



The impact of 3D, 4D, and 5D Building Information Modeling for reducing claims to service providers

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Abstract

In construction, claims are usually a request for additional time, cost, or quality of work. A dispute will occur if the claim is not resolved correctly. In industrial revolution 4.0, we can use the Building Information Modeling (BIM) method to increase efficiency. BIM is a digital display containing all information about building elements integrated with the building's life cycle period. BIM will accelerate and reduce risks in construction, including the impact of claims. In Indonesia, several consultants/contractors have been implemented BIM in construction projects. This research aims to determine the effect of using 3D, 4D, and 5D BIM in construction projects for reducing claims to service providers as seen from the indicators on BIM 3D, 4D, 5D BIM. The research method used is a descriptive research method with a Q-method approach using closed survey research instruments to 37 contractor/consultant respondents who use BIM. The results obtained from the 3D BIM 4 indicators affect the reduction of claims. The 4D BIM indicator has two hands that affect the decrease in claims. The 5D BIM indicators all involve reducing claims.

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INTRODUCTION

The construction industry is often associated with claims resulting from changes in quantity, quality, specifications, and many other problems. One way to minimize the impact of these claims is to deal with them proactively; it allows the project party to forecast potential allegations and take the necessary actions to avoid them [1].

Work delays, variation orders, design changes, and changes to the scope of work are causes of claims to service providers in the implementation of construction projects. Therefore, service providers can suffer losses due to claims. Claims are defined as actions or requests for someone's rights that were previously lost. According to Kapuasiana and Hardjomuljadi, claims that arise and then develop into disputes, the leading cause is regulation by service users, especially on the general terms of the Contract, which is due to the desire of service users to make a contract that is in favor of their interests (unilateral) [2].

To ensure the success of construction projects, construction dispute management has emerged as an essential aspect of construction project management.

One of the causes of frequent claims to service providers is variation orders. Very rarely is a project completed without any variation in work. A Variation Order is a sequence that closely matches the terms of the variation clause of the Contract, generally requiring written evidence of the variation in where the work differs from the original Contract. Variation orders always have cost and time implications. Regardless of interpretation, there is a risk due to a reduction in the original volume in the Contract. There is a risk of additional costs that must be taken into account consideration. If the variety of work is not handled correctly, it will be a significant contributing factor to claims. In previous research, variation orders are issued as orders to change the design, quantity, and work program. Usually, the employer will issue written orders after verbal instructions are given

on-site. The significant impacts are claims for additional work and extension of time, revision of the design and work program, and eventually, a new contract price will be changed. In addition to the above impacts, there are also other impacts: solving almost all claims-related problems, additional unforeseen costs, time extensions, and other physical conditions [3].

We have entered the era of the industrial revolution 4.0, marked by the development of information technology to achieve high efficiency and better product quality. All stakeholders involved in the world of construction must make the best use of technology while still considering natural resources that are effective and efficient. One of the breakthroughs in technology that can support infrastructure development is Building Information Modeling (BIM). BIM is a digital representation containing all information about building elements used to gather decisions within the building life cycle. Therefore, implementing BIM will accelerate and reduce risks to construction operations, including claims to service providers.

BIM regulations have been implemented in Indonesia. Ministry of Public Works and Public Housing of the Republic of Indonesia Regulation Number 22/PRT/M/2018 concerning Construction of State Buildings explains that the use of BIM must be applied to non-simple state buildings with criteria of the land area of more than 2000 m² and more than two floors [4].

Then in 2021, Government Regulation Number 16 of 2021 explains the procedures for implementing building construction, especially in technology-intensive buildings, must use Building Information Modeling (BIM) at least up to the fifth dimension and carried out by service providers at least with an intermediate classification. Involving quantity and construction surveyors [5].

The BIM concept uses digital (virtual) 3D modeling, which contains all integrated modeling information for coordination, simulation, and visualization facilities between all related parties. It can help owners and service providers design, build, and manage buildings [6]. The various dimensions of BIM usage have been categorized based on the process of implementing them. The BIM dimension can be divided into the 3rd dimension is space, the 4th dimension is time or scheduling and sorting, the 5th dimension is cost estimation, and the 6th dimension is facility management [7].

