Adoption and implementation of building information modeling (BIM) by the government in the Indonesian construction industry

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Abstract. Building Information Modeling (BIM) is the development of concepts of collaboration and integration in the construction industry. This concept was introduced in Indonesia formally by the Ministry of Public Works and Public Housing (PUPR) in 2017. Since its introduction, by the Indonesian government the PUPR ministry has made BIM Roadmap, created BIM Team PUPR, and issued ministerial regulations mandating the use of BIM on a state-owned building. BIM provides many benefits that can be utilized by every stakeholder involved in the project. Previous research has focused more on the readiness of the Indonesian construction industry in utilizing BIM. However, studies that focus on the implementation of BIM by the Indonesian government are still very limited. A literature review is used as the main method in this journal to collect information from government publications. This study provides updated information related to government efforts to implement BIM in Indonesia.

1. Introduction

Building Information Modeling (BIM) is a term that defines information modeling technology in the construction industry. BIM is an integration (continuous between the information and the tools used) from various disciplines. The BIM model will produce an intelligent and information-intensive parametric model [1]. The BIM concept supports the process of integration and collaboration. This is the main attraction for its users, including the government as the owner and regulator in the industrial sector in various countries [2]. Other advantages provided by BIM are supervision, interoperability, collision detection in each phase of the project life cycle [3, 4]. Private and public sectors trying to harness the benefits of BIM by using it for various purpose implementations. The public or government sector utilizes BIM to achieve its agenda. For example, the UK is using BIM as part of the 2011 construction strategy which aims to improve the efficiency and quality of the construction industry [5]. Brazil has an agenda to achieve 30% cost savings during the building life cycle. The State of Chile uses BIM to reduce 20% of project costs and save 20% of the costs of the project design process and duration of construction, as well as various other objectives to be achieved by various countries [6].

The Government of Indonesia through the Ministry of Public Development and Public Housing (PUPR) knows the benefits provided by the BIM concept and seeks to utilize them in various government projects. The government as the regulator has the authority and obligation to develop construction equipment and material standards, as well as the development of construction technology following what is mandated in Law No. 2 of 2017 concerning Construction Services. The concept of
BIM was formally introduced by the Indonesian government in 2017 by showing a roadmap for the implementation of BIM Indonesia and forming a BIM PUPR Team to accommodate the process of BIM adoption in the Indonesian government, especially the Ministry of PUPR. In addition to creating policies, commitment, and working groups, various events have been organized to deploy BIM concepts in the construction industry in many subjects such as government agencies, university academia, and the practitioners [7].

Research on the topic of BIM in Indonesia has been conducted since 2012 [8]. In that study, it was found that 7 BIM-based studies focus on the dimensions of technology and perspective. The implementation dimension has also been carried out in Indonesia by evaluating the application of the BIM methodology in the construction phase with the subject of contractors already using BIM [9]. BIM practitioners are the main subjects in the study of the relationship between the BIM methodology and the sustainability of construction in Indonesia [10]. BIM practitioners become the main subject of this research with the perspective of investment, risk, and obstacles in adopting the use of BIM [11, 12-15]. Research that focuses on government perspectives about the adoption and implementation of BIM is still very limited.

This paper aims to review the adoption of BIM in Indonesia through a government perspective. This study focused on exploring what the government has done, through various agencies and organizations related to the adoption of BIM in Indonesia.

2. Conceptual background

2.1. Building information modeling

BIM is a parametric data collection of representations of building objects that are designed and built the contain structural, architectural, mechanical, and electrical design information [16]. BIM can be used as a tool in the entire life cycle to facilitate planners, supervisors, K3 (Occupational Health and Safety) management, and contractors. In applying BIM, Azhar [4] found that BIM can be used in the initial phase, the design phase, the pre-construction phase, the construction phase, and the operation phase of the project. Not only serves as a tool, but BIM also provides an opportunity to change rigor in making changes and innovations in the construction sector [3]. Facility management can utilize BIM in careful operations and schedule repairs using real visualizations of buildings in the form of building models [3]. The benefits of interoperability and integration in the BIM concept can be used specifically to oversee various projects owned by one stakeholder. The intended stakeholder is the government who usually has many projects in various locations simultaneously and many assets in the form of buildings or other entities.

