

**Integrating BIM in Dispute Resolution: Development of a
Contractual Framework**



by

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This thesis is dedicated to my family and my respected teachers!

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ABSTRACT

Building information modeling (BIM) through its data-rich digital representation of building elements has brought a revolution in the architecture, engineering, construction and operation (AECO) industry. To ease the process of its implementation number of legal aspects related to BIM have been discussed and standardized in published contract systems, but legal aspects related to dispute settlement through BIM are yet to be established. Stimulated by this need, this study aims to provide a preliminary contractual framework for “BIM-based dispute resolution’. Objectives of the study include: (1) to identify and analyze potential legal aspects for integrating BIM in dispute resolution processes; and (2) to determine the corresponding contract provisions required in BIM contracts. A questionnaire survey was conducted to obtain an industry perspective. 140 retrieved questionnaire responses were analyzed. The results indicated 25 relative contract provisions that could potentially be incorporated in BIM contracts. Subsequent to a detailed analytical discussion and validation from experts, these provisions were then assimilated into a framework. While expanding the body of knowledge on BIM-based dispute resolution this study sets the grounds for the extension of BIM-contracts.

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LIST OF ABBREVIATIONS

AEC	Architectural, Engineering and Construction Industry (UK)
AECO	Architecture, Engineering, Construction and Operation
AIA	American Institute of Architects
BIM	Building Information Modeling
BIM-DRes	BIM in Dispute Resolution
CIC	Construction Industry Council
CIOB	Chartered Institute of Building
CIArb	Chartered Institute of Arbitrators
ICC	International Chamber of Commerce
ICE	Institution of Civil Engineers
ISO	International Organization of Standardization
JICA	Japan International Cooperation Agency
NBS	National Bureau of Standards
NRC	National Research Council

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INTRODUCTION

1.1 GENERAL

The construction industry is getting complex and competitive due to the increasing diversity of projects and demands of its stakeholders (Farooqui et al. 2012; Bequin 2018). With the growing complexity of construction projects, it has become imperative to embrace innovative techniques, emerging technologies, new standards, contracting and delivery methods (Soltani and Kang 2017). With the adoption of these aspects, the number of claims and disputes has increased substantially and now has become an inherent element of the construction industry (Al Shami 2018). Management of documents and proper communication of technical concepts has always been challenging in construction dispute resolution processes (Soltani and Kang 2017). Current dispute resolution methods with low technological inputs, do not accommodate for the increasing complexity of disputes in construction projects (Al Shami 2018).

The solution for the fragmented management of dispute resolution processes demands a dynamic approach to complexity. Building Information Modeling (BIM) is considered among such technological developments (Greenwald 2013; El Hawary and Nassar 2016). “BIM is a data-rich, object-oriented, intelligent and parametric digital representation of the facility, from which views and data suitable to various users’ needs can be extracted and analyzed to generate information that can be used to make decisions” (Khoshnava et al. 2012). These potential capabilities of BIM make it a fulfilling tool for forensic engineering and stimulate significant advances in traditional dispute resolution procedures (Soltani and Kang 2017). Implementation of BIM in

dispute resolution is currently facing a lot of challenges and limitations (Soltani and Kang 2017; Al Shami 2018; Marzouk et al. 2018). One such limitation is the absence of contractual protocols concerning dispute resolution processes (Greenwald 2013; Ali, unpublished data, 2018).

Aside from the technological aspects of the BIM process, legal aspects related to BIM implementation in dispute resolution needs to be considered and accommodated within the contractual frameworks of projects (Ali, unpublished data, 2018). As governments and developers are aiming positively towards the use of BIM on construction projects, a proper understanding of the contractual concepts and issues associated with dispute resolution is a must (Greenwald 2013). Internationally some BIM contract protocols have been developed for administering contracts and used on particular projects (Consensus Docs 2003; AIA 2008; AEC 2012; PAS 1192-2 2013; AIA 2013; CIC 2018; ISO 19650-1 2018). However multiple studies in this domain conclude that these developed contract systems do not adequately respond to various matters concerning BIM-based project delivery (Greenwald 2013; Chong et al. 2017; Arshad et al. 2019).

In order to highlight the neglected aspects and explore further in this area, plenty of research has been done to investigate the legal risks associated with BIM along with additions and changes need to be done in traditional contracts (Chong et al. 2017). Among these studies, Olatunji (2011) reviewed the potential legal implications of BIM. Likewise (Joyce and Houghton 2014) studied BIM's legal issues and concerns in contract while Kuiper and Holzer (2013) highlighted contractual arrangements for BIM in Australia. Some preliminary empirical studies were also conducted. For example, Arshad et al. (2019) investigated contractual risks of BIM whereas Chong et al. (2017) explored the administrative contractual provisions for BIM-enabled projects. A recent study by Fan et al. (2019) utilized the social network analysis approach (SNA) to

investigate the latent legal aspects associated with BIM contracts. These studies highlighted a number of areas that should be considered in BIM contract documents. But none of the research investigated the contractual provisions required for BIM-based dispute resolution. This emphasizes the requirement of a comprehensive study to address the potential contractual issues of BIM, particularly from the dispute resolution perspective.

To address the gap in the literature and respond to the critical requirement of dedicated contractual protocols for BIM-based dispute resolution, this study aims to develop a preliminary contractual framework for BIM-based dispute resolution. The study is based on Design-build (DB) project delivery method. As compared to other methods, when BIM is implemented in DB projects, it really showcases its ability enhance overall project quality. This is due to increased collaboration among the design and construction teams in DB projects. In its essence, BIM is a collaborative process, providing the DB team with a mutual platform to evaluate, document, and present information and to build much greater detail into the model earlier in the process. This enables better decision making and increased capability to evaluate different aspects of projects (DeLacey, DB is on rise and BIM has an essential role, unpublished data). Number of methods are in use for dispute resolution, the current study focuses on dispute boards (DB) under as they are widely used and are effective in dispute prevention and resolution (Harmon 2011; Agdas and Ellis 2013). DB can set up balanced solutions for all parties involved while keeping within the contractual boundaries (El-adaway and Ezeldin 2007; Chern 2015). The research is grounded on two main objectives: (1) to identify and analyze potential legal aspects for integrating BIM in dispute resolution processes; and (2) to determine the corresponding contract provisions required in BIM contracts. The industry's response was obtained through a

questionnaire survey. The findings of this research will add to the body of knowledge and industry by offering a detailed analysis of potential legal aspects of BIM implementation in the dispute resolution process, and dedicated contractual provisions that are feasible and practical for future uses of such an implementation.

1.2 JUSTIFICATION FOR SELECTION OF THE TOPIC

Disputes have become an indivisible part of construction projects and are considered counterproductive for the project success. For the proper and timely resolution of these disputes, the use of technology like BIM has become indispensable (Khaled and Shami 2018). But even though the tendency towards BIM is rapidly increasing in the construction industry, the application of standardized BIM protocols is low (Chong et al. 2017). Nevertheless, the benefits of BIM in dispute resolution will only be realized if the contractual documentation is adequately set up to allow the process to work as it should. Due to a lack of research in this particular area, there is a need for a comprehensive study to address the potential contractual issues, especially from the dispute resolution perspective which will ultimately facilitate the adoption and implementation of BIM in dispute resolution processes.

1.3 OBJECTIVES

The research objectives are as follows:

- To identify and analyze potential legal aspects for integrating BIM in dispute resolution processes.
- To determine the corresponding contract provisions required in BIM contracts.
- To develop a contractual framework for BIM incorporation in dispute resolution process.

1.4 RELEVANCE TO NATIONAL NEEDS

Pakistani Construction Industry has always been of economic and social significance to the country. Construction Industry due to its complex nature is really prone to disputes. The settlement of these disputes in a balanced manner is very important to avoid damages related to time, finances, personnel and opportunity costs. BIM, now as an emerging technology is serving in dispute resolutions through its collaborative and integrated nature and information management system. However, its use is less because of the lack of standard conventions. This study will formulate some protocols to be followed and will ultimately help in the implementation and adoption of BIM in dispute resolution processes.

