

Mitigating Disputes and Managing Legal Issues in the Era of Building Information Modelling

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Abstract: Construction disputes are inevitable. They often arise between project stakeholders for numerous reasons and to resolve them, construction professionals adopt various dispute resolution methodologies. This study aims to identify the role of building information modelling (BIM) in mitigating such disputes and addresses the legal barriers faced by the architecture, engineering and construction (AEC) industry while adopting BIM. The study reveals that disputes can be mitigated and managed efficiently with the intervention of BIM, as BIM offers various designing, planning, estimating, collaborating and controlling features. The benefits of BIM are impressive and exceptional; however, it comes with some legal issues that are first clarified and addressed with the support of a literature review and later validated through interviews with industry professionals. Dispute resolution, contractual arrangements, design responsibility, intellectual property (IP) rights and a lack of standardisation are identified as substantial concerns when adopting BIM. Thus, a strategy is proposed to manage these legal issues that entail the adoption of the appropriate contract suite, the formation of a common data environment (CDE) and the establishment of a firm BIM execution plan (BEP). Workshops, training sessions and seminars are also recommended to educate the industry with BIM features as it brings about the second revolution in the AEC industry.

Keywords: Disputes, Building information modelling, Legal issues, Contract arrangements, BIM execution plan

INTRODUCTION

The architecture, engineering and construction (AEC) industry contributes significantly to the socio-economic development of all countries and plays a crucial role in the improvement of their gross domestic products (GDP). The AEC industry is considered unique among other industries around the globe in several aspects, such as the participation of several stakeholders, the involvement of construction and non-construction risks, project uniqueness, the limited level of automation, the huge investment of funds and the longer time frame of the projects. Participants from different backgrounds and cultures with various motives, experiences and goals contribute to the development of each project, which increases the possibility of disagreements and arguments (Rauzana, 2016). All of these factors make the AEC industry distinctive and its work more challenging compared to other manufacturing industries.

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Furthermore, the AEC industry still requires substantial improvement and innovation in upgrading construction processes and making the construction cycle more efficient. In comparison with other industries throughout the world, technological advancement and automation were adopted relatively late by the AEC industry. Hence, the probability of uncertainties and the occurrence of conflicts and disputes are higher within this particular industry (Narh et al., 2015).

Lack of communication, ambiguous information, limited knowledge, variations in design, misinterpretation of contract documents and technical/non-technical issues are some of the major causes of disputes that arise between stakeholders (Soni, Pandey and Agrawal, 2017). Disputes are considered part and parcel of any construction project insofar as there are concerns for the overall performance of the project in terms of cost, time, quality, relationships and future business opportunities (Brockman, 2014). At the present time, most projects are delayed for months and incur extra costs due to the occurrence of disputes between the parties involved (KPMG International Cooperative, 2013). Therefore, to resolve these issues, researchers formulated the concept of building information modelling (BIM) and digital construction, which was first presented by Autodesk and later modified by other professional and statutory entities (Xu, 2017).

BACKGROUND

Building Information Modelling

According to Xu (2017), BIM is considered the second revolution in the AEC industry, as BIM allows professionals to integrate the extensive amount of data and visualise construction processes, which serves to increase efficiency and minimise risks from the design stage and throughout the life of the project. BIM stores all pertinent information, such as material properties, cost and time schedules, drawings and specifications, sustainability and energy consumption checkpoints and logistics plans (Politi, Aktaş and İlal, 2018). Similarly, Smith (2016) added that BIM is an advanced tool which assists in creating and managing data during the life of the project. Hardin and McCool (2015) further acknowledged the role of BIM in managing conflicts and mitigating disputes. Some of the key BIM features within the bounds of construction disputes are highlighted hereunder.

Role of BIM in Mitigating Disputes

Efficient project planning

The schedule of activities can be visualised with the implementation of BIM, which assists project teams in making sound decisions based on real-time information. Moreover, in the case of a design change, the interdependent activities in the critical path are automatically updated and an alternative path is provided together with the impact on the project schedule (Khoshnava et al., 2012). Song, Yang and Kim (2012) have pointed out how 4D (4-dimensional) simulation provides geometrical models with time and space parameters, which makes communication efficient, enhances constructability, reduces risks and makes the process less

laborious for planners. Similarly, Khoshnava et al. (2012) have highlighted the importance of space utilisation insofar as site logistics, yard operations, material storage and traffic access routes can be accommodated in the BIM model, which is highly beneficial at the execution stage.

