Understanding barriers of BIM-based knowledge management system: a case study of Indonesian state-owned construction enterprises

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Abstract. Construction companies experience obstacles to apply their knowledge in different cases due to the project's complexity. This study highlights the barriers of knowledge management and BIM implementation in Indonesia construction industry. Identifying barriers to the knowledge management process and assessing the characteristics and advantages of BIM are potential areas for research. Data is collected by interviewing sources or informants from Indonesian State-Owned Construction Enterprises (BUMN) in Indonesia. Eight informants were selected with top management qualifications as BIM and knowledge management users. Nvivo was used to process and analyze qualitative data. The results show that the barriers of BIM-Knowledge management implementation in Indonesian State-Owned Construction Enterprises are (1) The condition of contract or standard of the owner, which has not fully adopted ISO BIM 19650 standards, (2) The lack of experts who are proficient in integrating KM-BIM, (3) the lack of Organizational Culture that support integration of KM-BIM. This study assist in understanding the barriers to knowledge management when integrated with BIM. In addition, the study is expected to assist top management in providing strategies to reduce barriers to knowledge management through a better understanding of BIM-based knowledge management.

1 INTRODUCTION

Knowledge management is essential in the successful execution of construction projects, ensuring information sharing, collaboration and efficient decision-making. However, construction projects' complex and dynamic nature presents many constraints and

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challenges for effective knowledge management. Building Information Modeling (BIM) has emerged as a transformative technology that offers unique characteristics and advantages to address such challenges. According to [1], there are various obstacles to applying knowledge management in construction projects. The first is a lack of coordination among construction professionals during the project [4]. Secondly, the limited utilisation of communication networks leads to communication failures that slow down the project and do not effectively create a knowledge base shared by project staff over time [2]; thirdly, the absence of effort and the company's desire to produce a valuable pool of knowledge that can be transmitted to other projects. Construction projects are so special that they require unique processes and procedures that are difficult to generalise as a collective collection of usable knowledge [9], the four elements of culture and organisation [10]. Many construction projects in Indonesia may need a more robust knowledge-sharing culture and organisational support for knowledge management initiatives. Hierarchical structures, communication gaps, and resistance to change can hinder effective knowledge management practices. To that end, this paper explores the characteristics and advantages of using BIM in overcoming the constraints and challenges of knowledge management in the construction industry.

Overcoming these constraints and challenges requires a comprehensive approach that includes developing a knowledge-sharing culture, establishing standard processes and protocols, investing in technology infrastructure and training, developing effective communication channels, ensuring data quality and integrity, implementing change management strategies, and addressing legal issues. And intellectual property issues. Collaboration between stakeholders, government support, and industry initiatives can also contribute to overcoming knowledge management constraints and promoting a culture of knowledge sharing and innovation in construction projects in Indonesia.

1.1 Literature Review

According to [3], BIM can be said to be a repository of knowledge. Several studies have tried to build a separate knowledge base associated with BIM models for storing knowledge to overcome this challenge. Before delving into the characteristics and advantages of BIM, it is crucial to understand the barriers and challenges that hinder effective knowledge management in the construction industry. These may include information fragmentation, lack of standardised processes, limited data integration, ineffective collaboration, and difficulty capturing and sharing project knowledge. Building Information Modeling (BIM) has gained significant traction in the construction industry as a transformative technology. BIM involves creating and managing digital representations of building projects integrating multiple data sources and dimensions into a collaborative environment. Its application extends to the entire project life cycle, from design and construction to facility management.

1.2 Characteristics of BIM For Knowledge Management

This section explores the critical characteristics of BIM that contribute to addressing knowledge management challenges. These characteristics include centralised data repositories, information integration, parametric modelling, visualisation and simulation, version control, collaboration and communication, data analysis, and lesson retrieval. Construction organisations are increasingly implementing BIM to adapt and cope with increasingly complex situations and environments and improve the effectiveness of information communication [7]. [8] defines BIM as the interaction of specifications,

processes, and technologies that effectively manage project lifecycle data in a digital format. [5] believes that an information-containing BIM model can be used to avoid errors proactively. [6] agrees with this and explains that BIM is a methodology for integrating all graphical and digital data from a project to promote information exchange throughout the project life cycle – planning, design, construction, and operations.

