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Implementation Building Information Modelling For Construction Projects In Remote and Challenging Locations (Case Study Road Handling and Bridges Project Toapejat - Rokot - Sioban (Simp. Logpon))

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Building Information Modelling, Construction Projects, Remote Locations, Challenging Locations, Road Handling, Bridges Project.

ABSTRACT
This research discusses the innovative implementation of digitalization of infrastructure construction based on Building Information Modelling (BIM) 5D on the Toapejat - Rokot - Sioban Road and Bridge Handling Project (Simp. Logpon) in the Mentawai Islands. The focus is a collection of AEC software from Autodesk, including Revit, Civil 3D, Navisworks, and BIM 360, which supports the project's BIM goals. This method is proven to provide a holistic approach to planning, design, construction, and management of infrastructure projects. In the face of growing competition and innovation of BIM technology, this study emphasizes the need for continuous innovation for construction companies to participate in the development of digital construction technology. The project is considered a clear example of BIM's crucial role in overcoming construction challenges in remote areas, unlocking potential for future projects on isolated islands.

INTRODUCTION

The development sector is a sector that is of important concern to the government, especially infrastructure development, which has the aim of supporting growing infrastructure needs (Ding et al., 2023; Jung et al., 2023; Kaashi & Vilventhan, 2023). Innovation - continuous innovation developed in line with technological advances that are increasing daily. These various innovations support every development sector, from speed development and ease of implementation to the post-maintenance process development (Biswas et al., 2024; Pantiga & Soekiman, 2021; Sewasew & Tesfamariam, 2023).

The Toapejat – Rokot - Sioban (Simpang Logpon) infrastructure project is dedicated to implementing Building Information Modeling (BIM) 5D and Common Data Environment as part of the digitalization of construction processes in the Mentawai Islands region. This initiative aims to facilitate sustainable development, addressing the specific challenges faced in implementing BIM 5D and Common Data Environment in the Toapejat – Rokot - Sioban project.

The Toapejat – Rokot - Sioban (Simpang Logpon) infrastructure project is a testament to the pivotal role of Building Information Modelling (BIM) in contemporary engineering endeavours. BIM is more than just 3D modelling; it's a holistic approach that revolutionizes how infrastructure projects are planned, designed, constructed, and managed (Abuhussain et al., 2024; Al-Roumi & Al-Sabah, 2023; Gürcanlı & Hartmann, 2024; Huzaini, 2021; Klumbyte et al., 2023). In this context, Autodesk's AEC Collections have become indispensable tools in achieving the BIM goals set for the project.

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In the realm of competitive and innovative Building Information Modeling (BIM)-based technology, there exists a distinctive set of challenges in effectively implementing these advancements for infrastructure development (Dong et al., 2024; Ninić et al., 2024; Shahinmoghadam et al., 2024; Shaputra & Puspita, 2022; Wiranti et al., 2022). Balancing the trinity of quality, cost-effectiveness, and efficiency adds complexity to the equation to successfully navigate this landscape, every construction service company and executing contractor must immerse themselves in continuous innovation, actively contributing to the evolution of digital construction technology (Carvalho et al., 2023; Laorent et al., 2019; Marizan, 2019; Wang et al., 2024; Yeung et al., 2023). In the context of the Toapejat – Rokot - Sioban project, the integration of BIM 5D and Common Data Environment emerges as a pivotal undertaking. By identifying and overcoming the specific challenges associated with this integration, the project aims to set a precedent for successful implementation. The outcomes of this research, therefore, hold the potential to significantly contribute to the broader development of infrastructure and the construction industry as a whole. The lessons learned, and strategies devised in the process will not only impact the success of the Toapejat – Rokot - Sioban project but also serve as valuable insights for future endeavours in the dynamic landscape of digital construction technology.

METHODS

Autodesk's AEC Collections consist of a comprehensive suite of software tools tailored for the architecture, engineering, and construction industry. These collections offer diverse capabilities that align seamlessly with the Road Handling Work and Bridges Toapejat - Rokot - Sioban (Simp. Logpon) BIM-goals:

1. Revit: Revit is a BIM software that enables the creation of intelligent 3D models. It is instrumental in visualizing the entire project and facilitates early identification of potential issues, reducing costly design changes during construction.
2. Civil 3D: Civil 3D is used for civil engineering design and documentation for the road and bridge aspects of the project. This software helps create dynamic, data-rich 3D models of the infrastructure, enhancing efficiency and sustainability.
3. Navisworks: Navisworks, a part of the AEC Collections, is used for project review, simulation, and coordination. It is crucial in identifying clashes and minimizing construction errors and delays.
4. BIM 360: BIM 360 offers cloud-based collaboration, connecting project teams and data in real-time. This software improves stakeholder coordination and information sharing.