1.5 ADVANTAGES

This study will help the construction industry to adopt technology-based solution that will increase the overall quality of projects. Identification of contract provisions for BIM-enabled dispute resolution procedures will help promote and standardize future BIM-based dispute resolution. This will ultimately help reduce the related delays and costs in dispute resolution processes. Findings from this research can contribute to the body of knowledge about BIM-based contracts.

LITERATURE REVIEW

2.1 NEED FOR ADVANCEMENTS IN DISPUTE RESOLUTION PROCESS

Disputes being predominant characteristics of construction projects are being considered an integral part of project life-span (Gardezi et al. 2013; Koc and Skaik 2014; Charehzehi et al. 2015; Bequin 2018). When disputes are not settled in a timely manner, they become very expensive, in terms of opportunity costs, personnel, finances and time (Farooqui et al. 2012). The involved companies require spending millions of dollars annually to resolve subsequent disputes and associated problems (Charehzehi et al. 2015). National Research Council (NRC) stated that each year approximately \$4 billion to \$12 billion is being consumed in terms of the direct cost for settling disputes on construction projects (NRC 2009). Furthermore, the indirect costs involve the poor quality of the project and loss of working relationships amongst parties who may otherwise benefit from continued long-standing work relations (Greenwald 2013). As projects in the construction industry are consuming huge proportions of resources, the importance of efficiency in all phases of the projects has become even more important (Gardezi et al. 2013). The smooth and efficient resolution of disputes provides massive cost savings in construction projects (Al Shami 2018). Perceiving this, there is a growing realization that construction projects need to turn to some advance methods in disputes management to deliver more productive results.

2.2 BIMING DISPUTES

BIM can be considered as an efficient process that incorporates all disciplines, aspects, and arrangements of a facility within a single inclusive model (Arshad et al. 2019). BIM has been realized as an information-rich model (NBS 2011; ISO 19650-1 2018) as it utilizes the precise geometrical and associated details of building components to establish a database of information (Charehzehi et al. 2017). Utilizing BIM's database for managing documents, sharing information, communicating technical aspects can improve the process of supporting, managing and reviewing claims (Chou and Yang 2017). Establishment of a common data environment (CDE) is another characteristic of BIM in which data is communicated, shared and reused efficiently (PAS 1192-2 2013; ISO 19650-1 2018). Enhanced collaboration and communication through this feature of BIM help resolve disputes more effectively (Wesam, unpublished data, 2018). Moreover, BIM provides a visualized environment where the flow of information and all other different aspects of a project can be envisioned (Shahhosseini and Hajarolasvadi 2018). Visualization of related elements influence the level of perception of the decision-makers and enables faster and more accurate claim preparation (Soltani and Kang 2017; Al Shami 2018). Such characteristics of BIM have facilitated this technology to accomplish global recognition and adoption in dispute management.

In developed countries, there are examples where disputes have been settled through the help of this technology. One such utilization of BIM for forensic investigation purposes was at the collapse of I35W Bridge in Minnesota in 2007. In this project, the BIM model was used to codify the connection between the physical structure and data in a shared 3D environment and recognized as "Forensic Information Model (FIM)". This model assisted the parties to catalog and access existing information on every element of the truss bridge and enabled the communication between the clients and the

investigation team (Brando et al. 2013). Another case where BIM was practiced in forensic investigations was the facade examination of the Manhattan and Metro dome Roof deflation in Minnesota. The challenge of collecting and managing the substantial amount of historical and new data in the project was the main motive of implementing BIM in facade examinations (Karanci and Nagata 2018).

Furthermore, in some of the research studies conducted in this domain, Charehzehi et al. (2017) investigated the benefits of BIM in construction conflict management. Their study concluded that BIM functions of 3D visualization, 4D scheduling, clash detection, cost estimation, and structure analysis are most effective in dealing with conflicts and disputes. Similarly, Al Shami (2018) developed a framework of preventive effects and reactive actions to investigate the possibilities of settling claims with the help of BIM. Results indicated that BIM upholds high potential in dealing with the matters associated with avoiding, presenting and analyzing disputes while providing the ultimate benefits of cost and time savings, less change orders and less rework. To investigate the effects of utilizing a BIM model for claim and dispute resolution process Koc and Skaik (2014) implemented a comparative analysis approach with and without BIM through a case study. The research outcomes indicated that BIM through its capabilities of data storage and visualization of the changes, activities and periods, planned and actual sequences make the dispute resolution processes more efficient.

2.3 LEGAL FRAMEWORK FOR BIM

Advances in the dispute resolution system through technology like BIM demands changes in existing contract documents (Kuiper and Holzer 2013). Significant literature evidence indicates that certain advantages of innovations such as BIM can only be realized when their legal frameworks are well-defined and implementable (Olatunji 2011).

Standardized BIM contract protocols have been developed to administer BIM-enabled projects (Chong et al. 2017). Some of the commonly known examples include Consensus DOCS 301 BIM Addendum which regulates the BIM execution plan and responsibilities of different stakeholders (Consensus Docs 2008). American Institute of Architects (AIA) published E-202 and E-203 protocol exhibit. E-202 specifies protocols, levels of development (LOD) and authorized uses of BIM model (AIA 2008). Whereas E-203 establishes the protocols for the formation, usage, and exchange of digital data on the project (AIA 2013). Further, AEC (2012) published version 2.0 as an upgrading over the previous version to define protocols under the titles of BIM execution plan, collaborative working and Modelling methodologies. Similarly, the construction industry council released its BIM protocol which sets out the rights and responsibilities of main stakeholders and addresses some information and security related matters (CIC 2018). PAS 1192-2 (2013) issued by British Standard Institution (BSI), defines protocols for information management in a collaborative environment. On the basis of the UK 1192 series, a recent series ISO 19650-1 (2018) have been initiated by the International Organization for Standardization (ISO). Part 1 of the published document provides basic principles for information management including the development of information models, management of collaborative production of information and information delivery cycle. Part 2 of the document defines protocols for information management in all phases of the project from the point of invitation for tender to project closeout.

All of these documents are produced to establish protocols for Modelling methodology, information exchange, interoperability, security, development of BIM execution plan and to resolve issues of intellectual property and assign liability (Arshad et al. 2019). However, there are no existing contract provisions for the resolution of disputes through

BIM. In support of this concept Renken (BIM and ADR before during and after Construction, unpublished report) suggested that construction contracts concerning BIM projects should provide mechanisms that offer a constructive approach to conflict resolution. Similarly, Greenwald (2013) proposed the development of a comprehensive, project-specific Dispute Resolution Plan Addendum (DPRA), to be utilized on BIM-enabled projects. This will help solve disputes in a quick, goal-oriented and above all proper and professional manner.

2.4 LEGAL ASPECTS OF BIM IN DISPUTE RESOLUTION

Various legal issues are associated with the implementation of BIM in dispute management which need to be addressed (Greenwald 2013). This section of the paper intends to categorize these aspects under certain themes. This task was carried out in two main steps. First step was the identification of potential legal aspects and development of contractual clauses and the second step was distributing and allocating these aspects under certain themes. For the purpose, three types of documents were explored during the review of literature: 1) Published research; 2) FIDIC contracts and international dispute board rules, and 3) BIM contract documents.

In the first step, this exercise resulted in the identification of potential legal aspects with exclusive reference to BIM and dispute resolution. Due to a lack of studies on the subject of ‘legal aspects for dispute resolution through BIM’, published research related to ‘legal aspects of BIM’ was explored. The aim was to analyze which of these legal aspects can be reformed by virtue of their relativeness, to be a part of a contract for dispute resolution through BIM. Afterward, FIDIC contract forms and dispute board rules (ICE 2012; JICA 2012; CIArb 2014; ICC 2018) were analyzed to observe provisions related to dispute resolution and procedural rules for dispute board. This resulted in the determination of provisions that require modifications for imparting

BIM. Accordingly, the provisions were modified to develop specific clauses for integrating BIM in dispute resolution. Contrary, earlier mentioned BIM contracts were investigated to find the clauses in which elements of the dispute resolution can be amalgamated. These clauses were also reformed as potential contractual clauses.