2 Research Method

Analysis is carried out using structured interview methods to identify the characteristics and advantages of using BIM to overcome obstacles and challenges in Knowledge Management. Informants are selected by purposive sampling. The data from the interview is about the advantages of using BIM that can overcome obstacles and challenges. Knowledge Management was obtained from interviews with every BIM engineer, BIM staff, or respondents who use BIM and know about company Knowledge Management. Some information about informants is as many as eight interviewees; BIM Engineering consists of Informant 1, Informant 5, Informant 7, and Informant 8. BIM Modeler consists of 3 Informers. BIM Junior Expert consists of 6 Informants. The Board of Directors consists of 2 Informers. VP EBIM consists of 4 Informers, shown in Table 1

Table 1. Informant profile.

	Company[a]	**Position**	**Experience**
Informant 1	PT. A	BIM Engineer	5 Year
Informant 2	PT. B	Direksi	13 Year
Informant 3	PT. C	BIM Modeler	7 Year
Informant 4	PT. D	VP EBIM	15 Year
Informant 5	PT. F	BIM Engineer	5 Year
Informant 6	PT. G	BIM Junior Expert	5 Year
Informant 7	PT. H	BIM Engineer	8 Year
Informant 8	PT. I	BIM Engineer	4 Year

[a] Large-size qualification of construction companies (B2).

3 Results and Discussion

Eight informants were interviewed via Zoom meetings from December 2022 to January 2023, each for approximately 60 minutes. The interview questions were taken from the results of previous questionnaire analysis related to the advantages of using BIM that can overcome obstacles and challenges of Knowledge Management.

Figure 1 shows that the obstacles to knowledge management in companies using controlled BIM are primarily in the type of contract from the owner and project management. There is still not much expertise in Indonesia related to BIM, still centred knowledge management on each project and less integrated, differences in parameter formats, style models and file naming in BIM.

"For obstacles. Maybe the first one is more, too. If we will work based on a contract from the owner, it will be possible. If it is adherent, there is already a mandatory that all projects must have BIM. (Informant 1).

"If we look here at ISO mas, there is stage 1, stage 2, and stage 3 divided into stages, which distinguishes what if we look here yes he has already started to enter the distinguishing information layer, and most of us in Indonesia are just in the early stages of stage 2." (Informant 2).