Figure 1. AEC BIM Software

Conceptual Approach

The BIM (Building Information Modelling) workflow aims to improve efficiency and effectiveness in planning, designing, constructing, and managing buildings. Every staff in the Road Handling and Bridges Project Toapejat - Rokot - Sioban (Simp. Logpon) has implemented a well-structured BIM Implementation. It is essential to guide the project journey from the initial planning stage through modelling and documentation to successful completion. This ensures that the objectives set out in the BEP (BIM Execution Plan) are met and that all project stakeholders can access clear,

precise, and comprehensive information. By following this RoadMap Flow Chart, construction projects can harness the full potential of BIM, resulting in increased efficiency, reduced errors, and effective communication throughout the project lifecycle.

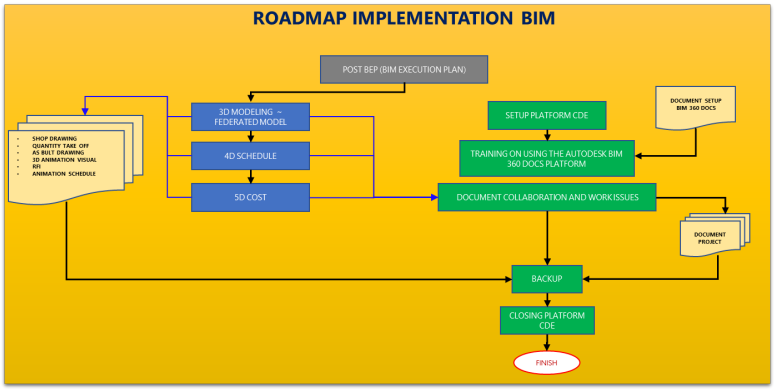

Figure 2. Roadmap Implementation BIM Road Handling and Bridges Project Toapejat - Rokot - Sioban (Simp. Logpon)

The following segregation data drawings are illustrations of 3D work that has been implemented by BIM Engineers on projects that have become road works, which will be created using Civil 3D, and structural works in the form of bridges and box culverts, which will use Revit. Modeling will be combined into one through a workflow mechanism that has been created and declared in accordance with the contents of the BEP (BIM Execution Plan) that has been distributed to the Supervision Consultant, and Owner.

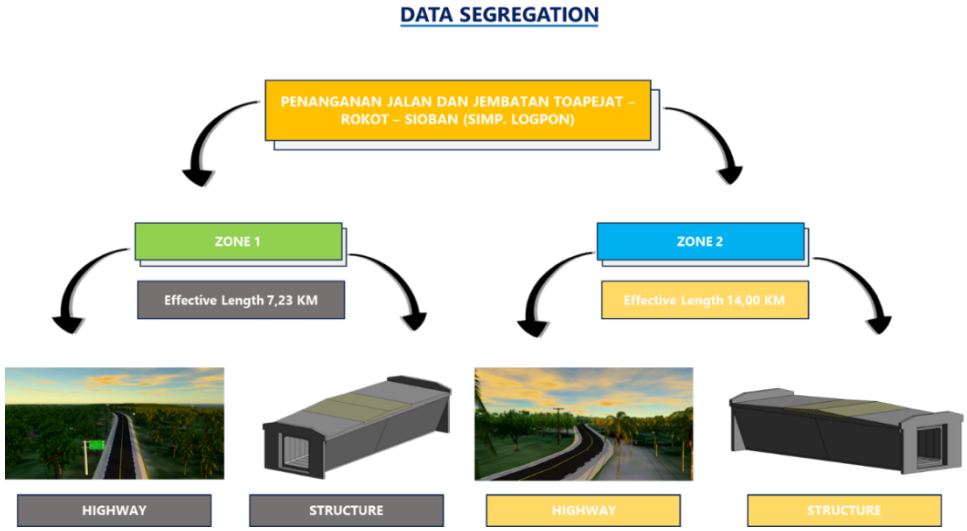

Figure 3. Data Segregation BIM Road Handling and Bridges Project Toapejat - Rokot - Sioban (Simp. Logpon)

RESULTS

BIM Challenge Implementation

Cost Estimation and Control: BIM supports accurate cost estimation by associating cost data with model components. It helps in tracking project costs in real-time and making informed decisions to stay within budget.