Several causes of claims caused by service providers often occur in construction projects, such as work delays, variation orders, design changes, and changes to the scope of work. If it is not resolved correctly, it will cause a dispute. However, by utilizing BIM, we can reduce this occurrence by applying BIM at the beginning of the project. The previous research described conflicts that adversely affect project performance, highlighting the importance of including risk management in contractual terms to prevent disputes [8]. Dispute mitigation is an essential factor in the success of completing a construction project. Due to the significant influence of construction project disputes, various studies have investigated the cause is construction disputes [8]. Dispute mitigation can analyze the leading causes of conflicts, such as unclear contracts, differences in interpretation, and risk allocation.

BIM is new strategic management innovation, and it is necessary to consider legal aspects when designing BIM contracts. The strategy is then consolidated into a conceptual framework for model data validation to protect data from loss, corruption, or manipulation [9].

This study aims to determine the effect of using BIM on reducing construction claims. However, this research is limited to discussing 3D, 4D, and 5D BIM used by contractors and consultants and defined by several causes of claims such as design changes, changes in the scope of work, delays, and variation orders.

METHODS

The research process is carried out in stages through a preliminary study by identifying problems and theories in state of the art. Then comes a title that will be used as research. The research hypothesis was conducted to achieve the research objectives.

Materials

BIM is experiencing increasing application in the global AEC industry. Investigations at the current stage of BIM practice have been carried out in various countries. In previous study [10], practicing engineers or contractors investigated current BIM practices to achieve visualization, BIM experience, BIM vision, and mission and BIM implementation barriers. BIM applications are expected to increase in the coming years. A previous review of BIM studies revealed that specific BIM-related issues might vary depending on the respondent's profession. For example, contractors perceive themselves as the most beneficiary of BIM technology.

In contrast, design and staff from other disciplines tend to perceive clients as benefiting the most from BIM. Contractors considered control costs to be the primary measure of the impact of BIM, whereas engineers noted a reduction in design changes as a critical benefit of BIM. In addition, the benefits of using BIM can also reduce design errors and construction rework [10].

As an information and communication technology used in the architectural, engineering, construction, and operations (AECO) industry, BIM enables project teams to manage projects through a model-driven cooperative approach. Among construction ICTs, BIM is interpreted as a technological disruptor that changes the AECO project life cycle [11]. The main goal of BIM is to provide project teams with visual aids and to enhance the AECO project environment with accurate data, simulation, and workflow analysis. In addition to building information management, BIM can also provide a sociotechnical system to restructure the project environment. Several studies have clarified the benefits of BIM from a project management perspective. BIM to improve project business efficiency by comparing two cases with and without BIM. We were reported that implementing BIM on projects contributed to reasonable control of time, cost, and quality, along with improved communication and collaboration. In addition, the use of BIM to promote project delivery is integrated through cooperation [11].

Based on Figure 1, The main principals of BIM are not only a 3D computer design model, but this is a process of making model and data simultaneously and collaborating between stakeholders from the planning, design, fabrication, construction, and maintenance processes.

Methods

Research methods used were carried out. To get the results of the study used Q-methods data analysis to obtain research conclusions.

Research Variable

Based on Figure 2, this study has three independent variables (X) and one dependent variable (Y). The dependent variable is a variable whose value is influenced or depends on the importance of other variables. The Independent variable is a variable that causes the emergence or change of the dependent variable.