Accuracy in cost and quantity estimation

Blazevic, Vukomanovic and Radujkovic (2014) have acknowledged the role of BIM in quantifying accurate quantities during the project life cycle, which results in enhanced contractor productivity, reduced construction waste and provided value for money to the client. Khoshnava et al. (2012) have discussed the impact of real-time cost information on project stakeholders and highlighted that BIM can assist in the management of conflicts between clients and consultants during the proposal stage and also while performing value engineering exercises. The cost and quantification features also help in curtailing disputes related to interim payments, the valuation of variations and the quantum assessment of claims (Rajaweera, Jayasena and Dissanayake, 2015).

Clash and collision detection

Clash and collision detection are essential features of BIM that help construction team in avoiding the collision of various building elements from different disciplines (Berdeja, 2014). According to Charehzehi et al. (2017), clash detection facilitates better decision making, delay minimisation, site performance improvement and design change curtailment.

Minimal prefabrication errors

BIM offers complete prefabrication and construction details, which minimises the occurrence of disputes and enhances the probability of achieving constructability (Khoshnava et al., 2012). According to Khanzode, Fischer and Reed (2008), steel and mechanical, electrical and plumbing (MEP) subcontractors utilise the BIM model consistently in fabricating elements to avoid collisions and clashes. Koc and Skaik (2014) have also confirmed that the prefabrication process becomes faster and more efficient due to digitally created models.

Minimising variation orders (VOs)

BIM possesses the potential to significantly reduce the number of VOs and requests for information (RFIs), which assists project teams in achieving time and cost certainty. According to Koc and Skaik (2014), the integration of disciplines and unambiguous project documents are key factors in curtailing VOs. Khanzode, Fischer and Reed (2008) have confirmed that the preparation of RFIs and creating a response is an inconsequential activity that consumes valuable time and costs.

Thus, it is apparent that disputes can be mitigated with the adoption of BIM; however, some significant legal issues are associated with BIM, which creates barriers for BIM adopters and the overall AEC industry.

Legal Issues Associated with BIM

The set of traditional legal issues found in the AEC industry has changed dramatically and taken on a new dimension after the adoption of BIM. Although the technical side of BIM has been sufficiently developed for the successful implementation of various tools and procedures, the non-technical features and contractual configurations are still relatively unsophisticated and underdeveloped for project teams to fully leverage the potential of BIM (Abdirad, 2015). In a paper by K&L Gates LLP (2019), the legal issues faced by professionals, arbitrators and litigation bodies are discussed and it was found that dispute resolution, contract arrangements and administration management were primary legal constraints.

Lacking in standard forms of contract

While using BIM, the entire dynamics of contract documents change as BIM has the potential to affect the roles and responsibilities of project teams due to the shared information exchange platform (Bodea and Purnus, 2018). The contractual status of BIM documents, the level of dependency on the data, the role of the BIM manager, reliance on the BIM output, the BIM execution plan (BEP) and the adoption level of BIM are some of the major contractual issues highlighted by Mosey et al. (2016). Furthermore, Sardroud et al. (2018) have argued that the level of collaboration between stakeholders, the quality of data standards, cybersecurity, ownership of the model, design responsibilities and the extent of change that the owner demands should also be outlined appropriately in the contract.

Lacking in dispute resolution protocols

The forensic investigation model (FIM) is a BIM tool that assists in the evaluation and identification of the factors behind a dispute; it is also extremely useful for identifying the affected party from the dispute (Soltani, Anderson and Kang, 2017). However, limited research has been conducted in this area, which makes the future implementation strategy of BIM unclear (Ghaffarianhoseini et al., 2017). According to Soltani, Anderson and Kang (2017), the reliability of the BIM model in resolving disputes is considered to be a key legal issue due to issues regarding the level of complexity, the reliability of the data, the lack of experimental support, the possibility of data manipulation and the limited knowledge of judges. Specifically, Bodea and Purnus (2018) have stated that the inaccuracy in data and errors in the model could lead to misleading decisions. Further, the limited knowledge of experts and the general unfamiliarity with BIM often becomes a legal barrier when assessing and resolving disputes (Soltani, Anderson and Kang, 2017).

Complex web of design responsibilities

The unified information exchange platform provided by BIM to all stakeholders has numerous advantages, though a high level of collaboration makes design responsibilities vague and unclear as all the participants work on the single model (Mesároš and Mandičák, 2017). Eadie, McLernon and Patton (2015) have also

confirmed that design responsibility becomes ambiguous when decisions are made by participants based on the information extracted from the common model, which is created and designed by other participants; hence, the design responsibility matrix in such cases becomes highly complex. Bodea and Purnus (2018) have also argued that even though the design responsibility is controlled at the development stage, the construction team or client often make changes in the model during the execution stage, which results in the dilution of responsibilities.

