CONTRACTUAL RISKS OF BUILDING INFORMATION MODELING: TOWARDS A STANDARDIZED LEGAL FRAMEWORK

by

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THESIS ACCEPTANCE CERTIFICATE

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DEDICATED

TO

MY FAMILY

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ABSTRACT

Building information modeling (BIM) is one of most promising developments in Architecture, Engineering, Construction and Operation (AECO). The construction industry has been increasingly embracing this new technology with passing time. Such positive development, however, is marred by the lack of legal infrastructure surrounding the implementation of BIM. Thus, prior to its adoption, legal risks due to BIM should be addressed for enhanced stakeholder satisfaction and project success. It must be noted that the developing nature of BIM hinders the farsightedness due to which the currently available standard contracts lack predisposed guidelines. Therefore, this research aims to develop a contractual framework of BIM for AECO of developing and high-risk construction industries such as Pakistan. Two objectives guide this research: to identify and analyze potential legal risks associated with BIM; and to formulate a legal framework for BIM incorporation into the standard contract documents. Based on a detailed literature review, 14 legal risks were identified. Five published contract systems catering BIM were analyzed in the light of identified risks to highlight any gap and to find mitigation strategy for each risk. A questionnaire survey was conducted to select the most appropriate risk mitigation strategy obtained from published contracts for each risk. A total of 150 valid survey responses were received and analyzed. By adopting a triangulation technique, best practices were selected and formulated into a contractual framework. This research will help in standardizing contract systems paving way for smooth induction of BIM into AECO industry.

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LIST OF ABBREVIATIONS

BIM	Building Information Modeling
AECO	Architecture, Engineering, Construction and Operation
SME	Small and Medium Enterprises
ICT	Information and Communication Technology
IFC	Industry Foundation Class
CIC	Construction Industry Council
CIOB	Chartered Institute of Building
AIA	American Institute of Architects
AEC	Architectural, Engineering and Construction Industry (UK)

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Chapter 1

INTRODUCTION

1.1 GENERAL

In recent times, Building Information Modeling (BIM) has elevated as the most promising development in the field of architecture, engineering, construction and operation (AECO). With the help of BIM, an accurate virtual model of building is developed. This virtual model eases clash detection and identifies potential problems that may occur at later stage of construction (Azhar, 2011).

BIM creates intelligent and data rich digital representations of the building project which can be used as an object-oriented three-dimensional (3D) model (Sampaio, 2017). Building information model contains geometry and other relevant data needed for the design, construction and operation activities. BIM can be viewed as a virtual process that contains all aspects, disciplines, and systems of a facility within a single, virtual model (Azhar et al., 2015). However, such value add comes with its own uncertainties and risks.

BIM risks can be divided into two broad categories: contractual and technical. When studying technical risks, incorporation of sub-contractor schedule into master schedule, design error and reliability of design are among many (Azhar, 2011). Legal issues can be ownership of model, financial obligations and duty of care to mention a few (Olatunji, 2011). When universal contracts are not present for BIM, its deliverables will be reduced to non-contractual items in projects (Olatunji and Akanmu, 2014). This means industry will not efficiently benefit from BIM.

Until date, few legal disputes have surfaced due to non-availability of BIM driven contracts which results into reliance on the traditional contracts. These traditional contracts have not shown adequate capacity to resolve or help avoid crisis. Recent times have seen cases with standard of care and professional negligence, intellectual property ownership issues and legal validity of digital models. Cases like these point to one thing that is a legal foundation for implementation of BIM in AECO industry (Alwash et al., 2017).

Though current state of global AECO industry in general and Pakistan's AECO industry in particular does not have any contractual foundation to expedite BIM implementation, there are a few contractual clauses for intangible project outputs such as project master schedule or construction drawings (PPRA, 2007). But it is imperative to note that these intangibles have limited focus during project life cycle for which convenient clauses are available. BIM on the other hand maintains its relevance throughout the project life, making it challenging to devise dynamic clauses which govern its ownership and use. The current state of contracting practices is less flexible and lacks predisposed strategies related to implementation of BIM in projects. Upon practical application, problems such as ownership of model, sharing of financial opportunities, control of data and emerging risks still exist.

In an attempt to respond to the mounting challenge of a dedicated contracting system for BIM, this study identifies potential legal problems of BIM implementation through literature. Based on content analysis, the significant legal problems are highlighted. Further, using a triangulation approach of existing contracting systems, expert opinion from AECO practitioners and custom manuscripts, a standardized legal framework is developed for seamless induction of BIM in mainstream contracts. The findings of this

research will contribute into the body of knowledge by providing a detailed analysis of existing contracting systems, legal risks of BIM implementation and dedicated contractual provisions of such implementation. The contribution to industry is in the form of a functional and applicable contracting system which addresses all identified legal risks associated with implementation of BIM in AECO industry.

1.2 JUSTIFICATION FOR SELECTION OF THE TOPIC

As recent studies suggest the fast adaptation of BIM in AECO industry, this expedition also fuels the issues related to BIM and its implementation. Severe lacks of contractual aspects are adding to the existing contractual and execution gap of BIM implementation which suggests that improvement and standardization are eminent. With the help of this research, proper contractual framework for BIM will be established that in turn will ease BIM implementation paving ways for project success.

1.3 OBJECTIVES

The research objectives are as follows:

- To identify and analyze potential legal risks of BIM and its implementation.
- To formulate a legal framework for BIM incorporation into the standard contract documents.

1.4 RELEVANCE TO NATIONAL NEEDS

BIM has been around for more than a decade but Pakistan's AECO industry is yet to implement it to its full. Problems of clashes between various trades during construction add to its complexity to the problems that are otherwise easily resolvable via BIM. This

study will help Pakistan's AECO industry in implementing BIM by providing a contractual framework ensuring sound legal aspects, disputes resolution and claim management.

1.5 ADVANTAGES

This research will have following advantages.

- Development of legal framework for BIM in AECO industry.
- Assignment of roles and responsibilities to stakeholders.

1.6 THESIS OUTLINE

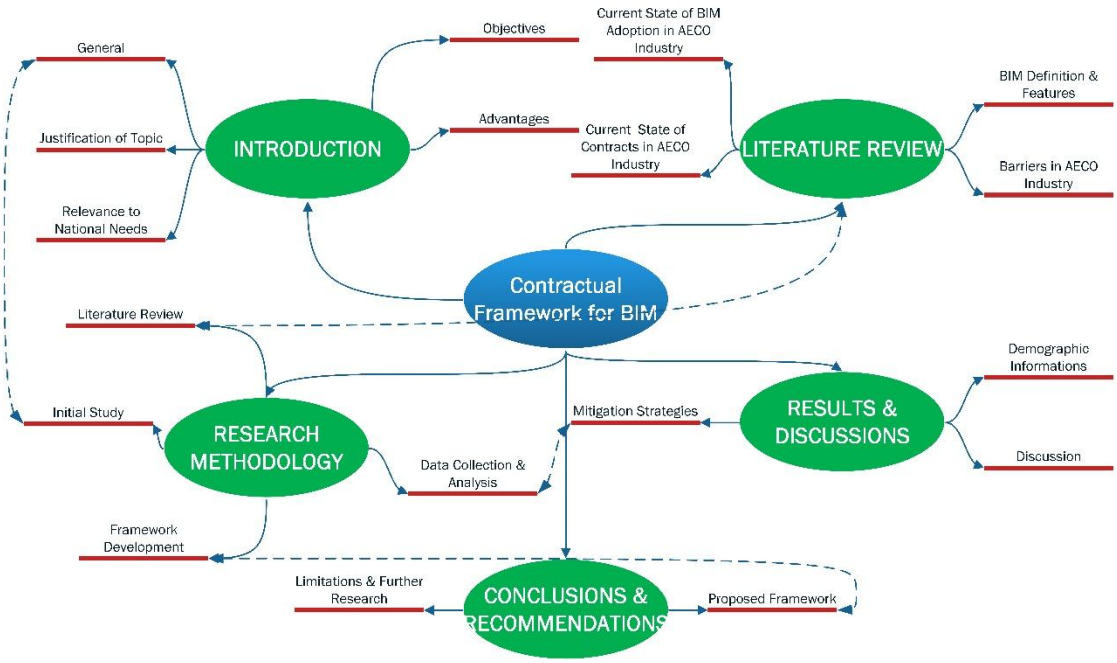

Figure 1-1 Thesis Outline

Chapter 2

LITERATURE REVEIW

2.1 BIM DEFINITION and FEATURES

Building Information Modeling or simply BIM can be defined as a digital representation of physical and functional characteristics of a facility, and is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life cycle (NBIMS, 2007). As per Autodesk (2002), BIM has three major features:

- It creates and operates on digital databases for cooperation.
- It manages change throughout those databases so that a change to any part of the database is coordinated in all other parts.
- It captures and preserves information for reuse by additional industry-specific applications.

