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Investment, Returns, and Risk of Building Information Modeling (BIM) Implementation in Indonesia's Construction Project

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Abstract: ***In the current development of the construction world, many efforts have been made to improve the quality and quantity of work, both structurally and in construction management. At least the efforts made are efforts to improve and achieve better work results. Technology development is needed, including in the construction world where one form of technology developed in the construction world is BIM (Building Information Modeling). For practitioners who adopt BIM or plan to invest in BIM in their future projects, there is a need to understand BIM's top investment priorities, risks associated after they start using BIM, and ways to increase BIM returns because this problem will influence decision making BIM investment. To overcome this, it is necessary to examine the main priorities of investment in adopting BIM, ways to increase returns on BIM applications, and risks in implementing BIM in developing countries, especially for actors who provide construction services. This study uses the Relative Important Index (RII) statistics to provide advice on how to improve and use BIM for industry professionals MEA or interests interested in investing in BIM or planning to use BIM in their projects.***

Keywords: ***Building Information Modeling, Investment, Returns, Risk***

I. INTRODUCTION

Building Information Modeling (BIM) as defined by [1]. is one of the most promising developments in the Architecture, Engineering, and Construction (AEC) industry with an accurate virtual digital construction model. The BIM concept envisions virtual construction before actual physical construction, to reduce uncertainty, improve safety, solve problems, and analyze potential impacts [2]. BIM has implications for making changes, encouraging the exchange of 3D models between different disciplines so that the process of exchanging information becomes faster and influences the implementation of construction [1]. BIM application form for planning a project is a combination of the results of several conventional software at once, this is an improvement in the efficiency of project planning.

The contractors are constantly challenged to deliver successful projects in spite of tight budgets, limited workforce, accelerated schedules, and limited information. Significant scientific disciplines such as architecture, structural design and MEP must be well-coordinated, because two things cannot happen at the same place and time.

Building Information Modeling helps in the selection of conflicts at an early stage, identifying problem conceptual differences between architects, structural, and implementers. The Building Information Modeling concept envisions virtual construction before physical construction is built, to reduce uncertainty, improve safety, solve problems, and simulate and analyze potential impacts. Starting and updating work involving BIM will require costs and initial efforts not only for software and hardware but also in technical, management and human resources, along with other aspects.

The application of Building Information Modeling (BIM) in Indonesia has been implemented by several big players in the construction industry sector such as PT. PP (Persero) Tbk. Which is a state-owned company and PT. Total Bangun Persada from a private company. The BIM method is also being applied in the developer sector, such as PT. Intiland. After that, the BIM method has also been applied by design consultants such as PT. PDW Architects. But after several years of BIM was applied in Indonesia, its use was felt to be not maximal, it could even be said to be increasingly stagnant. Indeed, BIM which has been applied in various sectors still provides benefits following the expectations of each actor. However, the application of BIM in the construction industry sector in Indonesia is still limited to answering the question of how to make efficient the needs of labor, time and money. If we reflect on how the application of the BIM method in the United States, the potential achieved from the application of the BIM method in Indonesia is far from the maximum word.

From previous research conducted by Yulian in [3] with the title "Evaluation of the Application of Building Information Modeling (BIM) in the Construction Industry in Indonesia" which explains the application of Building Information Modeling (BIM) in the Indonesian construction industry, states that the use of BIM in Indonesia not maximal, even though the application with the BIM concept has emerged a long time ago in Indonesia.

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For practitioners who adopt BIM or plan to invest in BIM in their future projects, there is a need to understand the main priorities of BIM investments, the risks associated after they start using BIM, and ways to increase BIM returns because this problem will influence decision making in BIM investment.

To overcome this, it is necessary to examine the main priorities of investment in adopting BIM, ways to improve the returns of BIM applications, and the risks in implementing BIM in developing countries, especially for actors providing construction services.

The results of this study provide advice on how to increase the returns and risks of using BIM for AEC industry professionals or stakeholders who invest in BIM or plan to adopt BIM in their projects.

