Risk, Liabilities and uncertainties in Building Information Modelling

A Legal Sociological Study

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Abstrakt

Denne afhandling behandler problemerne der vedrørende brug af Building Information Modelling (BIM) i standardkontrakter i byggesektoren. Teknologien og bevidstheden om BIM, har været igennem en stigende udvikling, da det blandt andet er blevet obligatorisk at inkorporere BIM i offentlige udbud rundt omkring i verdenen. Dette er senest sket i Stor Britannien og BIM er også nævnt i udbudsdirektivet, hvor EU opfordrer implementering af BIM i offentlige udbud.

Kommentatorer udtrykker bekymring over de juridiske konsekvenser, der følger af nye designmetoder, arbejdsmetoder og relationer mellem parterne i kontrakten og i skrivende stund er der et minimum af retspraksis til at vejlede parter, hvis tvister skulle opstå. På grundlag af en litteratursøgning, vil denne undersøgelse identificere og beskrive de potentielle uregelmæssigheder, misforståelser og huller i ansvaret, grundet mangel af udtrykkelige vilkår, der beskæftiger sig med tildeling af processer og risiko indført ved BIM indenfor standardkontrakter. Denne undersøgelse er sat i relation med de ofte brugte standardkontrakter af FIDIC , JCT og AB. I øjeblikket er det nødvendigt for alle tre at bruge en protokol som et tillæg til deres kontrakter for at imødekomme inkorporeringen af BIM.

For at underbygge teserne om de potentielle problemer, blev en undersøgelse af opfattelser og udtalelser fra professionelle i byggesektoren. Denne var baseret på retssociologisk empiri, hvilket skiller sig ud fra den traditionelle juridiske dogmatiske tilgang. En internet-baseret undersøgelse blev gennemført blandt en bred gruppe af fagfolk fra byggesektoren, der arbejder i 15 lande under både Civil og Common Law. Resultaterne indikerer, at alle de ni områder, hvor spørgsmål blev identificeret fra litteraturen, er af betydning for praktiserende branchefolk, og at integrationen af BIM i standardformularer vil kræve en klar struktur og yde særlig forståelse for de roller og allokering af risiko for parterne, for at minimere fortolkningsfejl og unødvendige forsinkelser. Den generelle opfattelse var, at en sådan specificitet mangler fra protokollen, som endnu ikke er fuldt integreret i de nyligt reviderede versioner af FIDIC & JCT formularer. Hvordan AB-systemet vil rumme BIM i sin kommende revision er endnu uvist.

Abstract

Issues relating to the use of Building Information Modelling in Standard Forms of Contract for construction work have been growing as the development of both technology and awareness of BIM have increased. Commentators express concern about the legal implications arising from new design methods, working practices and relationships between the parties to the contract; and at the time of writing there is virtually no case law to guide parties should disputes arise. On the basis of a literature search this study identifies and reports on prospective irregularities, misunderstandings and gaps in liability due to the absence of express terms that deal with the processes and risk allocation introduced by BIM within standard form contracts published by three well known providers FIDIC, JCT and AB. Currently all three use a protocol as an addendum to their contracts in order to accommodate BIM.

In order to assess the perceptions and opinions of those who will have to deal with problems that arise during the execution of projects under BIM, an empirical study based in legal sociology was employed, thus departing from the traditional legal dogmatic (doctrinal) approach. An internet-based survey was conducted amongst a wide group of construction professionals working in 15 countries under both Civil and Common Law. The results indicate that all of the nine areas, in which issues were identified from the literature, are of concern to practising industry professionals, and that the integration of BIM into any of the standard forms will require a clear structure providing specific understanding of the roles and risk allocation of the parties in order to

minimise misinterpretation and unnecessary delays that result from disputes. It was generally felt that such specificity is currently lacking from the protocol, which has not yet been fully integrated within the recently revised versions of the FIDIC & JCT forms. How the AB-system will accommodate BIM in its forthcoming revision remains to be seen.

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List of Abbreviations

AB	Almindelige Betingenlser for Arbejder og Leverancer
BIM	Building Information Modelling
CAD	Computer Aided Design
CIC	Construction Industry Council
CIOB	Chartered Institute of Building
CURT	Construction Users Roundtable
FIDIC	Fédération Internationale des Ingénieurs-Conseils
FRI	Foreningen af Rådgivende Ingeniører
ICC	International Chamber of Commerce
IFC	Industry Foundation Classes
IP	Intellectual property
JCT	Joint Contracts Tribunal
NBS	National Building Specifications
PQQ	Pre-qualification questionnaire
QC	Queens Counsel
RIBA	Royal Institute of British Architects
RICS	Royal Institution of Chartered Surveyors
SFC	Standard Form of Contract

Defining 'Legal Issues'

When this dissertation uses the term 'legal issues', it covers both problems related to the current state of the legal system within the construction industry, and problems of interpretation that can arise, when the current regulations, i.e. the rules governing the construction industry, and the rules and principles of interpretation etc., are applied to an agreement between two parties. For the most part, the term 'legal issues' in this work refers to matters arising in agreements that involve the application of BIM. Fundamentally the law that will be applied is not new, but with the incorporation of BIM into the construction industry, questions of clarification and interpretation of the law may well arise.

