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The 7D BIM Modeling for Building Asset Data Management Using Revit, COBIe Extension, and QR code

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Abstract

The management of building asset data has experienced many problems related to accessibility and storage issues. This causes difficulties for asset managers in managing and developing buildings after the construction phase. This research aims to develop a 7D Building Information Modeling (BIM) model of buildings to facilitate access to asset data in operational and maintenance activities. Autodesk Revit was used to perform BIM modeling and was integrated with COBIe and the cloud via QR code. The Faculty of Engineering Building Diponegoro University was used as a case study. Data was collected through observation, project documents, as-built drawings, technical specifications, etc. This 7D BIM model with COBIe plug-in is expected to address gaps in asset management, improve operational efficiency, reduce the risk of damage, improve the ability to classify assets in a systematic and integrated manner, and improve collaboration between stakeholders to increase the effectiveness of asset management significantly.

Keywords: 7D BIM Modeling; Building Asset Management; Revit Software; COBIe Integration; QR Code Implementation

1. Introduction

Building assets must always function optimally, so that their conditions are always safe and comfortable for users (Abdelhamid *et al.,* 2015). This means that assets are vital objects that are assessed and predicted, both in terms of function and condition. Thus, asset management is needed to maintain operational sustainability, cost efficiency, and increase asset value (Al-Kasasbeh *et al.,* 2015).

Asset management is the activity of managing assets to control risks and opportunities in order to achieve a balance of costs, risks, and asset performance. Asset management creates opportunities for stakeholders to systematically invest, maintain, upgrade, renew, and operate assets to maximize asset value and life (Amadi-Echendu *et al.,* 2010; Azhar, 2011). The asset life cycle has a longer duration when compared to the project life cycle, so continuous asset maintenance is required. Therefore, a good asset management system is needed to extend asset life (Attencia *et al.,* 2022).

Asset management has a role as a link between the project life cycle and the asset life cycle (Azhar, 2011). For example, during the planning phase, designs are selected using materials that consider post-construction maintenance and operations to reduce asset life cycle costs. Thus, it can also be known that a good asset management system always involves many stakeholders as system drivers, ranging from stakeholders in the asset life cycle (i.e. asset managers, maintenance teams, building owners, etc.) to stakeholders in the project life cycle (i.e. project teams, contractors, vendors, etc.). This means that the existence of an asset management system has been considered since the early phases of project planning and procurement, and will continue after the final handover of work (FHO) from the contractor to the owner. However, the asset management system will be more dominant and tend to focus on the post-construction period. In this regard, asset management has been shown to belong to the operational phase of the project life cycle (Azhar, 2011).

Accessibility and data storage of building assets are still the main challenges in managing and developing buildings in the post-construction phase. This obstacle often causes information related to the condition and maintenance needs of the building to not be well documented, making it difficult for asset managers to make strategic decisions (Cheng *et al.,* 2016). In general, asset data information is scattered in various formats and locations, such as physical documents, spreadsheets, or separate databases that are not integrated with each other (Eastman *et al.,* 2011). This lack of integration can hinder operational efficiency and increase the risk of errors in the building management process (El-Omari, 2011). Therefore, a centralized and easily accessible data management system is needed to improve the effectiveness and efficiency of building asset

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management (Florez *et al.,* 2018; He *et al.,* 2021; Jiang *et al.,* 2019).

Building Information Modeling (BIM) has changed the paradigm in building asset management with a holistic approach to managing information through the creation of three-dimensional (3D) digital models containing details of each building element (Johnson, 2021). BIM is able to provide more efficient data access to relevant stakeholders (asset managers, maintenance teams, and owners), thereby improving the decision-making process and increasing operational efficiency (Kassem *et al.,* 2015). However, traditional BIM is generally limited to the fifth dimension (5D) which only includes information on project costs and scheduling (Lee *et al.,* 2014). This limitation is a barrier to long-term asset management, especially in terms of maintenance and care.

The 7D BIM incorporates data such as location, element type, and maintenance schedule in an integrated BIM model that enables instant access to critical information required by asset managers for building management (Lin *et al.,* 2013; Love *et al.,* 2004). This research introduces the concept of 7D BIM as a significant innovation by expanding the traditional scope of BIM through the integration of information required for the comprehensive maintenance of building assets. This approach also addresses the challenges asset managers face in accessing scattered and poorly structured information. Therefore, this research aims to develop a 7D BIM model for buildings to facilitate access to asset data, especially structural assets, in operations and maintenance activities.