II. LITERATURE REVIEW

A. Building Information Modeling (BIM)

Building Information Modeling (BIM), digital technology that enables the creation of accurate virtual models and supports further activities in the project delivery process, is one of the most promising developments in the architectural, engineering, and construction (AEC) industry [1].

Building Information Modeling (BIM) is defined as a digital representation of the physical and functional characteristics of facilities. BIM is a shared knowledge resource for information about facilities that forms a reliable basis for decisions throughout its life cycle [4]

The B model is different from the traditional 3D CAD model where 3D CAD only depicts 3D displays. If one item of the model is changed, the other must be updated. The 3D CAD drawing data is only limited to graphics such as lines, curves, and circles. Instead, BIM integrates information related to all components, including all geometric and functional during the life cycle that is collected in a "smart object" [5].

Building Information Modeling (BIM) has received increasing attention in the construction sector. BIM has become a broad and general approach in the design, construction, and maintenance of building facilities. BIM is also one of the topics most widely discussed by both academics and professionals from the construction industry throughout the world [6].

The final process of three-dimensional modeling of buildings has a high quality resulting from BIM. If the contractor only uses modeling to further communicate the concept of BIM in a 3D model and does not use further information, then it is referred to as "Hollywood" BIM. The contractor can use this concept to win the job [7]

Sometimes BIM is used internally in only one project organization and is not shared with the entire project organization. This is called "lonely". For example, an architecture company might decide to design a BIM and use it for energy visualization and analysis. Architect companies have internal collaboration. However, architects can decide to provide images in two dimensions and restrict BIM access. This will hinder the construction manager unless the construction manager creates a new model [7]

B. Development of BIM in Indonesia

Today, the business world is experiencing an era of disruption where startup companies can topple long-standing companies. The era of disruption is driven by the development of the digital world. The construction sector is one sector that will definitely be affected by digital transformation. However, digital adoption in the construction sector is much slower compared to other sectors. Cost efficiency and productivity, quality improvement and time accuracy have always been challenges year after year in the construction field. The Company as one of the leading construction and investment companies in Indonesia always conducts studies and research to overcome the above problems. The Company views the need for a transformation towards the era of digital construction as implemented by several developed countries, one of which is by applying the concept of Building Information Modeling [8].

Tumyana added in [8] "The Company continues to develop BIM technology to collaborate with 3D Printing technology in producing buildings of actual size that are believed to be the beginning of disruption for the construction world. The BIM that has been implemented by Persero has also begun to collaborate into the SAP-based Enterprise ERP (Enterprise Resources Planning) system that has been implemented since 2016 so that it will be of maximum benefit in monitoring the company's overall business processes".

Investigations at the BIM practice stage have now been carried out in various countries. The implementation of BIM is accelerating around the world, and this is driven by the mandate of the government, as well as clients and contractors as they realize the possible benefits of BIM in the long and short term [9]. In previous research, the Survey found that BIM implementation in all countries increased significantly and is expected to continue to increase over the next few years. Many other countries, like Pakistan [10]. Meanwhile, research conducted by Yulian in [3] with the title "Evaluation of the Application of Building Information Modeling (BIM) in the Construction Industry in Indonesia" which explains the application of Building Information Modeling (BIM) in the Indonesian Construction Industry, states that the use of BIM in Indonesia has not maximum, even though the application with the BIM concept has emerged a long time ago in Indonesia.

C. Returns of BIM Implementation

AEC companies and professionals want to know whether the time and money invested in implementing BIM, such as the four-dimensional BIM software that is studied by [11] for use in construction projects, will provide valuable returns.

Returns On Investment (ROI) have been defined and measured in several empirical studies based on BIM applications. Some previous research shows that BIM does not accurately reflect the real benefits and costs that come with BIM implementation. Intangible benefits and indirect costs such as increased productivity and potential revenue growth associated with BIM are difficult to estimate [12].

Other returns from BIM implementation include improvement of project performance and reduction of design changes [13], improved visualization and better coordination [14], improved project performance through better information sharing [15], and works as a multidisciplinary platform for facility management [16].