Legal Terms

The following terms used in this dissertation are defined by the Oxford Dictionary of Law thus:

> 'de lege lata,' "*a phrase used to indicate that a proposition relates to the law as it is*"
>
> 'de lege ferenda' "*a phrase used to indicate that a proposition relates to what the law ought to be, or may be in the future*".

Citations and Referencing

Citations used in this dissertation are fully documented in the bibliography and presented in accordance with the Harvard (Author/Date) method, with citations appearing in the actual text (by family name, year of publication and page number where direct quotations have been included). If two or more people have authored the reference, "et al." appears after the name of the first author.
In the bibliography, publications are organized alphabetically according to family names, and if different publications are included by the same author, they appear in order of publication date. In the bibliography, URL's are listed with the name of the author/publisher, the web address and the last date of access to the site.

Footnotes are used for additional information and explanation, and in exceptional cases for referencing purposes, when the Harvard System appeared inadequate for the purpose of providing easy direction to a source.

1. Introduction

When having to choose a topic for my dissertation, I knew that it would be in Construction Law and about standard forms of contract (SFCs). With help from a family friend, who has worked in the industry for decades, I made contact with people working in the construction industry around the world to get a feeling for what they saw as being the key issues for the industry in the near future. Regardless of their geographic location, one particular subject was continually mentioned: the challenge presented by the introduction of Building Information Modelling (BIM).
Whilst the challenges mentioned ranged from issues concerning design delivery to practical working processes, which will change as a result of BIM's introduction, this dissertation focuses on potential legal issues associated with BIM. Currently, standard forms of contract accommodate BIM through an addendum to the main contract form, referred to as a BIM Protocol. However, with increasingly rapid technological change and developments in the industry, such an approach raises the question as to how long it will be before the existing standard form contracts used in the construction industry are littered with addenda, acting as contract documents, in order to ensure that the legal implications of all new developments are covered. In these circumstances, one might reasonably expect that revised forms should fully integrate BIM, thus removing the need for what is an essentially 'bolted-on' protocol. Thus, aim of this study is to investigate key legal areas that will need to be addressed in order for any such integration to be successful and secondly, evaluate the extent to which this integration has, or has not been achieved at this time.

1.1 Problem area

With its plethora of various specialist professions (Architects, Engineers of various disciplines, Quantity Surveyors etc.), and specialist as well as general building contractors, the construction industry has long been understood as fragmented. Such a situation, wherein there are different and individual contracts between clients, professional advisors and contractors has inevitably led to disputes and the industry being characterized as adversarial (Whitfield, 2012; Keung & Shen, 2013).
In recent years, technological developments have led to the possibility of reducing fragmentation in the industry (Utiome et al, 2014: Liu et al, 2013). Most recently this has been through the introduction of Building Information Modelling (BIM): a software-based process that involves generating and managing digital representations of the planning, design, construction, operation and maintenance of physical infrastructure and buildings. Put simply, a key feature of BIM lies in the sharing of knowledge between all participants in the construction projects and enabling complete 'virtual' construction, in advance, of any physical building. These features alone reduce fragmentation within the industry and improve communication and collaborative work between the parties involved (Azhar, S. 2011). During the last decade, the acceptance of BIM by the industry and by governments around the world illustrates that BIM has affected the conception, design, communication, and construction aspects of construction projects (Foster, 2008). However, there are also legal issues, risks and barriers that the industry has not yet fully addressed (Pinsent Masons, 2012).

In most countries around the world (including Denmark), construction projects are conducted under standard forms of contract. However, the rapid technological developments that have resulted in BIM's adoption have

moved much faster than developments and updates to standard form contracts. Moreover, the speed at which change has occurred means that at present there is little or no relevant case law pertaining to BIM. Whilst some countries, notably UK, USA, China, Brazil, Singapore, Norway, Sweden, Finland, France & Germany (CIOB, 2015) have adopted BIM protocols to provide a contractual link between the current SFCs and the new collaborative and information requirements brought about by BIM (Turner and Townsend, 2014), there is clearly a need for changes to the actual SFCs themselves that reflect the new reality (Manderson et al, 2015).