Accuracy and reliability of data

The potential of BIM lies in its capacity to manage the huge amount of data that is shared among project stakeholders (Krigsvoll, 2007). While using BIM, project participants work on the same model, which means that an error made by one party could cause damage to other parties; therefore, well-defined protocols must be explained explicitly to all participants (Udom, 2012). Furthermore, clients prefer to utilise the BIM model for managing and operating the facility; hence, the data incorporated during the design and construction stage must be reliable and trustworthy (Eadie, McLernon and Patton, 2015).

Issues of cybersecurity and unauthorised changes

Olatunji (2016) has highlighted the issues related to security, data theft, bugs, viruses, hacking and snooping of electronic files. As all the information is saved on a common platform, data can be manipulated within the BIM and an unauthorised entity can make unwanted changes. Manderson, Jefferies and Brewer (2015) have suggested that a certain level of insurance should be provided to parties regarding data security in order to secure any loss or avoid further data manipulation.

Issues related to ownership of the model

The ownership of the final model belongs to the client, as the raw information is obtained from him/her or his/her representative (Udom, 2012). The consequence of sole ownership of the BIM model by the client means that designers are given leverage to free themselves from design responsibility (Dean and Ryan, 2014). At the same time, some researchers have argued that designers should retain ownership, as the BIM model is their property and the established legal precedent also speak in favour of designers (Arensman and Ozbek, 2012).

Lacking in intellectual property (IP) rights

The key success of BIM lies in the digitisation of data; the product is designed in such a way that any information can be extracted and reused by any of the participants at any stage of the project (Fan et al., 2019). However, professionals have raised some concerns regarding plagiarism of design information and ideas, especially at the preliminary and technical design stages (Eadie, McLernon and Patton, 2015). Furthermore, local bylaws regarding data protection often deviate from the clauses stated in the contract; hence, careful consideration should be taken to avoid such misunderstandings in the contract documents (Fan, 2014).

Impact of procurement route

The procurement route impacts significantly in the implementation of BIM as it defines the leverage offered to BIM practitioners in terms of the utilisation of BIM applications and tools. For instance, while adopting a traditional procurement route, contractors come on board after finishing the major part of the design; hence, design-bid-build route limits the potential of BIM. Conversely, the design-build route offers a vast horizon within which the full potential of BIM tools and practices can be leveraged (Hardin and McCool, 2015). Mosey (2014) have also confirmed that the early involvement of the contractor is highly beneficial in allowing the involved parties to utilise the full range of BIM benefits. Moreover, second- and third-tier contractors should also be included in the design stages to improve design efficiencies (Mosey, 2014). Hence, the collaboration of project participants at the very beginning of the project is highly essential (Eastman et al., 2008).

Lacking in standardisation and litigation procedures

The primary legal barrier faced by professionals working on BIM projects is the lack of sophisticated contract suites (Englund and Gronlund, 2018). BIM policies, contract documents, standards of care, the standardisation of BIM processes, IP and data sharing rights, information exchange protocols, the right to rely on information, data security and interoperability have not yet been well established and regularised appropriately (Chong et al., 2017). Similarly, litigation protocols are also weak due to two major issues: first, there are not enough real-life BIM projects that have been vulnerable to disputes and second, the arbitrator's and jurors' capabilities are limited (Manderson, Jefferies and Brewer, 2015). Another prevailing factor is the change in language and terminologies between the traditional and BIM approach. A clear definition and common language should be standardised to avoid such legal issues (The Institution of Structural Engineer, 2018).

Framework to Overcome Legal Issues with BIM

According to Gibbs et al. (2015), BIM imposes a responsibility on legislative bodies to make amendments in the standard forms of contracts such as NEC (New Engineering Contract), the Joint Contracts Tribunal (JCT) and the Fédération Internationale Des Ingénieurs-Conseils (FIDIC). The NEC has published a revised contract known as the "How to use BIM with NEC3 Contracts" (NEC, 2014), which incorporates BIM related clauses and focuses mainly on the creation of the BIM and "nD" modelling (The Institution of Structural Engineer, 2018). At the same time, the JCT contract suite also modified their standard form by integrating BIM protocols, developing methodologies for exchanging information and establishing policies to minimise contractual ambiguities and misunderstandings (Gibbs et al., 2015). However, the FIDIC contract suite has thus far been silent on BIM (Bodea and Purnus, 2018). Sardroud et al. (2018) have added further that the contractual standing of BIM documents and information security protocols must be clarified and understood by all the stakeholders, as both issues have the potential to bring the dispute into litigation and courtrooms. Rock and Winfield (2018) have suggested that BIM professionals take responsibility for the weak legal framework and unsophisticated BIM culture in the AEC industry; hence, to strengthen the BIM legal community, training sessions and workshops should be organised primarily

for lawyers and clients to understand the importance of the BIM features as well as the complexities associated with their use.