BIM is a digital representation of accurate physical and non-physical features of a building. When completed, this model contains all relevant data needed for later stages of the project. BIM model does not treat data as 3D drawings, instead recognizes and characterizes individual building elements that can be used in estimation and planning phase. At any stage of the design, BIM can extract an accurate bill of quantities and spaces that can be used for cost estimation (Eastman et al., 2011). BIM eases clash detection and enhances coordination between different trades of construction industry (Aslani et al., 2009). These features are not limited for pre-construction and construction phases rather BIM can be utilized for facility management. BIM acts as the main data structure which can be

extended with other data sources (Sabol, 2008). In addition, BIM offers advantages of 3D visualization, generation of shop drawings, code reviews, quantity take off, project planning, clash detection between trades, forensic analysis and facilities management over traditional drawings (Azhar et al., 2008).

2.2 CURRENT STATE OF BIM ADOPTION IN AECO INDUSTRY

Major stakeholders of AECO industry have embraced the broad vision of BIM which enhances integration, coordination, accuracy and synchronization of different trades of construction industry. This in turn saves 10% to 30% cost on overall investment (Laiserin, 2007). For past decade, in developed countries like Finland, Sweden, Norway, Germany, France, Singapore and Australia, projects have been completed using BIM (Mihindu and Arayici, 2008). Approximately 50% of construction stakeholders in North America have adopted BIM (McGraw-Hill, 2012). Many major construction projects worldwide, like the Shanghai World Expo Cultural Center and Pavilion, Walt Disney Concert Hall, EMP Museum at Seattle Center, Washington National Park, the Bird's Nest and Water Cube constructed for the Beijing Olympics, and Shanghai Tower have been successfully completed by implementing BIM (Chien et al., 2014). But it can be seen that, with all its benefits, BIM adoption is still at exploratory stage in industry (Edirisinghe et al., 2016). This shows that with all its prosperities, BIM has some inherent challenges which hinder its fast induction into AECO industry.

The adoption of BIM is experiencing a global expansion as studied continent wise by Jung and Lee (2015). Their study points that the North America (Canada and US) has the most advanced BIM adoption, whereas the Oceania (New Zeeland and Australia) and Europe (France, Italy, etc.) can be considered as the second most advanced and are especially very

strong in the design phase. Middle East/Africa ranks on 3rd position and is considered in the 'beginner phase'. On the other hand, Asia is ranked 5th in the adoption level and BIM services and South America is ranked at the lowest position. Despite some countries leading the other in the adoption of BIM, it can be seen that, with all its benefits, BIM is still at exploratory stage in the industry (Edirisinghe et al., 2016).

2.3 BARRIERS IN AECO INDUSTRY

Various studies have been performed to investigate the barriers faced by BIM in the AECO sector. A few notable works are of Rezgui et al. (2013), Chan (2014) and Liu et al. (2015). The limitations can be summarized below.

Organizational barriers can be listed as dependence on paper-based legal documents, separation between design and construction activities, domination of SMEs, marginal investment in ICT and covering of additional costs (Chien et al., 2014). Contractual or legal barriers could be unclear arrangement regarding ownership and responsibility for BIM (Fan, 2013), liability in case of incorrect information, current procurement methods and stakeholders' roles. Software related or technical difficulties are lack of interoperability, access control, BIM data security and data integrity (Ding et al., 2015).

Pakistan is an emerging economy and its construction industry is dominated by traditional methods for project completion. But for past 5 years, BIM has gained enough appreciation in Pakistan. Many medium to large architecture firms have at least a basic knowledge of BIM. BIM is understood as a design approach that involves data sharing between consultants involved in building projects. The collaboration of construction and procurement details, environmental data in BIM or its use in project management or facility

management is understood to a lesser degree (Mankani, 2009, Hussain and Choudhry, 2013)

More than 25% of AECO organizations are using BIM or involved in adoption of BIM process in any capacity. BIM is more popular in architectural firms relative to other AECO organizations. According to the understanding of AEC professionals of Pakistan, faster and effective designing, effective construction management and reduction in rework during construction are major advantages of BIM. BIM has impact on reduction of cost, time and human resources. A total of 96% of AEC professionals are willing in implementing of BIM in Pakistan. Most needed aspects are its awareness and education (Masood et al., 2014).

Researchers have identified that barriers like medium to low knowledge about BIM, current practices are serving good, less knowledge about BIM benefits and use, unavailability of formwork, concern about software limitations or complexity, limited adoption in local market, legal and contractual concerns and lack of standards are hindering BIM implementation in Pakistan (Fatima et al., 2016).

One such limitation is unavailability of universal contractual guidelines for BIM which drop its efficiency by reducing BIM deliverables into non-contractual items in projects (Olatunji and Akanmu, 2014). Though some contractors choose to implement BIM on voluntary basis (Kumar et al., 2017), a well-structured, balanced and clear set of contractual guidelines will help boost BIM value proposition (Eadie et al., 2015).

The development for such guidelines is driven by the need of addressing legal risks regarding creation, usage and management of BIM associated information. Depending upon usage of BIM between project stakeholders, specific contractual guidelines and

provisions will be needed to cope with lack of predisposed strategies and outdated contracts (Kuiper and Holzer, 2013).

2.4 CURRENT STATE OF CONTRACTS IN AECO INDUSTRY

Responding to this demand, various contract documents have been developed to manage BIM and its related information. Presently, five contracting systems are available in the industry which incorporate BIM. These are ConsensusDOCS 301 BIM Addendum (ConsensusDOCS, 2008), AEC BIM Protocol (AEC, 2012), E203-2013 (AIA, 2013a), CIC BIM Protocol (Council, 2013) and CIOB Time and Cost Management Contract (CIOB, 2015a).

ConsensusDOCS 301 BIM Addendum is the oldest in the list of standard contract documents. The developers of this system, acknowledging the longer, wider and deeper penetration of traditional contracts in the industry, tried to expand the existing forms of agreement instead of drafting a whole new set of documents for BIM. (Lowe and Muncey, 2009) conclude that inadequate change management culture of construction industry may result into further problems if entirely new contracting regime is introduced. Further, AEC (2012) released AEC BIM Protocol version 2.0 as an improvement over version 1.0. This contract document urges the use of best practices available. American Institute of Architect drafted E202 for integrated project delivery (IPD) contract but it can be used as an addendum of existing general conditions for traditional delivery methods AIA (2013b). Similarly, Construction Industry Council's BIM Protocol makes the minimum changes necessary to the pre-existing contractual arrangements for BIM on construction projects (Council, 2013). Time and cost management contract is an improvement over Contract for Complex Projects by CIOB (2015a). However, upon detailed study, it is found that these

contracts do not sufficiently cater to various risks and uncertainties involved in BIM based project delivery (Al-Shammari, 2014), opening space for custom manuscript contracts (Abdirad, 2015). Thus, there are still many unclear legal requirements for the contract structure and policy, and the contractual relationships and obligations associated with BIM model and security (Chong et al., 2017).

Due to this lack of clarity, projects have encountered some legal disputes (Olatunji, 2015) which push the practitioners towards the alternative modes of contracting (Abdirad, 2015). But these alternative modes are non-standardized which complicate legal matters of BIM and hinder its adoption. Cases like these point to one thing: lack of legal foundation for implementation of BIM in AECO industry (Alwash et al., 2017). This lack of predisposed strategies for BIM implementation results into practical problems of model ownership, sharing of financial opportunities, control of data and emerging risks.