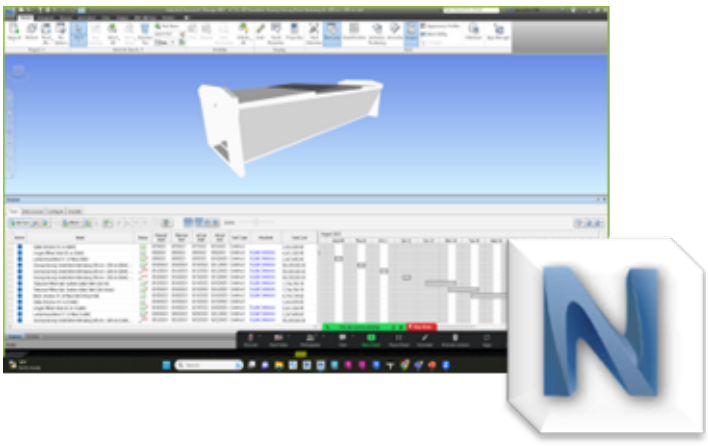

Figure 4. Implementation Navisworks for Cost Estimation and Control

Data Accessbility & Risk Mitigation: With accurate data and simulations, BIM allows for better risk assessment and mitigation strategies, reducing unforeseen issues during construction with embedded data into BIM Campaign.

Figure 5. Implementation of BIM Campaign for information data accessibility & Risk Mitigation

Enhanced Visualization: BIM creates 3D digital models of buildings and infrastructure projects, allowing stakeholders to visualize the design accurately. This improves understanding and decision-making throughout the project lifecycle.

Figure 6. Implementation digital twin with Twinmotion

Improved Collaboration: BIM fosters collaboration among different project stakeholders, including architects, engineers, contractors, and owners. It provides a centralized platform for all parties to work together, reducing communication gaps and conflicts.

Figure 7. Implementation BIM 360 for technology Collaboration

BIM Requirements.

Building Information Modeling (BIM) has rapidly gained prominence in the field of construction and infrastructure development around the world. In Indonesia, the adoption of BIM has been facilitated by specific regulations, notably those within the Ministry of Public Works and Public Housing (PUPR) sector,

To maximize the potential of BIM and avoid issues, the Ministry of Public Works (SE BINA MARGA No /11/SE/Db/2021) as the appropriate regulation is needed. This helps create a consistent and structured environment within the construction industry, which, in turn, can enhance the quality, efficiency, and safety of construction projects.

To meet demanding requirements SE BINA MARGA No /11/SE/Db/2021. Road Handling and Bridges Project Toapejat - Rokot - Sioban (Simp. Logpon) creating BEP (BIM Execution Plan) for describes the BIM implementation plan according to the targets stated in the BEP contains the software and hardware used, the level of detail in the BIM-model, delivery, and file format for delivery data.

Poces 3D Modelling

1. **Modelling Highway By Autodesk AEC "Civil 3D"**

   Civil 3D is a BIM application that has special advantages for modelling earthworks and roads. In the modelling process of the BIM Road Handling and Bridges Project Toapejat - Rokot - Sioban (Simp. Logpon), it is maximized completely, starting from modelling to utilizing QTO and shopdrawing reports. In that regard, we demonstrated that we have implemented BIM on the

project using Autodesk AEC Collection software from modeling in zone 1 (segment 1, segment 3, and segment

Figure 8. process 3D modelling modeling in zone 1 (segment 1, segment 3, and segment 4) in Civil 3D

Figure 9. Output 3D shop drawing Highway from civil 3D

2. Modelling Structure by Autodesk AEC "Revit"

Autodesk Revit is a powerful and versatile Building Information Modeling (BIM) software commonly used for architectural, structural, and MEP (Mechanical, Electrical, Plumbing) design and documentation in the construction industry. While Revit is primarily known for its architectural and

building design capabilities, it can also be a useful tool for the structural design of bridges, especially for smaller or less complex bridge structures.

The Road Handling and Bridges Project Toapejat - Rokot - Sioban (Simp. Logpon) has bridge and culvert repair items in box culverts. We maximize the modelling by utilizing Revit. In modelling, we do it parametrically and don't forget to embed data so that the data conveyed is not only 3D visual but also information on volume, concrete quality, reinforcement diameter, and the technical specifications of the work. We have carried out embedded data consistently, which is, of course, a special assessment in accordance with ISO 19650.