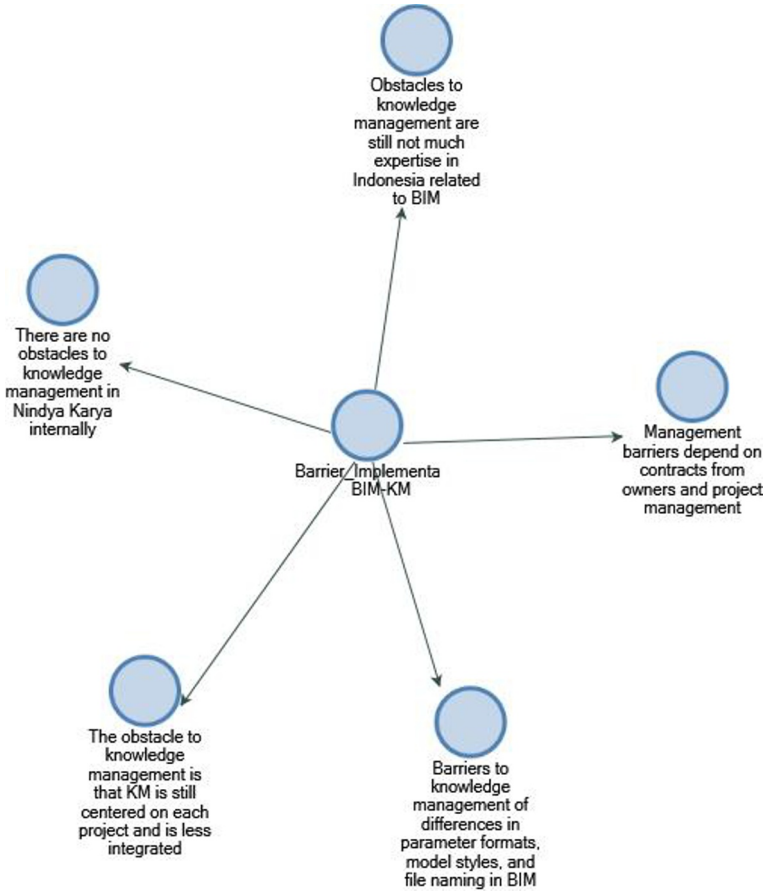

Figure 1. Barriers to knowledge management in companies using BIM.

"The beginning used to be understanding the function of BIM, software license, for surveys used to be conventional now using lidar aircraft. There are differences in format, parameters, and model style; file naming is also a problem." (Informant 3).

"There are no obstacles to knowledge management for internal Nindya Karya." (Informant 4).

"The lack of standards from the government regarding BIM implementation, and maybe the lack of management support to use BIM engineers in construction projects, so it is not just BIM modellers or still using conventional methods." (Informant 5).

"Corporate culture that tends to use the old culture, project projects that tend not to be connected to the company are not collected with the company. (Informant 6).

"The mindset, for example, the millennial generation is used to digital, it can. But for those born and raised, I mean it has been quite a long time since they have been able to adapt." (Informant 7).

"There is no expertise in Indonesia or local and environmental culture that supports fewer flight hours because to upgrade skills it takes time." (Informant 8).