2.5 LEGAL RISKS OF BIM

The existing research has discussed the advantages and challenges of BIM in greater detail (Migilinskas et al., 2013, Bryde et al., 2013, Newton and Chileshe, 2012). One of the challenges revolves around the uncertainties associated with BIM implementation which have been categorized into technical, managerial, environmental, financial and legal uncertainties (Chien et al., 2014); or software, design and legal liabilities (Eadie et al., 2015) or even more concisely, into the technical and legal risks (Azhar, 2011). For this study, the concise categorization is adopted under which technical risks are exemplified as inadequate project experience, lack of software compatibility, model management difficulties, inefficient data interoperability, etc. (Chien et al., 2014). Further, the legal risks, which form the fundamental focus of this study, are exemplified as cost

compensation, professional liability, legislation and judicial precedence, etc. (Manderson et al., 2015). It should be noted that the technical risks of BIM actively feed into its legal uncertainty and therefore addressing the latter will result into resolution of former (Olatunji, 2011, Manderson et al., 2015).

The legal risks were identified from the relevant articles published in recent literature as summarized in Table 2-1 List of Journals and their description was formalized.

Table 2-1 List of Journals

S No	**Name of Journal**	**Citation**
1	Journal of Construction Engineering and Management	1
2	Journal of Construction Economics and Building	2
3	Journal of Legal Affair and Dispute Resolution in Engineering	1
6	Journal of Construction Education and Research	1
7	Journal of Information Technology in Construction (ITcon)	1
8	Journal of Law in the Built Environment	1
10	Royal Institution of Chartered Surveyors COBRA	1
11	Others	2
	Total	**10**

These risks were identified based upon their frequent appearance in recent literature. Total 14 risks are identified and top nine (09) risks were found to be more impactful than rest six (06). A total of 14 risks are identified as given in Table 2-2 Detail of Legal Risks of BIM.

Table 2-2 Detail of Legal Risks of BIM

S No	**ID**	**Legal Risk**	**Description**	**Selected Reference**
1	LR1	Intellectual property	Protection of intellectual property of design and input data.	(Manderson et al., 2015, Alwash et al., 2017, Fan, 2013, Olatunji, 2011, Arensman and Ozbek, 2012)
2	LR2	Professional liability	Professional liability of shared information.	(Manderson et al., 2015, Alwash et al., 2017, Arensman and Ozbek, 2012)
3	LR3	Conditions of contract	Contract directs modeling deliverables and its sharing.	(Manderson et al., 2015, Alwash et al., 2017)
4	LR4	Data interoperability	When BIM files are exchanged, data loss may occur.	(Won et al., 2013, Bryde et al., 2013, Porwal and Hewage, 2013, Chien et al., 2014, Olatunji, 2011)
5	LR5	Protocols, processes & responsibilities	Development of communication structure between parties.	(Manderson et al., 2015, Olatunji, 2011, Arensman and Ozbek, 2012)
6	LR6	Data security	Security against data corruption, theft or manipulation.	(Manderson et al., 2015, Olatunji, 2011)

7	LR7	Cost compensation	Cost of model management and its reimbursement by stakeholders involved.	(Manderson et al., 2015, Olatunji, 2011, Arensman and Ozbek, 2012)
8	LR8	Unclear BIM standards	Unclear BIM standards and contracts to operate.	(Chien et al., 2014, Arensman and Ozbek, 2012, Azhar, 2011)
9	LR9	Standard of care and professional negligence	Parties are appreciated to render professional services with reasonable judgment to prevent loss.	(Alwash et al., 2017, Arensman and Ozbek, 2012)
10	LR10	Admissibility of electronic based documents	Admissibility of digital documents in court or local administration.	(Alwash et al., 2017, Olatunji, 2011)
11	LR11	Model management difficulties	As model is updated, more accurate data entry is required which causes model management difficulties.	(Won et al., 2013, Bryde et al., 2013, Porwal and Hewage, 2013, Gu and London, 2010, Chien et al., 2014, Ozorhon and Karahan, 2016)
12	LR12	Legal validation of design	Vetting of design from local administration.	(Manderson et al., 2015, Alwash et al., 2017)
13	LR13	Lack of software compatibility	Each firm is working with its typical software and hardware tools that	(Migilinskas et al., 2013, Porwal and Hewage, 2013, Azhar, 2011, Luthra, 2010, Chien et al., 2014)

			cause compatibility issues.	
14	LR14	Legislation & judicial precedence	Legislation for BIM to operate.	(Manderson et al., 2015, Olatunji, 2011)

Since all the identified risks were not found of necessarily a similar significance, a content analysis was carried out to quantitative and qualitative assess the identified factors in the literature. For quantitative analysis, the frequency of appearance was used and qualitative analysis was based on the impact of these risks in the view of authors of selected articles (Ullah et al., 2016, Siddiqui et al., 2016, Migilinskas et al., 2013, Bryde et al., 2013, Newton and Chileshe, 2012). The impact is described as high (H), medium (M) and low (L). The subjectivity in interpretation of authors' views cannot be entirely eliminated and its responsibility is assumed by the authors of this paper. However, to objectively understand the version of authors, the papers were read multiple times and the literal as well as figurate connotation of content was formalized. For example risk of cost compensation has high impact (H) according to Chong et al. (2017) because it had a Mean value of 1.11 while average Mean value was 0.64. But according to Eadie et al. (2015) it has a low impact since it was ranked at 13th position in the top 16 legal issues. However McAdam (2010) listed it at 5th position out of top 8 issues, which make its impact as medium. While these authors rank this at different numbers, authors like Alwash et al. (2017) and Abdirad (2015) did not discuss this risk. Similarly, all other risks were synthesized from the literature using such detailed process and great care was taken in interpretation from the literature.

This technique has been used in the past to eliminate the less impactful factors (Ullah et al., 2017) but in order to conduct a holistic analysis, the current study did not opt to eliminate any of the identified risks, regardless of its lower total score. This score is a linear product of cumulative frequency and overall impact which is derived by converting the qualitative scale into a numerical scale based on the weighted average of impact from each paper.

As shown in Table 2-3 Content Analysis for Legal Risk, risk of intellectual property is the most common when working with BIM and has been treated to have a high impact in 80% of papers. It has been reported by many authors like Fan (2013) and Olatunji (2015). Researchers are yet to decide about the model ownership and literature is unclear about the actual party which has intellectual claim over BIM model. After the risk of model ownership, the issue of professional liability is most prominent. Design consultants stand liable for the design contributions of others, including default changes by software (Manderson et al., 2015, Arensman and Ozbek, 2012).

Further, the contract needs to define the modeling products and what information is to be available for review and distribution. Also it should clearly states as to how BIM will work under different project delivery methods (Manderson et al., 2015). Researchers and industry professionals have discussed repeatedly on interoperability issues. When software tools are not working smoothly, potential issues can arise (Olatunji, 2015). Further, owing to its innovative organizational score, BIM requires new roles and responsibilities. Research has reported that a new set of professional services involved in BIM protocols are yet to standardize (Olatunji, 2011). Table 2-3 Content Analysis for Legal Risk shows how a risk has been discussed by an author over the span of eleven years.

Since BIM is a fully digital system, the shift from traditional documents to e-communication has caused concerns about data security. Ensuring that data is well protected against loss, its control access and any possible financial losses in case of breach is a major concern (Manderson et al., 2015). But all this is not going to come free. As BIM requires new set of professional skills and initial cost, its cost compensation should be discussed, deliberated and resolved. Since precise contracts for BIM are not present, it is still unclear as to how the participants will be compensated for the added cost (Chien et al., 2014). Also, the BIM product delivery and criteria for model building are not standardized. BIM stakeholders are obligated to use sensible professional judgment to prevent any loss (Alwash et al., 2017).