Figure 10. Item 3D model Box Culvert

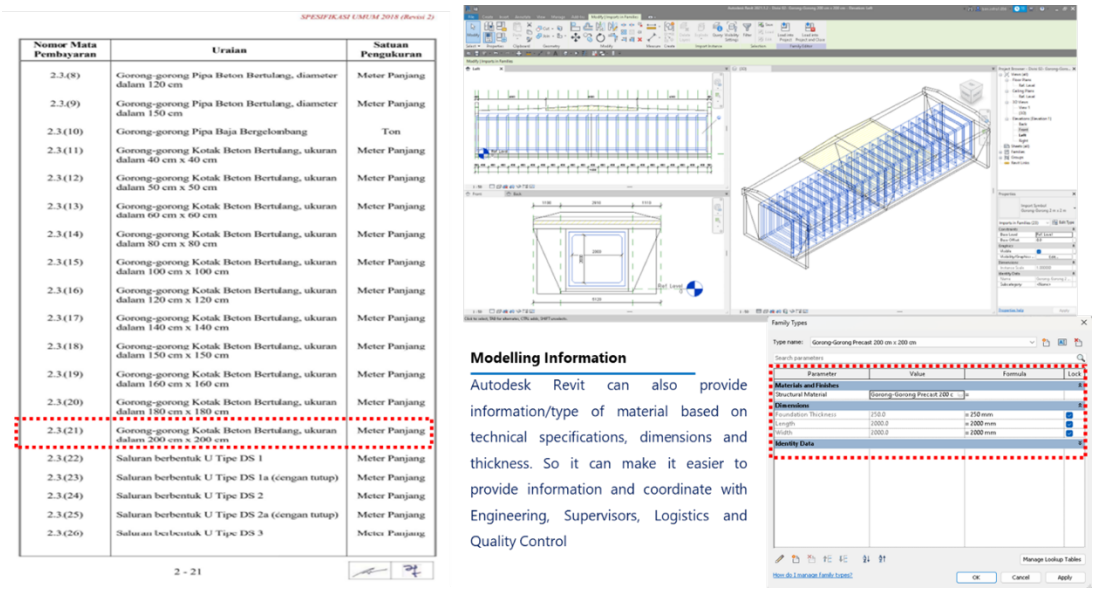

Figure 11. Process Embadded Data into 3D Model

3. Federated Model

A federated model, in the context of Building Information Modeling (BIM), refers to the process of integrating and combining multiple discipline-specific BIM models into a single, comprehensive, and collaborative model. This approach allows project stakeholders, such as architects, structural engineers, MEP (Mechanical, Electrical, Plumbing) engineers, contractors, and other parties involved in a construction project, to work together effectively and efficiently by having access to a consolidated BIM model.

In general, the project of Road Handling and Bridges Project Toapejat - Rokot - Sioban (Simp. Logpon) has created a separation between work items, both highway works and structural works, we implement using integrated Infraworks software based on global coordinates set in modeling created in 3D software and civil revit. Where the results of data separation are visualized on the

project as a whole and of course become a good visualization and in accordance with project projections when the work is completed.

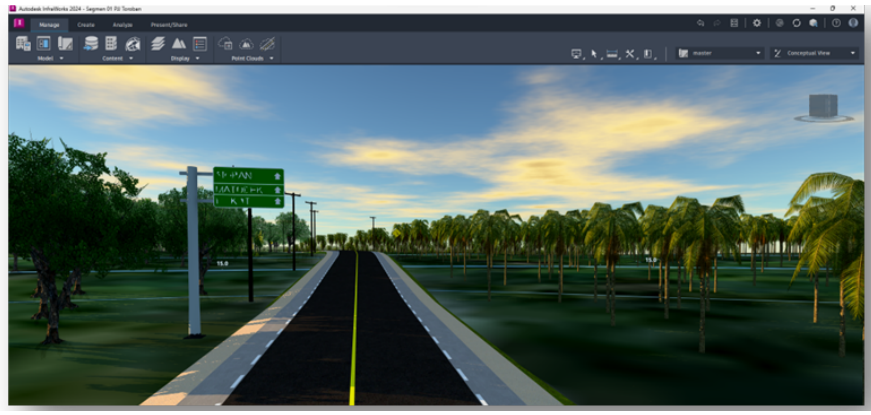

Figure 12. Federated Model Highway KM 22+600 s.d KM 23+884

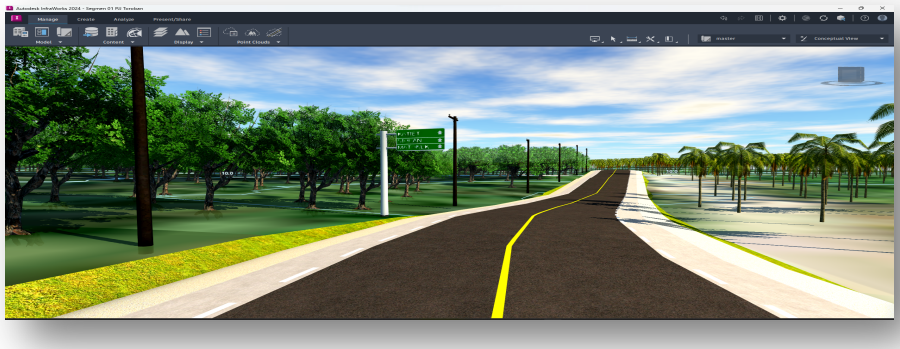

Figure 13. Federated Model Highway KM 26+631 s.d KM 27+525

Figure 14. Federated Model Highway KM 32+325 s.d KM 33+634

4. Digital Twin

A digital twin is a virtual representation of a physical object, system, or process. It's a dynamic, digital counterpart that replicates the characteristics, behavior, and performance of its physical counterpart in real time.