2.2. The government's role in the implementation of BIM

The government has a role as a regulator in developing the industrial sector and the construction sector. Smith [17] said that the main success factor in the implementation of BIM nationally was leadership and coordination factors focused on maximizing work efficiency while avoiding arising problems from a segmented implementation approach. The government can become the owner, customer, or regulator in construction projects. In applying the BIM concept, the client/owner in the construction project becomes the main beneficiary [18]. The role of the government is not only limited as a regulator, but the government can also play a role as the initiator, educator, funding agency, demonstrator, and researcher [2].

2.3 BIM implementation

The adoption and implementation of BIM have been carried out by various countries in the world. The United States has become a pioneer country for the adoption of BIM. Various government agencies at every level have compiled a BIM program, set goals for the use of BIM, and made a roadmap for implementation and standards for BIM use [2]. Based on research conducted by Cheng and Lu [2] found that not only America but also many countries in Europe have also implemented BIM significantly. For example, the UK became one of the main BIM implementation countries in Europe by requiring all
government projects to use BIM in 2016. BIM has also entered Asia such as Singapore and Hong Kong to become the country that led to the adoption of BIM in Asia.

3. Methodology
This study used a literature review as the main instrument to find previous research on BIM topics in Indonesia. The information for this study was retrieved mainly through reviewing the literature from journal articles and conference papers; as well as observing relevant reports and guidelines. The literature found will be analyzed to determine the focus of each study, the results of the study, the dimensions of the study where the result will be tabulated. Literature mapping will be conducted to find a gap in BIM research in Indonesia that has not been explored. The next stage in this research is to collect various activities and efforts carried out by the Indonesian government to adopt BIM. The research method used in this paper uses an integrative literature review. An integrative literature review is one type of method in the literature to assess, critique, and locate a topic using available resources [19]. Data sources used in this method come from various sources. The intended data sources are academic journals, construction news, textbooks, industrial journals, government-issued journals, and reports from government institutions. Furthermore, the results of the literature review synthesis to obtain information about government activities related to the implementation process and the adoption of BIM. The main source of information regarding government effort on BIM adoption can be accessed on bim.pu.go.id [7].

4. Finding

4.1 BIM research in Indonesia
BIM research in Indonesia was recorded and published for the first time in 2013 with the topic of the benefits of BIM to streamline construction projects in Indonesia [8]. In a review of BIM research in Indonesia, found that there are seven studies where five of them are focusing on the technological dimension and the two others are focusing on the perspective dimension. Since 2017, BIM research in Indonesia continues to grow. Recent studies in the field of BIM along with their findings and dimensions are attached in table 1. The categorization of each article on the BIM implementation framework dimension is suggested by Jung and Joo [20] following previous research [8]. Literature mapping created to give insight into the article published where the gap of the research can be identified.