The next step was to identify main domains to be considered for the contractual protocols related to dispute resolution using BIM. For this purpose previously mentioned documents were reviewed to identify main themes under which clauses are existent. Figure 2-1 synthesizes the identification of relevant common themes in the studied documents. Contract structure and policy, procedural rules of DB and roles and obligations were the found common themes that can be treated as domains for the purpose of this study.

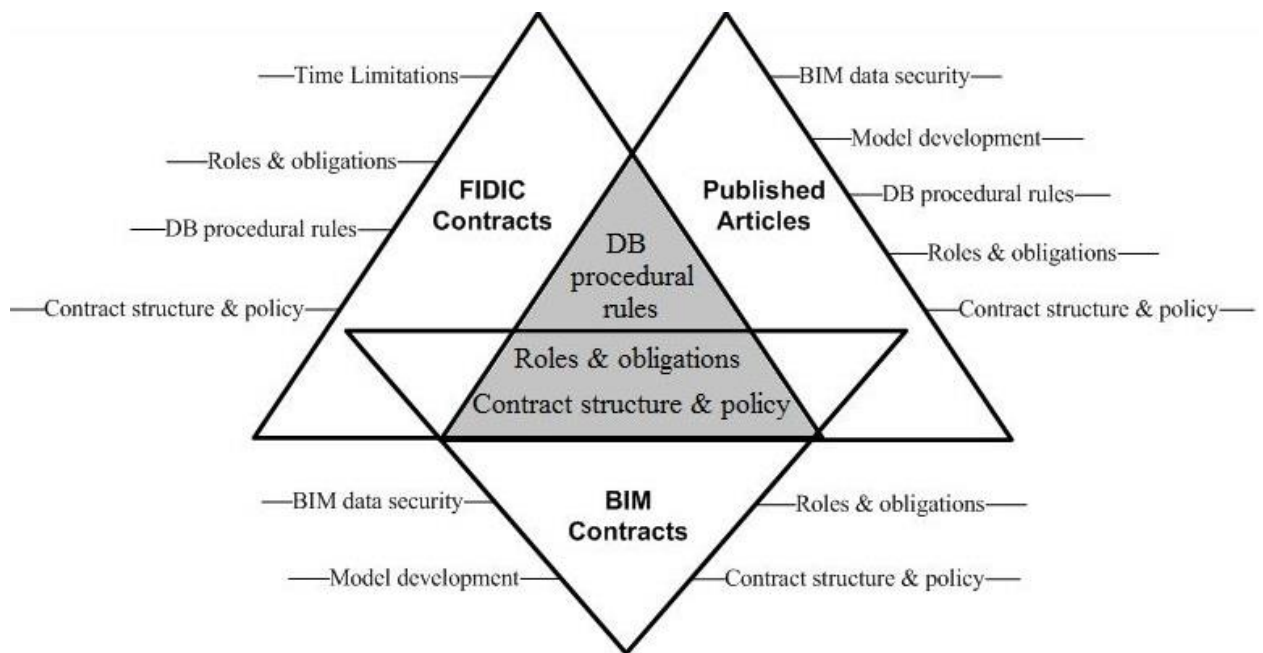


Figure 2-1: Categories Selection for Legal Aspects

The main reason behind the development of clauses in the first step followed by the identification of relevant domains was not to limit this study to particular areas that may result in neglecting clauses that do not fall under these specified areas. Interestingly all

the clauses fall under the three identified domains and subsequently were divided on the characteristic basis. The domains along with their potential legal aspects are discussed in the following sections.

2.4.1 Contract Structure and Policy

BIM enables and stimulates a collaborative working platform for all participants on a construction project (Marzouk et al. 2018). The traditional contracts which have been structured to administer fragmented working conventions and practices lack in dealing with collaborative environment established by BIM (Chong et al. 2017). The development of specific contractual provisions and guidelines with respect to BIM-enabled projects becomes necessary to overcome the deficiencies in conventional contracts (Kuiper and Holzer 2013). Acknowledging this need, numerous contract protocols have been established to deal with BIM and its associated information. Owing to the wide and deep penetration of traditional contracts in the construction industry, existing BIM contract protocols are usually used as an addendum to the main contract rather than designing a whole new framework for BIM (Arshad et al. 2019). The protocols offer new perspectives in governing project participants and dealing with BIM technology (Fan et al. 2019). However, there are still undecided policies and protocols in the dispute resolution domain.

To address the legal issues associated with BIM implementation in dispute resolution some potential legal aspects can be instigated. These aspects aim to formulate the elementary principles in the contract as shown in Table 2-1.

Table 2-1: Potential Legal aspects for Contract Structure & Policy

Legal aspects	Description	Selected References
LA1	All evidence i.e. supporting documents and digital data derived from BIM should be deemed admissible and have a legal basis in DB proceedings.	Chong et al. (2017), Alwash et al. (2017), and Arshad et al. (2019)
LA2	Provision implying ‘BIM integration in dispute resolution’ should be explicitly mentioned in BIM contract documents.	(Chong et al. 2017)
LA3	Protocols/Operating procedures for ‘BIM integration in dispute resolution’ should be included in BIM contract documents.	Chong et al. (2017) and Arshad et al. (2019)
LA4	While providing digital data as evidence, certain constraints should be implemented for its security and privacy.	Chong et al. (2017), Mat Ya’acob et al. (2018), and Arshad et al. (2019)
LA5	Considering the expeditious functioning of BIM, the time limit for DB’s decision may be reduced subsequent to an agreement with DB and both parties.	FIDIC (1999), Chern (2015), and FIDIC (2017)
LA6	DB members should have BIM knowledge.	FIDIC (1999) and FIDIC (2017)
LA7	If DB members possess BIM knowledge, their remuneration should be increased accordingly.	FIDIC (1999), FIDIC (2017), and Arshad et al. (2019).
LA8	If DB members do not possess BIM knowledge, DB specific BIM coordinator should be hired; or	FIDIC (1999), Chern (2015), and FIDIC (2017)
LA9	If DB members do not possess BIM knowledge, the services of Project’s BIM manager should be utilized.	FIDIC (1999), Chern (2015), and FIDIC (2017)

2.4.2 DB’s Procedural Rules

Defining procedural rules is a formal requirement for the implementation of a DB (Gould 2015). The procedural rules fulfill the dual purpose of formalizing the operation of the DB between the contracting parties and defining the operational procedures which the members are required to follow (Charrett 2009). These procedural rules are usually incorporated not only as part of the construction project contract but also in the DB members’ contracts with the parties (Charrett 2018). The World Bank, International

Chamber of Commerce (ICC), FIDIC, Institution of civil engineers (ICE) and Dispute Board Federation issued standard procedures for dispute boards that allow the dispute board to embrace whatever procedure it considers essential to conduct its business in an efficient and fair manner (Chern, 2015).

As the adoption of BIM has increased in dispute resolution, it involves process changes (Davies et al. 2017). While incorporating BIM in DB, BIM collaborative and digitalized attribute calls for changes in conventional Dispute board procedures. Consequently, some potential procedural rules can be instigated in traditional proceedings that can eventually provide the dispute board with a set of guidelines to follow while working on dispute resolution of BIM-enabled projects. These aspects are given in Table 2-2.