The Road and Bridge Handling Project Toapejat – Rokot – Sioban (Simp. Logpon) this uses a digital twin as best as possible and as realistic as possible, with the aim of getting the best results for the presentation of the finished project. In the digital twin creation phase, we do visual rendering using twinmotion applications using 3D model materials that have been integrated in the federation process in previous infrastructure applications, this can make it easier for coordination and implementation in the field to be easy to understand and reduce the risk of errors in the field.

Figure 15. Render photo 3D model Twinmotion Highway KM 22+600 s.d KM 23+884

Figure 16. Render Photo 3D model Twinmotion Highway KM 26+631 s.d KM 27+525

Figure 17. Render Video 3D Animation

(Link Video : https://drive.google.com/file/d/1lnBaW42Wssk8K0iI8IY-IybMLJKGRmge/view)

5. Monitoring Master Information Delivery Plan (Shopdrawing & BIM Product)

The Master Information Delivery Plan (MIDP) is a document used in Building Information Modelling (BIM) project management. The MIDP outlines what information is required and how that information will be generated, managed, and delivered throughout the project lifecycle. This document contains detailed guidance on using BIM in construction projects, including information

delivery schedules, file formats, standards, and procedures that all project stakeholders must follow.

The MIDP helps coordinate the use of BIM across the project team, ensuring consistency and alignment of the information produced while minimizing the risk of errors and non-compliance in the design, construction, and operation processes. This document also helps ensure that all parties involved in the project have a clear understanding of how BIM will be used and contribute to the project's overall success.

The Road and Bridge Handling Project Toapejat - Rokot - Sioban (Sim. Logpon) has successfully implemented 100% Shop Drawing using Building Information Modelling (BIM). This achievement shows that the project has effectively utilized BIM technology to create and manage detailed Shop Drawings, which can greatly improve the efficiency and accuracy of the construction process.

The MIDP is an essential part of BIM implementation that the project team must regularly conduct to achieve the best results in managing the information generated by the engineering team. This information is then communicated to the entire project team to ensure the successful execution of construction work.

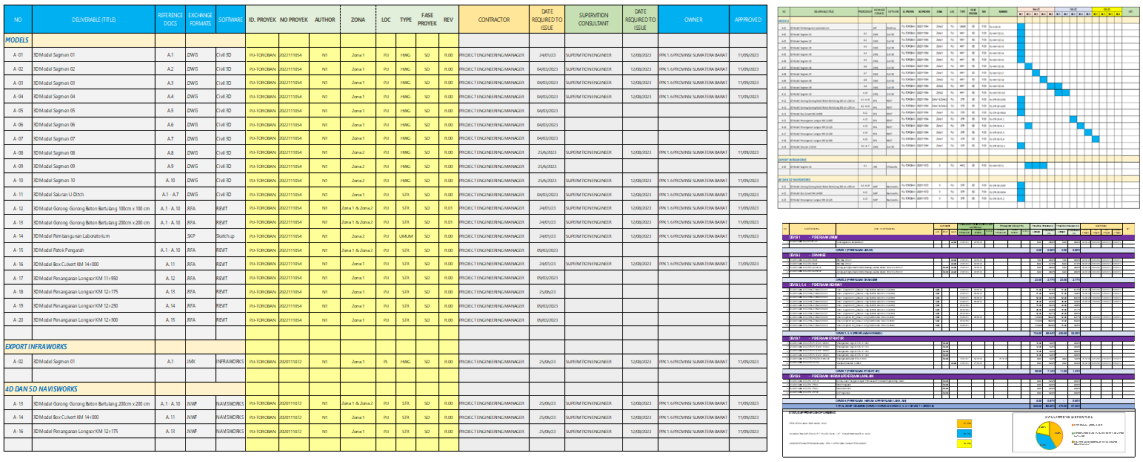

Figure 18. Evidence Form MIDP Project

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Shop drawings are essential for the construction phase of civil engineering projects, as they provide detailed instructions for turning design concepts into physical structures. Civil 3D is often used to streamline the process of generating these drawings, as it allows for efficient extraction of design data and the creation of accurate and detailed construction documentation.

