The Establishment and Implementation of Scan to BIM Process in Thermal Power Station Project

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Abstract. Building Information Modeling (BIM) has been a prevalent technology in civil engineering and asset management during the last several decades. A successful BIM implementation requires accurate visual and attribute information in BIM models, especially throughout the operation and maintenance phases of an asset's life cycle. In contrast, the building information included in BIM models may have inaccuracies, be out of current, or be missing from actual construction projects. Scan-to-BIM refers to the process of employing 3D laser scanning to capture the precise as-is condition of buildings and create as-is BIM models of such structures. The Scan to BIM implementation procedures that current academics are pursuing are still at a general level, they are employing equipment and software without stating Level of Accuracy (LOA), or there is no general process for the implementation of Scan to BIM projects for thermal power plants (TPS). The framework is oriented toward the specific Scan to BIM application that will be implemented using the created as BIM, which includes synthesizing fundamental concepts when applying Scan to BIM for establishing the process and establishing a Scan to BIM project implementation process using the TPS case study. In addition, the study applies the suggested method to a real-world project in order to assess its applicability and efficacy. The paper gives a complete review of the Scan to BIM method's fundamental concepts and primary procedures. The generated framework is then applied to a real-world project to evaluate its usefulness and viability and identify areas for improvement. The results indicate that the proposed framework is a significant improvement over existing methodologies and offers a range of benefits, including enhanced accuracy, efficiency, and cost-effectiveness.

Keywords: Scan to BIM · Thermal Power Station (TPS) · Building Information Modelling (BIM) · 3D laser scanning · Scan to BIM framework

1 Introduction

It is believed that the use of BIM would enhance the quality of the construction industry. In addition to BIM in the design and construction phases, BIM is also required in the operation and maintenance phases of buildings, particularly for finished structures that

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lack the prerequisites for technology application. The Scan-To-BIM technique is used for places and constructions that have been constructed over a long period of time.

According to article 26 of Decree 06/2021-ND-CP [1] for completion records, information regarding the project may be handled independently. Improper management of the quality of completion records will influence the operation, maintenance, repair, and assessment of safety elements over time. Thus, when applying Scan to BIM, information about the existing structure will be captured with precision and attention to detail. Due to these benefits, it is simple to restore corrupted completion records. From there, during operation, we can utilize the three-dimensional space of the architecture without having to physically visit the site, particularly in hazardous regions such as power plants where engineers cannot go immediately. In addition, Scan to BIM may identify changes or displacement of the structure over time, which contributes to the evaluation of the building's safety. In addition, the application of Scan to BIM will aid in the creation of an electronic library for the building.

Scan to BIM is the initial of the 25 BIM applications offered by the Penn State College of Engineering [2]. This is also a common BIM application listed in Appendix 1 of the Ministry of Construction Decision 348 [3]. Despite the advantages of Scan to BIM, the application is not yet prominent and popular in Vietnam owing to the expensive cost of equipment, the complexity of specialized software for data processing, the high degree of engineering expertise required, etc. Thus, examining the advantages that Scan to BIM may provide and the Scan to BIM project implementation process is one of the current areas of practical study interest.

This study is to investigate and assess the essential principles for a Scan to BIM project. The research will build a procedure for executing Scan to BIM for construction projects, which organizations and corporations may use as a guide if they want to develop Scan to BIM solutions. The created procedure will next be applied to a Thermal Power Plant project in order to assess the efficacy of the proposed process and the advantages of adding Scan to BIM in reality. Conclusions and recommendations will be generated to aid in the future development of Scan to BIM services for the Construction sector.

2 Literature Review

In the research of Scan to BIM in thermal power plants, the lack of a standardized framework for the process may represent a research gap. While there are defined guidelines for using BIM in the construction industry, there is less information on the Scan to BIM process in power plants. This may result in inconsistent execution and inefficiencies in the process. There may also be a need for study into the special problems and implications of applying Scan to BIM in the context of thermal power plants, such as the necessity for accurate 3D models of equipment and systems and the integration of numerous data sources. Addressing these research gaps might result in a more effective and successful implementation of Scan to BIM in thermal power plants, hence improving the safety, maintenance, and overall performance of these crucial assets. The main purpose of this paper is to investigate and assess the essential principles for a Scan to BIM project and to develop a procedure for executing Scan to BIM for construction projects. The procedure will be applied to a Thermal Power Plant project to evaluate the effectiveness

of the proposed process and the benefits of adding Scan to BIM in practice. The paper highlights the advantages of Scan to BIM in the operation and maintenance phases of buildings, particularly for structures that lack prerequisites for technology application. Additionally, the paper acknowledges that the application of Scan to BIM is not yet prominent and popular in Vietnam and examines the practical areas of interest regarding the implementation of Scan to BIM in the Construction sector.

