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A Study on Innovative Approaches Using Bim Technology In Facing Construction Challenges and Building Sustainable Infrastructure Using Autodesk Revit Software.

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ABSTRACT: *Building Information Modeling (BIM) is a digital representation of the physical and functional characteristics of a building, whether it's a structure or another type of construction. This representation includes all information from the planning stage to the demolition stage. One of the software that supports the BIM concept is Autodesk Revit. Advances in construction technology have brought significant positive impacts on societal structures, from local to global levels, in line with the progress of time and infrastructure development. Construction technology also plays a crucial role in sustainable development, which continues to evolve by incorporating ideas from architects and civil engineers. Many new breakthroughs are now being implemented, such as using digital technology software to operate various heavy equipment, making planning more efficient. To address various issues in the construction industry and with the continuous development of technological innovations from 1970 to 2023 (present), BIM technology in the AEC (Architecture, Engineering, and Construction) sector can simulate all project information into a three-dimensional model. BIM has several main functions, including 3D modeling, material usage information, coordination among architectural and structural engineering disciplines, various types of analysis, project management, collaboration, data documentation, waste reduction, facility maintenance and management, and improved planning quality.*

Keywords: *Construction, Autodesk Revit, Building Information Modeling (BIM), Digital Representation, Infrastructure Development.*

I. INTRODUCTION

Industri konstruksi adalah salah satu pilar utama dalam pembangunan infrastruktur yang mendukung perkembangan masyarakat dan ekonomi. Teknologi konstruksi merujuk pada penggunaan teknologi, alat, dan metode yang digunakan untuk merencanakan, mendesain, dan membangun struktur fisik seperti gedung, jembatan, jalan dan insfrastruktur lainnya. Kegagalan konstruksi dan kerusakan struktur bangunan dapat memiliki konsekuensi yang serius [1] Indonesia, melalui Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat Nomor 22/PRT/M/2018 tentang Pedoman Pembangunan Bangunan Gedung Negara, telah mengatur penerapan BIM meskipun masih dalam cakupan yang terbatas. Salah satu poinnya menyatakan:"Penggunaan Building Information Modelling (BIM) wajib diterapkan pada bangunan gedung negara yang tidak sederhana dengan kriteria memiliki luas lebih dari 2.000 m² (dua ribu meter persegi) dan lebih dari 2 (dua) lantai. Hasil dari

perancangan merupakan hasil penggunaan BIM[2]. Dalam mengatasi berbagai masalah dalam dunia industri konstruksi dan dengan semakin berkembangnya inovasi teknologi dari tahun 1970-2023 (sekarang) penggunaan BIM yang merupakan suatu teknologi di bidang AEC (Arsitektur, Engineering, dan Construction) yang mampu mensimulasikan seluruh informasi di dalam proyek pembangunan kedalam model tiga dimensi. BIM memiliki berbagai fungsi utama, yaitu pemodelan 3D[3] Secara umum, istilah tersebut biasanya dikaitkan dengan segala sesuatu yang bersifat maju, canggih, atau memiliki elemen kebaruan dalam dunia konstruksi, yang mendukung efisiensi, kualitas, serta daya saing baik dari sisi produk maupun proses. Hal ini memberikan berbagai pemahaman terkait teknologi konstruksi, sehingga dalam diskusi ilmiah sering terjadi tumpang tindih pemahaman dengan istilah-istilah lain yang serupa, seperti teknologi rekayasa (Engineering Technology),teknologi desain (Design Technology), atau bahkan teknologi manufaktur (Manufacture Technology) yang menghasilkan material konstruksi jadi atau setengah jadi Building Information Modeling (BIM) berfungsi sebagai alat komunikasi yang memfasilitasi kolaborasi antara para pemangku kepentingan. Dengan memanfaatkan BIM, kesepahaman, pencapaian desain optimal, serta integrasi data, ide, dan desain dari berbagai pihak dapat dicapai dengan lebih efektif. [1]

Revit adalah platform untuk mendesain dokumentais yang mendukung pembuatan gambar, jadwal, dan desain yang dibuthkan dalam BIM. Autodesk revit menawarkan banyak alat siap pakai yang relatif mudah dioperasikan, sehingga perencana dapat lebih fokus pada desain bangunan. [4] Secara implisit revit menyediakan informasi tentang desain proyek, ruang lingkup, tahapan pelaksanaan, kuantitas dan keperluan yang akan dibutuhkan seperti material konstruksi[2]. Lingkungan revit memungkinkan pengguna untuk memenipulasi seluruh bangunan atau desain dalam lingkungan proyek dalam modivikasi bentuk 3D [3]