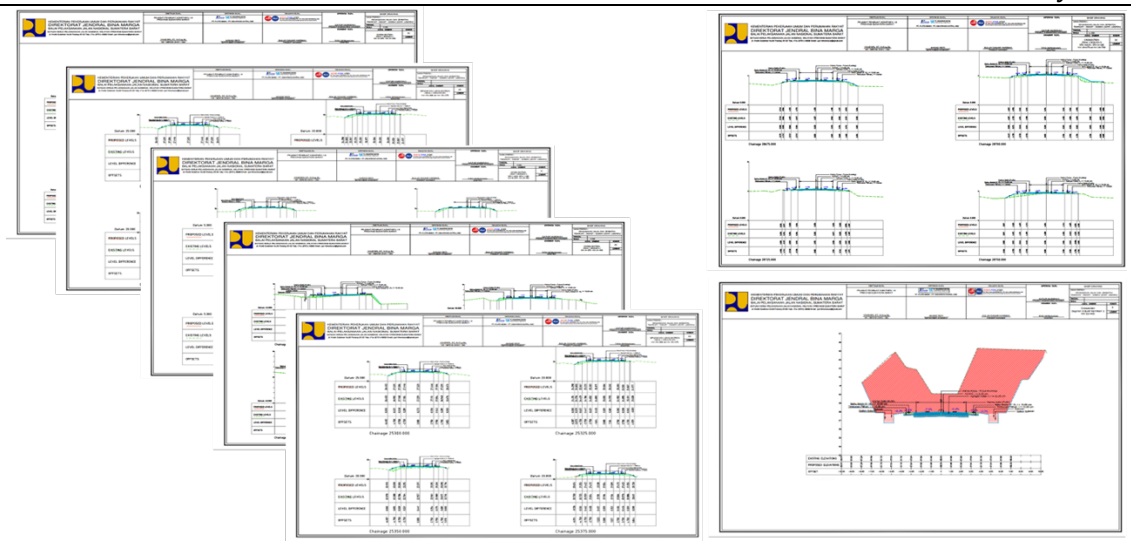

Figure 19. Evidence Shopdrawing By BIM

6. 4D Schedule Monitoring

The construction industry has witnessed a transformative evolution in recent years, thanks to the advent of Building Information Modeling (BIM) technology. One of the most notable advancements in this field is 4D BIM, which seamlessly integrates project execution schedules with 3D Detailed Engineering Design (DED), offering a holistic approach to construction management. This essay explores how 4D BIM is used to monitor construction progress schedules in an integrated manner, focusing on schedule integration within MS Project, utilization using Navisworks software, and involvement of all project stakeholders. Weekly progress reports detailing schedule monitoring using BIM are discussed as an important tool for coordinating with the project management team.

BIM 4D, which stands for Building Information Modeling with a time dimension, goes beyond the traditional 3D representation of construction projects. It incorporates the element of time by linking the 3D model with project schedules. This integration enables construction professionals to dynamically and collaboratively visualize and analyze the entire project life cycle, from conception to completion.

One of the key elements in the successful adoption of 4D BIM done by BIM Engineers on the Road and Bridge Handling Project Toapejat - Rokot - Sioban (Simp. Logpon) is the integration of a project schedule with software such as Microsoft Project (MS Project). By linking 3D models with schedules, stakeholders can visualize and analyze construction sequences in a dynamic environment. It helps identify potential clashes and conflicts and streamlines project scheduling, optimizing resource allocation and project delivery. This allows for real-time schedule adjustments, which can be invaluable in fast-paced construction environments.

Navisworks, a powerful BIM software, is important in the 4D BIM integration process. It is a central hub where DED 3D and project schedules come together. The software enables advanced impact detection, reducing the risk of errors and construction delays. In addition, Navisworks provides a platform to visualize the construction process, improve communication among stakeholders, and encourage collaboration. between Management Staff in the project such as Engineer, Procurement, Quality and Supervisor

Another important aspect of 4D BIM integration is the inclusion of all project stakeholders. While contractors initially adopted BIM technology for internal purposes, its scope has now expanded to include all parties involved in the project, including architects, engineers, owners, and project managers. This comprehensive approach encourages better collaboration and ensures that every stakeholder has access to real-time project data, thereby reducing the possibility of

miscommunication and disputes in field implementation, especially the Road and Bridge Handling Project Toapejat - Rokot - Sioban (Simp. Logpon)

For all stakeholders to be informed and on the same page, providing regular and updated progress reports is important. These reports serve as a detailed overview of the status of construction projects, focusing on monitoring schedules using 4D BIM. Weekly reports are often chosen as they balance providing timely updates and acceleration without burdening stakeholders.

The work progress report should visually represent the 3D model and project execution schedule, highlighting key tasks, tasks completed, and any deviations from the original plan. These reports help identify potential problems in real-time and enable quick corrective action. In addition, we can make informed decisions quickly, ensuring that project management can adapt to changing circumstances and make data-driven choices from applications in BIM, especially BIM 4D Schedule.