| Theme                                      | Finding                                                                 | Dimension | Year | Mapping                      |
|--------------------------------------------|-------------------------------------------------------------------------|-----------|------|------------------------------|
| Design and construction of prefabricated building [8] | BIM has benefit to streamline construction projects in Indonesia | Technology | 2013 | BIM in Design                |
| Application of BIM for pre-construction [8] | BIM provides information about pre-construction planning and particularly construction logistic planning. | Technology | 2014 | BIM Technology               |
| Awareness and implementation of BIM among academicians and practitioners [8] | 1. High awareness of BIM (70%) low implementation (38%).
2. BIM’s main uses are 3-D modeling and visualization | Perspective | 2016 | BIM Awareness and Perception |
| Perception of academicians and practitioners of BIM technology implementation in | Practitioners perceive BIM as informative software while academicians perceive BIM as integration software. | Perspective | 2016 | BIM Awareness and Perception |
| Title                                                                 | Year  | Category          | Description                                                                                                                                                                                                 |
|----------------------------------------------------------------------|-------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Comparison between Project using BIM and project using a conventional method in term of time efficiency, cost, and human resources [8] | 2016  | Technology        | Savings due to using BIM compared to conventional: 1. Project planning time by 50%. 2. Human resources by 26.66%. 3. Personnel cost by 52.25%.                        |
| Exploration of technological support for BIM implementation, benefits of BIM, challenges of BIM in construction project [8] | 2017  | Technology        | 1. The need for technological support for BIM is eminent. 2. BIM benefit is to reduce cost 3. Incompatibility between different BIM software.               |
| Challenges of BIM implementation in small-medium enterprise architecture [8] | 2017  | Technology        | 1. Main benefits of BIM are time efficiency, better communication and coordination, and improved project documentation. 2. Main challenges are lack of skilled BIM user, low demand from a client, high investment cost, and resistance to technological change. |
| Assessment of BIM in high-rise building construction in Indonesia [9] | 2018  | Technology        | Using Building Information Modeling Implementation Index (BIMII) produces a quite achieved score of 67.46% and the Importance Performance Analysis of Building Information Modeling (IPABIM) produced 4 quadrants of importance on BIM achievement. |
| BIM adoption towards the sustainability of the construction industry in Indonesia [10] | 2018  | Perspective       | 1. Awareness rate of BIM in Indonesia has to reach 67.5%, although mostly with limited or basic knowledge 2. BIM gives positive impact to sustainability aspects in construction |
| Factors that Affects the Maturity Level of BIM Implementation in Indonesia; Case Studies of 5 Construction Key Actors [11] | 2018  | Technology        | Factors that affect the maturity level of BIM implementation are: 1. The commitment of the leader 2. System and infrastructure development 3. Quality and capability of human resources |
Based on the finding in table 1, research of BIM from 2012 until 2017 concluded that the progress of BIM in Indonesia is still slow [8]. The low number of the international journal shows that BIM research is not yet mature in Indonesia. This situation had changed from 2018 – 2019. There are 5 publications on the BIM topic in Indonesia. A previous study reported that the low number of research on BIM was published in 2018 [8]. BIM used on high-rise building construction in Indonesia measured by [9] gives an average value of 67.46% (quite achieved) using Building Information Modeling Implementation Index (BIMII) measurement. The instant benefit received from applying BIM is considered to have slightly more impact for the practitioner, rather than the longer-term benefits. The main benefit of BIM has already been understood by practitioners, even though out of 40 respondents, only 2 said that they had competence in understanding BIM, while 25 others described that their knowledge of BIM was limited or just basic [10]. The understanding and level of BIM use in Indonesia are clarified through the discovery that states that BIM has still considered as a technology, not an integrated system, causing the use of BIM is not collaborative among stakeholders [11]. BIM as a tool to encourage sustainability in the construction industry could be achieved if stakeholders had a better understanding of BIM [10] [12]. The education sector is a major obstacle in the BIM adoption process which could be resolved by including BIM in the AEC curriculum. The government and practitioners alike must develop strategic roadmap, regulations, protocols, and standardization in the collaboration and implementation of BIM for the success of its process [12].

Investigation on BIM adoption in Indonesia conducted in 2019 discovered that the current project practice must follow standardization, a collaboration between stakeholders, complex bureaucracy, uses of the conventional method, and system plague effort on BIM adoption [13]. These problems enhanced the previous finding [12]. Recommendation to speed up BIM adoption directed to the government,
industry players, and roles of university align with the references given on the previous study. BIM uses in Indonesia, who started firstly in 2012 until 2019, were deemed to be less maximal. The study conducted on industry player who have already adopted BIM resulted in the need for investment in the form of BIM training, new or upgrade hardware, and BIM software, while the return of BIM implementation presumed by industry player is a positive impact on marketing, improving the result of the project process, and increase productivity [14]. The key risks are identified by [14] as follows technical risk, human resource risk, financial risk, management risk, and another risk. The main risk on each type is the rapid renewal of the BIM technology, lack of knowledge and capability of BIM employees and technicians, high short-term investment costs, previous management patterns, and lack of industry standards for BIM application. Barriers and driver factors of BIM adoption study carried out by [15] using an expert as a study object to identify 16 barrier and 18 driver indicators stem from the literature were considered relevant to measure barrier and driver factors of BIM adoption in Indonesia.

A study on the BIM topic in Indonesia used practitioners (13 out of 14 literatures) as the main source of study and information to discover, analyze, and measure of BIM adoption. Academics/Universities place second on object study who (5 out of 14 literatures) who try to extract information mainly perspective of academic, current curriculum of BIM, expertly composed of academic and practitioner, become the main object study of BIM research. Government place last as object study (2 out of 14 literature) despite [11-14] said that the lack of industry standardization, regulation, financing policy, complex bureaucracy, and conventional method used in the industry. This problem can be addressed by the government whose role as regulator and owner of many projects in Indonesia. Literature mapping provided in figure 1 depict BIM research mapping and study object in Indonesia. Collaboration between government, academics/universities, and industry players are needed in the process of adopting BIM in Indonesia. Each construction stakeholder in Indonesia must perform its role following their respective sectors. The study [14] recommended what shall be done by the government, industry players, and academics/universities to ensure BIM adoption in Indonesia.