Table 2-3 Content Analysis for Legal Risk

Legal Risk	P1		P2		P3		P4		P5		P6		P7		P8		P9		P10		Frequency	Overall Impact	Qualitative Score	Total Score
LR1	M	✓	H	✓	H	✓	H	✓	H	✓	H	✓	H	✓	H	✓	M	✓	H	✓	**10**	H	4.6	46
LR2	H	✓	H	✓	H	✓	H	✓	M	✓	H	✓	H	✓	M	✓	H	✓	M	✓	**10**	H	4.4	44
LR3	H	✓	H	✓	H	✓	H	✓	H	✓	H	✓					H	✓			**7**	H	5	35
LR4	M	✓	M	✓	H	✓	H	✓	M	✓	M	✓			H	✓	H	✓			**8**	H	4	32
LR5	H	✓			M	✓	M	✓	M	✓	H	✓			M	✓		✓			**7**	M	3.6	25.6
LR6	H	✓			M	✓	M	✓	M	✓	M	✓			H	✓	M	✓			**7**	M	3.5	24.5
LR7	H	✓			M	✓	L	✓					M	✓	L	✓	M	✓	H	✓	**7**	M	3	21
LR8	H	✓					M	✓	H	✓					M	✓			H	✓	**5**	H	4.2	21
LR9	M	✓	M	✓			L	✓	H	✓			L	✓	M	✓	M	✓			**7**	M	2.7	19.1
LR10	M	✓	M	✓	M	✓			M	✓					L	✓	M	✓			**6**	M	2.6	15.9
LR11	M	✓					M	✓	M	✓							M	✓	M	✓	**5**	M	3	15
LR12			H	✓	L	✓					L	✓					M	✓			**4**	M	2.5	10
LR13			L	✓			M	✓			M	✓							M	✓	**4**	M	2.5	10
LR14					M	✓			L	✓					M	✓					**3**	M	2.3	6.9

P1: (Chong et al., 2017); P2: (Alwash et al., 2017); P3: (Manderson et al., 2015); P4: (Eadie et al., 2015); P5: (Abdirad, 2015); P6: (Kuiper and Holzer, 2013); P7: (Arensman and Ozbek, 2012); P8: (Olatunji, 2011); P9: (McAdam, 2010); P10: (Thompson and Miner, 2006)

2.6 CONTRACTING SYSTEMS OF BIM

As previously introduced, five (05) contract documents are currently available in the industry that incorporate some of the legal risks of BIM. These documents are ConsensusDOCS 301 BIM Addendum (ConsensusDOCS, 2008), AEC BIM Protocol (AEC, 2012), E203-2013 (AIA, 2013a), CIC BIM Protocol (Council, 2013) and CIOB Time and Cost Management Contract (CIOB, 2015b). These systems provide a foundation for research and development as well as adoption of standardized contracting system for BIM implementation. Using the identified risks, as shown in Table 2-4 Content Analysis of Published Contracts, it is synthesized that these systems respond to some risks quite adequately but tend to forgo others. A quantitative synthesis of number of risks responded by a contracting system out of total identified risks reveals that ConsensusDOCS 301 BIM Addendum has the maximum coverage of 79%, followed by CIOB Time and Cost Management Contract and CIC BIM Protocol with coverage of 71%. On the other hand, E203-2013 and AEC BIIM protocol has the minimum coverage of 57%.

As shown in Table 2-4 Content Analysis of Published Contracts, The available contract documents were analyzed in the light of risks that have a legal impact in order to highlight their coverage and limitations.

These risks were collected from recent studies of legal implications of BIM and were addressed in preliminary contractual framework developed by Chong et al. (2017). In the light of scope of Chong et al. (2017), where remedies regarding judicial precedence of contract along with legal validation of design and risk allocation are not provided, the need of standard contract documents, data security and incorporation of new roles and responsibilities is enforced.

A summary of content analysis of contract documents is shown Table 2-4 Content Analysis of Published Contracts where it can be seen that AIA E202 contains less information than other documents as discussed by McAdam (2010). ConsensusDOCS BIM Addendum, despite being older, have briefly discussed more risks than other but does not specify any contractual provisions for conditions of contract and legal validation of design.

CIOB Time and Cost Management Contract is the latest document which has incorporated BIM. It discusses how the contract will help in case a separate BIM contractor is appointed. But it remains silent on cost compensation, conditions of contract and data security of BIM model. It encourages use of mutually developed model management protocol. If stakeholders do not devise one, then AIA E202 BIM management protocol takes precedence (CIOB, 2015a).

AEC BIM protocol has released its latest version 2.0 in 2012. This protocol encourages to use best practices for ownership of data and model management difficulties. However, the best practices are subjective to level of implementation of BIM, which is quite limited. CIC BIM Protocol gives average information. It instructs to appoint BIM manager and have a specimen provided for BIM management plan. This protocol remains silent on issues like cost compensation, standard of care and legal validation of design. AIA E203 BIM addendum covers fewer risks, overlooking major issues like professional liability which is described by other BIM addenda.

Issue of copyright or intellectual property has been discussed by all addenda. It is regarded that ownership of model shall remain with the party who developed it. A license will be issued to any other party using it. As roles and responsibilities will be reviewed after BIM, it is described that BIM manager will be appointed and two new roles were suggested by

AEC (2012). Responsibilities will be discussed in a new management plan called BIM execution plan. This plan will be developed by the parties involved. Issues like interoperability are briefly discussed and common data environment is recommended for smooth working. This clause can be used for improving software compatibility as discussed by BIM addenda. Issue of standard of care or professional negligence is described only in ConsensusDOC, which suggests that the data providing party will be liable for its input only.

Table 2-4 Content Analysis of Published Contracts

Risk ID	ConsensusDOCS (2008)	AEC (2012)	AIA (2013b)	Council (2013)	CIOB (2015a)
LR1	Parties will warrant to other parties about their ownership or copyrights.	Apply best practices.	Transmitting party is owner of digital data.	Project team shall own the model.	The copyrights and any information extracted shall remain with the contractor. No one else can grant IPR.
LR2	The Architect/Engineer is responsible for its duty.			Project team member shall have no liability to employer and vice versa.	Contractor is responsible for its duty.
LR3				Discuss the case of design-build (DB) contract.	
LR4	Common file format to be developed in BIM execution plan.	Common data environment approach is applicable.	Model management protocol will discuss.	Project team member shall have no liability in case of corruption of digital data.	Contractor shall provide common data environment and file transfer protocol.
LR5	Owner will appoint information manager and will chair BIM execution plan meetings.	Project BIM execution plan shall be put in place.	Project participants shall prepare a modeling protocol.	Specimen provided.	BIM modelling protocol to be established. Contractor shall notify the contract administrator regarding the appointment of a person to coordinate.
LR6	Information manager shall maintain security of model.	Project data shall be saved on network servers with monitored access.	Model management protocol will discuss.	Information requirements specimen is provided.	

LR7	Cost of information manager to be settled and covered by owner.				
LR8	Document shall be used as addendum to main contract.	BIM protocol shall serve as BIM standard.	Document shall be used as BIM standard.	Document shall be used as standard.	Detailed standard contract is provided.
LR9	All parties responsible for its data input duty.				Contractor shall be responsible.
LR10					
LR11	Parties shall prepare a BIM execution plan.	BIM execution plan shall be put in place.	Architect or project participants shall prepare a modeling management protocol.	Owner appoint an information manager.	BIM model shall be maintained by Contractor in accordance with BIM protocol which shall be prepared by stakeholders if not, use AIA BIM addendum.
LR12		Non-editable version to be produced.			Drawings can be extracted in accordance with BIM protocol.
LR13	To be addressed in BIM execution plan.	Common software shall be decided in BIM Execution Plan.	Architect is responsible.	Project team member shall have no liability.	Contractor shall select a common data environment.
LR14	Addendum shall take precedence.			Protocol shall take precedence.	If BIM is used, then this clause and appendix shall take precedence.

Chapter 3

RESEARCH METHODOLOGY

This study follows a 4-stage research methodology as graphically represented in Figure 3-1 Research Methodology. Maximum effort is put to ensure a scientifically sound and conveniently replicable methodology. The details of methodology are explained in the subsequent sections.

3.1 INITIAL STUDY

Initially a broad set of recent studies was analyzed to find the research gap. Recently published articles on IT and automation in civil engineering and construction were referred which guided the way towards BIM. When basics of recent literature on BIM were analyzed, a gap in recent research was found in the form of weak contractual support for full-fledged implementation of BIM despite the fact that this technology is promising and is attracting good reputation in market. But since its contractual obligations are not yet met, project participants are voluntarily implementing BIM (Kumar et al., 2017). In light of this limitation, a research statement regarding necessary contracts for BIM was developed. As per this statement, this study aims to propose a well-structured and balanced contractual framework for managing legal uncertainties of BIM implementation in construction projects which will result into a smooth induction of BIM into the AECO industry.