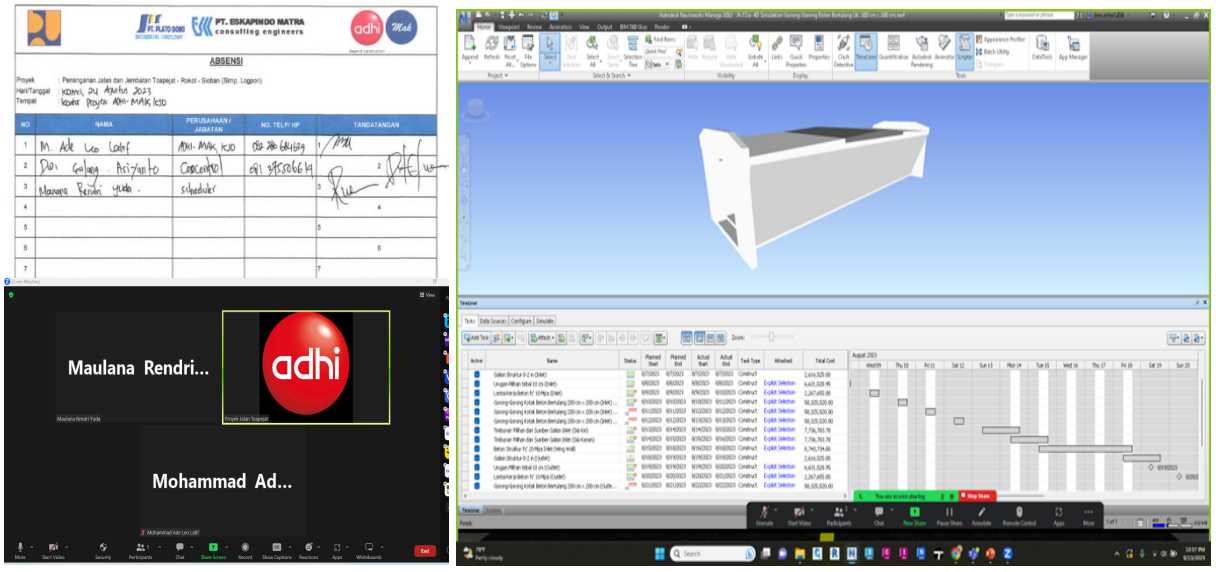

Figure 20. Meeting 4D Schedule Monitoring

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In today's complex construction projects, effective coordination between various project stakeholders is essential to ensure smooth project execution and timely completion. It discusses the importance of a coordination meeting between the BIM (Building Information Modeling) Engineer and the Scheduler, outlining the key aspects of this meeting, which include creating a master schedule, reviewing progress, and evaluating work in relation to the schedule, identifying causes of delays, developing mitigation strategies, and creating action plans for the remaining work.

CONCLUSION

Building Information Modeling (BIM) has emerged as a transformative method for streamlining project evaluation and control across various locations. Its versatile applications have the potential to bridge gaps and challenges faced in remote and geographically isolated construction projects. BIM a unique opportunity to showcase the power of BIM in these challenging conditions, and the Penanganan Jalan dan Jembatan Toapejat – Rokot – Sioban (Simp. Logpon) Project is set to exemplify how BIM can overcome limitations and lead the way for future projects in remote islands. In this essay, we explore the story of this pioneering project.

REFERENCES

Abuhussain, M. A., Waqar, A., Khan, A. M., Othman, I., Alotaibi, B. S., Althoey, F., & Abuhussain, M. (2024). Integrating Building Information Modeling (BIM) for optimal lifecycle management of complex structures. *Structures*, *60*. https://doi.org/10.1016/J.ISTRUC.2023.105831

Al-Roumi, H., & Al-Sabah, R. (2023). Exploring the rate of adoption and implementation depth of building information modeling (BIM): A case of Kuwait. *Journal of Engineering Research*. https://doi.org/10.1016/J.JER.2023.10.044

Biswas, H. K., Sim, T. Y., & Lau, S. L. (2024). Impact of Building Information Modelling and Advanced Technologies in the AEC Industry: A Contemporary Review and Future Directions. *Journal of Building Engineering*, *82*. https://doi.org/10.1016/J.JOBE.2023.108165

Carvalho, J. P., Bragança, L., & Mateus, R. (2023). Automating building sustainability assessment using building information modelling: A case study. *Journal of Building Engineering*, *76*. https://doi.org/10.1016/J.JOBE.2023.107228

Ding, Z., Xu, S., Xie, X., Zheng, K., DaochuWang, Fan, J., HongLi, & Liao, L. (2023). A building information modeling-based fire emergency evacuation simulation system for large infrastructures. *Reliability Engineering & System Safety*, 109917. https://doi.org/10.1016/J.RESS.2023.109917

