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Legal Liability for Construction Failures In The Digital Era: A Qualitative Analysis of The Use Of Building Information Modeling (BIM)

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Abstract. The development of digital technology in the construction industry has led to major innovations through the implementation of Building Information Modelling (BIM), which enables cross-disciplinary collaboration within a single integrated digital model. However, this transformation also presents new legal challenges, particularly regarding the allocation of responsibility in the event of construction failures. This study aims to analyse how contractual clauses govern risk distribution associated with BIM use and how digital collaboration practices shape the determination of legal liability in real-world projects. Using a qualitative approach grounded in literature review and normative analysis, it was found that the collaborative nature of BIM blurs the traditional boundaries between designers, contractors, and project owners. The lack of clear regulations and the weak implementation of the BIM Execution Plan (BEP) often make it difficult to identify the liable party in cases of design errors or technical failures. Therefore, reformulation of contracts and regulations is required to explicitly define rights, obligations, and digital audit mechanisms to ensure legal certainty. In conclusion, the use of BIM demands comprehensive legal adaptation to balance technological efficiency and professional accountability in the era of digital construction.

Keywords: building information modelling, legal liability, construction contracts, digitalization, construction failures.

INTRODUCTION

The development of information technology has penetrated nearly all aspects of civil engineering practice and the construction industry. One of the most significant transformations is the adoption of Building Information Modeling (BIM). This integrated approach combines three-dimensional geometric representation with technical data, scheduling, cost, and other information throughout the building's life cycle. BIM is not merely a modeling software; it represents a new collaborative paradigm in which multiple disciplines (architecture, structural engineering, MEP, contractors, and owners) work on a shared data source, thereby reducing potential errors caused by fragmented communication [1].

This transformation brings significant benefits: improved coordination, clash detection, 4D scheduling simulation, 5D cost estimation, and the ability to record a comprehensive history of design parameters and decisions. Consequently, BIM has the potential to enhance efficiency, reduce costs, and improve the quality of construction outcomes. However, this shift in workflow also introduces new complexities in legal and liability aspects: when a construction failure occurs, the previously clear boundaries of responsibility between designers, contractors, and supervisors become blurred, since the digital model is continuously updated and accessible to multiple stakeholders [2].

The legal issues surrounding BIM are multidimensional. There are concerns about risk allocation and contractual liability: who is responsible for discrepancies in the BIM model that later result in physical defects on site? Questions also arise regarding intellectual property rights and data ownership. Does the model belong to the designer, the contractor who modifies it, or the project owner? Professional liability and insurance coverage become difficult to define as the traditional roles of consultants and contractors shift toward a digital collaboration model, and digital documents can be modified throughout the project [3].

The adoption of BIM is increasingly driven by government regulations and policies. The Minister of Public Works and Housing Regulation No. 22 of 2018 and Government Regulation No. 16 of 2021 include provisions that encourage or mandate the use of BIM processes in certain projects, particularly state buildings and technology-intensive infrastructure projects. These policies reflect the government's commitment to modernizing planning and construction supervision practices. However, they also demand regulatory preparedness to govern the distribution of responsibilities, digital archiving, and data interoperability standards in order to minimize potential legal disputes.

In practice, BIM adoption in Indonesia remains varied. Several empirical studies indicate that although large-scale and state-owned enterprise (SOE) projects have begun implementing BIM, many industry players (including small consultants, local contractors, and project owners) still lack the technical capacity, contractual standards, or adequate insurance frameworks to handle BIM-specific risks. This gap creates the possibility of new disputes arising when construction failures occur due to discrepancies between the digital model and field reality, or when differing model versions are used to assign blame to a particular party [4].

Theoretically, the shift from separate documents to an integrated model requires a re-examination of the principles of contract law, civil liability (culpa/breach of contract), and professional liability. In the classical contractual approach, risk allocation is governed by contract specifications and work documents: design is the responsibility of the designer; execution and physical work quality are the responsibility of the contractor, while the supervisor or owner verifies the outcome. With BIM, the digital model can serve as a "single source of truth," yet the challenge lies in determining which version serves as the binding contractual reference. How should real-time modifications made by other parties be treated? Moreover, how should digital evidence be evaluated in the event of a damage claim? All these questions require adapting contract clauses, version control protocols, and explicit provisions regarding model ownership and usage rights.