D. Risks of BIM Implementation

Understanding, identifying and assessing risk factors for BIM in AEC projects is an important part of the BIM implementation process. Identifying risks early can enable users to plan and respond quickly to potential problems. This can help the successful implementation of BIM [17].

The requirements for implementing Building Information Modeling (BIM) in public investment worldwide are currently very high. Significant interest (sometimes also formulated as a requirement) in BIM technology can also be observed among private investors. The design technology that applies to BIM is supported by many private investors because of its many advantages. A group of developing construction designers (including steel, concrete and reinforced concrete) and installation designers, manufacturers of prefabricated elements (steel and reinforcements), engineers, architects, construction companies, developers, contract managers and investors in Poland and notification opportunities throughout. The world is offered by using BIM technology in the preparation and construction stages, as well as building management. At the same time experts in the construction industry draw attention to the low level of competitiveness of Polish construction companies in global and European markets caused, among other things by the lack of application of modern technology and innovation, as well as the lack of public investor initiative in promoting BIM application [18]

As for other studies, popularizing BIM not only attracts the interests of all stakeholders but also carries some risks. For example, financial factors are difficult to detect and control through BIM, information loss during transmission is prominent, and BIM does not have integrated standards and regulations for international construction [19]

Based on interviews and research literature, public knowledge about the risks associated with BIM in the Czech Republic, which is a country where BIM has not been used at a general level, has not been high. People often see innovation risk as a threat and they fail to see innovation opportunities. There are two main reasons, the first reason is that there is not enough clear information about the benefits of BIM and the fact that they are not influenced by the relevant providers. The second reason arises from the construction industry itself because it is difficult to generalize the disadvantages and benefits of BIM implementation because they are subject to certain projects, companies and market conditions [20].

III. RESEARCH METHODOLOGY

A survey questionnaire-based research design used to gather information about BIM investments, returns by adopting BIM, ways to increase returns and risks associated with BIM implementation in construction projects in Indonesia, with targeted survey participants from construction service providers, consultants and other elements relating to the field of construction in Indonesia and different levels of BIM experience. The questionnaire was adapted from a previous study by [17] where the questionnaire was developed by a research team from the University of Nottingham Ningbo China (UNNC) between August 2014 and May 2015 by professionals from the Shanghai BIM Engineering Center (SBEC). The data in this study came from primary data, namely questionnaires. The distribution of the research questionnaire began on June 2019. Questionnaires were distributed directly to respondents who filled out the questionnaire on the google form application where the distribution was carried out by providing web links through social media such as WhatsApp. The number of questionnaires distributed as many as 95 questionnaires with a percentage level of 100% of the total auditors and questionnaires returned and processed as many as 80 questionnaires, so the return rate of the questionnaire was 84%. Questionnaires that did not return were 15 questionnaires so the level of questionnaires that did not return was 16%. Questionnaires that fell as many as 3 questionnaires with a questionnaire level that fell by 3%.

The data collection technique in this study is a questionnaire-based survey. Questionnaire with the details listed, divided into two parts. The first part collects respondents' background information, including their work location in Indonesia; their work (e.g., BIM Manager, Project Manager, BIM Engineer, etc.); their BIM experience level (i.e., expert, advanced, intermediate, entry-level, and a little BIM experience); and software tools adopted in their work. The second part of the questionnaire consists of four sections, which are targeted at the focus of BIM investment, returns from using BIM, ways to increase relevant BIM returns, and risks faced in implementing BIM.

Likert and multiple-choice scales are the two types of questions designed in the survey.

For the question of scale, Related to investment, *returns*, and risk of BIM, it involves four statistical methods:

1. Relative Importance Index (RII) is used to rank several items in each section related to BIM returns and investments. From 0 to 1, RII values are calculated in Eq. (1),

$$RII = \frac{\sum w}{A \times N} \quad (1)$$

Where :

w = Likert scores (numerical values from 1 to 5 in integers) are chosen by each respondent in the questionnaire

A = The highest score on each item given (A equals 5 in this survey); and

N= Number of Responses. Items with a higher RII value will indicate higher significance or importance.