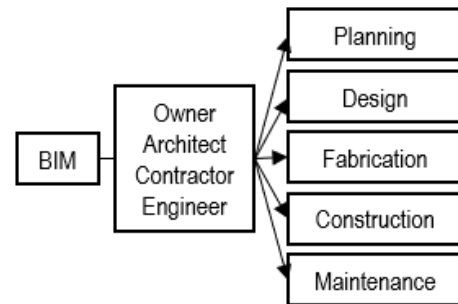


Figure 1. Main Principals of BIM

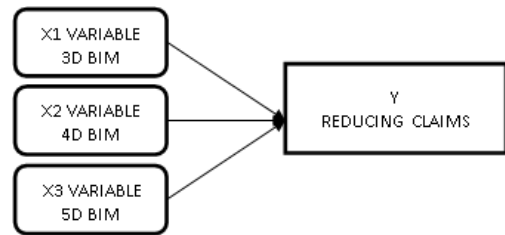


Figure 2. Variable on Research

Research Instrument

The instrument used to measure and determine data analysis was conducted using a closed questionnaire using a Likert scale assessment. This research instrument is used for measurements that aim to obtain accurate results or data so that each the instrument must have a scale [12]. The instrument framework is needed as a guide in formulating instrument items. The instrument framework must include the scope of the research variable material. The research instrument will be described in the tables. As shown in Table 1, the question items are based on the literature on indicators for X1 Variable. As shown in Table 2, the question items are based on the literature on indicators for X2 Variable. As shown in Table 3, the question items are based on the literature on indicators X3 Variable. The framework in construction claims is limited by several causes of claims such as design changes, changes in the scope of work, delays, and variation orders, as shown in Table 4.

Data Collection Technique

The questionnaires were distributed to 37 contractors/consultants who had used the BIM method specifically in high-rise building projects. Number of questions is 45. With scale Likert assessment, where: Very Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4 and Strongly Agree= 5.

The sampling method used non-random expert sampling, a non-random sample selection method with respondents the author trusts as someone who has the expertise required in the study.

Table 1. Instrument Framework of 3D BIM (X1 Variable) [13]

Indicator	Items	
Existing condition model	X1.1	The 3D BIM concept visualizes virtual constructs to reduce uncertainty, solve problems and analyze potential impacts
	X1.2	Ground Penetration Radar (GPR) for subsurface imaging in surveying subsurface to investigate underground utilities such as concrete, asphalt, metal, pipe, cable, or masonry.
Logistics and safety models	X1.3	Virtual and interactive HSE procedure validation can be visualized with a 3D model to prevent risks that will occur
	X1.4	Reduce non-conformity of material and material specifications in planning and implementation
Animations, rendering, walkthrough	X1.5	Represent building models and building information with a 3-dimensional model for all parties involved in the project (consultants, owners, contractors)
BIM Pre-Fabrications	X1.6	Presenting pre-fabrication information to the project owner to minimize changes in the scope of work
	X1.7	3D BIM management is more efficient because it is centered on one information model to minimize conflicts between parties
	X1.8	The 3D BIM concept can make the exchange of information between different disciplines faster
Laser accurate BIM driven field layout	X1.9	Detect clash detection between structural, mechanical, electrical works to reduce the occurrence of rework or additional work
	X1.10	Presenting field layout & civil data with 3D laser scanning makes information more accurate and efficient so that it can be used as evidence in case of disputes related to existing land

Table 2. Instrument Framework of 4D BIM (X2 Variable) [13]

Indicator	Items	
Simulation and project steps	X2-1	Presents an integrated simulation of the project stages of the 3D model so that it can identify delays that may occur
	X2-2	All steps of the project progress and construction activities during the project period can be seen by all parties involved in the project
Learn to schedule	X2-3	Linked between jobs can be controlled and controlled properly
	X2-4	The construction process is faster thanks to improved logistics management, smooth construction workflows, and reduced delays in material management
Learn to schedule	X2-5	Potential risks can be identified because critical points can be detected
	X2-6	Shows the path of activities that need to be considered in maintaining project completion
	X2-7	Help identify gaps between expected project completion time and actual time
	X2-8	4D BIM can create realistic schedules for each component according to the contractor's work schedule.
Visual validation for payment	X2-9	Visualize payment approval validation
Approval	X2-10	All parties involved in the project can collaborate on financial planning until final approval is obtained

Table 3. Instrument Framework of 5D BIM (X3 Variable) [13]

Indicator	Items	
Real-time concept modeling and cost planning	X3-1	5D BIM can display the modeling concept of planning costs and actual costs
	X3-2	Allows the contractor to make accurate cost estimates as the number of building components is accurately identified from the 3D model
Real-time concept modeling and cost planning	X3-3	If the cost estimates are accurate, there is less likely to be risk and loss or miscommunication
Extract quantity to support cost estimation	X3-4	Saving time on BOQ creation
	X3-5	The 5D BIM can eliminate calculation errors that are usually made manually
	X3-6	If cost estimates are linked to work and time, the process of calculating resources is faster, reducing problems due to financial or frequent changes
Trade verification from the manufacturer's model	X3-7	A quick calculation of cost estimates will make it easier to make decisions
	X3-8	5D BIM can accurately represent how much material will be used and when it is needed, cost estimates can be more detailed and accurate.
	X3-9	5D BIM helps facilitate material selection and implementation process to maintain project legality. Some of the most critical areas to examine include: Structure and MEP
Value engineering	X3-10	When using 5D BIM to analyze cost and functionality simultaneously, analyzing value engineering becomes much simpler
	X3-11	5D BIM assists in the development of value engineering, including Visualization, Quantity Extraction
Pre-fabrication Solution	X3-12	5D BIM can streamline the pre-fabrication process so that it can realize the concept of lean construction
	X3-13	A unique structure and architecture can be created offsite by incorporating the 5D BIM in critical areas like the MEP System.

