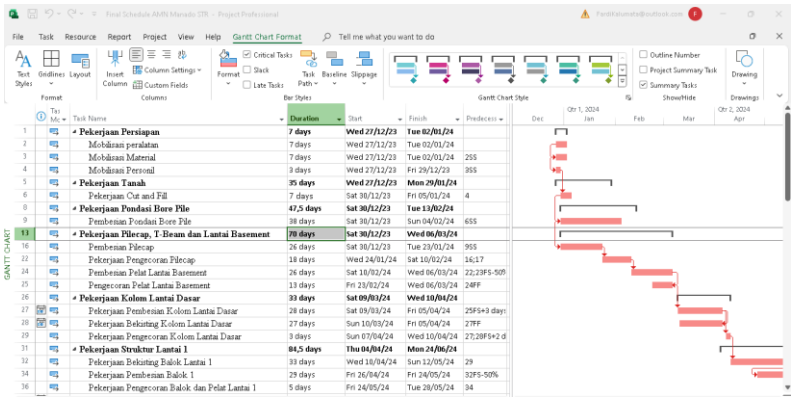


Figure 1 View of the Critical Path in AMN Project

1. Determine the critical path of work for acceleration

From the critical path data obtained in the planning schedule above, the work to be accelerated is then determined. The work that will be selected is the work with the longest critical path, so that it can very effectively shift the duration of the work and speed up the implementation time. At the selection and assessment stage, the author took jobs as in the table below to be accelerated.

Task Name	Durasi MS -Project	Durasi Awal Perhitungan	Predecessors
Pekerjaan Persiapan	**7 days**		
Mobilisasi peralatan	7 days	7	
Mobilisasi Material	7 days	7	2SS
Mobilisasi Personil	3 days	3	3SS
Pekerjaan Tanah	***35 days***		
Pekerjaan Cut and Fill	7 days	7	4
Pekerjaan Pengeboran dan Pembuangan Lumpur	35 days	35	
Pekerjaan Pondasi Bore Pile	***47,5 days***		
Pembesian Pondasi Bore Pile	38 days	38	6SS
Pemasangan Besi kedalam Lubang	38 days	38	9FF
Pengecoran Pondasi Bore Pile	38 days	38	10FF
Pemotongan Kepala Tiang	38 days	38	11FS-75%
Pekerjaan Pilecap, T-Beam dan Lantai Basement	***70 days***		