Utilizing Scan to BIM process, perform accurate scanned data in the form of a point cloud is a collection of points in three-dimensional space that offers a digital representation of the object in the form of several points in space, each having an x, y, and z coordinate. The data is then integrated into a 3D BIM model to create as-built models or guide design using real-world data. This process is referred described as Scan to BIM [4]. LOD is a modelling term that, according to Vietnamese Standard 348/QD-BXD, relates to the quality, quantity, and detail of elements in a BIM model at different phases throughout the construction project process [3]. The LOD for development or project must be included in the EIR and BEP. Importantly, when LOD develops, other information pertaining to those elements may likewise change along with the geometry. It represents the quantity of knowledge that can be relied upon for decision-making at a given time for a certain element. LOD pertains to model components as opposed to the whole model. This research has referenced and chosen USIBD [5] criteria for Scan to BIM projects for implementation. This standard offers the advantage of clearly specifying the degrees of accuracy for scanning diverse items, structures, and equipment at various project stages. The codes of items and construction equipment are compliant with the BIM Forum's LOD standards [6] while building the BIM model. In terms of LOD regulation, any LOA designation may be paired with any LOD level. Also, there is no connection between project lifecycle stages and LOA. The construction components are comprised of a range of components and tools; hence, their manufacturing tolerances or variances vary. Concrete components cannot be controlled to the same extent as steel components, hence the LOA is expected to fluctuate.

According to Reginato et al. [7], building rehabilitation has been addressed. Often, engineers utilize as-built drawings for design reasons. Yet, it is normal for as-built drawings not accurately depict the present level of work. Consequently, ongoing design modifications are required to update the as-built drawings, resulting in schedule delays and higher expenses. This disparity may result in conflicts such as:

- Conflicts between existing buildings and newly constructed.
- Incompatibilities between existing buildings and mechanical, electrical, plumbing, and drainage systems.
- Other conflict.

These conflicts will need on-site cooperation between several professions and design modifications. Contractors have begun adopting laser scanning technology to increase the quality of as-built paperwork and precisely record information about construction components in order to mitigate this problem.

Application of BIM and 3D Laser Scanning will create advantages in meeting the requirements in design and construction, as well as in handling errors and risks. Sepehr Alizadehsalehi et al., demonstrated this effective application through a questionnaire with 48 people from various positions. The author emphasized that Laser Scanning and

BIM only take a few seconds to capture site information. Therefore, this application is considered a development in the construction industry [8].

According to Wang et al. [9] have stated that current construction data is often inaccurate, outdated, or lacking information compared to the actual conditions, and BIM models contain unverified information about the site if the design is not continuously updated. In addition, completed construction projects cannot be used for operations and maintenance management without a BIM model. By the authors, there is a lack of well-planned process studies to create BIM models from scan data. Also, Thu et al. [10] viewed the conservation of heritage sites as a global priority. The lack of financial and political support, overexploitation, and rapid tourism growth have all put heritage sites at risk. 3D Laser Scanning technology can help retrieve drawings, which can be a major barrier to conserving existing structures with historical significance. The application of 3D Laser Scanning technology in renovation projects to capture geometric data for buildings that are over 20 years old is essential.

The objective of the research is to analyze the concepts and develop a process for implementing a Scan to BIM project. This will help readers understand the basic factors that need to be considered when carrying out a Scan to BIM project, as well as provide a reference for organizations that wish to develop or apply Scan to BIM. In addition, the article applies Scan to BIM to a real project to examine its effectiveness and the benefits it can bring, as well as the feasibility of the proposed process.

3 Methodology

The research evaluates and develops a process for implementing a Scan to BIM process in TPS according to the gathered research materials. The procedure will be offered as a flowchart with thorough explanations to assist organizations and businesses who may need to refer to it when creating or implementing Scan to BIM technology.