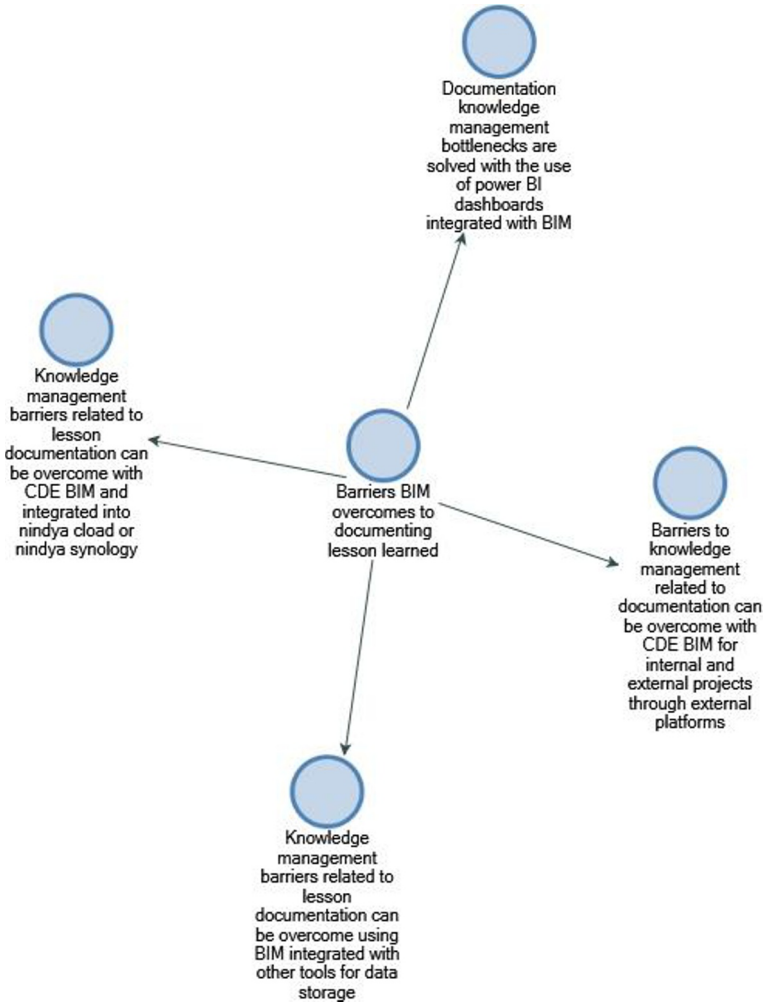

Figure 2. Document lesson learning using BIM**.**

Figure 2 can be seen to overcome the obstacles associated with documenting lessons learned, facilitated by BIM with the existence of a common data environment (CDE), BIM for other uses power BI dashboards to integrate with BIM or other tools for integration.

"There are some that may be consumed publicly and can be shared; it probably should still be possible, even though we store everything digitally, but for access, we have a level of access, which is the term who can access the folder." (Informant 1)

"Yes, it can be by the company dashboard (Power BI) that can be integrated with BIM." (Informant 2)

"It is possible because, in BIM, there is a family parameter so that it can be used in the next project." (Informant 3)

"We put the model and connection into Nindya Cload or Nindya Synology." (Informant 4)

"The schedule exposure is not using the S curve anymore, but with the BIM method through Navisworks." (Informant 5)

"BIM has tools to plot words or information that exists but again related to storage so not everything can be stored there, so it does need other tools or integration for other tools." (Informant 6)

"You can go directly to CDE; yes, actually, all the data can be processed." (Informant 7)

"Digitalization related to flow, making it easier to access we will use the cloud system so one day friends want to access that can be the cloud for internal friends." (Informant 8).

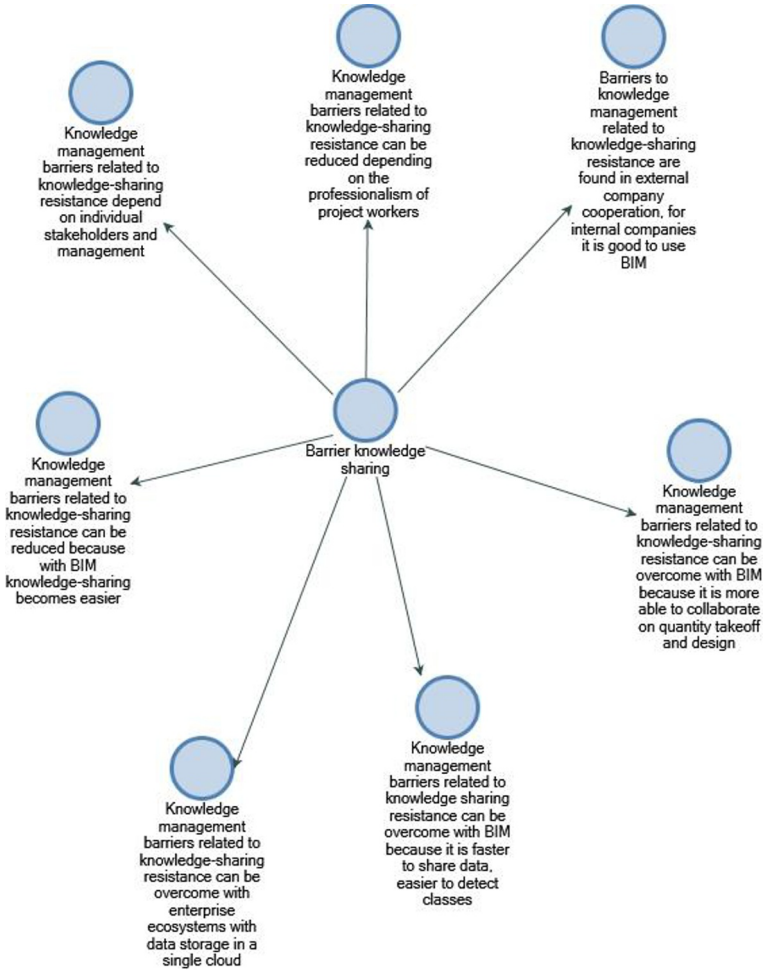

Figure 3. Barrier of knowledge sharing.