II. LITERATUR REVIEW

Building Information Modeling (BIM)

Building Information Modeling (BIM) is a set of processes, technologies, and policies that integrate all steps through collaboration in a digital model. In construction projects that use BIM, as well as in the design, procurement, and construction execution processes, all elements can be easily connected.[5]. To achieve this, a concept is needed that can encompass all aspects of construction, from the planning stage, design, procurement, to implementation in the field.[6]. The main functions of BIM are to isolate and improve the accuracy of the scope of work, facilitate project planning and management, and enable a high level of precision and accuracy in the planning and design of construction projects.[7] The structural elements that are modeled include foundations, main columns, practical columns, beams, primary beams, secondary beams, floor slabs, and roof frames. After the modeling of the structural elements is completed, the detailing process is carried out, which includes the addition of reinforcement and connections, adjusted to the data obtained from the design consultants[8].

Figure 1. layers of BIM

N-Dimensi BIM

The use of BIM allows for modeling in a 3D format that includes the dimensions of length, width, and height based on parametric objects. By adding a time element for scheduling, BIM evolves into 4D. Next, cost elements are added for estimation, making BIM 5D. In the following stage, BIM can be used for energy analysis and environmental impact evaluation, known as 6D. When all information elements in BIM are complete, this data can be utilized by the owner for facility management, including maintenance and operations, known as BIM 7D.[9]

Autodesk Revit

Revit is a software used in the building contruction indutry that serves as a 3D medeling tool[4]. Revit can create a project where all parts of the project are integrated with each other, including structural, mechanical, electrical, and plumbing elements. Revit simplifies work through software integration, the ability to detect design clashes, and accelerates the workflow process[2]. However, Revit also has drawbacks, such as high licensing costs and the need for high hardware specifications.[3] In the modeling process using the BIM method, there are various levels of development. Several paradigms are used to understand the definition of Level of Development (LOD), which is an important part of the BIM process.[10]

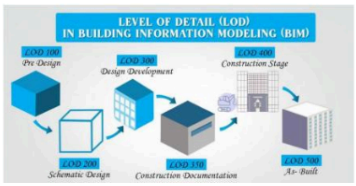

Figure 2. Level of Deployment

Revit includes objects that are referred to as "Families" in Revit terminology[2]:

a **Sistem Family** , yang sudah tersedia secara otomatis dalam sistem Revit. Sistem keluarga ini terdiri dari elemen-elemen dasar yang membentuk struktur bangunan.

b **Loadable Family** , yaitu elemen pelengkap bangunan seperti pintu, jendela, furniture, tanaman, dan lainnya. Elemen ini disimpan sebagai file eksternal dengan ekstensi *.rfa.

c **In-Place Family** , elemen yang bersifat unik dan dibuat sesuai dengan kebutuhan spesifik untuk bangunan tertentu.

Advantages of Using Revit in Building Design [2]:

a. **Virtual Building.** Instead of drawing lines to represent walls, designers create a virtual building, and 2D detailed drawings are automatically generate

b. **Object with Technical Information.** The virtual building system requires inputting numerous settings for each object created. This saves time during the design process as different element types reference previously created templates.

c. **Ease of Object Formation.** With the massing concept, architects can experiment with unconventional building shapes. Revit converts these shapes into walls, floors, and roofs, allowing the building's effectiveness to be analyzed without time-consuming manual drawings.

d. **Reduced Teamwork Obstacles.** Revit's worksharing feature allows efficient collaboration on medium to large-scale projects. With a computer network, tasks from each discipline are integrated virtually, and changes made by one person are updated across all workstations

e. **Instant Revisions.** Revit, which stands for "Revise Instantly," allows quick revisions without consuming much time or effort.

f. **Fast and Precise Drawing Production.** Once the objects are created, drawings such as elevations, sections, 3D views, and details can be generated as needed. You just need to prepare sheets and fill them with existing views, adding dimensions and notes for clarity during construction.

g. **Conventional Project Software Needs.** Traditional projects often require multiple software tools for structural analysis, design, drawing, volume calculation, and scheduling.

III. METHODOLOGY

The method in this study is carried out by reviewing various available literature regarding factors influencing the application and effectiveness of Building Information Modeling (BIM) in construction projects. The method used in this research is a literature review. The information obtained is related to the development of adoption, challenges, and benefits of BIM in Indonesia.