In Denmark the most common standard forms of contract are within the AB-system, comprising AB 92, ABR 89 and ABT 93. These contracts are currently under review by a committee established in 2015. The committee expects to submit their draft legislation in May 2018. However, the committee's deliberations are being held in private and without any disclosure of results or documents, so it is impossible to determine the extent to which they will provide for full integration, within the new suite of contracts, of the legal issues that BIM raises.

1.2 Problem definition

While BIM case law or disputes have yet to be publically reported (Winfield, 2016), UK construction law firm Kennedy's, report that they have already seen potential inconsistencies, confusion and gaps in liability due to a lack of express terms dealing with the process and risk allocation of BIM. They list examples of the real, and serious issues of liability that can arise including:

- *Where a contractor/client requests copies of models, but the contract/appointment is silent about models and BIM;*
- *Where an appointment sets out a copyright license for design, but is silent as to ownership or licensing of the BIM models;*
- *Where differences in the parties' software packages lead to different views of the project, amounting to problems of interoperability which are only discovered at a late stage;*
- *Where different understandings between the parties, for example of the scope of modelling, the meaning of "Level 2 BIM" and the extent and/or method of clash detection;*
- *Where firms find themselves unable to fully meet a strict obligation to comply with specified standards for a particular project, despite reasonable endeavours to do so.* (Winfield,2016),

A study carried out for the UK's Royal Institution of Chartered Surveyors (Eadie, et al, 2015), found that design liability and software liability issues (some of which are identified in the list above) are ranked as key legal issues that are not adequately addressed by the current contracts and protocol.
In short, "*if the contract is silent about the BIM process, parties will inevitably have a different understanding of what their obligations are, and what they are entitled to. Significant time and costs could then be expended to establish an accepted position between the parties.*" (Winfield, 2016 para 8)
Conversely, if the contract is structured in a manner that includes BIM-supportive terms, the result will be a reduction of avoidable time and costs, whilst having a positive effect on issues such as certainty, efficiency, and avoidance of gaps in liability. A clear structure would provide specific understanding of the roles and risk allocation of the parties, and thus minimise misinterpretation and unnecessary delays that result from disputes.
Given the concerns expressed above, and in light of the current lack of case law in this area (Arensman & Ozbek, 2012), this dissertation identifies and investigates potential legal issues associated with BIM and addresses the following research question:
"Does the BIM protocol provide adequate specificity of the role and risk allocation required for the legal safeguard of contracting parties using standard form contracts for construction work?"

1.3 Scope of the dissertation

The scope of this dissertation is limited to the legal issues relating to the implementation of BIM and does not take into consideration the intricacies of every delivery method available. The overall aim of this dissertation is to better understand how SFCs in the construction industry, need to address unique issues associated with the implementation of BIM processes. In order to fulfil the overall aim, the following objectives are pursued:

- Outline the concept of Standard Forms of Contract and explain them as a source of law
- Outline the standard contracts of FIDIC, AB92 and JCT to illustrate the legal issues with BIM
- Explain BIM and show how it affects legal liability

- Investigate perceptions of construction professions of legal issues associated with BIM
- Review how BIM is treated in various standard forms of construction contract

Due to the global reach of both FIDIC and the JCT, this dissertation also discusses the different understandings between Common Law and Civil Law when it comes to the usage of SFCs.

1.4 Methodology and sources

Legal research is traditionally based on the legal dogmatic method in which the applicable law and principles are described, analysed and systematized (Sund-Norrgård, 2016). However, this particular study concerns potential sources of conflict between contracting parties, and the legal issues arising therefrom, in both domestic and international scenarios and involving both Civil and Common Law. Furthermore the study has generated data from internationally published literature and the views and opinions of practicing professionals in 15 countries. As such the research does not lend itself to the legal dogmatic approach, which tends to focus on examining aspects of the existing law in a given jurisdiction i.e. *the 'de lege lata'* context.

For the above reasons and as a result of the argument presented below (at 1.4.1 and 1.4.2), this study has been undertaken using an empirical (legal sociological) methodology, which compares the sources of law (in both Civil and Common Law jurisdictions), *de lege lata*, and also involves an empirical study of practical contractual issues arising from necessary revisions to standard form contracts in the construction industry, *de lege ferenda*. This approach has been recognised and successfully used in recent legal scientific studies in Denmark by Henschel (2016), following earlier work by Wegener,[1] and also in Finland by Sund-Norrgård (2016).