From the perspective of civil law and liability, issues of proof and causation also emerge. Construction failures often result from a combination of defective design, poor workmanship, substandard materials, or changes in site conditions. When digital BIM documents become part of the evidence, courts and experts must possess the technical ability to examine digital audit trails and metadata and determine who made which changes to the model. The absence of standardized audit procedures or clear interoperability formats can obscure evidence and complicate the determination of the legally responsible party [5].

The importance of professional ethics and due diligence obligations is increasing. Engineers and designers still hold a professional duty to design with reasonable skill and care; however, the collaborative nature of BIM allows for more intensive interactions and potential interventions by other parties within the model. Therefore, it must be clearly defined to what extent such professional obligations can be transferred or limited through contractual clauses, while ensuring that no erosion of accountability occurs that could endanger public safety. Legal instruments such as professional practice standards, codes of ethics, and professional licensing regulations must be revised to encompass BIM practices, ensuring that responsibility is not lost within the digital collaborative framework [6].

In addition, questions surrounding insurance and compensation mechanisms deserve careful attention. Traditional insurance products such as Professional Indemnity (PI) or Contractor's All Risks (CAR) are based on clear assumptions about the parties' responsibilities. The BIM model, which facilitates iterative changes and data sharing across multiple entities, may introduce unforeseen claim exposures. Consequently, insurance companies require more detailed risk definitions, exclusion clauses, or coverage extensions specifically tailored to digital data and software interoperability [7].

From a policy perspective, Indonesia's need to implement BIM, as reflected in PUPR regulations, demonstrates a commitment to efficiency and public transparency. However, policies without complementary legal instruments—such as standard BIM contract templates, data ownership guidelines, digital archiving rules, and digital audit and forensic standards risk creating legal uncertainty that ultimately undermines these objectives. Therefore, research

examining how legal liability is allocated in BIM practices in Indonesia is highly relevant, as it can provide recommendations for formulating fair contractual clauses, updating professional standards, and developing adaptive insurance frameworks.

The purpose of this study is to fill that knowledge gap. Focusing on a qualitative analysis of the distribution of responsibility among parties in the use of BIM, this research examines: (1) how current contractual clauses allocate risks related to BIM; and (2) how BIM collaboration practices in real-world projects influence the determination of liability when construction failures occur. Such analysis is not only relevant to academics but also to legal practitioners, engineers, policymakers, and insurers who must navigate the intersection of technology and law to safeguard public interests and strengthen legal certainty.

The qualitative method is considered most appropriate for this study, as the issues involved are contextual, normative, and closely linked to socio-professional practices in construction projects. A qualitative approach allows for the examination of real contract documents, in-depth interviews with key actors (designers, contractors, owners, supervisors, and insurers), and case analyses of construction failures involving BIM. The empirical findings are expected to reveal the gap between written rules (regulations and contracts) and field practices, and to formulate pragmatic, contextually appropriate legal solutions for Indonesia [7].

Digitalization is not merely a matter of technology; it transforms patterns of responsibility, decision-making, and the nature of legal evidence. Construction failures in the pre-digital era were largely handled through analysis of two-dimensional drawings, specification documents, and physical inspections. In the BIM era, digital traces, metadata, and collaborative processes become central elements of the event narrative. Therefore, establishing an adaptive legal framework that integrates BIM-friendly contractual clauses, updated professional standards, data management guidelines, and appropriate insurance policies is a crucial step to ensure accountability, efficiency, and public safety in an increasingly digitalized construction industry.

METHODOLOGY

This study employed a qualitative descriptive approach to analyze legal liability arising from construction failures in the digital era, with particular attention to the implementation of Building Information Modeling (BIM) in Indonesia and comparative practices in other jurisdictions. The qualitative design was chosen because it enables a deeper exploration of the contractual framework, collaborative mechanisms, and legal implications related to BIM-based projects. Data collection relied primarily on document analysis of both primary and secondary sources. The primary sources included national regulations such as the *Regulation of the Minister of Public Works and Housing No. 14/PRT/M/2020*, which governs construction contracts in Indonesia. In contrast, the secondary sources consisted of international BIM-related contractual documents, such as the United Kingdom's Construction Industry Council (CIC) BIM Protocol and the United States' AIA Document E203. In addition, empirical and academic studies [8]; [9]; [10] were examined to identify the distribution and patterns of BIM implementation, the presence of digital risk clauses, and the occurrence of contractual disputes from 2020 to 2025.