2. *Cronbach's alpha* was adopted as a tool to measure the internal consistency of items [21] in each part of the investment and return on BIM. Alfa Cronbach ranges from 0 to 1, the greater value indicates a higher level of consistency among these items in one section. In other words, Cronbach's alpha which was calculated higher would indicate that survey participants who chose a Likert score for one item were more

likely to choose the same score for the remaining items in the same section.

3. In this study, Cronbach's alpha value was calculated in each of the three sections related to the BIM investment area, the returns recognized from the BIM implementation, and ways to improve BIM returns. Cronbach's alpha value will measure internal consistency between items in each of these sections. In general, Cronbach's alpha value from 0.70 to 0.95 would be considered a high internal interrelation [22]. In contrast, Cronbach's lower alpha values indicate a bad correlation between items [23].

IV. RESULT & DISCUSSION

A. Survey Participant

This study adopts a questionnaire-based survey approach to conduct statistical analyses of BIM Indonesia's practitioners perceptions of BIM investment, returns, and risks of BIM implementation, active BIM practitioners or those who plan to implement BIM in construction projects in Indonesia are targeted as a survey sample. Most of the respondents from the survey are employees of national contractors with various positions and experience in using BIM technology (Figure 1).

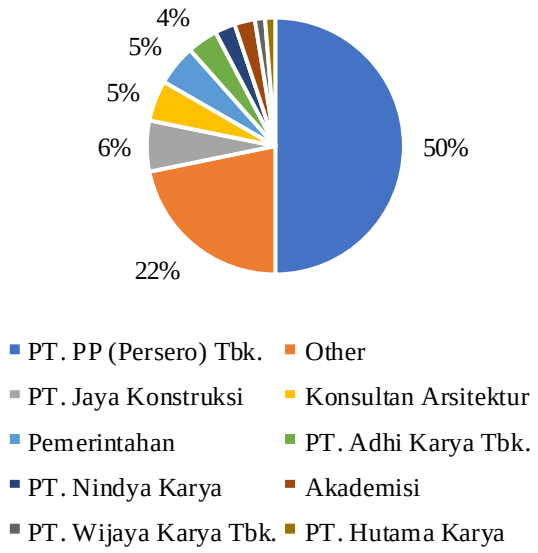

Fig. 1. Frequency of Respondents Based on Place of Work

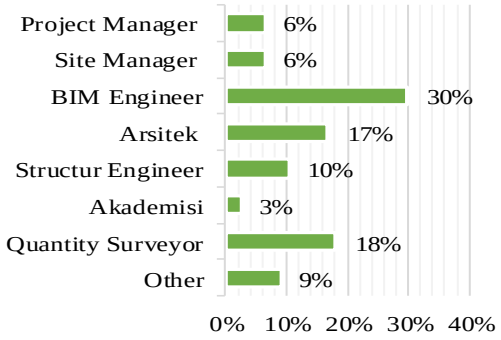

Fig. 2. Frequency of Respondents Based on Job Position

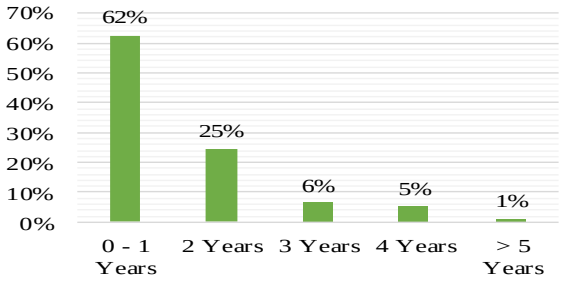

Fig. 3. Frequency of Respondents Based on the Length of Use of BIM Software

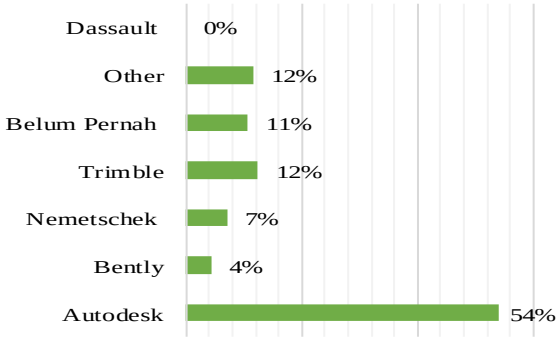

Fig. 4. Frequency of Respondents Based on Software Used

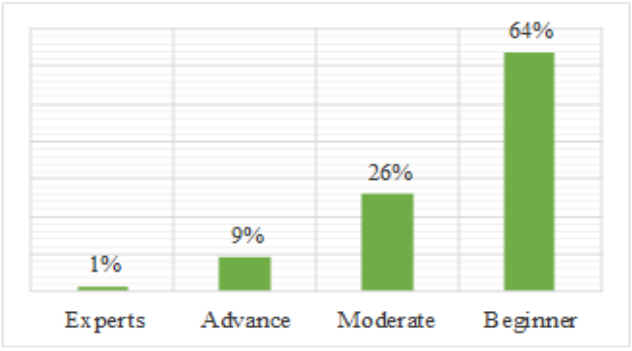

Fig. 5. Frequency of Respondents based on Proficiency

This research shows that BIM users in Indonesia have an average experience of 0-1 years (Figure 2) and are still at the beginner/beginner level in using BIM technology in their projects (Figure 3). Figure 4 above can be seen that the Autodesk application is still a very popular BIM application used by people working in construction in Indonesia. Whereas figure 5, shows that the use of BIM in Indonesia is still in the initial stage with the high number of respondents who are working in the construction sector being marked at the beginner stage.

B. BIM Investment