1.4.1 Sociology in Legal Studies

Over the years, the 'Sociology of Law' concept has been subject to numerous definitions, which according to Ervasti (2008) have depended on the dominant perception of science and theoretical traditions at various points in history. Typical terms for this area of study include Law and Society Studies, Socio-Legal studies and Empirical Studies of Law (Brockman, 2003 cited in Ervasti, 2008). These titles suggest that the sociology of law is a combination of legal science and general social science, but determining the relationship between these two scientific areas is problematic. Dahlberg-Larsen (1990) identifies four differing views of the sociology of law:

1. A set of predominantly quantitative methods used by legal scientists to examine legal questions, but with questionable relationship to general theories of sociology.
2. Investigation of legal issues from a sociological standpoint, using sociological methods and theories.
3. Research that focuses narrowly on the principal legal institutions and structures such as legislation, the courts etc.
4. Research into the factual significance of legal rules in society.

Given the differences in these views, it is not surprising that arguments have arisen between legal scientists and sociologists; legal scientists complain that sociologists do not understand the concept of law and therefore undermine law as a professional activity. On the other hand, sociologists complain that legal scientists apply insufficient attention to the social context of the law. This disagreement arises (according to Banaker and Travers, 2002), at least in part because, the two sides have little understanding of each others' main field; basic degree programmes in sociology include no law-related material (generally speaking), and few sociologists are taught in law schools. However, it is becoming, more common for law and society to be researched with an understanding that the two areas are entwined and difficult to separate from each other (Friedrichs, 2001). This approach had led to sociology of law being differentiated from the 'normal' core of legal science i.e. legal dogmatics.

The table 1 on "differences between legal dogmatics and sociology of law", that is designed by Ervasti, and published in his book from 2008 at page 142, has been deleted by the editors of Rettid in order to respect Ervasti's copyrights.

[1] Wegener, Morten (1997) Ophør af franchiseaftaler, Juristen No. 6, p.267 (cited in Henschel, 2016, p.311)

At the core of legal dogmatics is the exploration of the content of current legislation, and as such the researcher's view focuses entirely on current legislation. As a result, the area of interest and research methodology applied differs from that of the sociology of law, where the key factor is the explanation of social processes related to the law. For Friedrichs (2001) this requires the sociology of law to undertake empirical research and analysis of the interaction between key legal and social phenomena. Sutton (2001 p.14) provides a simple explanation of the difference saying that "*legal dogmatics is conceptual and steering whereas sociology of law is a descriptive and explanatory field of research*." The brief discussion above suggests that the sociology of law requires an approach to research that combines the methods used in social sciences with legal thinking, an appreciation of how the law is determined and of the reasoning that underpins legal decisions in the legal world; a form of theoretical pluralism. This idea is reinforced by Cotterrell (1998 p.171) who insists *that, "Legal scholarship entails sociological understanding of law. The two are inseparable."* In agreeing with Cotterrell and arguing that legal research is richer when it includes empirical methods, Posner (cited in Watkins & Burton, 2013) advocates the study of law in practice, using methodologies from science and social science and viewed from outside the legal system. Whilst there is considerable opposition to this idea from the 'doctrinal research' camp, it is perhaps important to underline that a sociological approach to research in law is only one approach to legal scholarship and should be applied only when appropriate.

1.4.2 Legal Studies in the Built Environment Field

Commenting on the matter of legal scholarship in the context of research into the built environment i.e. concerning the construction industry, Chynoweth (2008 p.37) points out that, "*In common with other humanities' disciplines, most legal scholarship is not concerned with empirical investigation, but with the analysis and manipulation of theoretical concepts… as the process is one of analysis rather than data collection, no purpose would be served by including a methodology section within a doctrinal research publication and one is never likely to find one. This is perhaps the most striking difference between the appearance of research outputs in the two traditions, and the one which has historically caused most difficulty for legal scholars when subject to peer review by other built environment researchers."* Chynoweth then calls for researchers in both the construction and law research communities to give more consideration to their own previously unquestioned assumptions about research in their own fields, and to communicate with each other. This echoes the arguments put forward by Cotterrell and Posner mentioned above. In an attempt to reduce the gap between the traditional approaches, achieve a comprehensive understanding of legal issues related to a specific contract document, in this case the BIM Protocol, and thus go someway towards answering Chynoweth's call, this dissertation has employed a mixed methods approach to research.

A mixed methods approach consists of a combination of qualitative (traditional in law research) and quantitative (traditional in construction research) approaches to research, and goes some way towards eliminating the inherent weaknesses of both purely qualitative and quantitative research methods (Dawson, 2002). A full explanation of the methodology used in this study is presented at the start of the empirical section in Section 7.