The collected data were analyzed using content analysis and comparative interpretation. Content analysis was employed to identify and categorize the legal and contractual elements that influence BIM-based collaboration, particularly concerning risk allocation, data ownership, and the assignment of digital responsibility. Comparative interpretation was then used to contrast Indonesia’s contractual and regulatory framework with those of other countries, highlighting differences and identifying potential reforms needed to develop an effective digital construction law regime. The analytical framework of this study was grounded in the theory of legal-technical integration, which emphasizes the intersection between digital construction technologies and legal accountability. This framework extends previous theoretical work [11]; [12]; [13] by examining how the collaborative nature of BIM challenges traditional bilateral liability structures and necessitates a reformulation of contractual norms.

To ensure the validity and reliability of the findings, triangulation was conducted by comparing statutory provisions, case-based evidence, and international contractual standards. Consistent coding procedures were applied to all data sources to maintain analytical reliability, following the methodological guidance from previous research on digital construction law [14]; [12]. This methodological approach enables other researchers to replicate the study and further explore the evolving relationship between technological innovation and legal responsibility in the construction field.

RESULT AND DISCUSSION

1. Risk Allocation in Contractual Clauses Related to the Use of Building Information Modeling (BIM)

In the conventional construction law system, the regulation of risk and responsibility has long been explicitly governed through construction work agreements, which generally define the roles and obligations of each party: the project owner, designer, contractor, and supervisor, based on the general principles of contract law, namely the principle of *pacta sunt servanda* and fault-based liability [15]. However, with the emergence of Building Information Modeling (BIM) technology, this paradigm has undergone a fundamental shift, as BIM creates a digital collaborative space that allows multiple parties to work simultaneously on the same building information model. Consequently, responsibilities that were once individual in nature may now become collective and overlapping [1].

In general, contractual clauses in BIM-based projects aim to regulate the allocation of responsibilities, intellectual property rights to the model and data, data maintenance obligations, and mechanisms for resolving digital disputes. However, there is no universal standard that explicitly defines how BIM-related risks are allocated. At the international level, several contractual approaches have begun to integrate BIM clauses, such as the AIA Document E203-2013 in the United States, the CIC BIM Protocol in the United Kingdom, and the FIDIC BIM Addendum currently under development [5]. These documents serve as references for many countries in formulating digital contract guidelines, but their implementation remains highly adaptive to each nation's legal context [5].

In the past five years, the adoption of Building Information Modeling (BIM) technology in Indonesia's construction industry has grown significantly, while also raising new challenges regarding contractual risk allocation and legal liability. For example, recent research indicates that the implementation of BIM in Indonesian public projects is still at an early stage, with relatively low levels of actual practice despite increasing awareness: studies reveal that although 70% of project stakeholders are aware of the BIM concept, only around 38% have meaningfully implemented it in their projects [8]. This situation has led to emerging issues in construction contract clauses that govern liability for BIM-related construction failures, including model coordination, digital documentation, and data integration.

With the growing use of BIM, the literature increasingly highlights the need for contractual provisions to explicitly address risks such as model miscommunication, data loss, and the reliability of digital information [9]. Furthermore, recent legal studies reveal that modern construction contracts are increasingly adopting clearer liability clauses and updated risk-sharing mechanisms, in line with the rise of digitalization and project collaboration [10]. Therefore, in the context of this study, which examines how contractual clauses allocate risks related to BIM and how BIM collaboration practices influence the determination of liability in the event of construction failure, the empirical data from the past five years is highly relevant as a foundation for analysis, ensuring contextual and up-to-date insights.

TABLE 1. Distribution of BIM Implementation and Contractual Risks (2020–2025)

Year	Country/Region	BIM Implementation Rate (%)	Percentage of Contracts with Digital Risk Clauses (%)	Estimated BIM-Related Construction Disputes	Source
2020	Indonesia	25	12	3 cases	[8]
2021	Malaysia	42	27	5 cases	[9]
2022	Indonesia	33	19	6 cases	[8]
2023	Singapore	78	65	2 cases	[10]
2025	Indonesia	38	26	8 cases	[8]; [10]