Table 4. Instrument Framework of Reducing Claims (Y Variable)

Indicator	Items	
Design changes [14]	Y-1	There are frequent claims from service users due to design changes
	Y-2	Design changes will affect the project schedule, which can result in delays
	Y-3	Design changes will affect budget/costs
Change in scope of work [15]	Y-4	Increasing or decreasing the volume of work stated in the Contract may raise claims from the project owner
	Y-5	Adding or reducing the type of work stated in the Contract may give rise to claims from the project owner
	Y-6	Changing the implementation schedule may result in claims from service users
Delays [1]	Y-7	There are often claims from service users due to delays in implementation from the specified time
	Y-8	Delays in work are caused by project implementation at the same time
Variation Order [3]	Y-9	Delays often occur due to wrong or unresponsive weather
	Y-10	Service providers often carry out variation orders to match work
	Y-11	There is an impact of the variation order on the cost of changing the contract value
	Y-12	Changes in work volume can add fewer implementation costs

Validity and Reliability Test

Questionnaire statements were distributed via google form with alternative answers provided using a Likert scale. The output of the questionnaire is then processed using the IBM SPSS 23 software. In the quantitative data processing stage, the first thing to do is test the data's validity and reliability.

Validity test using IBM SPSS 23 Software and the results of variable validation can be tested by comparing r count with r table. R table at α 0.05 with degrees of freedom $df = (N-2)$, in this study, the number of respondents $N = 37$ to $df = 35$. $R (0.05; 35)$ in one-way test = 0.2746. Decision Making: if the r count is positive and the r count $>$ r table, the variable is valid. Meanwhile, if r counts the variable or r counts $<$ r table, the variable is invalid. From the results obtained, all variables are declared valid.

Then, this is the Result from the reliability test using IBM SPSS 23 Software. From the results obtained, all Cronbach's Alpha values are 0.697 or $>$ 0.60; it can be concluded that this research variable is reliable.

Methods of Analysis

"Data analysis is an activity after data from all respondents or other data sources are collected." Based on the above understanding, it can be concluded that data analysis is carried out to process data into understandable information [12]. Easy and valuable for answering problems related to research activities. The data analysis method used in this research is the descriptive analysis used to respond to the problem formulation.

In this study, the questionnaire instrument that experts have validated has performed a Kendall-tau correlation test for each indicator on 3D BIM, 4D BIM, and 5D BIM against claims to service providers. The Kendall's-tau correlation test was processed using the Windows version of

the IBM SPSS 23 software. Then, the analysis of research data obtained from Kendall's tau correlation test, whose output is in the form of statistics, will be compared with the opinions of previous studies. This process is Q-methods, a middle ground analysis process between qualitative and quantitative, converted into structured factors [16].

RESULTS AND DISCUSSION

In this study, the target respondents needed to complete the questionnaire were service providers (consultants and contractors), especially those who use BIM in high-rise building projects, of 37 respondents. Data were obtained from seven companies' consultants and ten companies' contractors.

General Description of Respondents

Respondents based on kinds of service providers;

contractors : 21 peoples (0,57%)
consultants : 16 peoples (0,43%)

Respondents based on gender;
male : 33 peoples (89.2%)
female : 4 peoples (10.8%)

Respondents based on the level of education;

vocational high school : 3 peoples (8.1%)
associate's degree : 3 peoples (8.1%)
bachelor's degree : 23 peoples (62.2%)
master's degree : 8 peoples (21, 6%)

Then the distribution of respondents based on work experience;

$<$ 1 years : 1 person (2.7%)
1-5 years : 19 people (51.4%)
5-10 years : 8 people (21, 6%)
 $>$ 10 years : 9 people (24.3%).