Table 2-2: Potential Legal Aspects for DB’s Procedural Rules

Legal aspects	Description	Selected References
LA10	DB members should be provided with Orientation regarding the implementation of BIM as soon as DB gets functional in the project.	ConsensusDocs 301 (2003)
LA11	A complete briefing regarding project progress in BIM should be provided to DB members at every scheduled meeting.	FIDIC (1999), Chern (2015), FIDIC (2017), Arshad et al. (2019)
LA12	All letters or Notifications, site visit reports and decision reports from DB should be sent to parties through common data environment (CDE); or	PAS 1192 (2013) and ISO 19650-1 (2018)
LA13	DB should submit letters or Notifications, site visit reports and decision reports in hard form.	FIDIC (1999) and FIDIC (2017)
LA14	For facilitating the meetings apart from site visits, common data environment should be used as a platform; or	Dougherty, (2015), ICC (2018), ISO 19650-1 (2018)
LA15	All the DB meetings other than site visits should be through conventional methods (call, video conferencing).	ICC (2018)
LA16	During the hearing, BIM representatives from both parties should be present.	FIDIC (1999) and FIDIC (2017)
LA17	In case of any discrepancy, 2D drawings derived from 3D Model data should prevail over 2D CAD drawings; or	ConsensusDocs 301 (2003), Alwash et al. (2017), and Chong et al. (2017)
LA18	In case of any discrepancy, 2D CAD drawings data should prevail over 2D drawings derived from BIM Model.	ConsensusDocs 301 (2003), Alwash et al. (2017), and Chong et al. (2017)
LA19	If there is a conflict between model contribution and a portion of the design generated in a 2D medium, the model Contribution shall take precedence over the 2D drawings; or	ConsensusDocs 301 (2003)
LA20	2D drawings shall prevail over Model contribution in case of any disagreement	ConsensusDocs 301 (2003)
LA21	Documents for review shall be submitted to DB in PDF format; or	Arshad et al. (2019)
LA22	Documents for review shall be submitted to DB in Native file format (Dwg, Rvt, Xlsx, Docx, etc.).	Arshad et al. (2019)

2.4.3 Roles and Obligations

Different project participants work collaboratively in BIM-enabled projects (Chong et al. 2017). With distinct positions held by different project participants, defining key BIM roles becomes an essential step for successful BIM implementation (Davies et al.

2017). Al Hattab and Hamzeh (2015) illustrate that BIM influences all characters in a project, with a much higher degree of interaction and interconnection than traditional practices. The authors added that BIM adoption requires a change to most, if not all, relationships on a project. BIM effect on the scope of each role due to enhanced communication, collaboration and shared decision-making and in the situation where contractual relationships are not appropriately defined, the contribution of participants may not give rise to legal liability thus resulting in the economic loss (Mcadam 2010). Hence, the clear definition of contractual roles and obligations of key stakeholders will assist in regulating the defined responsibilities mentioned in the BIM execution plan (Fan et al. 2019). Many countries, industry bodies, individual organizations and research alliances have introduced standards and guides for BIM implementation, which often entails definitions of the key roles essential for successful BIM implementation (Davies et al. 2017).

This obligates that effective implementation of BIM in dispute resolution will require pre-defined roles and responsibilities. Table 2-3 highlights the potential legal aspects that can be considered for the contractual roles and obligations related to the implementation of BIM in dispute resolution.

Table 2-3: Potential Legal Aspects for Roles and Obligations

Legal aspects	Description	Selected References
LA23	BIM Manager should define and ensure compliance of protocols for integrating BIM in DB proceedings, in mutual agreement with DB and parties.	ISO 19650-1 (2018) and Davies et al. (2017)
LA24	BIM Manager should provide orientation to DB members regarding BIM as soon as DB gets functional in the project.	ConsensusDocs 301 (2003) and ISO 19650-1 (2018)
LA25	BIM manager would provide complete briefing regarding project progress in the BIM environment, to DB members at every scheduled meeting.	ConsensusDocs 301 (2003) and ISO 19650-1 (2018)
LA26	Standard of care should be applied by all parties submitting evidence via BIM.	Chong et al. (2017) and Arshad et al. (2019)
LA27	When evidence is provided from any specific discipline (MEP, Structure, and Architecture), discipline design Manager of respective disciplines would be responsible for the authenticity of that information.	Chong et al. (2017), ISO 19650-1 (2018), and Arshad et al. (2019)
LA28	BIM Manager should arrange for BIM data security during data usage in DB proceedings.	Chong et al. (2017), ISO 19650-1 (2018), and Arshad et al. (2019)

RESEARCH METHODOLOGY

Following the identification of the research gap and development of the problem statement, specific objectives were defined for the study. Afterward, to fulfill these objectives, an extensive literature review was carried out. Published articles, FIDIC contracts, and standard BIM contract documents were consulted and investigated for the purpose.

In the case of published research, articles were explored online using ASCE, Science Direct, Scopus libraries, Google Scholar, Taylor & Francis Online, and Emerald Insight, through the keywords BIM, Dispute resolution and Contracts. At first, the search explored the title and keywords which are sufficient to identify and discover the related articles. A total of 65 research articles were extracted by virtue of this exercise. Abstracts and conclusions of collected articles were read thoroughly to screen out the irrelevant articles which were then excluded and analysis of the remaining 15 papers was conducted. Meanwhile, FIDIC and BIM contract documents were also studied thoroughly. As a result of this exercise, 28 potential legal aspects were identified, as previously described in Tables 1, 2, 3.

Next, to obtain and investigate the industry perspective for potential legal aspects, a questionnaire survey approach was utilized. The questionnaire included two sections. In the first section, the demographics of the respondents were asked related to their organizational position, experience, and country of practice, etc. While the second section was related to the assessment of the potential legal aspects by means of two questions. The first question was related to the extent of respondents' agreement (on a

scale of 1–5) with the potential legal aspects. The second was associated with the appropriateness (on a scale of 1–5) of the legal aspects to be incorporated as contract provisions in the BIM contracts. The target respondents for this study were industry experts, consultants, and contract and BIM managers. The survey forms were forwarded to over 500 potential respondents through electronic means by using official emails, research networks like ResearchGate and Academia and professional networks such as LinkedIn and Opportunity during the period June – October 2019.

After the collection and examination of data, potential legal aspects and contract provisions were assimilated to develop a contractual framework that maps the legal aspects and contract provisions under defined phases of the project for ease of understanding. The framework also allocates all the identified potential legal aspects to the three main stakeholders (Client, BIM manager/Contractor, DB) who are associated with or affected by these aspects. Figure 3-1 summarizes the research methodology.