The table above shows that although the level of BIM implementation in Indonesia increased from 25% in 2020 to 38% in 2025, the percentage of contracts that include digital risk clauses remains relatively low, at only 26% in the most recent year. This condition indicates a gap between technological adoption and contractual legal readiness, which could lead to ambiguity in liability in the event of construction failure. The data also reinforces the importance of more specific regulations regarding the allocation of digital risks in BIM-based construction contracts in the digital era. In the CIC BIM Protocol issued by the Construction Industry Council (UK), for instance, it is stated that each party involved in a BIM project must have a "defined role and level of responsibility for model development," meaning that each party is responsible only for the portion of the model they create or modify. This clause aims to limit liability so

that it does not extend to downstream parties using the data. Thus, the risk of errors resulting from the use of BIM models by other parties is mitigated through a defined "Model Responsibility Matrix (MRM)" [16]. This approach is considered effective in avoiding liability disputes arising from data coordination errors [16]. Meanwhile, in the United States, the AIA Documents E203-2013 and G202-2013 issued by the American Institute of Architects stipulate that the use of BIM must be governed by a separate agreement known as the BIM Execution Plan (BEP). This document specifies who has the authority to modify the model, what types of information may be shared, and which software standards are to be used. Furthermore, the clause requires that all changes to the model be tracked through an electronic audit system to maintain data integrity [17]. With these provisions, the risk of liability for unauthorized modifications can be minimized, as each party is required to maintain data provenance or change history [17].

Although such clauses are quite effective in common law jurisdictions, their implementation in civil law jurisdictions such as Indonesia still poses challenges. This is because the Indonesian legal system tends to prioritize written evidence and signatures as formal indicators of agreement. In contrast, BIM operates in a digital environment characterized by dynamic and collaborative model updates [18]. Therefore, within the context of Indonesian contract law, the validity of clauses establishing digital responsibility must still comply with Article 1320 of the Civil Code, which sets out the legal requirements for agreements, including consent, capacity, a specific object, and a lawful cause [19].

The implementation of Building Information Modeling (BIM) in construction projects brings significant changes to work patterns, responsibilities, and risk distribution among the involved parties. In a contractual context, BIM functions not only as a technical tool but also creates new dynamics in legal relationships, particularly concerning data ownership, model accuracy, and cross-disciplinary coordination. Therefore, risk allocation becomes a crucial aspect that determines how effectively BIM can be applied without causing disputes among the parties. However, field practices show that risk arrangements in contracts still tend to follow traditional models that have not yet fully adapted to BIM's collaborative, digital nature. To illustrate the effectiveness of these arrangements and the types of problems that frequently arise in BIM implementation, the following table summarizes the main risks and their contractual mitigation.

Table 2. Effectiveness and Common Issues in Risk Allocation of BIM in Construction Project Contracts

No.	BIM Risk Aspect	Party Generally Responsible	Common Issues Encountered	Effectiveness of Contractual Regulation
1	Ownership and Copyright of BIM Data Model	Designer or Project Owner	Disputes over ownership of BIM data, especially during design revisions by third parties	Low – often unclear, leading to potential legal disputes
2	Data Accuracy and Model Precision	Design Consultant / BIM Coordinator	Discrepancies between the virtual model and field conditions are leading to additional cost claims.	Moderate – depends on model detail and verification responsibilities.
3	Multidisciplinary Coordination	All parties (design, contractor, MEP, structure)	Inconsistencies between models (clash) cause delays or rework	Moderate–High – effective if the contract applies, clash detection, and routine coordination schedules
4	Digital Data Security and Access	Project Owner / BIM Manager	Data breaches or data loss due to poor access management	Low – limited specific contractual regulation on digital data security
5	Liability for Design Errors from BIM Integration	Lead Design Consultant	Unclear boundaries of responsibility between the designer and the BIM modeler when errors arise from data integration	Moderate – depends on the clarity of the scope of responsibility in the contract.
6	Software Licensing and Interoperability Standards	Project Owner / BIM Coordinator	Incompatibility between versions or file formats is	Low – often not technically specified in contractual clauses.

			causing coordination disruptions and delays.	
7	Design Change Management	Project Owner and Designer	Absence of standard procedures to approve design changes affecting cost and schedule	Moderate–High – effective if supported by a documented change control system
8	Legal Liability from Reliance on BIM Model	All model users	Certain parties bear the risk of relying on non-final models for physical execution.	Low – requires a clear disclaimer of reliance clause.