The Kendall-tau Correlation Test

The partial correlation test used in Kendall's tau correlation test is processed using the IBM SPSS 23 Version program. The Kendall-tau correlation coefficient is one of the ranked variables (sorted), namely the variable X only or The Y variable, in this case, is usually the X variable. In comparison, the Y variable will be seen whether the value of the Y variable is in the direction (concordant) or opposite (discordant) with the sorted X variable [17].

The provisions in Kendall's tau test are as follows:

- If the significance value < 0.01 means the correlation is very significant and the hypothesis is accepted;
- If the significance value < 0.05, it means that the correlation is significant and the hypothesis is accepted;
- If the significance value is > 0.05, the correlation is insignificant, and the hypothesis is rejected.

While the nature of the correlation will Determine the direction of the closeness of the correlation described:

- 0.25 means the correlation is weak;

> 0.26 - 0.5 means that the correlation is quite strong;
 > 0.51 - 0.75 means strong correlation;
 0.76-1 means the correlation is solid.

Figure 3 is a visualization of Table 5 which means, 3D BIM indicators existing condition models, animation rendering and walkthrough, BIM Pre-fabrications, and laser-accurate BIM driven layout to reduce claims. But logistic and safety model indicator has not an impact in reducing claims.

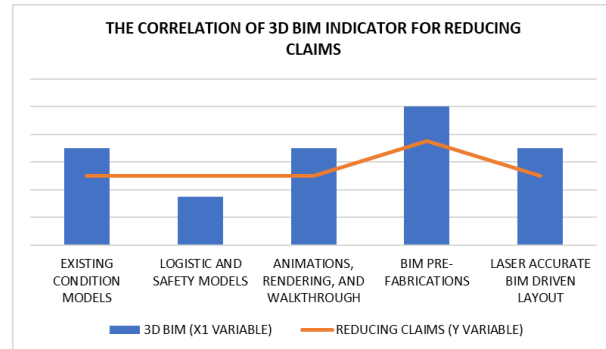


Figure 3. The correlation of the 3D BIM indicator for reducing claims

Table 5. The Result of the Kendall-tau correlation test for X1 to Y Variable

Indicators	Signification X1 to Y	Correlation X1 to Y	Result
Existing condition models	0.028	0.296	a significant and quite strong correlation
Logistics and safety models	0.076	0.237	a not significant and quite strong correlation
Animations, rendering, walkthrough	0.012	0.366	a significant and quite strong correlation
BIM Pre-Fabrications	0	0.501	a very significant and strong correlation
Laser-accurate BIM driven field layout	0.029	0.312	a significant and quite strong correlation

Table 6. The Result of the Kendall-tau correlation test for X2 to Y Variable

Indicators	Signification X2 to Y	Correlation X2 to Y	Result
Simulation and project steps	0.001	0.439	a very significant and strong correlation
Learn to schedule	0.001	0.434	a very significant and strong correlation
Visual validation for payment approval	0.056	0.259	a not significant and weak correlation

Table 7. The Result of the Kendall-tau correlation test X3 to Y Variable

Indicators	Signification X3 to Y	Correlation X3 to Y	Result
Real-time concept modeling and cost planning	0	0.591	a very significant and strong correlation
Extract quantity to support cost estimation	0	0.461	a very significant and quite strong correlation
Trade verification from the manufacturer's model	0	0.504	a very significant and quite strong correlation
Value engineering	0	0.564	a very significant and strong correlation
Pre-fabrication Solution	0	0.48	a very significant and quite strong correlation