2. The Standard Form of Contract as a Legal Source

2.1 Legal Concepts, Definitions and Sources

The knowledge bases underpinning existing law, *de lege lata*, are referred to as the sources of law. Sources of law differ between countries that adhere to Civil Law and those adhering to Common Law, but generally speaking the sources are the same for all countries under their respective Civil or Common Law system. Thus, it is the individual laws that are adopted and how they are written that varies between countries, rather than the sources of their system of law. Denmark adheres to Civil Law where the sources of law are considered according to the following hierarchy: 1) the existing law, 2) legislative work, 3) judicial decisions, 4) administrative practice, 5) customary practice and principles and 6) the nature of the relationship. Note, that whilst no definitive definition of the sources of law exists, it is acknowledged that any source should have a degree of authority that makes it appropriate to both use and obey it (Schaumburg-Müller, S. and Evald, J., 2004)

Under Common Law we find different sources, because there is generally no codification, and thus no comprehensive compilation of legal rules and statues. Common Law does rely on some statutes, which are legislative decisions, but is primarily based on precedent i.e. judicial decisions that have already been made in

similar cases. This means that judicial cases are regarded as the most important source of law, giving the judges an active role in developing rules.[2] The differences in the legal systems will have some impact on construction agreements. One difference concerns the length of the contracts themselves. For example, the FIDIC SFCs contain fewer pages than the UK drafted SFCs, such as those published by the JCT. This is because being based on Common Law, the UK SFCs try to include everything that should be regulated within the contract itself. In contrast, the FIDIC SFCs are drafted mainly for international use and Civil Law, and the contracts are much shorter, because regulation already exists and there is no need to repeat it in the contract.

2.1.1 The Implications of Legal Jurisdiction

Understanding legal terms requires an appreciation of how legal systems differ from each other in terms of the underlying principles and in further detailed analysis. Common Law, the legal system developed in those nations, which trace back to Britain (Jaeger, 2009), is different from Civil Law, which derives from the Roman *ius civile*; the law governing the citizens of Rome(Robbins Collection, no date). Consequently, understanding of the SFCs commonly used for construction projects varies, according to whether the ruling jurisdiction is that of a Civil or Common Law (Moss, 2007).

Parties entering into international contracts are free to choose the legal jurisdiction under which the contract is made i.e. the law of the client's country, the law of the contractor's country, or even with internationally recognised principles of contract law[3]. However, the choice of the legal jurisdiction in contracts may have important implications for the interpretation of the contract and its physical appearance. Denmark operates under Scandinavian-German Civil Law, and the drafting of contracts might be termed minimalistic, with the contract resting largely on the underlying feelings and interpretation of the parties' interests. On the other hand, England and Wales[4] operate under Common Law, and contract law in those countries is conducted in a different manner to Denmark and Civil Law countries. English & Welsh law includes the 'parol evidence rule', which means that it is the written word in the contract that matters, and so as a general rule, parties are prevented from presenting evidence that discloses an ambiguity and/or clarifies or adds to the written contract (Corbin, 1944). In other words, under Common Law it is the wording of the contract that matters and the intentions of the parties are not considered in any negotiation process. In Civil Law the emphasis is on the common intentions of the parties, which means that what counts is what the parties have negotiated, conducted etc. (Voorstel, no date)

2.1.2 The Standard Form of Contract as a Legal Source

Despite the differences between Civil and Common Law, case law does exist in Civil Law countries, but is not considered an official law as such. In Civil Law countries more focus is placed on the legislation, and Iversen's (2016) argument for the AB-system being considered as a source of law (in Denmark) is one interesting result of this focus.

In Denmark, there is no specific law related to the construction area that regulates the relationship between the parties to the contract; apart from procedures based on the Public Procurement Directive and the Danish Procurement Act[5]. When there is no applicable law on the area, one might think that there would not then be any legislative work to make the AB-system a source of law. However, this is not the case, because the AB-system has been used since the beginning of the 19th century and can thus be considered as a source of law. Although the AB-system is not actually a law, it still has elements of what might be referred to as 'quasi-legislation', in that the State has issued an official gazette[6] concerning the use of the AB-system, and it is used in 90% of all projects in Denmark. According to Iversen (2016) this makes it safe to say that it qualifies as a

[2] See the Legal Dictionary at: http://legal-dictionary.thefreedictionary.com/English+common+law

[3] Confirmed in the Rome I Regulation (EU Regulation 593/2008) on the law applicable to contractual obligations, which came into force on 17 December 2009. Note: this regulation is directly applicable in all EU Member States with the exception of Denmark. but as a signatory to the Rome Convention upon which Rome 1 is built, Denmark chooses to adopt this rule.

[4] Note that there are three different legal systems in the UK. The Law of England & Wales and the Law of Northern Ireland are Common Law, whilst Scottish Law is a mixture of civil and Common Law.