Survey participants were asked their perceptions about the importance of BIM investment based on the Likert scale question format with various investment fields that have been provided. Based on the ranking of numerical values with a scale of 1 very unimportant, 3 indicates neutral and 5 shows the most important. The eight BIM investment items that follow the RII score are listed in the following Table- I.

Cronbach's Alpha of 0.865 stated that the high reliability and consistency of survey participants' views of these BIM investment variable items. All total correlation values in Table- I shows a fairly positive value where the value of total correlation is greater than the value of r table (0.224) which can be declared valid, that each item has a strong relationship between other items.

Based on the results of the survey participants' perceptions about BIM investment, it explains that the main priorities in investing in BIM implementation in construction in Indonesia are:

- BIM Training.
- New or upgrade hardware.
- BIM Software.

This is different from what is found by [17] where they find in their country the top priority of BIM investment namely developing internal collaboration following BIM procedures, collaborative development of BIM processes with external parties and Software customization and interoperability solutions.

C. Returns of Implementasi BIM

Survey participants were asked their perceptions about returns from BIM investments based on the Likert scale question format with various fields of return provided. Based on the ranking of numerical values with a scale of 1 very unimportant, 3 indicates neutral and 5 shows the most important. Thirteen item returns from applying BIM that follow the RII score are listed in the following Table- II.

Cronbach's Alpha of 0.918 stated that the high reliability and consistency of survey participants' views of these BIM investment variable items. All total correlation values in Table- II shows a fairly positive value where the value of total correlation is greater than the value of r table (0.224) which can be declared valid, that each item has a strong relationship between other items. Based on Table- II can be seen 3 main returns from investment in the application of BIM, which are:

1. Positive impact on marketing.
2. Improve project process outcomes, such as fewer RFIs and field coordination problems.
3. Improved productivity.

Survey participants perceive that BIM is very positive for marketing which could be due to the reality construction trends in Indonesia have begun to provide conditions for using BIM technology for contractors that are deeply envisioned Peraturan Menteri Pekerjaan Umum Dan Perumahan Rakyat Republik Indonesia Nomor 22/PRT/M/2018 About the Construction of State Buildings.