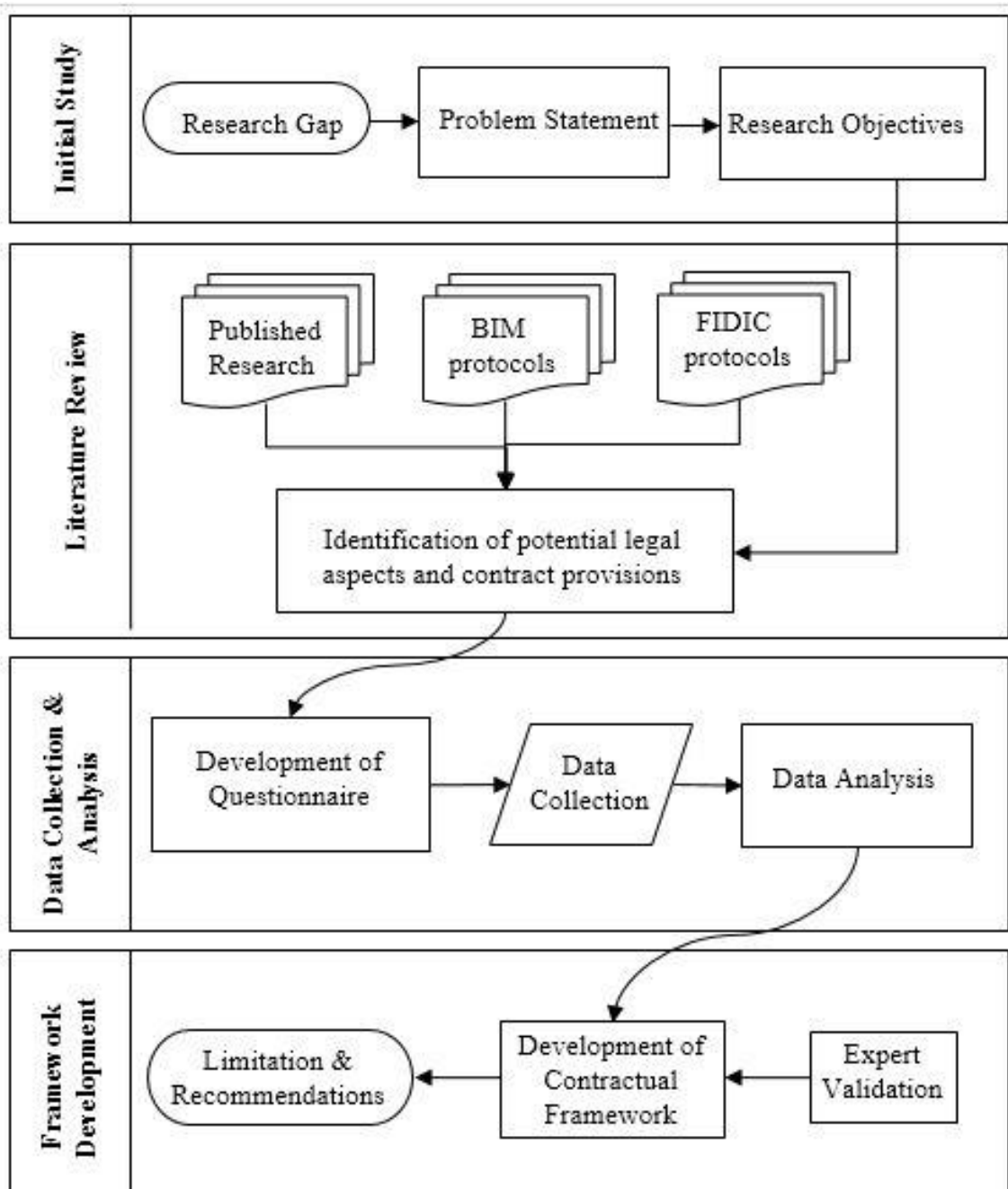


Figure 3-1: Research Methodology

RESULTS and DISCUSSIONS

4.1 RESULTS

Through a wide-ranging contact with industry experts, 140 valid questionnaire responses were received. This sample size is adequate according to statistics mentioned by Dillman et al. (2013). Respondents were inquired about their demographics and its summary is presented in Table 4-1.

Table 4-1: Demographic Information of Respondents

Description	Responses (%)
Role of Organization	
Consultant	47
Contractor	21
Architect	11
Client	6
Academia	5
Others	10
Role in organization	
BIM Manager	34
BIM Coordinator	21
BIM Specialist	11
Contract Manager	9
Project Manager	10
Others	15
Years of Experience with BIM	
1-5	53
6-10	32
11-15	11
Above 15	4
Years of Experience with Contracts	
1-5	69
6-10	12
11-15	7
Above 15	12

Most of the responses were recorded from Asia, as shown in Figure 4-1. A study conducted by Jung and Lee (2015) reported the worldwide status of BIM adoption. Findings of the study indicated that the BIM adoption in Asia is no less than any other

developed continents. This explains the reason behind a large percentage of survey participants in the current study.

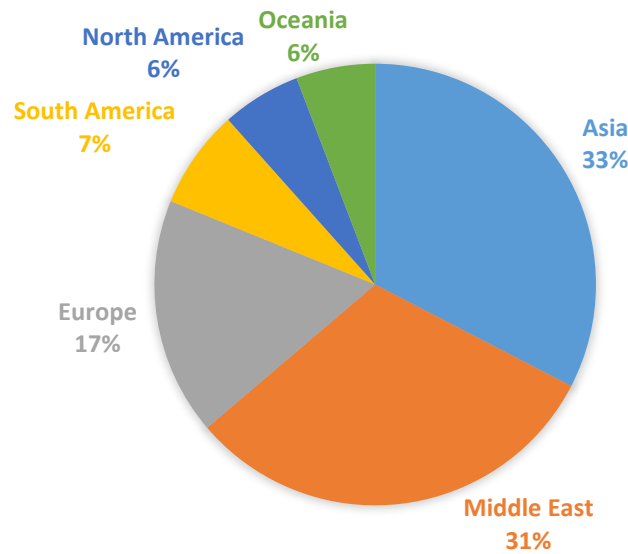


Figure 4-1: Regional Distribution of Respondents

Most of the responses were gathered from professionals affiliated to consultant and contractor organizations. As mentioned by Hannes (unpublished thesis, 2013), consultants and contractors are generally most familiar with BIM characteristics. Further, the majority of the respondents held a key position of BIM manager. It is worth noting that the BIM manager is a character that possesses the fundamental expertise to deal with BIM-related affairs (Barison and Santos 2010).

The current study was concerned with both BIM and contracts and required input from experts of both fields. Since BIM is a comparatively new technology and is getting experience with time Gerges et al. (2017), persons which have experience with BIM do not possess much expertise in contracts and similarly respondents with high experience in contract have less experience with BIM. Due to this. Thus, most of the direct experience of BIM and contract will stay on the less experienced side and it was noted that 85% of the participants fall in less than 10 years' experience level. These

statistics facilitated in confirming the quality of the survey sample and the reliability of the results of this study.

For the analysis, the means values were then evaluated based on the 5-point Likert scale. The analysis of the questions presented on the 5-point Likert scale (ranging from strongly disagree to strongly agree) was carried out by presenting the points in weighting (w) with values ranging from 1-5 respectively. The mean (x) of the number of samples (n) was then calculated as follows: $x = \frac{\sum_{i=1}^n wi}{n}$. The means were then categorized into three groups for ease of analysis as also executed by Chong et al. (2017). These categories included:

- Agree= $3.5 \leq \text{means} \leq 5$;
- Undecided= $2.5 \leq \text{means} < 3.5$; and
- Disagree= $1 \leq \text{means} < 2.5$

This implies, if the variables fell within agreement range, they can be included in BIM contracts. Cronbach's alpha test was performed on the collected data. Cronbach's alpha is a measurement of reliability and internal consistency among the variables with a threshold value of 0.70 (Taber 2018). The obtained inter-correlation scores were 0.93 (potential legal aspects) and 0.91 (potential contract provisions) for the two sets of variables. This describes that the variables are admissible in terms of internal consistency. Moreover, normality tests were also conducted, where significance value for all variables was less than 0.05 from both Shapiro-Wilk and Kolmogorov-Smirnov. This indicates that the samples were not normally distributed and the non-parametric test should be used for further analysis. To assess the strength of the relation between the variables, a non-parametric test 'Spearman's rho correlation' was practiced (Sheskin 2003). Results indicated that significant p-value for all variables was above

0.05. This implies that according to agreement scores there is a linear relationship among the variables. Data related to analyses conducted on the variables are presented in Table 4-2. All the variables were evaluated using the mean score values and were then grouped into three predetermined categories namely *agree*, *undecided* and *disagree*.