[5] http://mwblaw.dk/en/Doing%20Business%20in%20Denmark/Construction.aspx

[6] Vejledning om AB92 Almindelige betingelser for arbejder og leverancer i bygge- og anlægsvirksomhed af 10.12.1992 bygge- og boligstyrelsen, januar 1994.

source of law. Iversen (2016) also argues that there is no principal difference between declatorial laws concerning property and finance and the application of the AB-system.
In Denmark, contract law under 'Aftaleloven' is mostly declatorial, and therefore general rather than specific in its nature. With no laws regulating the relationship between the parties to a construction contract, construction law is governed by the principle of freedom of contract, and any issues concerning the relationship between the parties is subject, where appropriate, to the ordinary declatorical regulations within property and finance law.
Consequently, where a mandatory rule exists within a law e.g. the rules on nullity prescribed in Aftaleloven Chapter 3, it will be used to regulate the relationship between the parties to a construction contract, and cannot be waived under the normal declatorical rules. This practice accords with the unwritten laws and principles that have been developed over time in Denmark and has been incorporated into EU Law, as well as being codified in the Unidroit principles (see Section 2.1.3).
Whilst no laws regulate the relationship between the parties, such as exist, for example, concerning the renting of apartments and houses, there are laws that relate to the industry. These include, *inter alia*, laws concerning the environment and a law that places certain requirements on the finished project. An example is "Byggeloven"[7], which notes that the purpose of the law is to ensure satisfactory safety in terms of fire, health, and the reduction of the use of raw materials[8]. These laws regulate the end product and not the relationship between the parties to a construction contract. Nevertheless, these laws will have an indirect impact on the relationship, because the product must meet the legal requirements..

2.1.3 Customary Practice and Principles

In Danish contract law, the parties are under a mandatory obligation to act in accordance with good faith and fair dealing[9]. This principle of loyalty is also recognised internationally in the Unidroit Principles;[10] a document drawn up to help harmonize International Commercial Contract Law by the organization Unidroit; the International Institute for the Unification of Private Law.
The principle of loyalty is not generally mandatory in Common Law, and is thus not a tool to be used for interpretation of the purpose[11]. So, if the parties, or one of the parties, want to have the principle of loyalty within their contract, they will have to agree on it, whereas in contracts made under Civil Law, such a clause is unnecessary.

2.1.4 Lex mercatoria

Lex mercatoria is a collection of uniformed principles and soft law, which can be the foundation for a contract, or be incorporated as a part of the practice in the industry (Nielsen, 2015). Rodriguez (2002) points out that the origins of the concept are unclear, with some scholars arguing that it is founded in the Roman *ius gentium* that controlled financial relationships between Roman citizens and foreigners[12], whilst others claim that its roots go as far back as Ancient Egypt and the maritime trading between the Phonecians and Greeks[13]. In the relatively more modern, medieval times, Lex mercatoria developed into a system that allowed commercial transactions to take place across Europe. Although Lex mercatori became somewhat fragmented as nation states developed their own rules of law (Rodriguez, 2002), it can still be used as an interpretation tool for the courts, when they are ruling in cases of disputes. This is an advantage, when foreign law does not have independent applicability within a nation state. With the growth in international contract law, and the development and publication of EU common directives for implementation by all Member States, Lex mercatoria has enjoyed something of a comeback and now appears to have arrived to stay.

[7] Lovbekendtgørelse nr. 1178 af 23/09/2016
[8] Byggeloven § 1
[9] Henschel (2016, p.349) points to extensive discussion of this issue within Nordic legal literature
[10] Unidroit Principles, art. 1.7, 2010 edition
[11] However, see Section 5.1.3 which *inter alia* reports on recent developments that suggest the introduction of change in Common Law jurisdictions in respect of the doctrine of good faith.
[12] An example is Goldman (1983) Forum Internationale, vol. 3, 1983, p. 3.
[13] An example is Schmitthoff, C., Chia-jui Cheng (ed.), Clive M. Schmitthoff's Select Essays on International Trade Law, Martinus Nijhoff, 1988, pp. 20-37,

For the construction industry, where cross border elements in projects are common, such uniformity of an applicable law is advantageous for all parties.

2.1.5 Agreed documents and adhesion contracts

Agreed documents and adhesion contracts are terms used to describe certain kind of contracts, that have been developed either unilaterally or through collaboration between organisations.
In Denmark the term 'Agreed Documents', refers to a set of standard rules for certain industries (Von Eyben, 2015 p.41), that have been developed through a collaborative process involving members drawn from across the spectrum of the industry to which they apply. The Danish AB-system SFCs, and the UK's JCT suite of SFCs are examples of these in the construction industry. These forms of contract have all been developed by different interest groups/organisations in the industry along with some authorities of the State. The term is not known in the legal vocabulary of Common Law, and thus the law of England & Wales, where 'agreed documents' is simply the term used for a contract agreed by two or more parties.