From the table above, it can be concluded that the effectiveness of risk allocation in contractual clauses related to BIM use remains varied and often suboptimal. The risks most frequently leading to disputes are data ownership, liability for integrative design errors, and digital data security. These aspects indicate low effectiveness, as traditional construction contracts have yet to accommodate the collaborative and digital characteristics introduced by BIM.

The main weakness in BIM risk allocation lies in the lack of standardized contracts that adapt to digital collaborative environments, resulting in a reversion to traditional divisions of responsibility that rigidly separate designers and contractors [9]. Meanwhile, the *Integrated Project Delivery* (IPD) principle, which emphasizes collaboration, requires a proportional distribution of both risk and reward [12].

Furthermore, Khosrowshahi and Arayici (2012) found that differences in understanding and technical capacity among project participants often lead to imbalanced legal responsibilities [20]. For example, designers frequently bear risks stemming from data errors that are actually caused by coordination failures among other project teams.

The effectiveness of risk management can be improved if contracts include specific clauses such as:
1. BIM Protocols outlining roles, responsibilities, and model quality control mechanisms (e.g., based on *CIC BIM Protocol* or *AIA E203*).
2. Data security and digital copyright clauses to protect the intellectual property rights of BIM models.
3. Digital dispute resolution provisions, such as a *BIM audit trail* serving as electronic evidence.

Thus, BIM risk allocation will be effective only when contracts are drafted in detail through a collaborative approach that aligns with the digital nature of construction projects, rather than relying solely on traditional contract structures.

In practice, there are two main approaches to allocating BIM-related risks: the Traditional Contractual Allocation model and the Integrated Project Delivery (IPD) model. The first model maintains the conventional boundaries of liability, where designers are responsible for design errors and contractors for execution. At the same time, BIM is treated merely as a visualization and coordination tool. As a result, legal risks remain divided along traditional work phases, even though the BIM model is used collaboratively. This approach is often used in government projects that lack comprehensive BIM regulations [21].

Conversely, the Integrated Project Delivery (IPD) model transforms this paradigm by creating a system of "shared risk and shared reward." In IPD, all key parties (owner, architect, contractor, engineer) sign a single multiparty contract agreeing to share project profits and losses based on overall performance rather than individual contributions. Consequently, BIM-related risks are not allocated to a single party but are managed collectively through joint incentive and penalty mechanisms [22]. This approach is considered effective at reducing disputes by fostering transparency and collaboration, though it requires a high degree of trust among parties [22].

However, the primary legal issue in BIM contracts concerns ownership and copyright of the digital model. In many cases, architects or designers view the model as their intellectual property, while project owners regard it as a deliverable belonging to the employer. According to the AIA Document E203-2013, copyright over the BIM model remains with its creator. However, the project owner is granted a non-exclusive license to use the model for the duration of the project [17]. This provision aims to prevent copyright infringement when the model is reused in other projects. However, when contractors or subcontractors modify the model, liability for design errors becomes blurred since it is difficult to determine which version of the model is legally "official" [23]. Another important issue concerns liability for data loss or interoperability errors between BIM software platforms. In global practice, most BIM contracts include a "disclaimer of liability for software failure" clause, which exempts parties from liability for errors caused by software bugs, crashes, or incompatibility between software versions [24].

This is because service providers have no full control over the technology being used. However, such clauses may conflict with the principle of strict liability under consumer protection law and result in unfairness to the injured party [24].

Construction work contracts are regulated under Government Regulation No. 14 of 2021 on the Implementation of Construction Services, which emphasizes the principle of balanced rights and obligations among parties. However, this regulation does not explicitly address the use of BIM as a basis for allocating legal liability. Consequently, in the event of construction failure caused by errors in the BIM model, dispute resolution generally still relies on the general principles of civil liability either for breach of contract or unlawful acts (Construction Services Law No. 2 of 2017). In such cases, BIM is merely treated as supplementary evidence in establishing causation [25].

To address this gap, several international institutions, such as FIDIC, have developed a BIM Protocol as an additional standard clause in their contracts. In the FIDIC 2022 BIM Addendum, it is stated that "each Party shall remain responsible for the accuracy and completeness of the information it contributes to the BIM Model." This means that each party remains liable for the accuracy of the data they input, even though other parties later integrate the model. This clause reinforces individual accountability while providing a foundation for proportional risk allocation [26].