![Figure 1. Literature mapping on bim research in indonesia](image-url)

A literature review on conceptual background shows that the adoption and implementation of BIM have been carried out by various countries. The government's role as a regulator in the process of adoption and implementation BIM in the construction industry is one of the main driving forces. Indonesia became one of the countries that also began to adopt BIM. Research in the field of BIM in Indonesia has been running since 2013 - until now. Based on the literature mapping, industry players, academics, and BIM practitioners have become the main sources in the research. The government as a
regulator in Indonesia has been highlighted as research study but limited as a source to find out the adoption and implementation of BIM in Indonesia.

4.2 Roadmap for BIM implementation

The implementation of BIM in Indonesia began formally at the "Digital Construction Day", an international conference held by PT PP in Jakarta on October 4, 2017. The conference invited many speakers from practitioners, government agencies, BIM authoring software, and many researchers/academics. In this conference, it was conveyed that the benefits and use of BIM carried out both by PT PP. Conference the topic discussed at the conference was the achievements of the government, represented by the Ministry of PUPR reports on the implementation of BIM in China and Singapore, experience in using BIM by various consultants and demonstrations of the use of BIM by authoring software and introduction Indonesian BIM Institute as an organization has the aim of developing the implementation of BIM in Indonesia. One of the main results of this conference was the first time public roadmap presentation for the implementation of the Indonesian BIM, which was then called the Indonesian digital construction roadmap by the Ministry of PUPR. In this roadmap, the BIM implementation process is divided into 4 phases which will be implemented in 7 years from 2017 to 2024. The phases submitted by the Ministry of PUPR contain the stages and objectives to be achieved by implementing BIM in Indonesia. Indonesia's digital construction roadmap can be seen in Table 2.

| 2017 | 2024 |
|------|------|
| **Adoption** | **Digitalization** | **Collaboration** | **Integration** |
| Construction Stakeholder adopted BIM | Licensing | Standard rules related to the construction industry collaboration | Implementation of cloud construction management |
| Compilation of National BIM Standard (SNI) | Monitoring and supervision | Implementation of Virtual Design and Lean Construction | Integration of construction process systems (licensing, claim, commissioning, handover, etc.) |
| BIM as a curriculum and competency standard for universities and professional associations | Commencement of a digital market for the construction sector | BIM Implementation (3D to 7D) |

4.3 PUPR BIM team

The PUPR BIM Team is a workgroup team formed through Decree of the Director-General of BALITBANG PU (Research and Development Public Works and Housing) No. 32/KPTS/KL/2017 on 12 December 2017 as a follow up to the government's commitment in implementing BIM and the BIM roadmap for Indonesia. This team was formed with 3 main tasks, namely formulating roadmaps as well as BIM implementation strategies, preparing national guidelines/standards about how to apply BIM, and conducting socialization and workshops for BIM. The focus of the work area of the BIM PUPR team is to implement BIM especially within the body of the Ministry of PUPR. Not limited to implementing BIM in the ministry, the PUPR BIM team also has the task to monitor and evaluate pilot projects that apply the BIM concept [7].

One of the first products from the PUPR BIM Team was the "Adoption of BIM in the organization" guidelines, aimed at guiding by helping organizations adopt and implement BIM. These guidelines have been prepared using a variety of sources, namely BIM Essential Guide of Adoption in an Organization by Building and Construction Authority (BCA) issued in August 2013, BIM for Transport and Main Road: A Guide to Enabling the BIM on Road Infrastructure Project, the Queensland government, published in May 2017, the National BIM Guide for Owners, National Institute of Building Sciences, published in January 2017, BIM Guide Series 01 - overview, US General Services
Administration, published in May 2007. This guideline was prepared through collaboration between the BIM PUPR Team and IBIMI. In addition to make guidance products for BIM implementation, the PUPR BIM Team works together with BALITBANG PU and DJBK PU (Directorate General of Construction) to make policies, ministerial policies, standards and protocols, SNI (Indonesian Nationals Standards), SKKNI, adoption guidelines, and what is needed to accommodate the BIM implementation. Figure 2 provides timelines for various activities that have been carried out by the BIM PUPR team in collaboration with various government institutions, industry players (practitioners) and involve academics/universities as a government effort to the adoption of BIM in the construction industry in Indonesia. Activities start in 2017 by the creation of the BIM PUPR team, BIM Roadmap, and IBIMI introduction on public in may to become one of the collaborative teams who help PUPR BIM team on various occasions. PUPR BIM team activities in 2018 marked by BIM implementation commitments and agreed by various government institutions and ministerial regulation of PUPR no 22/2018 was set on this year. BIM team activities starting from 2017 and reaching peak performance in 2019 with many socialization agenda, training, and preparation of standard and guideline as to the main focus in 2019. Other significant activities this year are preparing the BIM institutional agreement at the national level, led by Bappenas in the form of the National BIM Workshop. BIM training for civil servants (ASN), conducted in collaboration between the PUPR BIM team, state institutions, and external parties (IBIMI, academics/universities), was held in August – November to increase the knowledge and understanding of BIM in the internal government.