Dong, B., Zheng, Q., Lin, Y., Chen, B., Ye, Z., Huang, C., Tong, C., Li, S., Deng, J., & Wang, K. (2024). Integrating physical model-based features and spatial contextual information to estimate building height in complex urban areas. *International Journal of Applied Earth Observation and Geoinformation*, *126*, 103625. https://doi.org/10.1016/J.JAG.2023.103625

Gürcanlı, G. E., & Hartmann, T. (2024). Digitalization for safer restoration practices of industrial buildings using building information modelling (BIM): A review and a case study for gasometers. *Digital Applications in Archaeology and Cultural Heritage*, *32*. https://doi.org/10.1016/J.DAACH.2023.E00313

Huzaini, S. (2021). *Penerapan konsep building information modelling (BIM) 3D dalam mendukung pengestimasian biaya pekerjaan struktur*.

Jung, D. E., Kim, S., Han, S., Yoo, S., Jeong, H., Lee, K. H., & Kim, J. (2023). Appropriate level of development of in-situ building information modeling for existing building energy modeling implementation. *Journal of Building Engineering*, *69*. https://doi.org/10.1016/J.JOBE.2023.106233

Kaashi, S., & Vilventhan, A. (2023). Development of a building information modelling based decision-making framework for green retrofitting of existing buildings. *Journal of Building Engineering*, *80*. https://doi.org/10.1016/J.JOBE.2023.108128

Klumbyte, E., Georgali, P. Z., Spudys, P., Giama, E., Morkunaite, L., Pupeikis, D., Jurelionis, A., & Fokaides, P. (2023). Enhancing whole building life cycle assessment through building information modelling: Principles and best practices. *Energy and Buildings*, *296*. https://doi.org/10.1016/J.ENBUILD.2023.113401

Laorent, D., Nugraha, P., & Budiman, J. (2019). Analisa Quantity Take-Off Dengan Menggunakan Autodesk Revit. *Dimensi Utama Teknik Sipil*, *6*(1), 1–8.

Marizan, Y. (2019). Studi Literatur Tentang Penggunaan Software Autodesk Revit Studi Kasus Perencanaan Puskesmas Sukajadi Kota Prabumulih. *Jurnal Ilmiah Bering's*, *6*(01), 15–26.

Ninić, J., Gamra, A., & Ghiassi, B. (2024). Real-time assessment of tunnelling-induced damage to structures within the building information modelling framework. *Underground Space (China)*, *14*, 99–117. https://doi.org/10.1016/J.UNDSP.2023.05.010

Pantiga, J., & Soekiman, A. (2021). Kajian Literatur Implementasi Building Information Modeling (BIM) Di Indonesia. *Rekayasa Sipil*, *15*(2), 104–110.

Sewasew, Y., & Tesfamariam, S. (2023). Historic building information modeling using image: Example of port city Massawa, Eritrea. *Journal of Building Engineering*, *78*. https://doi.org/10.1016/J.JOBE.2023.107662

Shahinmoghadam, M., Kahou, S. E., & Motamedi, A. (2024). Neural semantic tagging for natural language-based search in building information models: Implications for practice. *Computers in Industry*, *155*, 104063. https://doi.org/10.1016/J.COMPIND.2023.104063

Shaputra, M. R. E., & Puspita, N. (2022). ANALISIS PENYEBAB KETERLAMBATAN MASA PELAKSANAAN PADA PROYEK JALAN RUAS BETUNG–MANGUNJAYA. *TEKNIKA: Jurnal Teknik*, *9*(1), 65–74.

Wang, Y., lu, H., Wang, Y., Yang, Z., Wang, Q., & Zhang, H. (2024). A hybrid building information modeling and collaboration platform for automation system in smart construction. *Alexandria Engineering Journal*, *88*, 80–90. https://doi.org/10.1016/J.AEJ.2024.01.013

Wiranti, F., Nisumanti, S., & Al Qubro, K. (2022). ANALISIS PERHITUNGAN QUANTITY TAKE-OFF MENGGUNAKAN BUILDING INFORMATION MODELING (BIM) PADA PROYEK JALAN TOL INDRALAYA-PRABUMULIH. *JURNAL REKAYASA*, *12*(2), 192–202.

Yeung, J., J Hahn Menacho, A., Marvuglia, A., Navarrete Gutiérrez, T., Beach, T., & Rezgui, Y. (2023). An open building information modelling based co-simulation architecture to model building energy and environmental life cycle assessment: A case study on two buildings in the United Kingdom and Luxembourg. *Renewable and Sustainable Energy Reviews*, *183*. https://doi.org/10.1016/J.RSER.2023.113419