Some previous studies have discussed the implementation of BIM in asset management, but most of them only focus on the 5D dimension which includes project costs and scheduling. Al-Kasasbeh's research discusses BIM in the context of facility management, but is limited to application in the construction phase without discussing long-term maintenance aspects (Abdelhamid *et al.,* 2015). Furthermore, Vanier & Lacasse's research discussed the durability and life cycle of assets, but did not provide a solution for integrating asset data in one easily accessible platform (Al-Kasasbeh *et al.,* 2020). In addition, Patacas' research has offered a framework for the development of asset information, but is also unable to integrate cloud technology or quick access methods such as QR codes (Attencia *et al.,* 2022). Based on some previous research, it can be seen that there are shortcomings in the integration of asset data needed for the maintenance process, as well as the absence of using the latest technology to improve accessibility and real-time collaboration in asset management. Thus, in this research, efforts are made to improve the shortcomings of previous research by providing asset data integration capabilities and data accessibility.

The novelty of this research lies in the development of a 7D BIM model integrated with COBIe, QR codes, and cloud storage to facilitate real-time access to building asset data. This research combines previously separated elements (maintenance information, asset conditions, and technical specifications) in one integrated platform which enables asset managers to make faster and more accurate maintenance decisions. The use of QR codes that can be accessed directly in the field also accelerates the process of information retrieval and collaboration between parties.

There are several challenges that may occur during this research. First is the difficulty in collecting and integrating asset data that is scattered in various formats and locations, such as physical documents, spreadsheets, or separate databases. In addition, there are challenges in linking the BIM model with COBIe and QR codes to ensure all asset data can be accessed in real-time. Another obstacle is ensuring collaboration between stakeholders (asset managers, maintenance teams, building owners) can run smoothly due to the variation in technological understanding between them. The last issues is that the adoption of new technologies such as cloud storage also requires training and adaptation for users which is can slow down the implementation.

2. Literature Review

2.1. Integration of BIM with Latest Technologies: COBIe, QR Code, and Cloud

The integration of BIM with COBIe (Construction Operations Building Information Exchange), QR codes, and the cloud creates new opportunities in building asset management. COBIe provides a standard for the exchange of critical information between different stages of a project, from planning to maintenance (Motamedi *et al.,* 2014). The combination of BIM and COBIe allows asset data to be stored in a structured manner and accessed easily, enabling more efficient asset management and reducing the possibility of data loss or misinformation (Owen *et al.,* 2013).

The use of cloud-connected QR codes adds flexibility in real-time information access. QR codes allow stakeholders to scan the code on-site to obtain detailed information on the condition, maintenance history, and status of the asset (Patacas *et al.,* 2015). This integration also supports data transparency and improves collaboration between stakeholders in the management of building assets **[20].**

2.2. Regulations and Policies Related to Asset Management

The management of building assets in Indonesia must follow various regulations set by the government, including the Minister of Finance Regulation Number 214/PMK.06/2020 concerning Procedures for Implementing Inventory and Valuation of State or Regional Property. This regulation underlines the importance of recording, valuing, and reporting state or regional assets accurately and

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transparently. Therefore, a 7D BIM approach integrated with QR codes and cloud technology can help fulfill these regulatory requirements by providing a structured, easily accessible, and integrated information system for real-time management of building asset data (Smith, 2007).

2.3. BIM Implementation in Improving Asset Management Effectiveness

The implementation of 7D BIM can bring various benefits in building asset management, including increased transparency, operational efficiency, and reduced risk of asset damage (Smith, 2020). Previous studies have shown that such implementation can reduce maintenance and repair costs by up to 20% by reducing the need for manual inspections and speeding up response to damage (Succar, 2009). In addition, BIM 7D also enables a more structured and integrated asset classification that helps asset managers identify proactive maintenance needs (Teicholz, 2018). This is highly relevant for enhancing collaboration between stakeholders and improving the overall effectiveness of asset management.

3. Method

The research was conducted at the Faculty of Engineering Building Diponegoro University, Semarang. Data was collected from September 2023 to May 2024. The research method consists of several steps, namely:

- Reviewing relevant laws and regulations to identify building asset management.
- Conducting literature studies on journals, articles, or books related to the research.
- Collecting asset data information from the surveyed buildings to facilitate asset manager's decision-making. The parameters of this research, such as type of asset element, asset location coordinates, asset construction time, last maintenance time, date of establishment of a building, asset specifications and conditions, asset materials, asset drawings (block plan, site plan, plan, view, cut, structural view, architectural plan, structural plan, MEP plan, and details), asset condition (maintenance history), dimensions, area, and volume of assets, asset maintenance costs, and etc.
- Choosing appropriate software to develop BIM model. Autodesk Revit Software and COBie Extension were chosen in this case, and QR codes were developed later on.