Figure 3. FlowChart

IV. RESULT AND DISCUSSION

National development aims to realize a just and prosperous society based on Pancasila and the 1945 Constitution of the Republic of Indonesia. Based on the Bureaucratic Transformation, the Directorate General of Construction Development established Presidential Regulation No. 2 of 2017 (previously Law No. 2 of 2007 on Construction Services, which repealed Law No. 18 of 1999 on Construction Services) regarding the organizational change of the Ministry of Public Works into the Ministry of Public Works and Public Housing. This change was necessary because the construction services sector had not been able to meet the demands of good governance and the dynamic development of construction service management, thus requiring improvements in the regulation of construction services.[7] Several issues in construction development are as follows:

1. Low Competence of Construction Workers (TKK)
2. Quality of Training Implementation
3. Lack of Orderliness in Construction Services
4. Inefficient and Non-transparent Procurement System for Goods and Services
5. Inability of Construction Services Institutions
6. Suboptimal Capacity of Supply Chain, Materials, Equipment, and Construction Technology.

Sustainable construction in the context of modern infrastructure development is highly relevant because infrastructure is an integral part of human life. Sustainable infrastructure allows for the efficient use of resources, reduces environmental impact, and improves the quality of life for communities. In the context of modern infrastructure development, sustainable construction is crucial as it can dynamically respond to changes such as climate change, population growth, and advancing technologies.[4].

In this study, the application of Building Information Modeling (BIM) technology using Autodesk Revit software has proven to be an innovative and effective approach in addressing the challenges faced in the construction industry. The use of BIM technology facilitates a more collaborative process by integrating all stakeholders involved in a project, including designers, engineers, contractors, and clients. This integration helps improve coordination, reduce errors, and enhance the overall quality of the construction process. One of the key findings from this study is the ability of BIM to enhance accuracy in planning and design. By creating detailed, parametric 3D models, all aspects of the project—structural, mechanical, electrical, and plumbing—are better visualized and interconnected, which significantly reduces the risk of design clashes and construction delays. This capability also supports a more efficient workflow and faster decision-making, as real-time updates and modifications can be easily incorporated into the model. Furthermore, BIM contributes to the achievement of sustainable infrastructure. Through features such as energy analysis and material optimization, BIM allows for the design of structures that are not only cost-effective but also environmentally responsible. The ability to simulate and evaluate the environmental impact of different design options enables the selection of solutions that minimize resource consumption and reduce carbon emissions. The study also highlights that while BIM implementation requires significant upfront costs in terms of software licensing, training, and hardware requirements, the long-term benefits outweigh these initial investments. These benefits include reduced project costs, improved project delivery times, and better facility management during the operational phase. Additionally, BIM's contribution to sustainable construction aligns with the global trend toward building more eco-friendly, energy-efficient, and resilient infrastructure.

Overall, the application of Autodesk Revit and BIM technology in construction projects is a valuable tool in overcoming industry challenges, improving the quality and sustainability of infrastructure, and enhancing overall project efficiency. However, the adoption of this technology should be supported by proper training, investment, and a gradual transition to fully integrate BIM into construction processes.

V. CONCLUSION

Research conclusions related to implementation Building Information Modeling (BIM) in Indonesia based on a literature review, namely as follows:

a. Addressing Construction Challenges with Innovation.

Building Information Modeling (BIM) has emerged as a groundbreaking solution to address the challenges of construction and structural failures. This technology enables professionals to plan, execute, and manage construction projects with a higher degree of accuracy. By doing so, it reduces the risks associated with project failures while significantly contributing to the development of sustainable infrastructure.

b. Proactive Problem Identification and Efficiency.
One of the key advantages of BIM lies in its ability to identify and resolve potential issues in construction design before the project even begins. Through the use of advanced design software, project management tools, simulation, and visualization capabilities, BIM ensures a more streamlined and efficient workflow. Furthermore, its application in facility maintenance, sustainability, and energy efficiency provides a comprehensive approach to construction. These features not only reduce the financial risks associated with failures but also enhance safety and optimize the use of resources, minimizing waste in materials, labor, and time.

c. Challenges in Adopting BIM.
Despite its numerous benefits, adopting BIM is not without its challenges. Transitioning to this technology requires significant initial investment in both hardware and software, as well as in the training of human resources. Moreover, successful implementation of BIM demands enhanced collaboration among all project stakeholders to maximize its potential. This collaborative approach is essential to ensure that BIM's benefits are fully realized in practice.

d. BIM as a Step Towards a Sustainable Future.
In the face of construction and structural challenges, BIM serves as a progressive step toward a safer, more efficient, and sustainable future. It is a tool that must be embraced and wisely utilized by the construction industry to create infrastructure that is resilient and capable of delivering long-term benefits to society. By leveraging technological innovations such as BIM, the industry can overcome its challenges and achieve the vision of sustainable and enduring infrastructure development.

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