It is thus evident from the research that BIM has the potential to minimise the occurrence of disputes, mitigate their impact and manage them proactively. The aforementioned features of BIM have facilitated its dissemination all around the globe and many professionals benefit from its use in a range of construction processes. Although BIM is considered an advanced construction tool that optimises the construction cycle and makes various processes more efficient, it is still considered a modern form of technology that has yet to reach a more mature stage and some processes are still relatively rudimentary. This is due to a few reasons: first, few projects that have employed BIM features have experienced legal issues; second, standard contractual suites offer limited BIM integration protocols; and lastly, arbitrators and jurors have insufficient knowledge of BIM, which often results in prejudiced and fallacious outcomes. A summary of the various legal issues that researchers encounter in their projects using BIM is provided in Table 1.

Table 1. Summary of Legal Issues Associated with BIM

Legal Issues with BIM	Author(s)
<ol style="list-style-type: none"> 1. Ownership of model 2. Priority of documents 3. Reliability of information 4. Weak collaborative culture 5. Lack of information exchange protocols 6. Investment of time and money 	<p>Gibbs et al. (2015)</p>
<ol style="list-style-type: none"> 1. Risk allocation 2. Reliance on data 3. Evolution and responsibility of the model 4. Lack of standardisation 5. Sharing of copyright data 6. Design and software liability 7. Additional project insurance 	<p>Eadie, McLernon and Patton (2015)</p>
<ol style="list-style-type: none"> 1. Uniqueness of BIM for forensic purposes 2. Complexity of model 3. Limited BIM knowledge on the part of jurors and courtroom experts 4. Reliability of model and data 5. Lack of experimental support 6. Dominance of experience in the litigation system 	<p>Soltani, Anderson and Kang (2017)</p>
<ol style="list-style-type: none"> 1. Legal liability of the model 2. Lack of standardisation and weak regulation 3. IP rights 4. Absence of real BIM based projects 5. Lack of finance and investments 6. Security threats 7. Information reliability 	<p>Sardroud et al. (2018)</p>
<ol style="list-style-type: none"> 1. Vague design responsibilities 2. Novelty for forensic investigation 3. Potential to prejudice the legal proceedings 4. Limited successful examples of dispute resolutions 5. Model perceived as risky 	<p>Bodea and Purnus (2018)</p>

RESEARCH METHODOLOGY

A qualitative approach was selected to collect data in order to obtain a firm understanding of the relevant disputes, the significance of BIM in mitigating these disputes and the legal issues associated with projects adopting BIM. A semi-structured interview methodology was adopted for this part of the study, which comprised open and close-ended questions. A research roadmap is described below in Table 2, which summarises the methodologies used to achieve the research objectives.

Table 2. Research Roadmap

Objective	Methodology	Description
Significance of BIM in mitigating disputes	Literature review	Investigate the role of BIM in mitigating disputes
	Interview	Identify the role of BIM in mitigating disputes
Legal issues associated with BIM	Literature review	Highlight the legal issues addressed by researchers
	Interview	Investigate the current legal issues professionals experience in projects adopting BIM
Framework to overcome legal issues	Interview	Identify the legal framework used to strengthen the contractual arrangements and propose the strategy to make the legal process efficient

Background of Interviewees

The interviewees were selected from the AEC industry to ensure that respondents possessed the relevant knowledge and information required for the present study. The respondents' backgrounds differed in terms of the level of experience, organisational culture, occupation and geographical location. Some brief information related to the backgrounds of the interviewees is shown in Table 3.