This can be attributed to the fact that 48% of the survey participants' perception believes that a high increase in the use of BIM in green building projects in the future. BIM can improve project work outcomes, such as less RFI (Request for
Information) and the problem of field coordination as well as improving productivity to be one of the main returns from applying BIM to construction projects.

Table- I: Survey Results of Importance of BIM Investment Areas

Code	Indicator	RII	Total Correlation	Cronbach's Alpha	Rank
R1	Better multiparty communication and understanding from 3D visualization	0.844	0,547	0,918	4
R2	Improve project process outcomes, such as fewer RFIs and field coordination problems	0.857	0,629	0.915	2
R3	Improved productivity	0.849	0,778	0.909	3
R4	Increased application of prefabrication	0.834	0,763	0.910	7
R5	Positive impact on marketing	0.86	0,581	0.918	1
R6	Reduced cycle time for project activities and delivery	0.839	0,759	0.910	5
R7	Lower project cost	0.73	0,676	0.915	12
R8	Improve jobsite safety	0.725	0,802	0,907	13
R9	Positive impact on sustainability	0.813	0,810	0,907	9
R10	Positive impact o recruiting/retaining staff	0.743	0,738	0.911	11
R11	Faster plan approval and permits	0.764	0,713	0,912	10
R12	More Accurate constructions documents	0.836	0,711	0,912	6
R13	Improved operations, maintenance and facility management	0.831	0,708	0,912	8

Table- II: Survey Results of Recognitions on Returns from BIM Investment

Code	Indicator	RII	Total Correlation	Cronbach's Alpha	Rank
I1	BIM Software	0,875	0,797	0.836	3
I2	Developing internal collaboration according to BIM procedures	0,849	0,785	0.838	5
13	Marketing your BIM capability	0,829	0,764	0.843	8
14	BIM Training	0,948	0,689	0.851	1
15	New or upgrade hardware	0,894	0,709	0.85	2
16	Developing collaborative BIM processes with external parties	0,844	0,650	0.861	7
17	Software customization and interopebility solutions	0,847	0,711	0.848	6
18	Developing custom 3D libraries	0,868	0,649	0,859	4

D. Ways to Increase Returns of BIM Implementation

This study also aims to find out how to increase BIM returns were in this study produced 3 main ways to increase returns in the application of BIM. Cronbach's Alpha of 0.918 stated that the high reliability and consistency of survey participants' views of these BIM investment variable items. All total correlation values in Table- III shows a fairly positive value where the value of total correlation is greater than the value of r table (0.224) which can be declared valid, that each item has a strong relationship between other items. Based on Table- III can be seen 3 main ways to increase returns of BIM implementation in the application of BIM, which are:

1. More readily available training on BIM.
2. More clearly defined BIM deliverables between parties.
3. Integration of BIM data with mobile devices/ applications

AEC companies must increase BIM training for their employees to improve the quality of their employees if they want to accelerate returns from BIM investment. It is also important to define the results of the BIM to many parties concerned where this is recommended to increase the confidence of construction service users in the BIM technology that will be adopted in their projects. To improve the work efficiency of BIM technology users are expected to be able to integrate the BIM data they have created with the mobile application.

Table- III: Survey Results of Perceptions on Ways to Increase Returns of BIM Implementation

Code	Indicator	RII	Total Correlation	Cronbach's Alpha	Rank
C1	Improved interoperability between software applications	0.818	0,692	0,920	10
C2	Improved functionality of BIM software	0.87	0,800	0.917	4
C3	More clearly defined BIM deliverables between parties	0.878	0,710	0.919	2
C4	More internal staff with BIM skills	0.855	0,762	0.919	5
C5	More owners consulting for BIM	0.831	0,672	0.922	8
C6	More externals firm with BIM skills	0.81	0,691	0.922	13
C7	More 3D building product manufacturer to employ more prefabrication	0.834	0,732	0.921	7
C8	More use of contract language to support BIM and collaboration	0.826	0,615	0,926	9
C9	More incoming entry-level staffs with BIM skills	0.818	0,546	0,926	11
C10	Willingness of AHJs (Authorities Having Jurisdiction) to accept models	0.805	0,783	0,918	14
C11	Reduced cost of BIM software	0.797	0,655	0,924	15
C12	More hard data demonstrating the business value of BIM	0.844	0,714	0,922	6
C13	More readily available training on BIM	0.909	0,689	0,922	1
C14	Integration of BIM data with mobile devices/applications	0.878	0,712	0,919	3
C15	More readily available outsourced modeling service	0.813	0,664	0,922	12