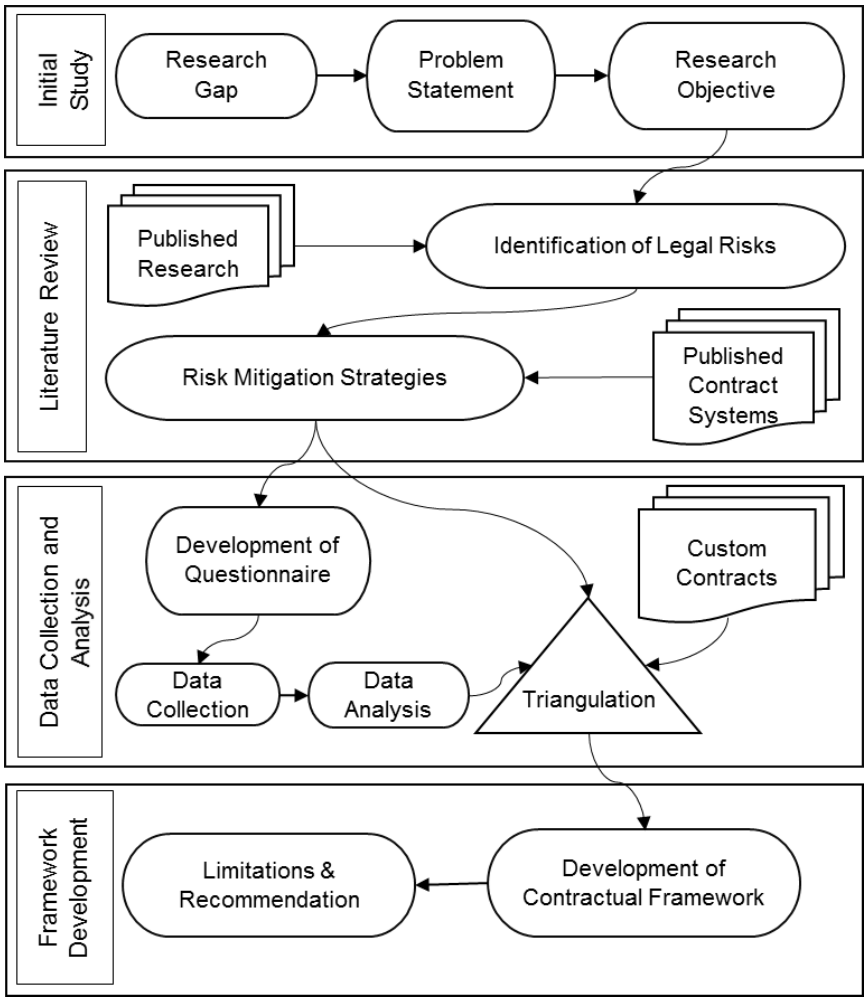

Figure 3-1 Research Methodology

3.2 LITERATURE REVIEW

To cover as much recent literature as possible, an inverted pyramid approach was adopted as shown Figure 3-2 Inverted Pyramid for Literature Review Process under which a large number of papers were consulted initially and screening was performed in the later stages to obtain the most relevant ones. For doing so, research papers were searched on the internet with keywords of “BIM”, “Contracts” and “Legal Risks”. At first, a total of 79 research papers were retrieved. A first level screening was performed by carefully reading the abstract and conclusions of these papers. As a result, papers not dealing with contractual

and legal risks were filtered. As a result, only 37 research papers were shortlisted. In the second level screening, these papers were analyzed in detail in order to identify the ones purely discussing the legal risks and offering a risk taxonomy. In response to this exercise, irrelevant papers were eliminated and the content analysis of remaining 10 papers was carried out to identify legal risks, as shown in Table 2-3 Content Analysis for Legal Risk. In a separate activity, five standard contracting systems were studied in detail to find the mitigation strategies and best practices to manage the identified risks, as formulated in Table 2-4 Content Analysis of Published Contracts. After that, a synthesis of the past research was developed.

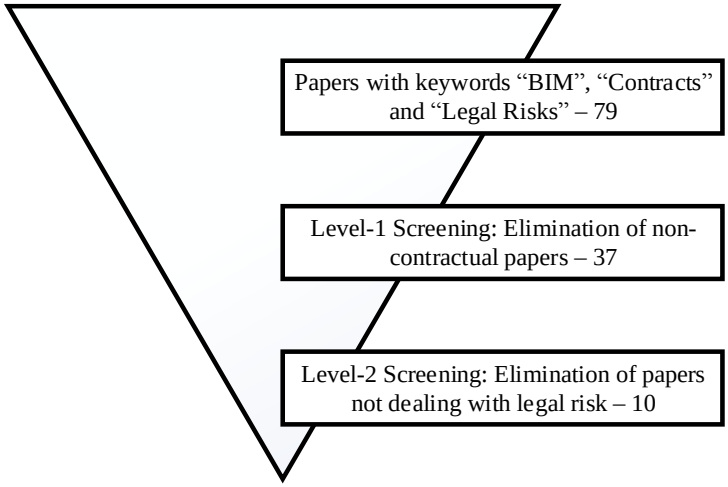

Figure 3-2 Inverted Pyramid for Literature Review Process

3.3 DATA COLLECTION AND ANALYSIS

Risk mitigation strategies identified from the past research and contract documents was incorporated into a questionnaire survey which was distributed to the practitioners to incorporate expert opinion. The questionnaire has 2 sections. Section 1 inquired about the demographics information of the respondents including their personal and professional

details such as experience, organizational position in the project and country of practice, while section 2 had 14 questions aimed at identifying the appropriate mitigation strategy for each legal risk from a pool of multiple possible strategies extracted through review of recent relevant literature and contract documents. Respondents were asked to pick any one or can comment if more than one responses are necessary. The questionnaire (Appendix 1) was distributed online to academicians and industry professionals including architects and engineers, contract and BIM managers, and contractors and facility managers. Survey was initially developed in English but later on the demand of potential respondents from Latin America, a Spanish version was also circulated. Responses were then analyzed to identify the industry trends. Further, to obtain the most appropriate and efficient mitigation options for an effective contractual framework, a triangulation approach was carried out. In research terms, 'triangulation' is used to gather the observation of the research issue from two or more different points (Flick, 2004). In this research, a 3-point reference system of triangulation is employed between the literature, industry trends and custom contracts to identify the optimum risk strategy for each legal risk.

3.4 FRAMEWORK DEVELOPMENT

After triangulation of collected and analyzed information, proposed risk mitigation strategies were incorporated into a contractual framework which maps legal risks with their most optimum response strategies. Based on this framework, a few model contract clauses are suggested which can be implemented in actual projects. More such clauses can be developed using the proposed framework. However, based on the limitations of the proposed contractual framework, future research recommendations can be extracted to improve the contracting system of BIM.

Chapter 4

RESULTS and DISCUSSIONS

4.1 DEMOGRAPHIC INFORMATION OF SURVEY RESPONDENTS

The survey was circulated to over 500 respondents using online means including official email, professional networks such as LinkedIn® and Opportunity®, research networks such as Academia® and ResearchGate®, and social networks such as Facebook® and Google+™ between July 2017 and October 2017. A total 150 valid responses were collected. Most respondents belonged to Asia (30%) and least from North America (7%) as shown in Figure 4-1 Regional Distribution of Respondents. The respondents were asked about their country of practices and this information was aggregated into a regional categorization on the basis of Jung and Lee (2015) who studied the continent level BIM adoption. As per their findings, the status of BIM adoption in Asia is perceived similar to other advanced continents, which validates the higher percentage of respondents in the current study.

