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Effectiveness of Using Building Information Modeling (BIM) in The Ministry of Health's UPT Vertical Hospital Project in Surabaya

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A B S T R A C T

Building Information Modeling (BIM) is collaborative tool application in the construction world that will enhance effectiveness and efficiency from planning to maintenance of construction results. Specifically for government building structures, with the existence of Minister of Public Works and Public Housing Regulation No. 22 of 2018, the obligation of using BIM for Non-Simple State Building with criteria of an area above 2000 (two thousand) m2 and above 2 (two) floors is mentioned. Although there is no further description of the regulation, the main purpose of the rule is very good, besides following the latest technological developments in construction applications, it also increases the accuracy of construction implementation and anticipates the possibility of problems in the field. This paper will discuss the general use of BIM in the construction world in Indonesia and specifically the Vertical Hospital UPT project in Surabaya. However, in its implementation, there are quite a few challenges faced in the implementation of BIM. Literature reviews on the use of BIM are conducted to provide a deeper understanding.

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1. INTRODUCTION

BIM (Building Information Modeling) is a collaborative digital tool application for construction service business actors from planning to completion of construction or maintenance during operational time. In dimensional terminology, when the visualization of construction results (building structures) is 3D, then with BIM it can be up to 6D (Koutamanis, 2020) or even up to 8D (Biswas et.al, 2020). With BIM, all parties involved in the planning process can collaborate from the outset, including architectural, mechanical, electrical, electronic, and structural stakeholders, including the building owner and users. BIM detects potential issues between these parties early in the planning process, providing clash detection notifications that must be anticipated and addressed to prevent further problems during implementation.

BIM applications are much more advanced than CAD (computer aided design) applications (Biswas et.al, 2020). A general overview of CAD is that it draws on a computer for each part of a building separately, including plans, elevations, sections, 3D perspectives, and details of each part. Meanwhile, BIM draws lines containing a wealth of information and 3D from the beginning of the drawing, so that it automatically forms plans, elevations, sections, and perspectives from any desired angle. By including information related to the building structure, mechanical, electrical, electronic, and other equipment in the building, potential problems can be coordinated from the start and can be immediately corrected if found, so that problems will not occur during the construction process later.

Regulation of the Minister of Public Works and Public Housing No. 22 of 2018 states that construction service providers for state buildings above 2,000 m2 and above 2 stories are required to use BIM. The regulation does not specify the type of BIM application or the extent of the BIM specified. Of the various BIM applications available worldwide, the most popular and widely used is the BIM AEC (Architecture, Engineering and Construction Collection) application produced by Autodesk. Within Autodesk's AEC, there is the Revit application used as a digital tool for architects and engineers in creating designs. Access to this BIM application is not easy considering the investment cost of licensing per user is quite high. Training on the use of this application is also still limited, so the availability of human resources trained in BIM is also not widely available. Since the enactment of this regulation, there has not been a single project that has been used as a reference for the full use of BIM from planning to implementation. In contrast to Malaysia, where the government initiated the use of BIM in several pilot projects since 2007 (Latiffi et.al, 2013).

Not many architecture schools in Indonesia have adopted BIM in their curriculum. The Islamic University of Indonesia in Yogyakarta is one of the campuses where the architecture school has included BIM in its curriculum since 2013 (Fadjar Maharika et.al, 2020). The BIM application used is ArchiCAD, a global pioneer in architectural BIM applications. Meanwhile, at other schools, students tend to strive for independent learning to master BIM. This difference in applications initially presented a challenge due to the low level of compatibility, resulting in much of the information and object data in the files being lost or misplaced. Although each application provides an IFC (Industry Foundation Classes) file format for file exchange, there are still obstacles to information or data loss during the file exchange process between different applications.

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2. LITERATURE REVIEW

In this section, we will discuss BIM from various literature, especially those related to theory and application in the field.