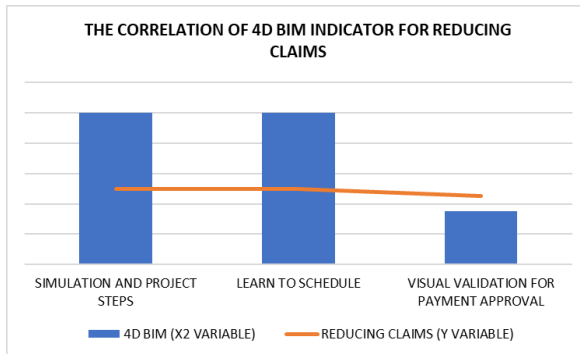


Figure 4. The correlation of the 4D BIM indicator for reducing claims

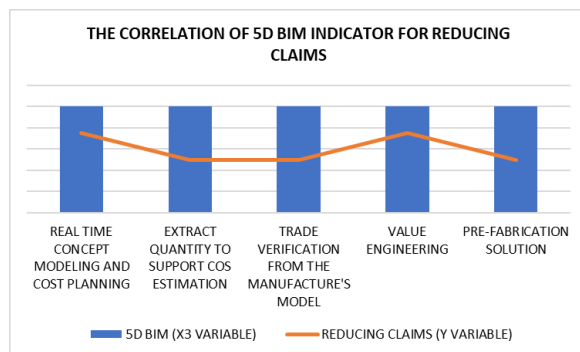


Figure 5. The correlation of the 5D BIM indicator on reducing claims

Figure 4 is a visualization of Table 6 which means that 4D BIM indicators simulation and project steps and learning to the schedule impact reducing claims. But visual validation for payment approval indicators has not a mark on reducing claims.

Figure 5 is a visualization of Table 7, 5D BIM indicators real-time concept modeling and cost planning, extract quantity to support cost estimation, trade verification from the manufacturer's model, value engineering, and pre-fabrication solution has an impact in reducing claims.

Discussion

This section will discuss the results based on the Kendall-tau correlation test compared to the opinion of previous research:

The results based on Table 5 with indicators of Existing condition model, Logistic & Safety Models, Animation, Rendering & Walkthrough, Pre-fabricated BIM, and Lasser Accurate BIM Driven Field Layout are as follows.

Existing condition model

The Result of the existing condition model indicator has an impact on reducing the claims. The existing condition model represented in 3D can optimize the early stages of design and

subsequent decision-making. The early-stage analysis was not carried out well in the conventional method because it was not fast and integrated with the design. Designing multi-functional buildings that combine buildings with an integrated design process complete the project during the planning stage to ensure all necessary design specifications and requirements are met [18].

Logistic & Safety Models

The Result of the logistic & safety model indicator has not an impact on reducing claims. Contrary to the opinion of previous research, it is explained that the building design and implementation plan affect workplace safety at the project site. Identifying how a project activity is carried out, knowing the size of the work material to be carried out, understanding the process flow on how to safely carry out a work activity are some of the approach steps that engineers can take. Several tools to manage project work safety have also been widely used, such as online databases, virtual reality, geographic information systems, entity-based 4D CAD, Sensing & warning technologies [19].

Animation, Rendering & Walkthrough

The animation, rendering & walkthrough indicators have an impact on reducing claims. 3D guides can show several areas or introduce view spots [20] so that service providers can use animations, renderings & walkthroughs to share with project owners, thereby reducing the occurrence of claims.

Pre-fabricated BIM

The Result of the Pre-fabrication BIM indicator has an impact on reducing claims. Pre-fabrication is a construction practice whose basic units are components that are also considered the essential elements of BIM. BIM excellence in building lifecycle management [21]. Using the BIM model will also have the opportunity to cut other times, such as clash detection and pre-fabrication using a ready-to-use model. The actual construction has the main concern at the project location. However, a significant part of the worksite can also be generated outside the construction site, namely pre-fabrication. Currently, automated applications for building construction can use BIM used at the design and construction stages to support construction management, precast concrete and steel detailing, and local casting. BIM facilitates various design and construction activities such as digital fabrication of building components and

digital workflows from design to fabrication for everyone involved in a construction project.

Lasser Accurate BIM Driven Field Layout

Lasser's accurate BIM-driven field layout indicator has an impact on reducing claims. Laser scanning technology is a beneficial feature in developing point cloud models in the life cycle of a building in various stages of building construction work, more quickly and precisely. The fastest laser scanning job is possible through laser scanning with manual measurement and multiple techniques. Laser scanning will impact the project work, then provide accurate field data [22].

The results based on Table 6 with indicators of Project Stages Simulation, Scheduling, and Visual Validation of Payment Agreements are as follows.

Project Stages Simulation

The Result of the project stage simulation indicator has an impact on reducing claims. In particular previous research, four-dimensional simulations (4D) are becoming more common in the construction industry to minimize productivity losses and delay claims. The 4D simulation is generated by linking the three-dimensional (3D) model with the priority diagram method project schedule. It can be used to visualize critical pathways to identify cause-and-effect relationships and the entities responsible for the context of claim avoidance or claim resolution [23].