Adhesion contracts, (or 'adhæsion kontrakter' in Danish), is a standard form of a contract that has been developed unilaterally by one party (Von Eyben 2015 p.35). An example is the suite of FIDIC SFCs. These SFCs have been developed and created by engineers and their organisations. In this situation, the contract is more advantageous to the engineer (and therefore indirectly to his employer i.e. the client).
Adhesion, as a term in Common Law, is defined as a standard form contract drafted by one party, who usually has stronger bargaining power[14] [15]. An example of an adhesion contract is a standardized contract form that offers a good or service to the consumer in a dominating way, so that the consumer does not have easy access to negotiating terms that would benefit their interests. This is similar to the Danish term.

2.1.6 The Role of Arbitration

Under both Civil and Common Law jurisdictions, cases of civil dispute are normally dealt with in the courtroom. An exception to this is when the parties agree to a process of arbitration instead. Despite the adversarial nature of the industry, court cases in the construction industry are the exception and thus limited in number, because one of the most common ways of handling construction project disputes is by arbitration[16].
Arbitration is a process that is agreed upon by the parties, and most standard forms of contract within the industry include this agreement. The advantages of arbitration for the parties are that the proceedings are held in confidence and the outcome is confidential, the parties choose their arbitrators, they can choose whether they want a private or a public arbitration tribunal, it provides a quick and flexible solution when compared to court proceedings (Cook, 2016) and the parties can choose whether the arbitrator's decision is final. Moreover, the arbitration process (although not the focus of the arbitration itself) is the same regardless of whether the contract is executed under Civil or Common Law. All construction SFCs include clauses setting out the conditions relating to arbitration.

2.2 Standard Form Contracts and why they are used

In most countries there is no specific 'construction law' and construction projects fall under the same rules as for any other buying & selling transaction. Thus, the construction industry is mainly regulated by the free will exercised by the parties. However, the complexity and uncertainty associated with such transactions in the construction industry has led to the development of standard form contracts, which deviate from the normal rules pertaining to contract (Murdoch and Hughes, 2000).
The use of SFCs is not exclusive to the construction industry. However, the industry might be said to have more variety and sophistication than other commercial sectors due to the complexity of the contractual chains set up in the industry, the diverse needs of particular types of project, and the industry's readiness to use standard forms (Fenn et al, 2013). At the same time, the use of standard forms is not compulsory and parties are free to contract on whatever terms they agree.

[14] https://www.law.cornell.edu/wex/adhesion_contract_contract_of_adhesion
[15] http://legal-dictionary.thefreedictionary.com/Adhesion+Contract
[16] Other alternatives to litigation include mediation, adjudication and expert determination

In construction, there are long-established standard forms to govern relationships between the employers and contractors for building and civil engineering works; particularly in contracts with local authorities, governments and government bodies, and between contractors and sub-contractors (Fenn 2015).
Construction projects are usually subject to tight timetables and budgets, and SFCs save the time and effort of 'starting from scratch' whenever a new contact needs to be drawn up, and save the cost of employing lawyers to prepare each individual contract (Fenn et al, 2013). Furthermore the parties are normally conversant with the package of obligations involved, which over time have become common and familiar, and the standardisation of terms allows the contracting parties to focus less on the actual contracting terms during the bargaining process (Murdoch and Hughes, 2000).

2.3 Problems with standard forms

Standard forms are often amended, or completely revised (Greenwood, 1993), and consequently it is dangerous for any party to the contract to simply assume that the form is the same as the one with which they have earlier become familiar. Amendment and revision of three standard forms: FIDIC, AB92 and JCT are discussed in Section 3.

It is not uncommon for parties to modify SFCs to suit their own particular needs, or to allocate risk in respect of particular circumstances. Commonly such amendments are an attempt by one party to retain the 'best bits' of a standard form, but leave out the rest and to use that in conjunction with their own usual written terms of business. The results are not always successful (Fenn, 2015) and The Latham Report, 'Constructing the Team', commissioned by the UK government to investigate perceived problems within the construction industry, recommended the use of standard contracts without amendments (Latham, 1994). In the English courts, Lloyd QC in the case of Royal Brompton Hospital National Health Trust v Hammond and Others[17], criticized the amendment of standard form contracts saying, *"A standard form is supposed to be just that. It loses its value if those using it or, at tender stage those intending to use it, have to look outside it for deviations from the standard."* However, not everyone agrees with this view. For example Ndekurgi and Rycroft (2009) argue that the variety of specific requirements in each project cannot be catered for in an SFC without amendment. Moreover, they point to instances where amendment is essential as a result of changes in the industry and in cases where certain clauses become obsolete.