3.1. Schematic of 7D BIM Model with COBIe Extension and QR code

The model scheme illustrates the relationship between variables in this research (Figure 1). It is expected to create an effective asset management system with strong and integrated relationships between its variables. Thus, this development does not rely solely on existing theories but results in a more comprehensive approach to asset management.

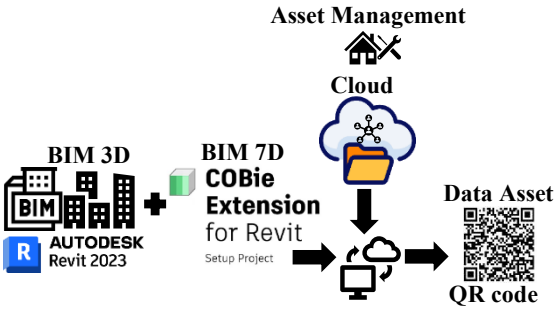

Figure 1. Schematic of 7D BIM model with COBIe extension and QR code

The model scheme in Figure 1 demonstrates that in this research the 3D BIM model was developed into a 7D BIM model to facilitate access and management of asset data information. The collaboration between the software and the extension is able to provide asset data information of the surveyed building and maintenance overview so that effective asset management can be achieved. To increase data accessibility, the model is integrated using the cloud. Cloud storage has more value because not only asset managers but also everyone who has access can access asset data information, so the information search process becomes more flexible. The final modeling result of BIM 7D is in the form of asset data that can be accessed through a QR code, making it easier for building owners, asset managers, and maintenance teams to make decisions and accomplish maintenance operations quickly and efficiently.

4. Results and Discussion

In this research, there are two main discussions to observe the solution to the problems faced by an asset manager. The first discussion is about the application of 7D BIM model in building projects that can help classify building assets, and the second discussion is about the integration of asset data in the building of BIM model that is connected via QR code and connected to the cloud.

4.1. Implementation of 7D BIM Modeling in Classifying Building Assets

This asset management modeling of the Building Information Modeling (BIM)-based The Faculty of Engineering Building Diponegoro University shows the application of post-construction asset maintenance with a focus on asset data management to assist in classifying and managing building asset data that can be shown from an easier asset management system.

Modeling is only done on structural assets, such as beams, columns, foundations, plates, stairs, and roofs. The modeling results are equipped with their respective asset data information. The asset data is used by the asset manager to be managed as a basic

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need in making asset maintenance decisions. If there is an asset problem in the review building, the asset manager can easily access the information. The form of asset management modeling results can be shown in Figures 2 and 3.

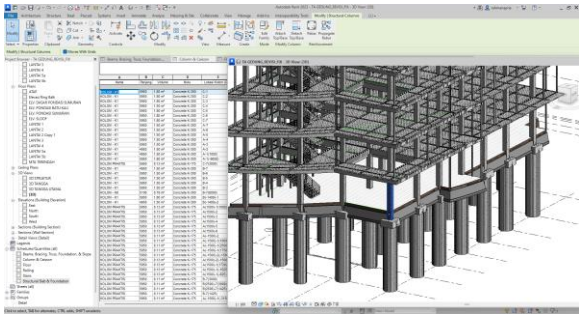

Figure 2. A snapshot of the 7D BIM model

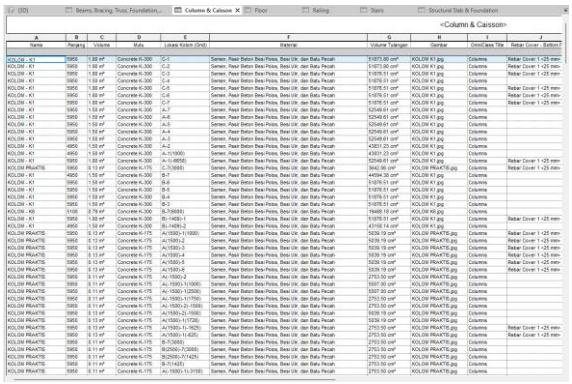

Figure 3. Asset data in COBIe.

This systematic asset management environment has answered asset manager's gaps in asset management. The used of Revit, COBIe extensions, and QR codes creates guaranteed data quality and accessibility, real-time data integration, and collaboration between stakeholders in the management system. In addition, it illustrates that the application of BIM 7D modeling can help manage building asset data and facilitate asset tracking and minimize input errors.