Scheduling

The result scheduling indicator has an impact on reducing claims. One of the factors causing the delay is ineffective planning and scheduling by the contractor. One of the efforts to anticipate the delay in the duration of construction activities is to optimize the period of the activities. Based on a four-dimensional (4D) building information model (BIM) in project schedule and progress. Automatically input data progress into 4D BIM. This method modifies the schedule hierarchy; updating the progress ratio for building elements; color-coded building elements based on actual and expected progress, and updating task duration and completion date [24].

Visual Validation of Payment Agreements

The visual validation of approval indicators had not to impact reducing claims. Previous research explained that 4D simulation could help obtain efficiency in analyzing delay claims [15]. The central part of BIM 4D modeling is to enter

all the scheduling-related information from the model to carry out the visualization according to the work date. The visual validation of the payment agreement has not provided sufficient information to reduce claims. The results based on table 7 with indicators of Real-time Concept Modeling and Cost Planning, Extract Quantities to Support Detailed Cost Estimate, Trade Verification of Manufacturer's Model, Value Engineering (VE), and Pre-Fabrication Solutions are as follows.

Real-time Concept Modeling and Cost Planning

Real-time concept and cost planning indicator has an impact on reducing claims. Calculation concepts can be based on data and information related to specific components in a graphical model. This information allows financial managers to easily extrapolate the number of particular elements to a project, applying costs to the quantity to arrive at the overall cost for development. Previous research explained that the BIM model could integrate all information in a construction project. All project stakeholders can coordinate well through the BIM platform to make accurate decisions, and is conducive to realizing construction project management. They have simulated impact detection in the program design stage to avoid collisions caused by demolition, a reworking of waste in the construction phase. All this information can be monitored and managed in real-time. All parties work together to share information to improve the quality of construction projects, shorten the construction period, thereby reducing construction costs, significantly improving work efficiency [25].

Extract Quantities to Support Detailed Cost Estimate

Extract Quantities to Support Detailed Cost Estimate indicator has an impact in reducing claims. 5D BIM matrices and models to visualize and forecast project claim areas or even potential claims. Visualization and data storage features that help manage construction claims using BIM. Accordingly, a report is created that analyzes each project update, including supporting detailed cost estimates in case of changes in price or quantity [1].

Trade Verification of Manufacturer's Model

Trade Verification of Manufacturer's Model indicator has an impact on reducing claims. Construction professionals can use the resulting BIM 5D model to provide a faster decision on project costs, allowing the designer to adjust the project design to fit the budget. Field managers

using the BIM 5D platform to extract daily, weekly, or monthly material requirements, according to the duration of labor analysis, funding analysis, material analysis, timely and accurate material requirements planning to avoid the accumulation of material on-site or not due to the material causing waste. By laying out the construction area in advance, planning can increase resource use and product procurement efficiency [25].

Value Engineering (VE)

The Result of the value engineering indicator has an impact on reducing claims. BIM is proving to be an excellent tool for facilitating value engineering in today's industrial stage. Previous research describes how Value Engineering (VE) can be used to control construction costs. The findings suggest that BIM integration in VE facilitates design modification and extraction of information such as cost data. Through this approach demonstrated a 10% savings in project cost and duration. In addition, the overall quality and performance of the project improve. The results show the importance of integrating BIM and VE to enhance the functionality and implementation of a building project before, during, and after the construction phase [26].

Pre-Fabrication Solutions

Pre-Fabrication Solutions indicator has an impact on reducing claims. BIM technology is highly integrated with the concept of integrated construction of pre-fabricated buildings. Mainly under the general contract, application and application advantages of BIM-based pre-fabricated buildings are becoming more prominent [27].

CONCLUSION

The results and discussion regarding the impact of using 3D, 4D, and 5D BIM on the decrease in claims, explained that the results obtained from the 3D BIM indicator have four indicators that affect claims reduction. Then the 4D BIM indicator has two indicators that affect the decrease in claims. In comparison, the 5D BIM indicators all affect reducing claims. From the statement above, it can be concluded that 5D is the most influential in reducing claims, followed by 3D BIM and then 4D BIM.

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