"It depends on the individual who wants to learn BIM because BIM costs are still high. But if it is a professional one, maybe they can share." (Informant 1)

"Back to the policies of each stakeholder or management respectively2." (Informant 2)

"Internally, it has been going well to share knowledge with BIM." (Informant 3)

"So what was previously reluctant to be reluctant to share knowledge with BIM has become easier." (Informant 4)

"Here, it is still conventional from QS, there is from a scheduler, there is BIM modeller, right, but from that, we are even more able to collaborate, right? For example, we check the volume; it turns out that there is a difference from the design; it is also like that." (Informant 5)

"It cannot be reduced because BIM is still a tool, again because it is related to culture." (Informant 6)

"With BIM, all the data is stored there so that the data can be direct. It is constructive to create a system or ecosystem of companies where the data goes into the same cloud so there is no resistance among stakeholders." (Informant 7)

"With BIM, we often share knowledge because there are many new things for projects, especially about acceleration, with BIM faster, with BIM more able to detect classes." (Informant 8)

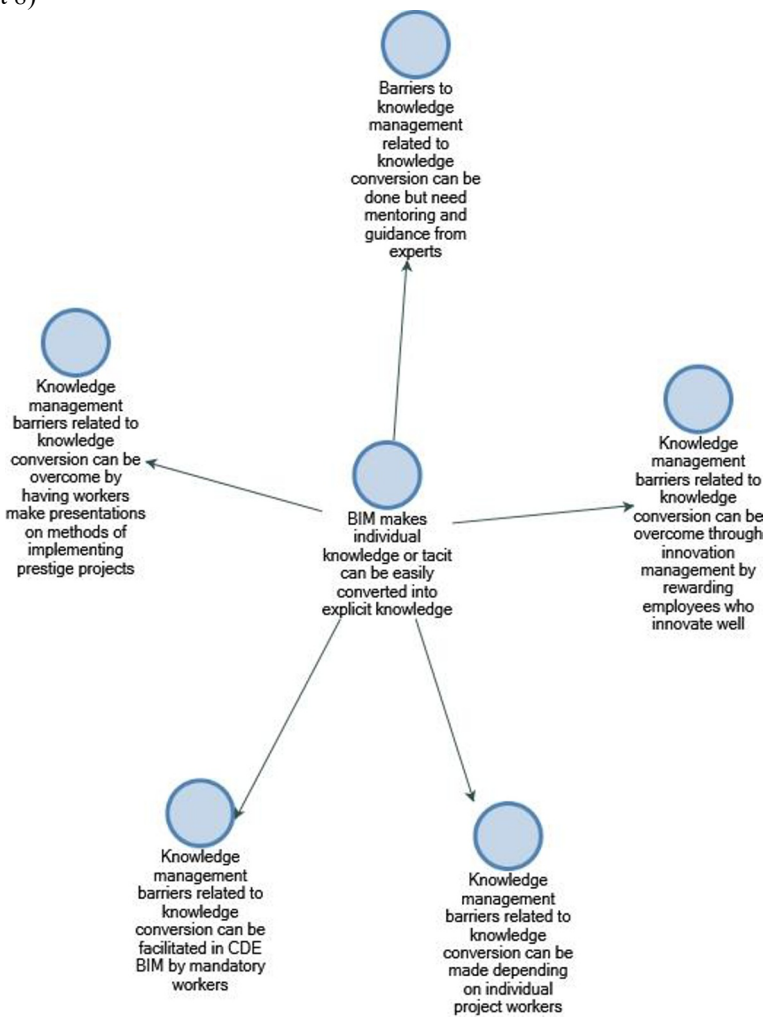

Figure 4. BIM makes individual/tacit knowledge easily converted into explicit knowledge.