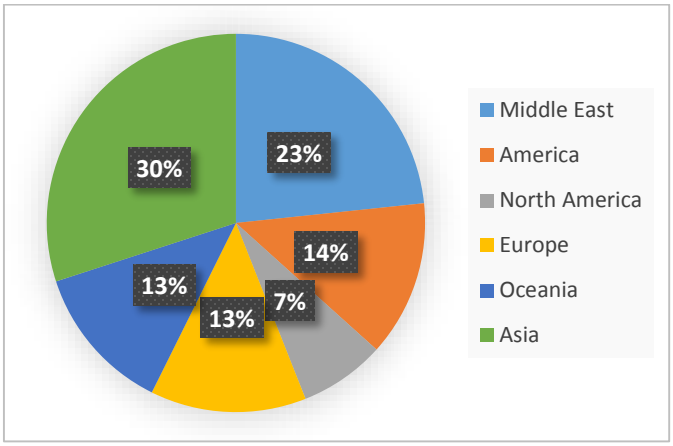

Figure 4-1 Regional Distribution of Respondents

Responses were collected from different level of experienced industry professionals as well as researchers as shown in Figure 4-2 Experience of Respondents in Years.

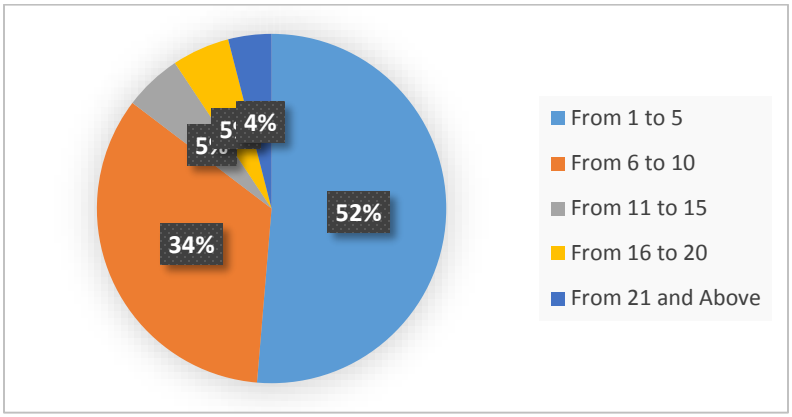

Figure 4-2 Experience of Respondents in Years

It can be observed that 85% of the respondents had less than or equal to 10 years of experience. It is mainly because BIM is a relatively new technology and it is gaining experience with time as discussed by Yan and Damian (2008), Chien et al. (2014) and Gerges et al. (2017). Thus, majority of direct experience of BIM will remain on younger side of the distribution.

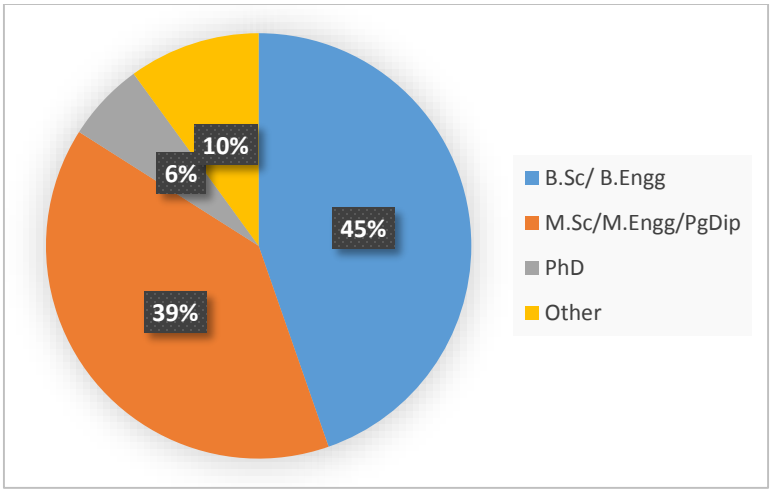

Figure 4-3 Qualification of Respondents

Further, all respondents were well qualified having minimum 16 years of education as also followed by Chong et al. (2017) as shown in Figure 4-3 Qualification of Respondents.

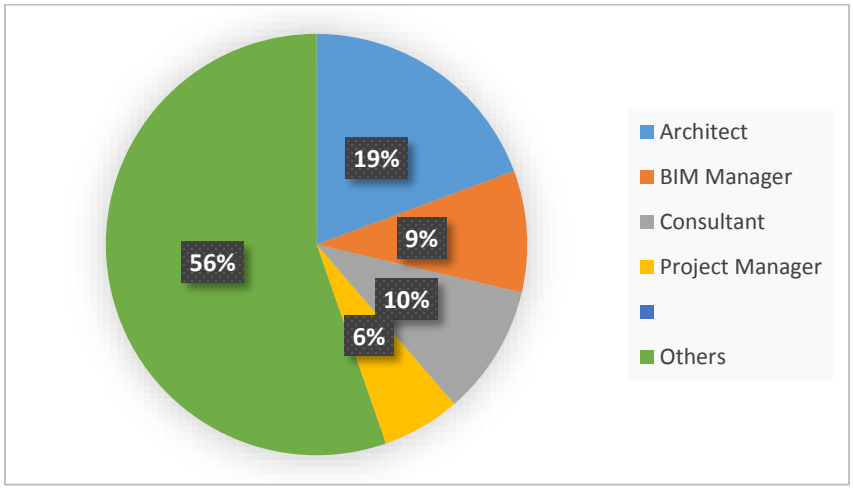

Figure 4-4 Professions of Respondents

Most respondents held key positions such as architect and BIM manager as shown in Figure 4-4 Professions of Respondents. According to Bin Zakaria et al. (2013) and Ding et al. (2015), architects are the foremost field practitioners of BIM and have more experience compared to any other key management personnel.

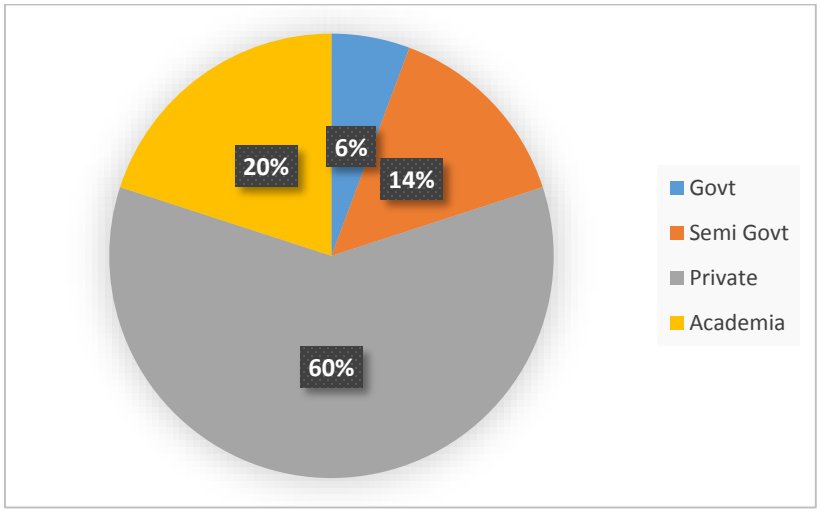

Figure 4-5 Organizations of Respondents

Large number of responses were collected from respondents belonging to private organizations and academia as shown in Figure 4-5 Organizations of Respondents. As discussed by Bin Zakaria et al. (2013), the private firms are more inclined towards BIM adoption than their public counterparts. These statistics help ensure the quality of survey sample and make the findings reliable.

4.2 MITIGATION STRATEGIES

The respondents were asked to select the most appropriate mitigation strategy for each identified legal risk. In case their opinion was different from the available strategies, they were invited to provide their own mitigation strategy. The data collected from the questionnaire survey is compiled in Table 4-1 Responses Collected from Survey where the frequency for each strategy shows its applicability and user preference against the mentioned risk.