Table 3. Background of the Respondents

Respondent	Designation	Business Area	Location
A	BIM Manager	Consultant	United Arab Emirates (UAE)
B	Arbitrator	Consultant	Australia
C	BIM Manager MEP	Consultant	Brazil
D	BIM Manager	Client	UAE
E	Senior BIM Coordinator	Contractor	Malaysia
F	BIM Manager	Client	Saudi Arabia
G	Associate Director	Consultant	England
H	BIM Adviser	Consultant	England

DATA ANALYSIS AND DISCUSSION

Part One: Role of BIM in Mitigating Disputes

All of the respondents believed that disputes were inevitable and occurred quite frequently during the life of the project. The main reasons for the occurrence of disputes highlighted by respondent A, C, D and F were poor communication, excessive design variations, lack of contractual arrangements, poor planning, unclear scope of the work and vague allocation of risks. Respondents A and F further added that, due to the occurrence of disputes, not only was the cost, time and quality of the project compromised, but the future opportunities and the goodwill of the company were also affected.

Respondents A, E, F, G and H acknowledged the potential of BIM in mitigating disputes and mentioned some of the benefits of its use, which included a collaborative working environment, better planning, more accurate estimations, minimal design variations and better allocation of risks. Respondents B and E stated that BIM added value to the project and they also believed that forensic analysis was beneficial not only in mitigating disputes but also in resolving them. However, respondents C, D, G and H stated that the potential of BIM was highly dependent on the degree of implementation and the execution strategy. The overall consensus of all the respondents is shown in Figure 1, which confirms that BIM was perceived as helpful in mitigating disputes. A comparative analysis of their responses was also carried out and Table 4 was created to connect the views of the respondents to the research objectives.

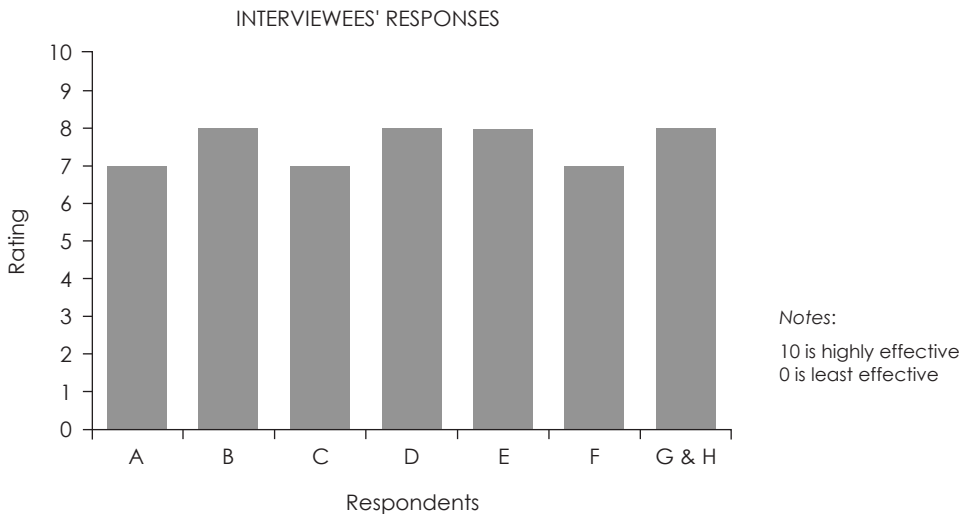


Figure 1. BIM Rating in Mitigating Disputes

Table 4. Role of BIM in Mitigating Disputes

Respondent	Dispute and Its Cause(s)	Role of BIM
A	Design code misunderstandings, contractual misinterpretations, miscommunication and human interference/errors	Clash detection, minimising rework, better risk allocation, foreseeing risks, improved communication, added value and improved scheduling
B	Design variation, progress payments, unforeseen risks, poor planning and limited client's expertise	Resolving schedule problems, forensic analysis, allocation of risks and clash detection
C	Contractual misunderstanding, unfair distribution of risks, lack of coordination, installation mishandlings, incomplete specification and design variations	Improved communication, better planning, accurate estimation, shared platform, clash detection and integration of Primavera (P6) with three-dimensional model
D	Lack of communication, unclear scope of work, fragmented nature, poor planning, incorrect bidding, quantity variations and contractual language	Integration of all parties, common goal, well-defined scope of work and better allocation of risks
E	Design variations, client's expectations, contractual arrangements, claim errors, human behaviour and poor communication	Clash detection, well-defined scope of work, improved communication, better planning and better allocation of risks
F	Lack of coordination and error in drawings	Better risk allocation, improved collaboration, improved document management and better visualisation
G and H	Change in law, change in technical design and change in client's requirements	Better transparency to stakeholders, well-defined scope of work, fewer arguments, better communication and provision of structured information