2.1. BIM Concept

BIM involves digital modeling and management of the entire construction project lifecycle. A BIM model contains a variety of data, including geometry, costs, and specifications. A BIM model is a digital representation (a file, set of files, or database) of a building that collects all lifecycle information or data about its components. BIM implementation has various benefits, such as increased productivity, cost reduction, and better schedule integration. BIM can be applied to green building, conflict detection, and early design optimization. Several factors, including knowledge and commitment, are crucial in BIM implementation. The benefits of BIM extend to both short-term and long-term investments (Biswas et. al, 2024).

BIM technology is a new building construction platform for presentation and management. Significant benefits of BIM implementation include increased productivity and efficiency. It is also stated that BIM can integrate costs and schedules, supporting efficient assessment, tracking, and monitoring processes for various stages of a construction project. Furthermore, BIM can be used in the evaluation, analysis, and monitoring of green buildings. BIM can also be applied for clash detection and early design optimization. Various benefits of BIM, for example, reduction in time, costs, clashes, and improvements in productivity and communication, are considered. It was also identified that the most important factors, such as level of knowledge and perception, trust, respect, and commitment, play a vital role in BIM implementation (Musa S et. al, 2016).

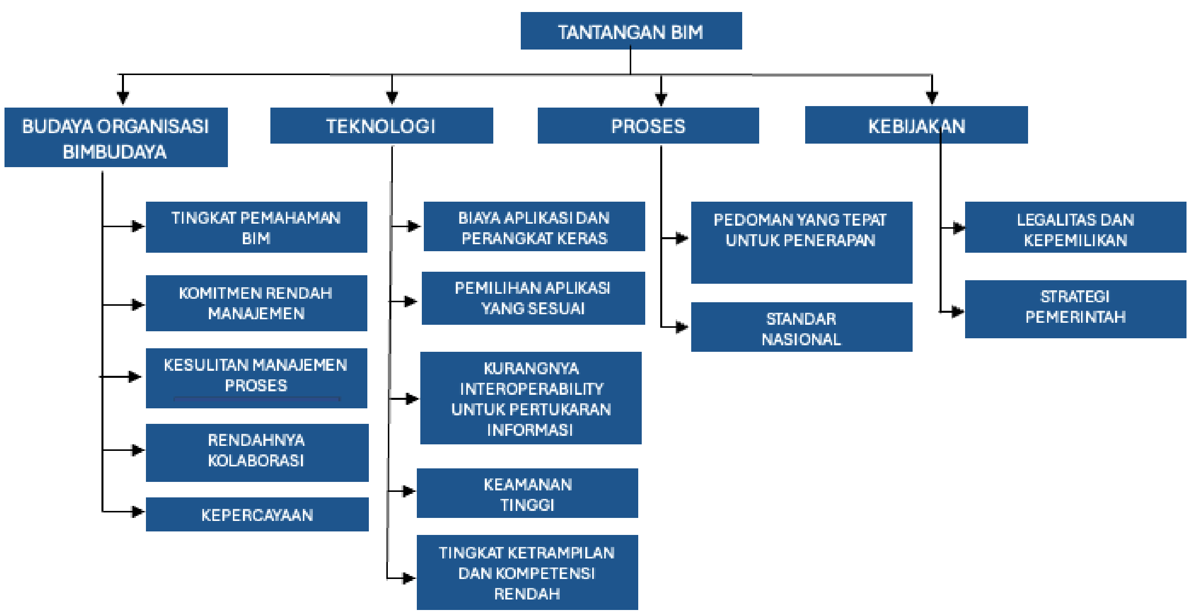

Figure 1. BIM Challenges (Source : Biswas HK, Sim TY, Lau SL. Impact of Building Information Modeling and Advanced Technologies in the AEC Industry: A Contemporary Review and Future Directions. Journal of Building Engineering. 2024) BIM Implementation

BIM can be used to support several tasks in construction project management systems that can be (semi-)automatically modified or adjusted when changes occur in the BIM model, and

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such features are not available to architects or designers working with two-dimensional (2D) or three-dimensional (3D) CAD tools that produce only fragmentary drawings or other documents. BIM also helps avoid or detect and resolve design conflicts early in the design phase of a construction project. Intelligent building design, monitoring, testing, and construction management can be performed using BIM-based platforms (Jia et al., 2024). BIM also plays a crucial role for contractors and construction supervisors in understanding the extent of work completion (Lidelöw et al., 2023).