Meanwhile, in public project practices across Europe, many countries have begun implementing a BIM Execution Protocol (BEP) as a mandatory document that specifies responsibilities, model upload schedules, version control systems, and change approval mechanisms. The BEP then serves as a contractual reference for determining fault when model errors or coordination failures occur. Thus, the BEP serves as a legal risk-mitigation instrument that complements the main contract [3].

In practice, BIM contractual clauses must also account for integration with electronic legal evidence systems. Because BIM models exist as digital data, liability evidence must be traceable through an audit trail. In this context, legal responsibility is measured not only by the model's content but also by each actor's digital behavior during the model's update. Therefore, modern BIM contracts require a Common Data Environment (CDE) system that records all user activities to ensure digital evidence is legally admissible in court [5].

Based on the above explanation, it can be concluded that contractual clauses in the context of BIM are currently evolving from a traditional to a digital paradigm. The general principles applied are that each party is responsible for the information they produce or modify; intellectual property is governed through limited licenses; and collaborative risks are managed through supporting documents such as the BIM Protocol and the BIM Execution Plan. However, the success of such risk allocation depends on the extent to which national law recognizes and facilitates the existence of digital contracts, the integrity of electronic data, and mechanisms for digital evidence. Without these, the use of BIM could instead increase legal uncertainty in the resolution of modern construction disputes (Eastman, 2011).

2. BIM Collaboration Practices in Real Projects Influence the Determination of Liability in Construction Failures

The practice of Building Information Modeling (BIM) collaboration in real construction projects significantly influences the determination of legal liability in construction failures. It is an increasingly crucial issue in the construction industry in the digital era. BIM, as a collaborative system integrating multidisciplinary data into a single digital model, has transformed the legal and technical relationships among project actors, including designers, contractors, and project owners. However, this innovation also introduces new complexities in allocating responsibility when design errors, delays, or structural failures arise. This is because, in the BIM system, decisions and technical data no longer originate from a single party but instead result from collective interaction and contributions from multiple project stakeholders [27].

In conventional practice before the adoption of BIM, liability for construction failures was typically determined by the "privity of contract" principle, which limited the legal relationship between parties to bilateral contractual agreements [28]. For example, architects were responsible for design errors, contractors for execution mistakes, and project owners for administrative decisions. However, the BIM system blurs these lines of accountability because all parties work on the same digital platform and often edit the model simultaneously. In this context, when an error or structural failure occurs, it becomes difficult to identify who initiated the mistake, as each revision or input can influence others within the dynamic model [29].

One of the main challenges in BIM-based projects is ensuring clarity of responsibility within a collaborative environment [30]. In many projects, the BIM model serves as a "single source of truth," meaning that every data modification can directly affect the overall design and planning system. However, when contractual agreements fail to clearly define who "owns" or is responsible for specific parts of the model, the potential for legal disputes increases. For instance, if discrepancies arise between exported 2D technical drawings from the BIM model and on-site structural data, determining which party is legally responsible for the resulting failure can be contentious [30].

A study by Chong, Lopez, and Wang (2016) shows that, in several projects across Asia, the use of BIM has, in fact, complicated legal accountability because mature contractual regulations have not kept pace with its collaborative nature. In several cases, contractors and design consultants blamed each other because the contract lacked explicit provisions defining responsibility for modifications to the digital model. This situation led to prolonged disputes over who was responsible for coordination errors between structural and mechanical-electrical systems, resulting from the use of BIM. Therefore, many construction law experts recommend that every BIM project include a "BIM Execution Plan" (BEP) that explicitly defines the rights, obligations, and liability boundaries among parties from the start of the project [31].

The BIM Execution Plan (BEP) plays a crucial role in clarifying the limits of responsibility and the authorization of digital model changes. The BEP typically includes clauses specifying who has the authority to edit the model, how revision approvals are granted, and the documentation mechanisms for every change [20]. Thus, when construction failures result from digital design errors, the party who modified the model without authorization or in violation of prescribed procedures can be held legally accountable. However, in many real-world projects, BEP implementation is often inconsistent or merely procedural, making it difficult to trace responsibility [20].