"It can be possible for people to make the BIM process to make the term their experience into a journal. For example, journaling knowledge about BIM can be just right. He is rarely like that; he wants to write it neatly, document it neatly, it is rare." (Informant 1)

"That is yes from innovation management, mas because there is something new then they will write the Because in Brantas abipraya in innovating every year the best innovation will be selected and get awards, but the innovation is not the best. For example, we still manage it in KM, so other employees can access it." (Informer 2)

"Yes, sir, BIM promotes collaboration between project team members. Examples in the BIM 360 database are centralized; examples in survey data, quality data, and quantity data can be accessed by other stakeholders if needed." (Informant 3)

"BIM can provide a visual representation of a building or infrastructure project. This can lead to better communication of design ideas and intent, but it comes back to the individual. So, for example, if there is the use of a DOM-shaped steel frame or what it is, usually there are personnel who will be asked to make steps in what kind of PowerPoint to produce such a shape to be shared with others." (Informant 4)

"These visualizations can help individuals, including designers, engineers, and construction professionals, externalize their tacit knowledge by allowing them to view and interact with projects virtually. From the design, it is also like that. So initially, people looked at the design only from 2-dimensional images, right? However, when we want to translate it, translation with BIM is it, oh, it even looks like this, it should not be like this, it should be like this, it should even be a collaboration tool, in my opinion, it is no longer a separator, yes, if from here, it can be, because that is what we were communicating to the owner to the user, right, they are not technical experts." (Informer 5)

"If the conversion is a challenge anyway, it has said it is easy, yes, but it has said that it is okay, yes, because that is a change in the way of thinking for the example of the gini used to be the guy counting on the paper, right? Then it turns out to be Growing up to wear excel gitu. That will change the same way that this BIM arrives adjustment again because we have to explain how to use it. BIM promotes collaboration between project team members. A collaborative tool in BIM software facilitates real-time communication, enabling experts to explain their decisions and thinking processes." (Informant 6)

"Overall, yes, but mandatory; it still needs guidance, so there needs to be someone who assesses. Like, for example, we stay. Communicative is here to hook us whether. Now, we make schools in MSI can already be done. So discuss. The management team can already be the company's early warning system. BIM can be used to capture and document learning throughout a project. By recording these learnings in a BIM environment, they become part of an explicit knowledge base that can benefit future projects. We still need that guidance." (Informant 7)

"The conversion of tacit knowledge into explicit BIM can be facilitated because cloud technology can effectively convey various data information from several BIM software without downloading the software. Collaboration tools in BIM software facilitate real-time communication, allowing experts to explain their decisions and thought processes." (Informer 8).

From Figure 5, it can be seen that there is another potential use of BIM to overcome barriers to knowledge management apart from the results of coding data; namely, BIM has the potential to integrate with other knowledge management technologies and techniques to improve knowledge management efficiency so that BIM facilitates collaboration and communication among project stakeholders by providing a common platform for sharing and exchanging information. It enables real-time collaboration, document sharing, and coordination, improving knowledge transfer and ensuring that the correct information is available to stakeholders at the right time. By improving communication and collaboration, BIM supports effective knowledge sharing and improves the overall efficiency of the knowledge management process (Collaboration and Communication); BIM helps manage knowledge more actively (proactive) during the project planning process; BIM can facilitate the updating and communication of building information more easily. Furthermore, another potential of BIM to overcome barriers to knowledge management, according to respondents, is that BIM combines a fully integrated standard format in data collaboration between various vendors so that BIM facilitates the integration of information from various sources and disciplines, including architectural, structural, and MEP (Mechanical, Electrical, and Piping) systems. This integration makes it possible to view projects holistically, promoting knowledge sharing and better collaboration among project stakeholders. By integrating data from multiple sources, BIM enables a more