Some important "dimensions" of a BIM model are commonly known, including 3D, 4D, 5D, 6D, 7D, and 8D. A 3D BIM model is a basic design model with all components and geometry. Scheduling information (i.e., the time dimension) can be added to a 3D BIM model to form a 4D model that allows for construction process simulation and the identification of dynamic conflicts that would not be identifiable with a 3D model alone. The 5th dimension of BIM is generally considered to be “cost” (Smith, 2014).

By adding cost information to the model, cost calculations can be performed more effectively, with any design changes potentially automatically factored into the cost estimate. During the construction phase of a project, facility and operations managers can use 6D models to make decisions regarding maintenance or even renovations. 7D models are of interest to practitioners to ensure the sustainability of construction projects. Construction safety and security are considered by introducing 8D models. Although broad in scope, the information required to do so is often collectively referred to as the 8th dimension of BIM (Biswas et. al, 2024) as seen in figure 2.

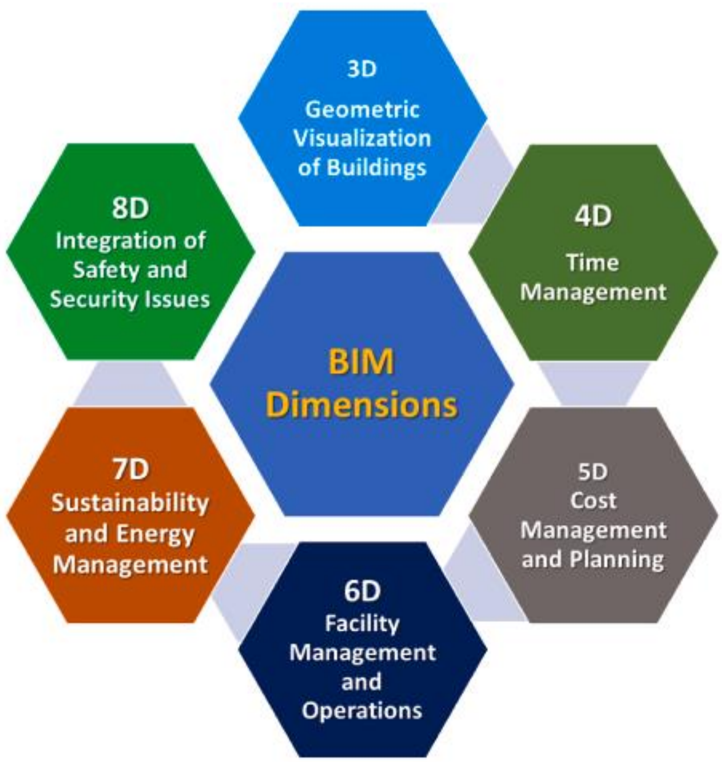

Figure 2. BIM Dimensions (Source: Biswas HK, Sim TY, Lau SL. Impact of Building Information Modeling and Advanced Technologies in the AEC Industry: A Contemporary Review and Future Directions. Journal of Building Engineering. 2024)

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The construction industry is not only implementing BIM to digitize building construction projects from traditional practices, but also using BIM to achieve operational excellence in optimizing quality and performance levels throughout the construction project lifecycle. Various BIM parameters, such as BIM dimensions, are developed to improve and manage real-time data and information sharing among stakeholders. However, there is a need for further investigation due to the many barriers (lack of BIM technology, contracts, training, interoperability and collaboration, and trust between stakeholders) that cause low BIM implementation worldwide.