Table 4-1 Responses Collected from Survey

S No	Risk ID	Mitigation Strategy	Frequency (%)
1	LR1	Copyrights and any information extracted shall remain with the Engineer/Architect (A/E)	44.00%
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	23.33%
		Parties will warrant about their copyrights	22.00%
		Project team shall own the model	9.33%
2	LR2	The Architect/Engineer is responsible for its duty	42.67%
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	22.67%
		Data provider (designer or contractor) shall be responsible	20.67%
		Project team member shall have no liability to employer and vice versa	12.00%
3	LR3	Modelling deliverable and sharing shall be discussed in BIM Execution Plan	43.33%
		Modelling deliverable shall be specified by client. Non-editable versions of model shall be shared	22.00%

		Modelling deliverable shall be specified by the Architect/Engineer. Construction ready BIM model shall be transmitted to Constructor.	22.00%
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	10.67%
4	LR4	Common file format to be developed in BIM execution plan	44.67%
		The Architect/Engineer shall provide common data environment	30.00%
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	24.00%
5	LR5	Client will appoint Information Manager who shall develop BIM execution plan and chair BIM execution plan meetings	41.33%
		BIM Manager shall be appointed	26.00%
		The Architect/Engineer shall prepare a BIM execution plan	22.00%
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	9.33%
6	LR6	Project data shall be saved on network servers with monitored access	46.00%
		Each superseded file shall be saved and its log shall be maintained	26.67%
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	26.00%
7	LR7	Client	42.67%
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	26.00%
		Consultant (The A/E)	20.00%
		Contractor	7.33%
8	LR8	Contractual framework shall be incorporated into an addendum of standard contract document	43.33%
		All remedies of contractual risks shall develop a BIM standard	28.00%
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	28.00%
9	LR9	All parties responsible for its data input duty	43.33%
		Spearin Doctrine shall govern (Parties shall not be responsible for faulty data provided by other)	27.33%
		Contractor shall be appreciated to render professional services with reasonable judgement to prevent loss	16.00%
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	12.67%
10	LR10	Digital data should be treated as a part of contract document	48.67%
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	17.33%
		Hard data govern over soft data	16.00%
		2D drawings shall be plotted to be presented in court or local administration	15.33%
11	LR11	BIM Model shall be maintained by the Architect/Engineer in accordance with BIM protocol which shall be prepared by stakeholders	33.33%

		Parties shall prepare a BIM execution plan with mutual understanding	32.00%
		The Architect/Engineer is responsible for model management	22.00%
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	10.67%
12	LR12	Non- editable version to be produced that can be presented in local administration	41.33%
		Drawings can be extracted in accordance with BIM Protocol	26.67%
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	18.00%
		2D drawings shall be plotted to be presented in court or local administration	12.67%
13	LR13	Common software shall be decided in BIM execution plan	56.00%
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	24.67%
		Project Team Member shall have no liability in case of incompatibility	16.00%
14	LR14	If BIM is used than this addendum shall govern	57.33%
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	40.00%

With an aim to identify the most appropriate strategy to manage the legal risks of BIM and based on the triangulation approach, each risk is addressed through custom contracts, published standard contract systems and industry experts.

4.3 DISCUSSION

The mitigation of risk of intellectual property (LR1), custom contracts do not provide any effective resolution. On the other hand, the standard contracts emphasize that the model shall remain with the designer or developer, which has also been discussed by Chong et al. (2017). The survey results seem to endorse this opinion; the majority of respondents (44%) suggest that copyrights and any information extracted shall remain with the A/E, along with a sizeable population (23.33%) who advocate the application of best practices. Thus, it can be inferred that the A/E shall have the ownership of the model and will act as a central entity in case of any dispute. Like intellectual property, survey results suggest that incase

of professional liability (LR2), the A/E would assume responsibility for its data input (42.67%) and nearly half of this proportion supports the application of best practices (22.67%). In lieu of this trend, custom contracts also emphasize upon the liability of A/E for its input. The same line of argument is maintained by the published contracts which validates the results of survey data.

Further, the published contracts except CIC BIM Protocol (Council, 2013) remain silent on the conditions of contract (LR3) and CIC BIM Protocol too is limited to the case of DB. One of the custom contracts defines that A/E shall be responsible for contract administration, the others do not offer any contractual provision for LR3. Survey results suggest that modelling deliverable and sharing shall be discussed in the BIM Execution Plan (43.33%), transferring the liability issue to the A/E since this party has also been allocated the LR2. Data interoperability (LR4) is one of the most important and discussed risks. The published contracts suggest that common data environment to use BIM shall be specified in the execution plan, while the custom contracts make this the A/E's responsibility. Survey results suggest that an execution plan made in concurrence of all stakeholders (44.67%) will suffice as discussed for LR3. For protocols, processes & responsibilities (LR5), all published contracts specify that the execution plan or protocol specified for each project shall be prepared. Adding to this, custom contracts declare the A/E's to be liable for devising such a plan/protocol which shall discuss creation of any new roles and responsibility of such roles. Survey results concur with the above by stating that the A/E shall prepare a BIM execution plan (22.00%) and that the client shall appoint an Information Manager (41.33%) who would be responsible for smooth execution of BIM implementation along with chairing the BIM execution plan meeting (ConsensusDOCS,

2008). Furthermore, Chong et al. (2017) reinforced the need of data security (LR6). The published contracts enforce that data will be protected on network servers and custom contracts add that the A/E will be responsible for its security. Survey results are tilted towards saving of data on network servers (46.00%) and also suggest that each superseded file shall be saved and its log shall be maintained (26.67%). It can be seen that survey respondents show a high level of awareness in terms of digital data management. Cost bearing and compensation (LR7) are important aspects when implementing BIM. The published contract systems and custom contracts do not provide any solid basis to clarify cost bearing and compensations of stakeholders involved. Survey results explicate that client should take the financial responsibility by assuming extra cost (42.67%) and further add that best practices may be applied to clear out any ambiguity (26.00%). This puts the client at the center of financial liability for BIM implementation. But this transfer of responsibility is not without its perks; the client also receives advantages due to reduced issues and improved quality of final product (Bryde et al., 2013).

But achieving such advantage would require some standardized procedures and protocols. Unfortunately, all published contract documents try to address the issues due to lack of BIM standards (LR8) but certain gaps were identified in all documents which need improvements to avoid any ambiguity. Custom contracts were created mainly to address these gaps and improve field practices. Survey results suggest that all risk mitigation strategies shall be compiled into one addendum of standard contract for future use (43.33%). Standard of care (LR9) was discussed by two standard contracts (CIOB, 2015a, ConsensusDOCS, 2008). It is clear from published documents and past practices that every stakeholder is responsible for its input and will be liable for its own scope only. One custom

contract specified that the A/E shall be responsible. Survey results suggest that all parties will be responsible for its input (43.33%) as dictated by ConsensusDOCS (2008).

With the induction of smart systems into field of civil engineering, it is necessary that digital documents should be admissible (LR10) and read in concurrence with conditions of contract as discussed by for the case of 2D drawings. Published contracts do not seem to be evolved for this stage but custom contracts have attempted to resolve this deficiency by allowing the model to be acceptable in specific formats with digital stamping. Survey results discuss that digital documents should be considered as part of contract as suggested by nearly half of the respondents (48.67%). Further, for model management (LR11), all custom as well as standard contracts demand new role of Model Manager and discuss an execution plan. Survey results are divided into two major strategies in this regard: BIM model shall be maintained by the A/E in accordance with BIM protocol which shall be prepared by the stakeholders (33.33%) and parties shall prepare a BIM execution plan with mutual understanding (32%). If BIM execution plan is prepared by all stakeholders and the A/E will manage it due to professional liability and ownership, other risks like conditions of contract (LR3) and data interoperability (LR4) will be automatically resolved. Legal validation of design (LR12) requires plotting of drawings. Two out of five contract systems discuss this issue and propose the solution in form of plotting of drawings. Custom contracts emphasize upon the responsibility of A/E for legal validation of design. Survey results state that non-editable version must be produced that can be presented in local administration (41.33%) and such drawings can be extracted in accordance with BIM protocol/execution plan (26.67%).

Software compatibility risk (LR13) is discussed by all standard and custom contracts. It is the A/E's responsibility to suggest a common software to manage this issue. Custom contracts suggest specified software if the A/E does not dictate one. Survey results validate the clause that common software shall be decided in BIM execution plan (56.00%) of AEC (2012). Risk of legislation and judicial precedence (LR14) was catered in same pattern by all standard and published contracts by suggesting that an addendum shall be specified for BIM and will be applicable if BIM is utilized. More than half of survey respondents agree and state if BIM is used, then this addendum shall govern (57.33%).