Part Two: Legal Issues Associated with BIM

Lacking in standard forms of contracts

All the respondents agreed that BIM was still not mandated in many contracts, nor was it even regulated by government entities. Indeed, it would take some time to regulate BIM globally. Respondents D, E and F agreed that standard contract forms were still underdeveloped and the lack of contractual arrangements was the primary legal barrier that their organisations encountered. Respondents A, B, C, G and H further added that standard contract forms were absent; however, it was indicated that NEC3 with X12 (Partnering), Z clauses and CIC (Construction Industry Council) BIM Protocol Version 1 could be used until the AEC industry develops and

adopts any suitable standard contract form. To mitigate legal issues, respondents G and H suggested the use of the NEC4 contract form as it included X10 (information modelling) and X12 (multiparty collaboration) clauses together with the CIC BIM protocol.

Lacking in dispute resolution protocols

Respondents B, G and H stated that the resolutions of disputes could only be trusted on the quality of data provided to the arbitrators instead of their expertise in BIM. Respondents C and E further added that judgements made on BIM models were genuine until and unless the data were not manipulated. Respondents B, D and F indicated that BIM was a hurdle for arbitrators, though they acknowledged the role of BIM in resolving disputes by claiming that BIM helped arbitrators get a better understanding of the design and construction activities. All of the respondents believed that judges and experts were not familiar with BIM because fewer disputed projects were faced by experts, which made the presence of BIM a challenge when resolving disputes. Globally, all of the respondents believed that BIM improved the dispute resolution process and established more credibility in the judgements, though considerable improvements are still required to reach a certain level of perfection.

Issues related to the model

Complex web of design responsibilities

Respondents A, B and C believed that, due to the high level of integration, design responsibilities were vaguely determined and this created ambiguities between the project stakeholders. Respondents D and F further added that the allocation of risks and responsibilities was also a barrier for BIM adopters. In contrast, respondents E, G and H completely denied such arguments, stating instead that the essence of BIM was the integration of all stakeholders through work on a common model. According to respondents E, G and H, the design responsibility matrix was certainly complex, but this was not considered to be a legal issue if stakeholders clearly understood their roles and implemented detailed BEP.

Accuracy and reliability of the data

Respondents A, B and C stated that it was the responsibility of the BIM modeller to input the correct information, though continuous changes diminished the credibility of the information; hence, excessive changes must be controlled. Respondents D and F argued that correct data were helpful for clients to operate the facility, as all the relevant information is stored in the model. Respondents E, G and H further added that material type, supplier, warranty, installation procedures, material manual and asset life could be extracted from the BIM model; however, the implications of incorrect information and data manipulation made it far too vulnerable for client and facility management contractor. According to respondents A, B, C and D, the level of development (LOD) was crucial for managing legal issues related to the reliability of data and the LOD must be delivered to project participants and

understood by them from the very beginning of the project. Lastly, unauthorised changes in the model were another issue highlighted by respondents G and H, as they could trigger problems related to the reliability of the data.

Ownership of the model

All the respondents expressed the identical view that the authorship of the model was a legal threat to BIM adopters. Authorship should be retained by the client as it is beneficial for the efficient operation and maintenance of the facility; however, in cases where the project participant wishes to retain the model, it was maintained that this must be explicitly stated in the contract agreement.

Lacking in IP rights

Respondents A, B, C, G and H believed that the idea theft and plagiarism of sensitive information was another legal issue that could arise due to a cloud-based working environment; according to these respondents, ideas can be stolen and plagiarised more quickly as compared to traditional processes due to a shared working environment and the weak formation of a common data environment (CDE). However, respondents D, E and F disagreed with this argument, instead stating that the BEP and contract documents should be well-defined and thoroughly understood by all project participants in order to avoid any negative consequences.

Impact of procurement route

Respondents A, B, C, G and H strongly believed that early intervention on the part of the main contractor had a significant impact on minimising legal issues. Although respondents D, E and F considered that the selection of a procurement route was not a legal threat, responsibilities and risks were stated in the contract documents. Broadly speaking, all the respondents agreed that the collaborative route and early involvement of contractors were beneficial for developing models with appropriate information.

Lacking in standardisation and litigation protocols

All the respondents indicated that contractors possessed less knowledge compared to consultants on the subject of BIM and often neglected the importance of BIM protocols. According to respondents A, B, D and F, there were two more significant factors that were likely to result in the occurrence of legal issues. First, BIM itself was thought to be lacking and not well developed in the non-technical domain and second, the industry was not yet ready to adapt to these changes and still preferred to follow conventional construction techniques. In the worst cases, professionals considered BIM to be a computer-aided design (CAD) tool. Comprehensively, all of the respondents agreed that the AEC industry still needed time to standardise and regulate BIM smoothly because professionals still preferred and were more familiar with the traditional approaches.