Figure 1 demonstrate the research methodology of implementation process of Scan to BIM project establishment for TPS consists of five parts. The first part involves defining the research problem and research objectives, which are to identify the challenges and opportunities of implementing Scan to BIM in thermal power stations, propose a comprehensive Scan to BIM process, and evaluate its effectiveness through a case study. The second part involves conducting a feasibility study that conducts to assess the viability of implementing Scan to BIM in thermal power stations. The feasibility study will involve a review of literature on Scan to BIM applications in similar industries, a survey of experts in the field, and an analysis of the technical and financial feasibility of the proposed process. The third part involves proposing a Scan to BIM process that includes a detailed workflow, required software and hardware, roles and responsibilities of the project team, and quality control measures. The fourth part involves applying the proposed process to a case study of a thermal power station and evaluating its effectiveness based on the accuracy and completeness of the BIM model, the efficiency of the process, and the benefits realized from the BIM model applications. The fifth and final part involves summarizing the key findings, conclusions, and recommendations for future implementation of Scan to BIM in thermal power stations, including guidelines for implementation, best practices, and areas for further research.

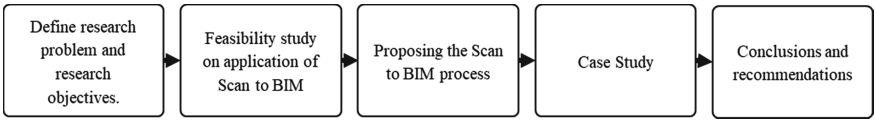

Fig. 1. Research methodology

4 Results

Through the implementation of the proposed process and preliminary feasibility evaluation, the following aspects have been clarified.

- The effectiveness of the proposed process in practical application.
- The benefits that Scan to BIM technology can bring to the construction industry.

Figure 2 proposes a Scan to BIM process with 4 main steps regarding to.

4.1 Preparing for Scan to BIM

During the first step in preparing for Scan to BIM, the team will receive initial information and collect data from the survey area. This information will be used to determine the scope of the project and identify any potential challenges that may arise during the Scan to BIM process. Once the initial data is collected, the team will begin the second step of preliminary planning for the Scan to BIM process. This includes proposing a preliminary 3D Laser Scanning survey plan and creating a Pre-BIM Execution Plan (Pre-BEP) to outline the steps that will be taken during the project. The team will then move on to the third step of preparing a proposal, negotiating, and signing a Scan to BIM contract with the owner. This involves presenting the Scan to BIM plan to the owner and discussing the project timeline, budget, and any other specific requirements. Once the contract is signed, the team can move forward with the actual implementation of the Scan to BIM process.

4.2 Implement Scan to BIM

The implementation phase of Scan to BIM involves carrying out the actual 3D laser scanning survey and the subsequent BIM modelling. This phase starts with the development of a comprehensive implementation plan that outlines the scope of work, timelines, budget, and quality assurance measures. The 3D Laser implementation plan covers the actual scanning process, including setting up the scanner, scanning, data processing, and data registration. BEP outlines the process for creating the BIM model from the scanned data, including the creation of a 3D point cloud, modelling, and data validation. The owner's approval is crucial at this stage, as it allows for any necessary adjustments to be made and ensures that the project is progressing according to the agreed-upon plan. Close collaboration with the owner during this phase is essential to ensure that the project is completed on time and meets the owner's requirements.