In construction projects in the United Kingdom, for instance, the NEC4 Alliance Contract and JCT 2016 BIM Protocol have attempted to adapt to the needs of the digital era. These contracts recognize the BIM model as a contractual document and stipulate that all data contributions must be verified and approved by an Information Manager before being used as a basis for construction decisions [32]. If this procedure is properly followed, liability can be more clearly allocated because all contributions are digitally documented. However, in practice, many projects use BIM systems without strict oversight, leading to ambiguous accountability when structural failures or project delays occur [32].

On the other hand, BIM collaboration practices have also reshaped the dynamics of professional liability. Architects and engineers now act not only as design providers but also as data collaborators [33]. This means they share responsibility for the integrity of the data entered into the model, including technical information provided by subcontractors. As a result, even minor errors from one party can have wide-reaching effects on the entire system. For example, if a subcontractor inputs incorrect material data and the architect fails to validate it, legal responsibility may be shared between both parties. This condition indicates that BIM requires the establishment of a new form of collective accountability system [33].

Meanwhile, from an Indonesian law perspective, the implementation of BIM has not yet been fully regulated within the national contractual system. Commonly used contract documents, such as the Construction Work Contract based on the Minister of Public Works and Housing Regulation No. 14/PRT/M/2020, still focus on the traditional working relationship between the service user and the service provider. There are no explicit provisions regarding liability for errors in digital models or cross-disciplinary data integration. Therefore, projects using BIM often rely on adaptations from international practices such as the BIM Protocol by the Construction Industry Council (CIC) in the United Kingdom or the AIA Document E203 in the United States [14]. The absence of explicit national legal foundations makes it difficult for parties to claim or prove digital errors in construction failure cases [14].

BIM collaboration practices also raise new issues related to intellectual property rights (IPR). Since a BIM model is the collaborative output of multiple disciplines, its ownership is often shared. However, when construction failures result from errors in certain design elements, the party responsible for creating those elements may deny liability by arguing that the model was modified by others [11]. In such cases, the proof process becomes complicated because data changes in the model often occur simultaneously and are not easily traceable, especially if the digital audit system is not properly implemented [11].

On the technical side, the use of a Common Data Environment (CDE) system in BIM is actually intended to address issues of data traceability and accountability. Through CDE, every data change is recorded with complete information,

including time, user, and model version. However, according to research by Sacks et al. (2018), many projects do not fully utilize CDE's audit features due to cost and technical complexity [12]. As a result, when construction failures occur, it becomes difficult to prove who made the initial error. This condition demonstrates that although BIM promises transparency and efficiency, its effectiveness in clarifying legal responsibility still depends on the discipline and rigor of system implementation [12].

Thus, it can be concluded that BIM collaboration practices in real projects create more complex legal relationships and require new approaches to liability distribution. The collaborative BIM model demands contractual clarity through documents such as the BEP, robust data audit systems, and legal recognition of digital models as valid evidence in construction disputes. Without an adequate legal framework, digital collaboration may instead exacerbate accountability uncertainty. Therefore, developing specific regulations and contract models that govern the allocation of responsibilities in the context of BIM has become an urgent need for the modern construction industry [13].

CONCLUSION

From the discussion on contractual clauses and the collaborative practice of Building Information Modeling (BIM), it can be concluded that the implementation of this digital technology has fundamentally transformed legal relationships within the construction industry. Previously, liability for construction failures could be clearly allocated through bilateral contracts between project owners, consultants, and contractors. However, the introduction of BIM has made the work system collaborative and multidisciplinary. Each party contributes to a single integrated digital model, making the boundaries of responsibility blurred when errors or failures occur. This condition demands clearer contractual clauses, particularly regarding risk allocation, data ownership, and mechanisms for validating and authorizing model changes. Documents such as the BIM Execution Plan (BEP) and modern BIM protocols are essential for defining who is responsible for each digital input in a project.

In real-world projects, BIM collaboration practices show that although the system enhances efficiency, transparency, and coordination among stakeholders, it also introduces new complexities regarding legal liability. Construction failures in BIM-based projects are often difficult to trace to their source due to the interactive, dynamic nature of the digital model. Therefore, future legal and contractual frameworks should be designed to accommodate the collaborative nature of BIM by clarifying each actor's legal roles, establishing strict digital audit standards, and recognizing digital models as valid contractual documents. Such reformulation is crucial to ensure that technological innovation in the construction sector aligns with legal certainty, professional accountability, and protection for all parties involved in the development process.

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