**Figure 2.** Compilation of PUPR BIM team activities 2017-2019, source : [7]
4.4 Policies – collaboration

One of the various ways in starting the implementation of BIM nationally is by making BIM an obligation or inculcating the obligation to use BIM in regulations, policies, government mandates, statutes, and special policies of the construction sector as a concept to accelerate infrastructure development. This stage in the process of implementing BIM nationally has been applied by several countries, not only regulating regulations and issuing national guidelines or standards but also using the BIM concept as a foothold to achieve national construction goals. Utilizing BIM in achieving the national goals implemented by Brazil to achieve cost reductions of up to 30% in the building life cycle, reducing the cost and time of building planning and construction processes in the country of Chile, streamlining the construction industry, and making interoperability data during the project life cycle in China [6]. The Indonesian government also used the method to implement BIM one of them translated in the direction of the minister PUPR containing 5 breakthroughs for pushing acceleration of infrastructure development, where one of the five directives that contain the implementation of research and construction technologies presented in the Indonesia Infrastructure Finance Forum 2017. These directives had been one of the basic implementation strategies in the infrastructure development of the Ministry of PUPR.

After the formation of the PUPR BIM team and the Indonesian digital construction roadmap in 2017, the Ministry of PUPR also launched PUPR ministerial regulation No. 22 / PRT / M / 2018 on the construction of state buildings. In the PUPR ministerial regulation, one of the attachments, namely No. 13 concerning construction planning service providers, states that the use of BIM is mandatory in non-existent state buildings with area criteria above 2000 m2 (two thousand square meters) and above 2 (two) floors. This regulation clearly states that the use of BIM as one of the obligations for construction service providers of the state buildings construction, therefore starting from 2018 all state-owned buildings that are in the planning and construction phases are obliged to use BIM. Although the use of BIM is required based on PUPR Regulation No. 22 / PRT / M / 2018, there are still no regulations that regulate how far the uses of BIM are and only regulate the final result of BIM operation which is ASME (Architecture, Structure, Mechanical, Electrical), which produced drawing, volume breakdown work, and budget plan. Collaboration between the Indonesian and the UK government by adapting 3 UK infrastructure planning and development methodologies is more effective and sustainable. One of the programs adopted is BIM. The duration of this collaboration is for 2017 – 2021. Further discussion regarding collaboration between Indonesian and the UK government resulted in the Global Infrastructure Program: BIM National strategy workshop on 19-20 March 2019.

5. Conclusions
The implementation of BIM in Indonesia has been started since 2017. This is marked as the publication of the roadmap for the implementation of BIM Indonesia or the Indonesian digital construction roadmap. Not only the BIM roadmap the Indonesian government has also formed a BIM team to implement BIM in government although the main focus is still on the internal needs of the Ministry of PUPR. These tools, formed by the government, are the beginning in producing/developing various tools to implement BIM, one of which is the adoption of BIM in the organization, as well as Minister of PUPR Regulation No. 22 / PRT / M / 2018 regarding the construction of state buildings. Collaborating with various parties in Indonesia, both from academia, practitioners, and various internal institutions, the Indonesian government has carried out the initial stages needed to create space and foster conditions to accelerate the process of adoption and implementation of BIM. These initial stages are needed to further produce guidelines, conduct research, and develop national standards in the use and implementation of BIM to achieve the acceleration of infrastructure development in Indonesia.

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