Chapter 5

CONCLUSION and RECOMMENDATIONS

5.1 CONCLUSIONS AND RECOMMENDATIONS

A contractual framework was developed, by triangulating the data collected from survey, custom contracts and past research.

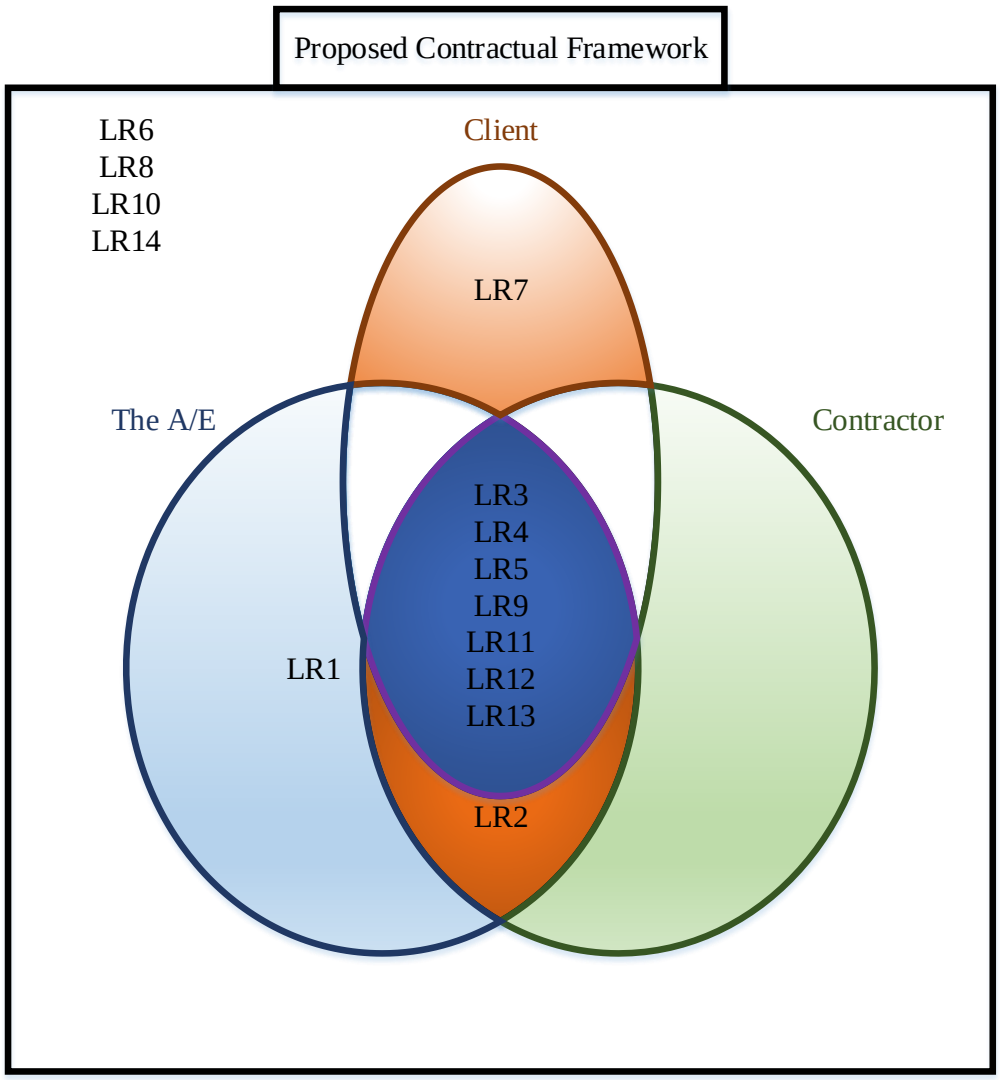

Figure 5-1 Proposed Contractual Framework

This figure shows the responsible party for each risk. All the risks that are shared between three stakeholders will be mitigated through the BIM Execution Plan which will be developed by consensus of stakeholders on directions of client and it will be managed by the A/E.

5.2 LIMITATION AND FURTHER RESEARCH

This study discusses five standard contract documents and three custom manuscripts only along with field data gathered from survey. Further researchers can incorporate more custom manuscripts and detail interviews from field practitioners to get even more realistic results. This study provides the basics for a standardized contract structure focusing in BIM and its deliverables. Future research can use this as basics for a more advances contract system.

This study focuses in contractual framework for a Design Bid Build (DBB) type delivery system only. Further research can be carried out for Design Build (DB), Turn Key to name a few. Contractual framework developed emphasize on an elaborate BIM Execution Plan which has not been discussed in detail. Future research focusing on developing a detailed BIM Execution Plan will help a lot in providing a standardized contractual framework for BIM implementation in AECO industry.

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Appendix 1

Section 1
1. Please indicate your years of professional experience. *
From 1 to 5
From 6 to 10
From 11 to 15
From 16 to 20
From 21 and above
2. Please indicate your field of work (Please select all that may apply) *
Architecture
Building design
Infrastructure management
Construction management
Quantity surveying
Engineering
Site execution
Project management
Financial consultancy
BIM Management
Other:
3. Please indicate your institute type *
Government

Semi-Government
Municipalities
Private
International Funding Agencies
NGOs
University (Academia)
Other:
4. Please indicate your job title. *
Project Director
Project Manager
Construction Manager
Contract Administrator
Contract Administrator
Assistant Manager
Site Manager
Project Engineer
Architect/Designer
University Professor
Consultant
BIM Manager/Coordinator
Other:
5. Please indicate your highest academic qualification. *
B.Tech

B.Sc/B.Eng
M.Sc/M.Eng/M.Tech/P.G.Dip
PhD/D.Eng
Other:
6. Please indicate your country. *

Section 2			
S No	**Risk ID**	**Mitigation Strategy**	
1	LR1	Copyrights and any information extracted shall remain with the Engineer/Architect (A/E)	
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	
		Parties will warrant about their copyrights	
		Project team shall own the model	
2	LR2	The Architect/Engineer is responsible for its duty	
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	
		Data provider (designer or contractor) shall be responsible	
		Project team member shall have no liability to employer and vice versa	
3	LR3	Modelling deliverable and sharing shall be discussed in BIM Execution Plan	
		Modelling deliverable shall be specified by client. Non-editable versions of model shall be shared	
		Modelling deliverable shall be specified by the Architect/Engineer. Construction ready BIM model shall be transmitted to Constructor.	
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	
4	LR4	Common file format to be developed in BIM execution plan	
		The Architect/Engineer shall provide common data environment	
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	

5	LR5	Client will appoint Information Manager who shall develop BIM execution plan and chair BIM execution plan meetings	
		BIM Manager shall be appointed	
		The Architect/Engineer shall prepare a BIM execution plan	
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	
6	LR6	Project data shall be saved on network servers with monitored access	
		Each superseded file shall be saved and its log shall be maintained	
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	
7	LR7	Client	
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	
		Consultant (The A/E)	
		Contractor	
8	LR8	Contractual framework shall be incorporated into an addendum of standard contract document	
		All remedies of contractual risks shall develop a BIM standard	
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	
9	LR9	All parties responsible for its data input duty	
		Spearin Doctrine shall govern (Parties shall not be responsible for faulty data provided by other)	
		Contractor shall be appreciated to render professional services with reasonable judgement to prevent loss	
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	
10	LR10	Digital data should be treated as a part of contract document	
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	
		Hard data govern over soft data	
		2D drawings shall be plotted to be presented in court or local administration	
11	LR11	BIM Model shall be maintained by the Architect/Engineer in accordance with BIM protocol which shall be prepared by stakeholders	
		Parties shall prepare a BIM execution plan with mutual understanding	
		The Architect/Engineer is responsible for model management	
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	

12	LR12	Non- editable version to be produced that can be presented in local administration	
		Drawings can be extracted in accordance with BIM Protocol	
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	
		2D drawings shall be plotted to be presented in court or local administration	
13	LR13	Common software shall be decided in BIM execution plan	
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	
		Project Team Member shall have no liability in case of incompatibility	
14	LR14	If BIM is used than this addendum shall govern	
		Apply best practices (Practices prevailing in previous projects which can be settled by stakeholders involve)	