Table 4-2: Analyzed Variables

Legal aspects	Mean value	Contract Provisions' variables	Mean value	Correlation value	Categories
LA1	4.05	CP1	4.10	0.546	Agree
LA2	4.22	CP2	4.28	0.616	Agree
LA3	4.32	CP3	4.21	0.623	Agree
LA4	4.16	CP4	4.21	0.421	Agree
LA5	3.72	CP5	3.76	0.536	Agree
LA6	3.91	CP6	3.97	0.518	Agree
LA7	3.88	CP7	3.85	0.607	Agree
LA8	4.15	CP8	4.05	0.616	Agree
LA9	4.08	CP9	4.01	0.660	Agree
LA10	4.07	CP10	4.02	0.609	Agree
LA11	4.05	CP11	3.94	0.569	Agree
LA12	4.10	CP12	4.13	0.547	Agree
LA13	3.21	CP13	3.37	0.585	Undecided
LA14	4.10	CP14	4.03	0.573	Agree
LA15	3.34	CP15	3.23	0.628	Undecided
LA16	4.30	CP16	4.18	0.671	Agree
LA17	3.80	CP17	3.88	0.601	Agree
LA18	3.03	CP18	3.20	0.719	Undecided
LA19	3.72	CP19	3.80	0.661	Agree
LA20	2.95	CP20	3.02	0.761	Undecided
LA21	3.81	CP21	3.82	0.674	Agree
LA22	3.75	CP22	3.72	0.704	Agree
LA23	4.25	CP23	4.16	0.485	Agree
LA24	4.15	CP24	4.11	0.591	Agree
LA25	4.15	CP25	4.03	0.622	Agree
LA26	4.32	CP26	4.29	0.639	Agree
LA27	4.30	CP27	4.14	0.686	Agree
LA28	4.25	CP28	4.22	0.677	Agree

4.2 SHORTLISTED VARIABLES

The respondents were asked to indicate the variable which has the potential to be a legal aspect (LA) and contract provision (CP). Interestingly the accepted variables, which were selected as legal aspects were also approved as contract provisions from respondents. For the ease of discussion, all the approved variables will be discussed as contract provisions in the further sections.

4.2.1 Contract structure and policy

For the case of the admissibility of BIM documents for dispute resolution (CP1), published literature seems to be in support of this aspect. Authors have argued that due to the increasing trend of utilization of smart systems like BIM in construction projects, it has become necessary that the digital data from BIM should be treated as part of contract documents (Chong et al. 2017; Arshad et al. 2019). Published contracts have not addressed this problem as of now whereas some custom contracts have tried to fulfill this deficiency by letting the digital data be admissible in certain formats (Arshad et al. 2019). The survey results with a mean score value of 4.10 concur with the literature argument. Similarly, while applying a new concept or technology on the project it is important to have a written agreement from both parties (Chen et al. 2018). As BIM implementation on the project is agreed through contract (Jiang et al. 2018) there should be a written agreement on 'BIM integration in dispute resolution' (CP2). Survey results showed a mean score value of 4.28 that implying a high agreement of respondents for the aspect.

FIDIC and all other types of construction contract documents tend to include a section regarding protocols for dispute resolution process and methods (FIDIC 2017). This highlights the need to incorporate protocols in BIM contracts for BIM-based dispute

resolution (Greenwald 2013). This aspect was enquired from respondents through CP3 where majority of respondents (4.21) appear to be in agreement.

Protecting and securing digital data (CP4) is also an important concept in BIM (Chong et al. 2017). Some of the existing BIM protocols deal with the security of data transmission among stakeholders (AEC 2012; AIA 2013; CIC 2018). Survey results with a mean score value of 4.21 suggest that the security and privacy of data while being transmitted as evidence should also be catered through contractual protocols.

Concerning the time limit for DB's decision (CP5), survey results (3.76) suggests that it can be reduced due to expeditious functioning and characteristic of BIM. FIDIC contract documents specify realistic time limits for the dispute resolution process and also allows the parties to reduce the time limit (FIDIC 2017). This fact seems to support the survey results.

CP6 pertains to BIM knowledge possession by DB members. The adoption of innovative and administrative technologies, such as BIM, requires basic knowledge from involved personnel (Garcia et al. 2018). Correspondingly, it is considered effective for DB members to have related field expertise (Chern, 2015). This accentuates that DB members may also have some basic knowledge regarding BIM as they are in continuous connection with the project through site visits and meetings. Survey results (3.97) encouraged DB's possession of BIM knowledge.

In the case of DB's remuneration (CP7) FIDIC contracts in comparison to other board members specify a high amount of remuneration for DB chairperson due to his/her expertise. Similarly, there have been instances where services of additional paid experts are permitted (FIDIC 2017). These facts support the survey result (3.85) that if DB

member possesses BIM knowledge which is extra expertise, his/her remuneration should be increased.

As previously mentioned that FIDIC contracts allow DB members to utilize the services of experts. Survey results seem to support the fact that in case DB members do not possess BIM knowledge, services of BIM experts may be hired. Respondents were given two scenarios inquiring to utilize services of BIM coordinator (CP8) or project BIM manager (CP9) in the matter. Interestingly mean score values for both options were nearly equal (CP8:4.05, CP9:4.01) providing choice to parties to opt for any suitable option.

4.2.2 DB's Procedural rules

When hired, DB members get an orientation pertaining to tasks and activities of the project (Chern, 2015). As BIM is a technological entity that brings changes in the traditional ways of tasks and activities being carried out, training or orientation for involved personnel is a must (Masood et al. 2014). AEC (2012) BIM protocol suggests conducting a BIM kickoff meeting for project members. This leads to the concept that to educate DB members regarding BIM they should be provided with an orientation (CP10) and results (4.02) elaborated that industry experts also consider this an important aspect to follow.

Furthermore, DB makes regular visits to the project site where meetings are held to brief DB regarding project progress (Chern, 2015; ICC 2018). CP11 was inspired by this concept and survey results (3.94) also validated the aspect.

Further, data interoperability is one of the vital characteristics of BIM (Olatunji 2016; Chong et al. 2017). Through BIM, information sharing and data transmission have become much easier (Charehzehi et al. 2017). Experts were asked about the concept

that data sharing should be through CDE (CP12) or traditional methods (CP13). Survey results agreed with CDE utilization with a higher mean score value of 4.13 rather than traditional methods with a mean value of 3.37. Moreover, BIM through CDE provides video and web conferencing facilities, messenger systems and instant chat, online meeting spaces and portals that help people collaborate digitally (Mordue 2018). Standard contract documents are emphasizing its use as a communication platform (PAS 1192-2 2013; ISO 19650-1 2018). Respondents were asked through two scenarios that CDE can be utilized for meetings and collaboration (CP14) or it should be through traditional approaches (CP15). CP14 was agreed by respondents with a higher mean value of 4.03 than CP15 with a mean value of 3.23. This highlights that respondents have a high level of awareness regarding CDE and are eager to turn towards digitalization.

According to (Chern, 2015), during the hearing, the presence of representatives from both parties is essential. Additionally, experts from the particular field could also be called upon when needed (FIDIC 2017). Keeping in view, while utilizing BIM in the dispute resolution process, the presence of BIM representatives in hearing (CP16) can result in a smooth and efficient process. Results indicated that the majority of experts (4.18) responded in the agreement of this aspect. Consensus Docs (2008) provide two selections regarding the production of 2d drawings, from 3d model or 2d CAD drawings. CP17 and CP18 were inspired by this asked the respondents that in case of disagreement which type of drawings should be consulted. Results indicated that on the basis of responses mean score value for CP17 was 3.88 while the same for LA18 was 3.20. Even though LA17 with a higher score is the selected option but since both values have not much of a difference, the decision for this aspect can be left for parties to go with appropriate preference.

Similarly, In case of any conflict between model contribution and a portion of design generated in 2D medium (CP19,20), Consensus Docs (2008) provides two options for parties to agree upon. Respondents' opinion for these two options was asked that either model contribution (CP19) or 2D drawings (CP20) should prevail. Survey results (CP19:3.80, CP20:3.02) suggested that model contribution should take precedence over 2D drawings. Although, in view of adopted methodology CP19 is prevailing but it does not have an absolute agreement. So the study recommends that it should be the parties' decision to select the most suitable one after considering both aspects.

(Arshad et al. 2019) discussed that a noneditable version of files must be produced to present in local administration. Respondents were asked about suitable design format to be submitted to DB for review through CP20 and CP21. Survey results indicated that mean score values for CP21 and CP22 are 3.82 and 3.72 respectively. Although the majority of respondents were in favor of noneditable version submission but since both options are agreed by respondents, it would be the choice of parties to go with the most suitable selection.