Figure 2 Comparison of MS Work Duration - Project vs Manual

Table 3 Critical Work Items

Task Name	Duration	Start	Finish	Predecessors
Pekerjaan Persiapan	**7 days**	**Wed 27/12/23**	**Tue 02/01/24**	
Mobilisasi peralatan	7 days	Wed 27/12/23	Tue 02/01/24	
Mobilisasi Material	7 days	Wed 27/12/23	Tue 02/01/24	2SS
Mobilisasi Personil	3 days	Wed 27/12/23	Fri 29/12/23	3SS
Pekerjaan Tanah	**35 days**	**Wed 27/12/23**	**Mon 29/01/24**	
Pekerjaan Cut and Fill	7 days	Sat 30/12/23	Fri 05/01/24	4
Pekerjaan Pengeboran dan Pembuangan Lumpur	35 days	Wed 27/12/23	Mon 29/01/24	
Pekerjaan Pondasi Bore Pile	**47,5 days**	**Sat 30/12/23**	**Tue 13/02/24**	
Pembesian Pondasi Bore Pile	38 days	Sat 30/12/23	Sun 04/02/24	6SS
Pemasangan Besi kedalam Lubang	38 days	Sat 30/12/23	Sun 04/02/24	9FF
Pengecoran Pondasi Bore Pile	38 days	Sat 30/12/23	Sun 04/02/24	10FF
Pemotongan Kepala Tiang	38 days	Mon 08/01/24	Tue 13/02/24	11FS-75%
Pekerjaan Pilecap, T-Beam dan Lantai Basement	**70 days**	**Sat 30/12/23**	**Wed 06/03/24**	
Pekerjaan Urugan Pasir di bawah PileCap	3 days	Tue 13/02/24	Fri 16/02/24	12
Pekerjaan Cor Lantai kerja di bawah Pilecap	3 days	Fri 16/02/24	Mon 19/02/24	14
Pembesian Pilecap	26 days	Sat 30/12/23	Tue 23/01/24	9SS
Pekerjaan Bekisting Pilecap	22 days	Sat 30/12/23	Sat 20/01/24	16SS
Pekerjaan Urugan Pasir di bawah T-Beam	1 day	Mon 12/02/24	Mon 12/02/24	
Pekerjaan Cor Lantai kerja di bawah T-Beam	2 days	Tue 13/02/24	Wed 14/02/24	18
Pembesian T- Beam	24 days	Wed 10/01/24	Fri 02/02/24	
Pekerjaan Bekisting T- Beam	12 days	Sun 04/02/24	Thu 15/02/24	
Pekerjaan Pengecoran Pilecap	18 days	Wed 24/01/24	Sat 10/02/24	16;17
Pekerjaan Pengecoran T-Beam	5 days	Mon 05/02/24	Sat 10/02/24	22FF
Pembesian Pelat Lantai Basement	26 days	Sat 10/02/24	Wed 06/03/24	22;23FS-50%
Pengecoran Pelat Lantai Basement	13 days	Fri 23/02/24	Wed 06/03/24	24FF

After completing the adjustments to the schedule and structural elements using Timeliner, the next step is to create an animation using the simulate menu to schedule work according to the work sequence that has been previously set in the Ms-Project software. For more details, see the image below:

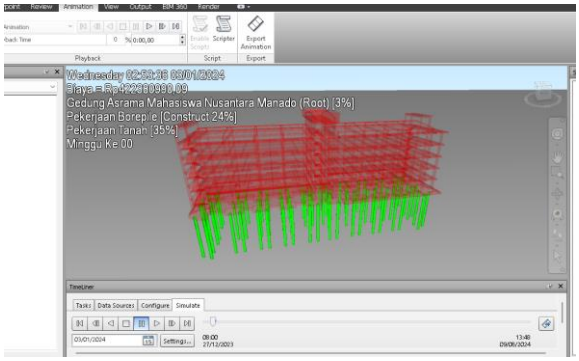


Figure 3 Simulation model week – 01 progress 3%

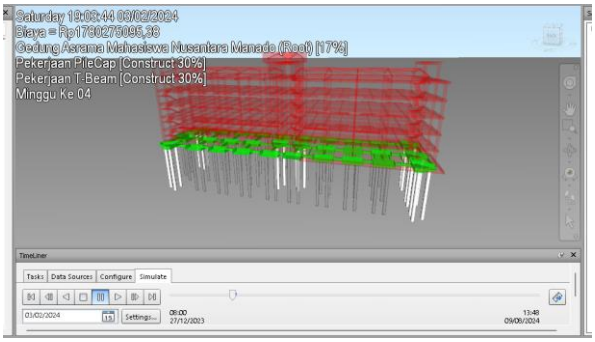


Figure 4 Simulation model for week 4 progress 17%

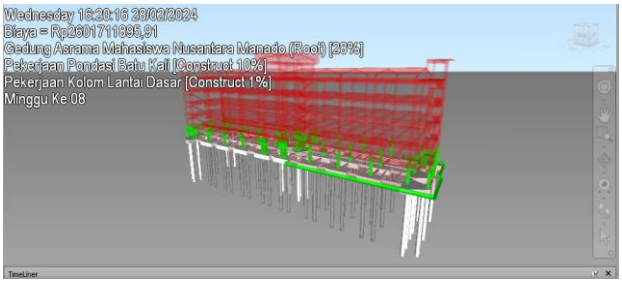


Figure 5 Simulation results for week 8, progress 28%

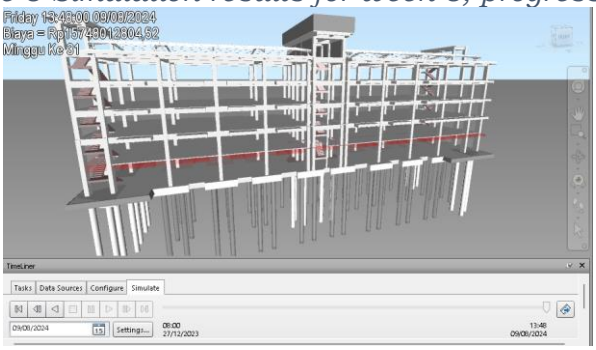


Figure 6 Simulation results for week 32 – progress 100%

CONCLUSION

Based on the results of the research carried out, it can be concluded as follows:

1. Implementation of BIM using Autodesk Revit and Microsoft Project software in the Indonesian student dormitory building construction project resulted in a large number of resource requirements, both labor and material requirements. After conducting an analysis using BIM, it was found that the workforce needed to complete the work within 217 calendar days was 296 people. By applying BIM the volume of work can be obtained accurately. It is also possible to see the amount of use of material resources, labor for each work item, and the peak load of use of these resources. By applying BIM, you can produce a more dynamic analysis, where if there is a delay in work, you can know the effect on other work and the distribution of manpower and materials.

2. Implementation of BIM using Autodesk Revit and Autodesk Naviswork software can detect clash detection so that modeling and preparation of working drawings can run together and will not be repeated. Implementing BIM with Autodesk Naviswork software can make it easier to review work items and revisions can be made immediately if changes occur, which will directly change the work volume of each structural element. By implementing BIM, both engineers, architects and all those interested in preparing work drawings and in carrying out work can coordinate and work together and this will directly reduce repetitive work.

3. Implementation of 4D and 5D BIM where visualization of the progress of the AMN Manado construction project work in virtual 3D form and combined with the work implementation schedule really helps coordination. Service users no longer need to check the item and weight of each work item, but just by looking at the visuals in the form of a simulation, they can quickly find out the weight of the work that has been achieved. From the visual simulation, it can be seen that the progress of work in each week can be seen in the visual simulation in the first week the work weight is still 3%, in the 4th week the work weight reaches 17%, in the 8th week the work progress reaches 28% and in the 31st and 32nd weeks the work weight is already reach 100%. This simulation really makes coordination easier because the construction objects or elements are not only in 2-dimensional drawing form but are already in 3-dimensional form, and if there is a delay from the planned schedule it can be seen clearly.

BIBLIOGRAPHY

[1] Berlian C, Adhi R, Hidayat A. 2016 Comparison of Time, Cost, and Human Resource Efficiency Between Building Information Modeling (BIM) and Conventional Methods (Case Study: Planning a 20 Storey Building) Journal of Civil Engineering Works

[2] Eastman, C., Teichloz, P., Sacks, R., & Liston, K. (2008). BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors (1st ed.). John Wiley & Sons, Inc.

[3] Module 5 3d, 4d, 5d, 6d, and 7d modeling, as well as simulation and level of Development (LOD) Ministry of PUPR 2018

[4] Nelson, Sekrsari J. 2019. Factors that influence the application of building information modeling (BIM) in the pre-construction stages of multi-storey buildings. Civil Engineering Partner Journal

[5] PUPR, T. B. (2018). Guide to BIM Adoption in Organizations. Center for R&D Policy and Technology Application.

[6] Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 22 / PRT /M/2018 concerning State Buildings

[7] Raflis, Yuwono Bambang, Rayshnda R. 2018. Benefits of Using Building Information Modeling (BIM) in Construction Projects as a Communication Media for Stakeholders. Journal of Civil Engineering