comprehensive understanding of projects and improves the ability to manage knowledge effectively (Information Integration), with BIM implementing a culture of updating data on BIM's Common Data Environment (CDE) for decision-making so that BIM serves as a centralized repository for project information, capturing data from multiple disciplines and stakeholders. This centralized data store encourages efficient knowledge management by providing a single source of truth and easy access to information. This eliminates the problem of fragmented information and allows better organization and retrieval of knowledge (Centralized Data Repository). Execution of post-project review becomes more manageable with the recall of data back as a reference to news events because BIM software offers data analysis and reporting capabilities that allow extraction of valuable insights from project data. By analyzing BIM data, project teams can identify trends, patterns, and performance metrics that inform decision-making and improve knowledge management. Data analysis helps identify knowledge gaps, evaluate project performance, and implement continuous improvement initiatives (Data Analysis and Reporting); with BIM, knowledge management barriers in the project environment can be overcome with tools such as Virtual Reality or Mixed Reality because BIM provides visualization and simulation tools that allow stakeholders to visualize projects in a virtual environment prior to construction. It encourages better understanding and acquisition of knowledge, enabling early detection of design problems, detection of conflicts, and analysis of performance. Visualization and simulation improve the ability to communicate and share knowledge effectively among project team members, leading to better decision-making and project outcomes (Visualization and Simulation). BIM software allows documentation and captures lessons learned during the project life cycle. Stakeholders can record insights, challenges, solutions, and best practices, promoting knowledge storage and transfer for future projects. Lessons learned can be attached to specific BIM elements, making it easier to retrieve and apply knowledge in similar project scenarios (Lessons Learned) when the number of BIM experts is increasing, thus minimizing conventional knowledge management because BIM parametric modelling capabilities allows the creation of intelligent objects with related properties and relationships. It supports knowledge management by capturing and storing detailed information about building components, materials, performance characteristics, and other relevant data. The parametric nature of BIM objects ensures that changes and updates are reflected automatically across the model, ensuring consistency and accuracy of data over conventional methods (Parametric Modeling).

The finding of this study suggest the availability of BIM learning portal to be publicly accessible, utilizing CDE for corporate data mining, standard style in BIM and the determination of software to have a reference from the owner or employer, maximizing the use of AR or MR for field inspections, by maximizing the function of BIM to overcome management obstacles knowledge.