4.2.3 Roles and Obligations

Davies et al. (2017) stated that BIM Manager being the most aware person regarding BIM activities should be responsible for the development and delivery of the BIM execution plan, and setting BIM protocols for the project. In this context, CP23 was developed to undertake the opinion of industry experts and they also responded in favor of the aspect (4.16) that this responsibility should be of BIM manager.

Further, Consensus Docs (2008) states that it is BIM-manager's responsibility to schedule and manage BIM-related meetings. Experts' opinion in this perspective was requested through CP24 and CP25. Results for these with mean values of 4.11 and 4.03

respectively, highlighted that experts also agree to put these responsibilities on BIM manager.

Arshad et al. (2019) and Chong et al. (2017) discussed that to run the project in a smooth progression standard of care (CP26) should be applied by all parties involved. Survey results (4.29) were also in favor of this aspect.

As with intellectual property, the Published contracts emphasize the discipline design manager would assume responsibility for its data input. Likewise, the same line of argument is maintained by survey results which suggest that in case of evidence from any specific design discipline (CP27), the discipline design manager would assume responsibility for its data provided (4.14). In the case of CP4 results suggested that certain actions should be taken for BIM data security and privacy. Now to specify responsibility of this task Consensus Docs (2008) states that BIM managers should establish and maintain encryption, access security measures and also undertake information system scans to maintain Model security. (Davies et al. 2017) also discussed that the BIM manager would be responsible for secure information exchange. Survey results for CP28 presenting a high agreement from respondents (4.22) also validated the concept.

4.3 PROPOSED CONTRACTUAL FRAMEWORK – BIM-DRes

Following the data analysis and discussion, a preliminary contractual framework is then formulated to describe the analyzed legal aspects and contract provisions in a systematic manner. The framework is describing two concepts first, it distributes the legal aspects and contract provisions into certain phases of the project and second, it allocates liabilities of all the legal aspects and contract provisions to concerned stakeholders. As shown in Figure 4-2, in mid circle there is the title of framework

“BIM-DRes” which implies ‘BIM incorporation in dispute resolution’. In the second level circle, contract provisions on the basis of their relativity to the particular phase are divided into four phases named: 1.Contract development 2.Formulation of DB 3.Project execution (except dispute period) 4.Project execution (dispute period). To differentiate the allocation of provisions to three main stakeholders (client, BIM Manager/Contractor, DB members) different color combinations are utilized. While the third level circle is to explain the liabilities of stakeholders where numbering is the aspect’s ID and coloring represents its liability to concerned stakeholders. For example, box 5 represents LA5 and its black color represents that all three parties are liable to this clause. Some aspects are related to more than one category and so were placed accordingly.

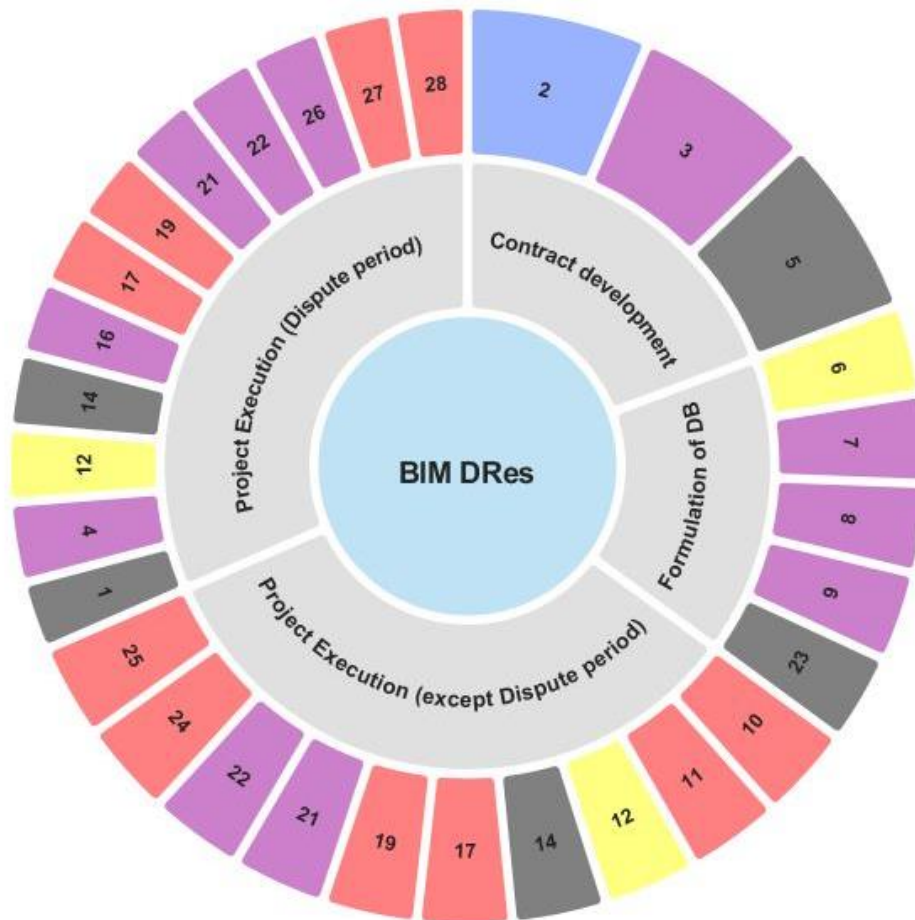


Figure 4-2: Proposed Contractual Framework

Legend	
Client	BIM manager + DB members
BIM manager	Client + DB members
DB members	Client + BIM manager
Client + BIM manager + DB members	

Next, to get a critical review of the applicability and soundness of the framework, three experts from the industry were consulted. One of the experts, offering an encouraging and critical response, highlighted that the identified legal aspects and contract provisions are adequate and will assist to ease the process of dispute resolution through BIM. Another BIM expert, appreciating the sound basis of the framework, underlined

that more depth was needed by including more legal aspects and contract provisions into the framework. While the third one suggested that the industry professional suggested that LA17 & LA19 also applies in phase 3 (as they were first placed in phase 4 only).

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

BIM is gaining significant recognition as a dispute resolution tool in the AECO industry, and practitioners are tending towards the utilization of this characteristic of the technology. To contribute to this domain, this study recognized 28 potential legal aspects related to ‘BIM integration in dispute resolution’ through a detailed analysis of published research and contract systems. These aspects were distributed in three core classifications: (1) contract structure and policy, (2) Procedural roles and operations of DB, and (3) Roles and Obligations. Analysis of the questionnaire survey indicated that 25 of them are significant and should be considered in BIM-enabled dispute resolution processes. Afterward, a preliminary contractual framework was formulated with respect to the analyzed legal aspects and contract provisions. The proposed framework demonstrates all the legal aspects and contract provisions on dispute resolution time span and also allocates liabilities of these aspects to their related stakeholders. The study provides insightful references for the future development of contractual protocols for BIM-based dispute resolution. It also encourages the researchers, construction professionals and legal bodies to contemplate the contractual uncertainties in BIM-based dispute resolution in order to facilitate the uptake of BIM in this domain.

5.2 LIMITATION AND FURTHER RESEARCH

The study is limited by its respondents’ less experienced in both BIM and contracts which future studies may improve. The study revolves around Dispute boards, further studies with other dispute resolution methods are also recommended. The current study

was based on Design Build delivery method, further studies could be done utilizing other project delivery system. Another expansion of this research could be done through more detailed research with the development of new legal aspects and contract provisions.

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Questionnaire Survey

Questionnaire Survey

Dear Respondent,

This survey is part of a MS Thesis Research being conducted in National University of Sciences and technology with an aim to develop a framework to integrate BIM in dispute resolution. The objective of this survey is to identify potential legal aspects for integrating BIM in Dispute resolution process in order to determine the related contract provisions required in BIM contracts. This study is focusing on Dispute boards for dispute resolution method and Design Build method of Project delivery. Job of BIM manager is assumed to be performed by contractor. This study will help construction industry to adopt technology based solution in dispute resolution.