The implementation of 7D BIM monitors the condition of assets in real-time, so that maintenance can be better scheduled, reduces the risk of damage, and improves the operational efficiency of the building (Then, 2010). Thus, it not only helps in asset classification but also improves the overall asset management process by providing accurate and reliable data. This is also in line with the results of previous research regarding the adoption of technology for asset management to improve accuracy and provide the best decision for accomplishing asset maintenance so as to reduce labor, time, and work costs. The technology integration can help asset managers observe and predict all building assets, so they can make the most appropriate decisions (Al-Kasasbeh *et al.,* 2020).

4.2 Integration of Asset Data with QR Code and Linked to the Cloud

The process of integrating asset data in the application of 7D BIM can be seen in two processes, namely the integration of BIM into the cloud and the integration of cloud into QR codes. Both integration processes have different goals. Integration of BIM modeling into clouds aims to include asset data in the cloud, while integration of clouds into QR codes has the aim of being an intermediary tool for accessing the asset data that have been inputted into cloud.

The integration of asset data in the building is an important step to improve the efficiency and accessibility of information by extracting and classifying it using COBIe in asset management modeling and preparing for storage on the cloud platform. Figure 4 demonstrates the integration of BIM to cloud which contains, such as Excel data from COBIe output, Specification Drawings of building elements, and DED of these building elements.

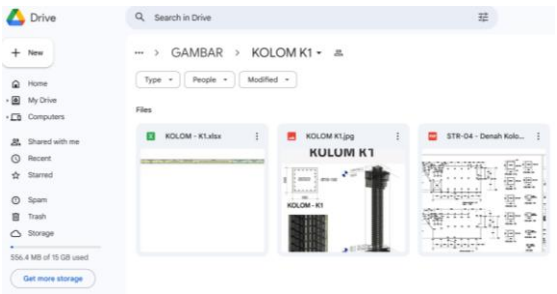

Figure 4. BIM to Cloud Integration.

In the cloud database process, each asset is given an identification code to make it easier to track asset elements. Then, to be able to connect the data information to the user, an intermediary is needed to access it, so a QR code intermediary is used. Figure 5 demonstrates that this QR code is affixed to physical assets in the building to be scanned using a device or mobile device by the asset manager and maintenance team. When scanned, it will display asset data stored in the cloud database in real-time.

STRUCTURAL COLUMN K1
(a)

STRUCTURAL BEAM B1
(b)

Figure 5. Cloud-to-QR code integration


STRUCTURAL SLAB
(c)


STRUCTURAL MAIN STAR
(d)

Figure 5. Cloud-to-QR code integration

This integration has been able to solve the main problems in conventional asset management, namely the lack of data integration and low accessibility of information. This issue is like what happens in the field, where assets are only given codes, notes, and floor plans of the building assets. This means that conventional methods cannot determine the location of assets, and it is difficult to update asset data information from the building (Vanier *et al.,* 2010). Therefore, an asset management process using BIM technology is needed so that better risk management because asset managers can identify and evaluate asset conditions more accurately and can facilitate better collaboration between teams because all parties involved have access to the same actual information. This research not only solves the problem of data access, but also improves the efficiency of coordination in building asset management.

5. Conclusion

The implementation of 7D BIM modeling has been successfully applied to assist in classifying assets in the Faculty of Engineering Building, Diponegoro University. Thus, asset managers can manage assets more effectively and ensure all important information is available and can be easily accessed to support building operations and maintenance by using BIM technology. Thus, integration in buildings using QR codes and cloud can be done, thereby increasing the level of data accessibility and efficiency of asset management. Therefore, risk management and maintenance decisions can be better accomplished between teams, improving operational efficiency and coordination in building asset management.

Further research can be done by developing and applying predictive analysis algorithms to predict maintenance needs and extend asset life. These algorithms can use historical data and real-time data from IoT sensors to provide maintenance recommendations and explore the use of AI (Artificial Intelligence) and machine learning to analyze asset data and provide automated recommendations. This technology can help identify maintenance patterns and predict possible asset failures before they occur.

References

Abdelhamid, M. S., Beshara, I., & Ghoneim, M., 2015. Strategic asset management: Assessment tool for educational building in Egypt. HBRC Journal, 11(1), 98–106. https://doi.org/10.1016/j.hbrcj.2014.01.004

Al-Kasasbeh, M., Abudayyeh, O., & Liu, H., 2020. A unified work breakdown structure-based framework for building asset management. Journal of Facilities Management, 18(4), 437–450. https://doi.org/10.1108/JFM-06-2020-0035

Amadi-Echendu, J. E., Willett, R., Brown, K., Hope, T., Lee, J., Mathew, J., Vyas, N., & Yang, B. S., 2010. What is engineering asset management? In J. Mathew, L. Ma, A. Tan, J. Mathew, & D. Lim (Eds.), Definitions, concepts and scope of engineering asset management (pp. 3–16). Springer. https://doi.org/10.1007/978-1-84996-178-3_1