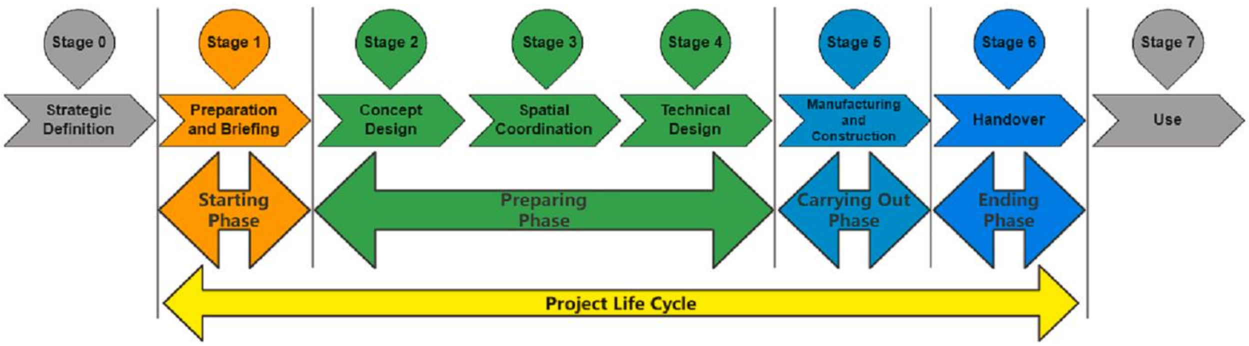

Figure 3. Project Cycle (Wang T, Chen HM. Integration of building information modeling and project management in construction project life cycle. Autom Constr, 2023)

The implementation of BIM in Indonesia, especially in government projects, despite being mandatory, faces the same challenges as implementation in other developing countries. The main obstacle is the significant investment required to procure BIM applications and the hardware to run them. For example, a widely used application for building construction is Autodesk AEC, which includes Revit and other applications. The rental fee for one complete license per year is around Rp. 33,000,000 (thirty-three million rupiah), excluding the hardware required to support the application's smooth operation. If one project requires four licenses for four architects working together, the above cost is multiplied by four. If one office has multiple projects, it is also multiplied by the number of projects.

3. RESULTS AND DISSCUSSION

The Ministry of Health's Vertical UPT Hospital in Surabaya is a central general hospital with a total number of beds approaching 800 with superior services for cancer, heart disease and stroke/brain. The total area of the planned building is approximately 192,000 m2 consisting of 4 buildings: building A for the general podium, building B for heart services, building C for brain services and building D for cancer services. Building A consists of 7 floors while the other 3 buildings have 11 floors outside the semi-basement. Behind the 3 buildings B, C and D are connected to a multi-storey parking building as an important part of the facilities at this hospital.

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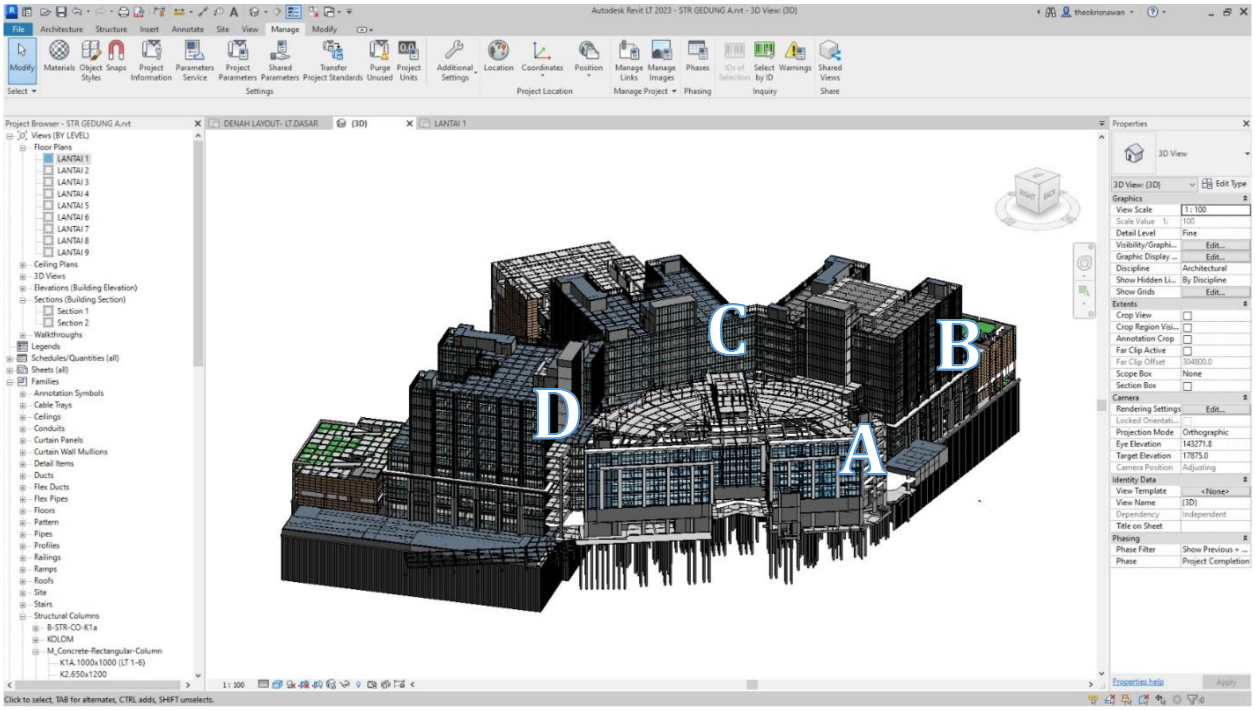