In this scenario your valuable response is required.

In case you have any queries, feel free to contact.

Regards,
Rabiah Muhammad
Post graduate Student,
Dept. of Construction Engineering & Management, National Institute of Transportation,
School of Civil and Environmental Engineering,
National University of Science & Technology (NUST), Islamabad, Pakistan
Email: rabiahmuhammad@nit.nust.edu.pk

* Required

Personal Information

1. **Name:** *

2. **Please indicate your Organization's role:** *

Mark only one oval.

- Client
- Consultant
- Contractor
- Architect
- Academia
- Legal adviser
- Other: _____

3. **Country of your Organization:** *

4. Your role/designation in your Organization: *

Mark only one oval.

- Project Director
- Project Manager/Construction Manager
- BIM Manager
- BIM Modeler
- BIM Coordinator
- Resident Engineer
- Planning Engineer
- Contracts Manager
- Professor
- Researcher
- Legal Adviser
- Other: _____

5. Does your Organization has any experience of using BIM for Dispute Resolution in Construction Projects *

Mark only one oval.

- Yes
- No

6. Please indicate the experience (in years) you have with BIM *

Mark only one oval.

- No experience
- 1-5
- 6-10
- 11-15
- Above 15

7. Please indicate the experience (in years) you have with Contract Management *

Mark only one oval.

- No experience
- 1-5
- 6-10
- 11-15
- Above 15

Section 1: Do these provisions contain legal characteristics?

Following a thorough literature review, 28 potential legal aspects, for integrating BIM in dispute resolution procedures were identified.

Indicate the extent of agreement on a scale of 1–5 (1 being very low and 5 being very high) with the potential legal aspects.

8. **All evidence i.e. supporting documents and digital data derived from BIM should be deemed admissible and have legal basis in Dispute Board (DB) proceedings. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

9. **Provision implying 'BIM integration in dispute resolution' should be explicitly mentioned in BIM contract documents. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

10. **Protocols/Operating procedures for 'BIM integration in dispute resolution' should be included in BIM contract documents. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

11. **While providing digital data as evidence, certain constraints should be implemented for its security and privacy. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

12. **Considering expeditious functioning of BIM, time limit for DB's decision may be reduced subsequent to agreement with DB and both parties. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

13. **DB members should have BIM knowledge. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

14. **If DB members possess BIM knowledge, their remuneration should be increased accordingly.** *

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

15. **If DB members do not possess BIM knowledge, DB specific BIM coordinator should be hired.** *

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

16. **If DB members do not possess BIM knowledge, services of Project's BIM manager should be utilized.** *

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

17. **DB members should be provided with Orientation regarding implementation of BIM as soon as DB gets functional in the project.** *

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

18. **A complete briefing regarding project progress in BIM should be provided to DB members at every scheduled meeting.** *

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

19. **All letters or Notifications, site visit reports and decision reports from DB should be sent to parties through common data environment (CDE). Common data environment: <https://www.thenbs.com/knowledge/what-is-the-common-data-environment-cde>** *

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

20. **DB should submit letters or Notifications, site visit reports and decision reports in hard form. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

21. **For facilitating the meetings apart from site visits, common data environment should be used as a platform. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

22. **All the DB meetings other than site visits should be through conventional methods (call, video conferencing etc.) ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

23. **During hearing, BIM representatives from both parties should be present. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

24. **In case of any discrepancy, 2D drawings derived from 3D Model data should prevail over 2D CAD drawings ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

25. **In case of any discrepancy, 2D CAD drawings data should prevail over 2D drawings derived from BIM Model. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

26. **If there is a conflict between model contribution and a portion of the design generated in a 2D medium, the model Contribution shall take precedence over the 2D drawings ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

27. **2D drawings shall prevail over model contribution in case of any disagreement. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

28. **Documents for review shall be submitted to DB in PDF format. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

29. **Documents for review shall be submitted to DB in Native file format (dwg, rvt, xlsx, docx etc.). ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

30. **BIM Manager should define and ensure compliance of protocols for integrating BIM in DB proceedings, in mutual agreement with DB and parties. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

31. **BIM Manager should provide orientation to DB members regarding BIM as soon as DB gets functional in the project. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

32. **BIM manger would provide complete briefing regarding project progress in BIM environment, to DB members at every scheduled meeting. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

33. **Standard of care should be applied by all parties submitting evidence via BIM. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

34. **When evidence is provided from any specific discipline (MEP, Structure and Architecture), discipline design manager of respective discipline would be responsible for authenticity of that information. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

35. **BIM Manager should arrange for BIM data security during data usage in DB proceedings. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

Section 2: Can these Provisions be incorporated as a contract provision:

For the same Provisions stated in previous section, indicate the appropriateness on a scale of 1–5 (1 being very low, 5 being very high) of following to be incorporated as contract provisions in BIM contracts.

36. **All evidence i.e. supporting documents and digital data derived from BIM should be deemed admissible and have legal basis in Dispute Board (DB) proceedings. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

37. **Provision implying 'BIM integration in dispute resolution' should be explicitly mentioned in BIM contract documents. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

38. **Protocols/Operating procedures for 'BIM integration in dispute resolution' should be included in BIM contract documents. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

39. **While providing digital data as evidence, certain constraints should be implemented for its security and privacy. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

40. **Considering expeditious functioning of BIM, time limit for DB's decision may be reduced subsequent to agreement with DB and both parties. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

41. **DB members should have BIM knowledge. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

42. **If DB members possess BIM knowledge, their remuneration should be increased accordingly. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

43. **If DB members do not possess BIM knowledge, DB specific BIM coordinator should be hired. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

44. **If DB members do not possess BIM knowledge, services of Project's BIM manager should be utilized. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

45. **DB members should be provided with Orientation regarding implementation of BIM as soon as DB gets functional in the project. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

46. **A complete briefing regarding project progress in BIM should be provided to DB members at every scheduled meeting. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

47. **All letters or Notifications, site visit reports and decision reports from DB should be sent to parties through common data environment (CDE). Common data environment: <https://www.thenbs.com/knowledge/what-is-the-common-data-environment-cde> ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

48. **DB should submit letters or Notifications, site visit reports and decision reports in hard form. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

49. **For facilitating the meetings apart from site visits, common data environment should be used as a platform. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

50. **All the DB meetings other than site visits should be through conventional methods (call, video conferencing etc.) ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

51. **During hearing, BIM representatives from both parties should be present. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

52. **In case of any discrepancy, 2D drawings derived from 3D Model data should prevail over 2D CAD drawings ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

53. **In case of any discrepancy, 2D CAD drawings data should prevail over 2D drawings derived from BIM Model. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

54. **If there is a conflict between model contribution and a portion of the design generated in a 2D medium, the model Contribution shall take precedence over the 2D drawings ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

55. **2D drawings shall prevail over model contribution in case of any disagreement. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

56. Documents for review shall be submitted to DB in PDF format. *

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

57. Documents for review shall be submitted to DB in Native file format (dwg, rvt, xlsx, docx etc.). *

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

58. BIM Manager should define and ensure compliance of protocols for integrating BIM in DB proceedings, in mutual agreement with DB and parties. *

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

59. BIM Manager should provide orientation to DB members regarding BIM as soon as DB gets functional in the project. *

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

60. BIM manger would provide complete briefing regarding project progress in BIM environment, to DB members at every scheduled meeting. *

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

61. Standard of care should be applied by all parties submitting evidence via BIM. *

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

62. **When evidence is provided from any specific discipline (MEP, Structure and Architecture), discipline design manager of respective discipline would be responsible for authenticity of that information. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

63. **BIM Manager should arrange for BIM data security during data usage in DB proceedings. ***

Mark only one oval.

	1	2	3	4	5	
Very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very high

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