Part Three: Framework to Overcome Legal Issues

Lacking in standard forms of contract

Respondents B, G and H stated that government mandates and international support were required to design and draft a new contract form that aligned with BIM language and incorporate BIM arbitration clauses within international contract forms. Respondents E, F, G and H further added that certain adjustments were required in standard contract forms. For example, it was suggested that the FIDIC Red Book could be used with the supporting manuals provided by public institutions, or the NEC4 with the CIC BIM protocol (Version 2); these were thought the best combinations to avoid legal issues.

According to respondents A, B, C and D, any contract agreement, be it either the supplemented FIDIC or the NEC suite with the CIC BIM protocols, could mitigate contractual issues. As different projects have different requirements, it was maintained that one specific form could not be used for all BIM projects. Last, respondents G and H mentioned that the UK construction industry offered BIM protocols that were highly beneficial to implement and regulated BIM efficiently; they further added that the International Organization for Standardization was drafting standard BIM clauses under ISO 19650, which could be utilised globally.

Lacking in dispute resolution protocols

Respondents A, D, E, F, G and H believed that jurors' knowledge was limited in resolving disputes that occurred with respect to projects adopting BIM. However, they also stated that BIM improved the quality of judgement during the dispute resolution process and enhanced the probability of satisfying the disputed party. The use of a third-party consultant was recommended by respondent E to vet the BIM model to more effectively resolve disputes in the cases where experts were not familiar with BIM, or where the information provided was doubtful. Respondents B and C added that the knowledge of the jurors and arbitrators was limited since fewer numbers of BIM projects have ended up in the courtroom. Nevertheless, respondents A, D, E, F, G and H maintained that issues related to dispute resolution could be controlled through a well-implemented CDE. Broadly speaking, all of the respondents encouraged the role of BIM in a courtroom by stating that BIM reduced the time consumed in resolving disputes because information flow was quicker and faster.

Issues related to the model

Respondents A, B, G and H stated that token access, access rights and secure IT infrastructure were required to ensure cybersecurity. In terms of modelling responsibility, respondents D, E and F suggested that responsibility matrix and model segregation methodology should be adopted to more clearly define design responsibility. Additionally, in order to ensure the reliability of the data, it was suggested by respondents G and H that quality checklists and gates be established while receiving data from other parties. In terms of ownership of the model and IP rights, all the respondents stated that they should remain with the client as such

ownership helps in the maintenance and operation of the facility throughout a project's life; however, this ownership should explicitly be stated in the contract documents and the BEP.

Impact of procurement route

All respondents agreed that the early involvement of the main contractor, subcontractors and maintenance contractors was highly beneficial for the proper implementation of BIM. First, it helped the designers in incorporating execution strategies in the model and second, it facilitated the forecasting of construction risks and ensured better constructability. Hence, the design-build procurement route was preferred to the conventional design-bid-build approach.

Lacking in standardisation and litigation protocols

Respondents A, B, C and D suggested that training programmes, awareness sessions and support from BIM experts could be helpful tool for educating those in the AEC industry. Respondents G and H further added that the steering committees from the most well-known technology companies and the most matured government entities that had mandated BIM for a long time could play a vital role in framing BIM appropriately. It was suggested by respondents E and F that the government intervene and assist professionals in adopting BIM technology by providing incentives and creating opportunities for positive competition between the consultants and the contractors.

Table 5 summarises the information gathered from the interviews; all the legal issues addressed by the respondents are presented individually and a methodology is suggested for each issue based on their responses in Table 6.

Table 5. Respondents' Views of Legal Issues Associated with BIM

Major Legal Issue	Respondents							
	A	B	C	D	E	F	G	H
Lacking standard contract forms	✓	✓	✓	✓	✓	✓	✓	✓
Dispute resolution protocol		✓		✓		✓	✓	✓
Design responsibilities	✓	✓	✓	✓		✓		
Reliability of data	✓	✓	✓		✓		✓	✓
Ownership of the model	✓	✓	✓	✓	✓	✓	✓	✓
IP rights	✓	✓	✓				✓	✓
Impact of procurement route	✓	✓	✓				✓	✓
Lack of standardisation and litigation protocols	✓	✓	✓	✓	✓	✓	✓	✓