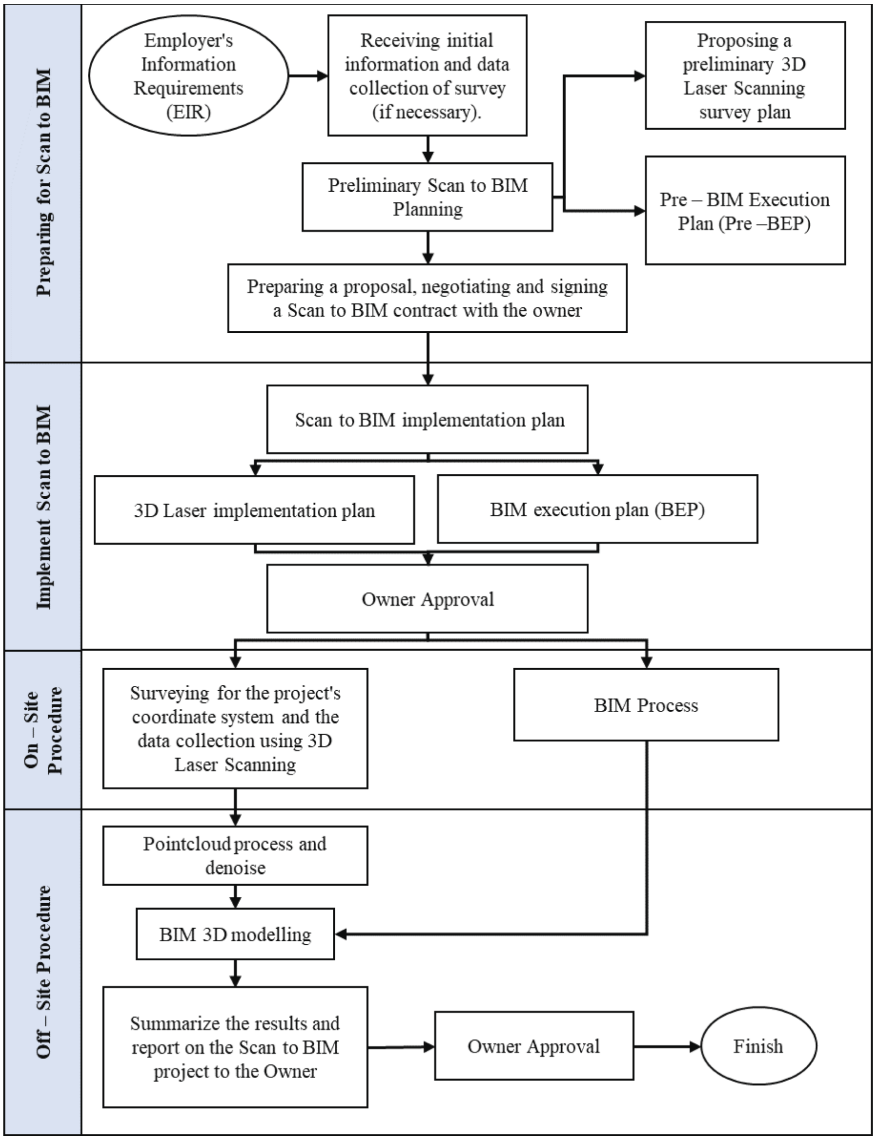

Fig. 2. Scan to BIM process in construction

4.3 On-Site Procedure

During the on-site procedure, the project's coordinate system is surveyed, and data is collected using 3D Laser Scanning technology. The collected data is then processed through the BIM process, which involves creating a 3D model of the scanned area, adding details to the model, and verifying the accuracy of the model against the actual site. This

process requires a highly skilled team of technicians and engineers who specialize in laser scanning and BIM modelling.

4.4 Off-Site Procedure

In this step of the Scan to BIM process, the off-site procedure is carried out. The first task is to process and denoise the point cloud data collected from the site using specialized software. Next, the BIM process from the previous step and the cleaned point cloud data are used to create a 3D BIM model of the project. This model includes all relevant information gathered from the site, such as measurements, dimensions, and material properties. Once the 3D BIM model is complete, the team summarizes the results and prepares a detailed report to present to the Owner. The report includes all aspects of the Scan to BIM project and highlights any potential issues encountered during the process. The team then waits for the Owner's approval before proceeding to the final step of the process. If approved, the project is considered finished, and the final BIM model is handed over to the Owner.

5 Conclusion and Recommendation

5.1 Conclusion

The research performed practical applications of the suggested procedure in a project to evaluate the feasibility and efficacy of the Scan to BIM application in practice. It was concluded that the study identified the fundamental ideas and documents required for a Scan to BIM project and presented a method for conducting a Scan to BIM project in distinct phases. In addition, the study demonstrated the advantages of Scan to BIM application in the construction sector and proposed a comprehensive procedure for conducting a Scan to BIM project.

The article subsequently applies the suggested method to a practical construction project, and the results obtained demonstrate the advantages of the proposed approach over current procedures for planning and executing a Scan to BIM project. It also evaluates the practical advantages that the Scan to BIM tool provides.

5.2 Research Limitations and Future Research

Due to the comprehensive application of the proposed process throughout the life cycle of the Scan to BIM project, as well as the work coordination among multiple parties involved and the time limitations for the research has not been able to fully apply the process to real construction projects. The research only applied the process with the following limitations.

- Studying the application of the proposed process for the main and important steps.
- Demonstrating important and necessary documentation when applying Scan to BIM technology.

Through the application of the proposed process in a real project, the results showed some improvements compared to the current procedures in planning and implementing a Scan to BIM project, as well as partially assessing the effectiveness of the benefits that Scan to BIM technology can bring in practice. This partially demonstrates the feasibility and effectiveness of the proposed process. However, the project applied the proposed process only as a trial, so the cost issue needs to be considered for future projects. Furthermore, the proposed process needs to be applied to more practical projects to further refine the process.

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