Attencia, G., & Mattos, C., 2022. Adoption of digital technologies for asset management in construction projects. ITcon, 27, 619–629. https://doi.org/10.36680/j.itcon.2022.030

Azhar, S., 2011. Building information modeling (BIM): Trends, benefits, risks, and challenges for the AEC industry. Leadership and Management in Engineering, 11(3), 241–252. https://doi.org/10.1061/(ASCE)LM.1943-5630.0000127

Cheng, J. C., Lu, Q., & Deng, Y., 2016. Analytical review and evaluation of civil information modeling. Automation in Construction, 67, 31–44. https://doi.org/10.1016/j.autcon.2016.02.001

Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2011). BIM handbook: A guide to building information modeling for owners, managers, designers, engineers, and contractors (2nd ed.). John Wiley & Sons.

El-Omari, S., & Moselhi, O., 2011. Integrating automated data acquisition technologies for progress reporting of construction projects. Automation in Construction, 20(6), 699–705. https://doi.org/10.1016/j.autcon.2010.12.001

Florez, L., & Afsari, K., 2018. Integrating Facility Management Information into Building Information Modelling using COBie: Current Status and Future Directions. Proceedings of the 35th International Symposium on Automation and Robotics in Construction (ISARC), 832–839. https://doi.org/10.22260/ISARC2018/0116

He, Q., Wang, G., Luo, L., & Shi, Q., 2021. A review of empirical studies on Building Information Modeling (BIM) in facility management. Automation in Construction, 120, 103388. https://doi.org/10.1016/j.autcon.2020.103388

Jiang, Y., Wu, G., & Li, J., 2019. Research on application of BIM 7D technology in asset management. IOP Conference Series: Earth and Environmental Science, 224(1), 012046. https://doi.org/10.1088/1755-1315/224/1/012046

Johnson, A., 2021. Advanced asset management: International systems and processes. AM Press.

Kassem, M., Kelly, G., Dawood, N., Serginson, M., & Lockley, S., 2015. BIM in facilities management applications: A case study of a large university complex. Built Environment Project and Asset Management, 5(3), 261–277. https://doi.org/10.1108/BEPAM-02-2014-0011

Lee, S.-K., Kim, K.-R., & Yu, J.-H., 2014. BIM and ontology-based approach for building cost estimation. Automation in Construction, 41, 96–105. https://doi.org/10.1016/j.autcon.2013.10.020

Lin, Y. C., & Su, Y. C., 2013. Developing mobile- and BIM-based integrated visual facility maintenance management system. The Scientific World Journal, 2013, Article ID 124249. https://doi.org/10.1155/2013/124249

Love, P. E. D., Irani, Z., & Edwards, D. J., 2004. A rework reduction model for construction projects. IEEE Transactions on Engineering Management, 51(4), 426–440. https://doi.org/10.1109/TEM.2004.835092

Motamedi, A., Hammad, A., & Asen, Y., 2014. Knowledge-assisted BIM-based visual analytics for failure root cause detection in facilities management. Automation in Construction, 43, 73–83. https://doi.org/10.1016/j.autcon.2014.03.005

Owen, R., Palmer, M., Smith, D., Steele, J., MacDonald, J., & Moses, R., 2013. Integration of construction and asset information using BIM: A review. International Journal of 3-D Information Modeling, 2(2), 44–57.

Smith, D. K., 2007. An introduction to building information modeling (BIM). Journal of Building Information Modeling (JBIM), 12–14

Smith, J., 2020. The impact of strong variable relationships on asset management efficiency. Journal of Asset Management, 15(1), 45–67

Succar, B., 2009. Building information modelling framework: A research and delivery foundation for industry stakeholders. Automation in Construction, 18(3), 357-375. https://doi.org/10.1016/j.autcon.2008.10.003

Teicholz, P., 2018. BIM for facility managers. Wiley. https://doi.org/10.1002/9781119572633

Then, D. S. S., 2010. Strategic asset management: Building a framework for a sustainable future. In J. E. Amadi-Echendu, R. Willett, K. Brown, T. Hope, J. Lee, J. Mathew, N. Vyas, & B. S. Yang (Eds.), Definitions, concepts and scope of engineering asset management (pp. 3–16). Springer. https://doi.org/10.1007/978-1-84996-178-3_1

Vanier, D. J., & Lacasse, M. A., 2010. BELCAM Project: Service Life, Durability and Asset Management Research. https://www.researchgate.net/publication/44066122