E. Risk of BIM Implementation

The risks in implementing BIM are divided into 5 types of risks namely technical risk, human resource risk, financial risk, management risk, and other risks. The division can be seen in Table- IV.

The most important risk on technical risk is Rapid update of BIM technologies. This shows that anyone who wants to implement BIM and their work activities must know this BIM technology requires each user to always continue to develop their knowledge of BIM technology because of the rapid movement of this BIM technology itself. Every BIM technology user must maximize this technology in his work so that he quickly knows the shortcomings of the BIM software he uses. The most important human resource risk, which is the lack of knowledge and capabilities among current employees and technicians, shows the importance of BIM training for companies in implementing BIM in the work environment. Financial risks are high cost of short-term investment. This is reinforced by BIM investments where the main priorities in investing in BIM are BIM training, BIM hardware, and software upgrades. On risk management, the difficult transition of management pattern shows the most influential risk in implementing BIM and other risks that can occur in implementing BIM is the lack of industry standards for BIM implementation.

Research in the areas of investment, returns, ways to increase returns, and risks in implementing BIM provide advice to AEC professionals and business owners about focusing on BIM investment, expectations of adopting BIM, suggestions for increasing returns from BIM implementation, and related potential risks.

Table- IV: Key Risk of BIM Implementation Identified within Mutiple Categories

Technical Risk	32%	Poor adoption of BIM technologies
	31%	The difficulty of BIM technologies
	44%	Rapid update of BIM technologies
	30%	Imperfect BIM software
Human Resource Risk	65%	Lack of knowladge and capabilities among current employees
	27%	Reluctance to accept nem BIM Technologies
	55%	Lack of BIM technicians
	12%	Tight schedule of current bussines
Financial Risk	43%	Long periode of return on invesment
	18%	Uncertainty of profit
	61%	High Cost of short-term investment
Management Risk	66%	The difficult transition of management pattern
	31%	The difficult transition of bussines procedures
	32%	Reluctance to adopt BIM from the management level
Other Risk	23%	Unclear legal liability
	47%	Low recognition of society
	55%	Lack of industry standards
	32%	Unknown intellectual property

V. CONCLUSION

Based on the results of the preparation of the thesis of the previous chapter, then in this chapter which is the final part of this study, it can be concluded that several descriptions to answer the problem formulation following the research are as follows:

1. The main priorities in investing in the implementation of BIM in construction in Indonesia are (1) BIM training, (2) updating or upgrading software and (3) BIM software.
2. Implementation returns obtained from the results of this study are, (1) positive impact on marketing, (2) improving the results of the project process, such as a little RFI and the problem of field coordination and (3) increase productivity. As for how to increase BIM returns were in this study produced data as follows: (1) increasing the provision of BIM training, (2) diffusing BIM results to many parties, and (3) integrating BIM data with mobile devices/applications.
3. Risks in the BIM implementation are divided into 5 types of risks namely technical risk, human resource risk, financial risk, management risk, and other risks.
   - The most important risk on technical risk is the rapid renewal of the BIM technology.
   - The most important human resource risk is the lack of knowledge and capability of BIM employees and technicians.
   - Financial risks, namely high short-term investment costs.
   - Risk management, a difficult transition from previous management patterns.
   - BIM and other risks that can occur in implementing BIM are the lack of industry standards for BIM application.

For future research, it can be extended to in-depth studies of how BIM management is in construction projects and how to maximize the use of BIM in construction projects.

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