Figure 4. View of the entire Ministry of Health's Vertical UPT Hospital Building in the BIM Revit Application. Source: PT. Patroon Arsindo, Planning Consultant

Interviews with planning consultants revealed that the initial planning phase still used CAD applications due to the limited number of architects skilled in BIM applications for large-scale projects like this hospital. Changes made in CAD applications were only two-dimensional and unrelated to elevations, sections, or other details related to the building. Only when CAD drawings were relatively small were they redrawn using the BIM Revit application. This demonstrates that the advantage of BIM, which automatically changes every element related to the associated drawing, such as elevations and sections, is not realized. Furthermore, there is an inefficient process of repeating drawings from CAD applications to BIM Revit.

The limited human resources for BIM are not limited to architecture but also to structural engineering and mechanical, electrical, electronic, and plumbing (MEEP). Once architectural BIM is available, other related fields should be able to quickly create designs directly within the BIM application. However, due to these human resource constraints, the promised speed and accuracy of BIM applications cannot be achieved and are still combined with traditional CAD applications. So, the initial hope for BIM to reach 5D or cost management and planning is also not realized. On the other hand, the cost calculation application also uses the sophisticated Cubicost application from the company Glodon which can directly connect with the BIM Revit application so that volume calculations are more accurate, faster, and each element can be monitored to avoid duplication of calculations (for example, at the junction of the plate with the beam which in conventional calculations can be counted twice).

Another advantage of using BIM Revit is the ability to detect clashes between architectural elements and the structure, as well as MEEP elements. For example, a wastewater pipe collides with a beam due to the beam being larger than initially estimated and the pipe elevation being incorrectly determined. This can occur if there is effective collaboration between the

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architectural, structural, and MEEP departments, utilizing the collaboration features in BIM Revit.

However, in this project, there was no good collaboration in BIM depiction between fields simultaneously so that the clash detection that occurred could be thousands of points and require more time for repairs and the work became less efficient.

During field implementation by the contractor, the BIM Revit files from the planning consultant were submitted with various unresolved clash detections. However, the contractor also faced limited BIM Revit human resources, particularly in the MEEP. Therefore, BIM Revit was primarily used for three-dimensional visualization, which has very limited information and lacks the added value necessary for efficient construction implementation in the field.

4. CONCLUSION

The discussion concludes that the use of BIM applications in the Ministry of Health's Vertical Technical Implementation Unit (UPT Vertical Hospital) project in Surabaya, from planning to implementation, remains ineffective. One of the primary factors is the limited human resources skilled in BIM applications, particularly in the MEEP area. As is known, the MEEP area requires a significant number of elements to be clearly defined to enable early identification of potential problems (clash detection) during the construction process.

With the enactment of Ministerial Regulation No. 22 of 2018, which mandates the use of BIM in construction, significant challenges remain in providing human resources for BIM applications. The high cost of training, the high cost of application rentals, and the need for adequate hardware support add to the burden of implementing BIM applications, which are actually very beneficial.

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