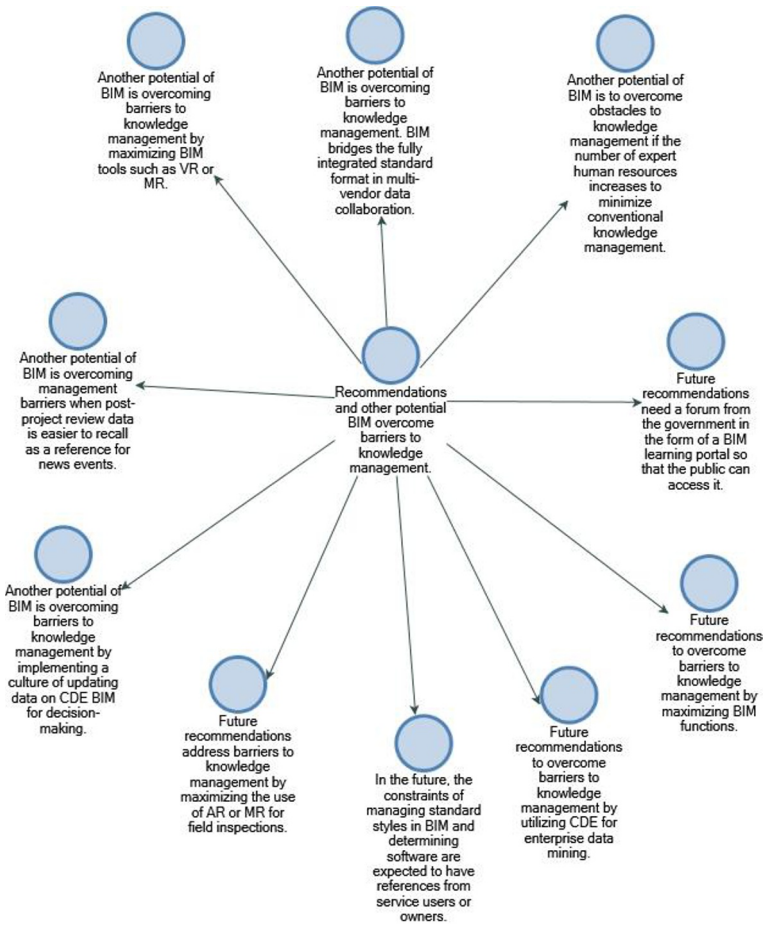

Figure 5. Recommendations and other potential BIM overcoming barriers to knowledge management.

4 Conclusion and Future Works

In this study, it was found that the obstacles to knowledge management using BIM are the lack of standards from the government itself related to the implementation of BIM to manage knowledge, a corporate culture that tends to use conventional methods still to manage knowledge, not much BIM expertise to be able to manage knowledge. BIM can overcome obstacles and challenges in Knowledge Management by utilising the characteristics and advantages mentioned above. BIM promotes centralized data management, information integration, parametric modelling, visualization and simulation, collaboration and communication, data analysis, and learning retrieval. These capabilities enhance knowledge exchange, improve decision-making, enable proactive problem-solving, and encourage continuous improvement in knowledge management processes in construction projects. Respondents' recommendations related to BIM to overcome barriers to knowledge management need a forum from the government in the form of a BIM learning portal, utilizing CDE for corporate data mining. There are standard standards in BIM, and software determination has a reference from the owner or employer, maximizing the use of AR or MR for field inspections.

The study focused on a specific context—Indonesian state-owned construction enterprises. The findings may not be directly generalizable to other countries or different types of construction organizations. Future research should investigate a more diverse range of contexts to establish broader applicability. Suggestions for future research conduct comparative studies across different countries or regions to examine how cultural, regulatory, and industry-specific factors influence barriers to BIM-based knowledge management.

References

1. Korkmaz, K. A., & Bahidrah, S. (2017). Implementation of knowledge management in construction projects. Advancements in Civil Engineering \& Technology, 2(3), 1–14.
2. Maqsood, T., Finegan, A. D., & Walker, D. H. T. (2003). A soft approach to solving hard problems in construction project management.
3. Meadati, P., & Irizarry, J. (2010). BIM--a knowledge repository. Proceedings of the 46th Annual International Conference of the Associated Schools of Construction, 12, 2010.
4. Mohammed, A. H., & Wei, L. L. (2005). The development of a knowledge sharing culture in the construction industry. Intra-Departmental Paper, Department of Property Management.
5. Park, C.-S., Lee, D.-Y., Kwon, O.-S., & Wang, X. (2013). A framework for proactive construction defect management using BIM, augmented reality and ontology-based data collection template. Automation in Construction, 33, 61–71.
6. Sacks, R., Kaner, I., Eastman, C. M., & Jeong, Y.-S. (2010). The Rosewood experiment—Building information modeling and interoperability for architectural precast facades. Automation in Construction, 19(4), 419–432.
7. Sebastian, R. (2011). Changing roles of the clients, architects and contractors through BIM. Engineering, Construction and Architectural Management.
8. Succar, B. (2009). Building information modelling framework: A research and delivery foundation for industry stakeholders. Automation in Construction, 18(3), 357–375.
9. Wetherill, M. (2003). Knowledge management for the construction industry: the e-cognos project. Journal of Information Technology in Construction (ITCon), 7(12), 183–196.
10. Will, A. J., Levitt, R. E., & Scott, W. R. (2007). Understanding knowledge acquisition, integration and transfer by global development, engineering and construction firms. CRGP Working Paper Series.