Table 6. Strategies to Overcome Legal Issues Associated with BIM

Major Legal Issue	Management and Resolution Strategy
Design responsibilities	Segregation of responsibilities Establish firm CDE Explicitly stated in contract agreement
IP rights	Information exchange protocols Firm implementation of BEP Explicitly stated in contract agreement
Reliability of data	Quality checkpoints Token access Responsibility of the modeller
Procurement route	Early involvement of the contractor Collaborative procurement route Design-build route
Dispute resolution	Third-party assistance Training Workshops and seminars
Contractual arrangements	NEC4 with CIC BIM protocols ISO 19650 Industry requirement of standardised contract suit
Ownership of the model	Retained by the client Stated in contract agreement Stated in the employer's information request
Cybersecurity	Information exchange protocols Establish firm CDE Firm implementation of BEP
Data manipulation	Access log Data encryption Limited licences
Lack of standardisation and litigation protocols	Intervention of government and professional bodies Role and responsibility of BIM experts Training programmes, seminars and workshops

CONCLUSION

BIM in Mitigating Construction Disputes

It is clear that disputes are inevitable. Further, the major disputes identified as resulting from literature review and data collection approaches are almost similar. For instance, some of these similar disputes include design deficiency, financial mismanagement, lack of quality, excessive changes, errors in documents, unreasonable client expectations, poor planning and estimation. Some of the more common reasons behind dispute occurrences include contractual misunderstandings, lack of coordination, unfair distribution of risks, ambiguous scope identification, fragmentation, less automation and, sometimes, human behaviours.

BIM plays a vibrant role in mitigating disputes due to its substantial number of features. Some of these features include the concept of n-Dimensional (nD) modelling, integration of stakeholders, clash and collision detection, reduction in design changes, fewer numbers of VOs and RFIs, improved planning, accurate estimation and better allocation of risks and responsibilities.

Thus, it is apparent that BIM possesses a tremendous amount of potential, which helps in both mitigating and minimising disputes.

Legal Issues Associated with BIM

Due to the integration of project stakeholders within a single platform, design responsibilities often become blurred and nebulous. Commonly used contract forms are generally non-existent and the AEC industry tends to use supporting documents instead of a standardised contract form. Furthermore, constraints related to cybersecurity, IP rights, ownership of the model and the reliability of data are unclear as well. The litigation domain is also weak and scattered for two reasons; first, arbitrators and judges are not familiar with BIM tools; and second, fewer dispute resolution cases are available in which jurors' judgement is to be based on BIM models. Also, the contractor's intervention occurs either at the design stage or after the completion of the design, both of which have a vast impact on the use of BIM features. This means that the selection of the procurement route is crucial and it is one of the major drivers that trigger the abovementioned legal issues.

Hence, it is evident from the literature and the collected data that legal issues are threats to BIM adopters and that they should be managed appropriately to leverage the full potential of BIM.

Methodology to Overcome Legal Issues

To embrace the BIM industry and overcome legal issues, it has been determined that BEP should be appropriately implemented, CDE and information exchange protocols should be firmly established, contract agreement should be well-drafted and understood by all project stakeholders and a collaborative procurement route should be adopted. Furthermore, BIM experts and third parties can help in resolving disputes, whereas contractual issues can be handled with the implementation of NEC4 with CIC BIM protocols and ISO 19650. Cybersecurity issues can be controlled

through secure data exchange protocols and the challenges related to the ownership of the model can be resolved by explicitly stating such control in the contract documents. Data manipulation can be avoided with the assistance of access logs and limited licences. Last, the lack in standardisation and litigation protocols can be improved with the involvement of government entities and professional bodies together with the assistance of BIM experts.

Recommendations and Further Research

The following list includes policy recommendations and avenues for further research in the area of BIM and related legal issues:

1. The NEC4 and CIC BIM Protocol Version 2 should be adopted, as it includes clauses that can help the parties involved to develop the model.
2. ISO 19650 should be adopted in the future to standardise BIM globally.
3. An employer's information request (EIR), BEP and information exchange protocol manual should be part of the contract documents.
4. Government entities and professional bodies should work together and make the use of BIM mandatory for public projects.
5. Training programmes, workshops and seminars on the subject of BIM should be organised by BIM experts, regulating bodies and government entities.
6. This research work focuses on the use of BIM in mitigating disputes and mainly those involving legal issues; however, the existence of other technical and non-technical issues has also been validated by other researchers, such as the role and expertise of the BIM manager and LOD. Hence, further study is recommended to clarify the other issues associated with BIM to ensure firm and steady implementation.

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