Although generally clear in their meaning, SFCs are far from perfect: some inconsistencies and ambiguities only become apparent (and are tested) when a problem arises. On this matter judges can be scathing in their criticism, with one commenting on a commonly used SFC that it was, *"… so deviously drafted with what, in parts, can only be a calculated lack of forthright clarity."*[18] The issues of clarity and ambiguity, in the case of contracts involving Building Information Modelling, are analysed later, in Section 5.

2.4 Content and interpretation of standard forms

In the UK and the EU, most SFCs comprise the following:

- a set of articles of agreement[19] for execution by the parties, incorporating all other contract documents by reference
- a set of conditions of contract
- one or more appendices requiring insertion of particulars relevant to the parties, the works and the contract sum.
- a clause identifying the priority/hierarchy of the different documents and parts of the agreement

However, whilst the constituent parts of the SFC look the same across all EU Member States, their interpretation varies depending on whether they are subject to Common or Civil Law jurisdiction.

[17] *Royal Brompton NHS Trust v. Hammond & Others* (No. 9) [2002] EW HC 2037
[18] *per* Sachs, LJ in *Bickerton v North West Metroplitan Regional Hospital Board* (1977) I AII ER 977
[19] Articles of Agreement contain: 1, the name and character of the parties; 2, the subject matter of the contract; 3, the covenants which each of the parties bind themselves to perform; 4, the date; 5, the signatures of the parties.

3. Standard Forms of Contract in the Construction Industry

In order to comprehensively review the legal issues arising from the introduction of BIM within standard forms of contract, the focus of this dissertation has been on the SFCs published by three well known organisations. Firstly, the internationally acknowledged FIDIC forms (based on Civil Law); secondly, the British JCT forms (developed and used, both domestically and internationally under Common Law) and thirdly to provide a domestic perspective, the AB-system from Denmark (based on Civil Law and commonly used in domestic projects).

3.1 FIDIC

3.1.1 The History of FIDIC

The international organization of advising engineers, Fédération Internationale des Ingénieurs-Conseils, known as FIDIC, was established in Belgium in 1913. Since 1957 the organization has developed standard contracts for use in large international construction projects within the entire construction and concessions area. In cooperation with 97 engineering unions around the world, these standard form contracts have become the most commonly utilised at the global level.[20]

The members of FIDIC are mostly represented at the national level; primarily by the leading engineering association within a country. Denmark's representative body is 'Foreningen af Rådgivende Ingeniører' (FRI)[21].

FIDIC's SFCs are frequently employed on large construction projects that contain a cross-border element i.e. where the construction works are undertaken either wholly or partly in a country that is not the home country of at least one of the parties: for example, a Danish Contractor, who builds a project, or is consulting in a country outside of Denmark. In such cases, borders have been crossed and this has implications in terms of culture, authorities and legal regulations. For many years, these SFCs have been popular with banks, employers and contractors, and FIDIC has developed special editions, such as the MDB[22] contracts, that are used by the World Bank (Totterdill, 2006).

The following description of FIDIC SFCs is not a comprehensive review of all of the editions that they have published over the last 60 years, or even of their current full range of contract options. The focus in this dissertation is on FIDIC's Red Book and Yellow Book from 1999.

3.1.2 The FIDIC Rainbow

Until 1999 FIDIC's standard contracts were limited to the Red Book for use with traditional construction works, the Yellow Book for mechanical & electrical engineering, and the Orange Book used for design and build contracts. In addition to these, FIDIC has developed a range of different standard contracts for other procurement approaches, including joint ventures etc. (Uff, 2009)

Following the completion of a major revision of their existing standard contracts in 1999, FIDIC developed a range of different SFCs. This is referred to as the FIDIC Rainbow as numerous new standard forms have been introduced to those previously on offer and are generally referred to by the colour of their covers (Driver Trett, 2013). Along with revisions to the Red and Yellow books, the rainbow now includes the Silver Book for turnkey-projects; the new Red Book for contracts where the majority of the design rests with the Employer; the Pink Book, which is an adaptation of the Red Book; and the Gold Book, which is FIDIC's first Design, Build and Operate form of contract[23].

Even though new revisions of the FIDIC SFCs are available, the parties are not bound to use them in their agreement; especially if they have developed a fondness for one of the former editions of FIDIC. There is no requirement for the parties in a construction agreement to employ the latest relevant FIDIC book: this follows from the principle of freedom of contract.

[20] http://fidic.org/about-fidic
[21] http://fidic.org/members
[22] Multilateral Development Banks Harmonized Conditions of Contract for Construction
[23] https://www.thenbs.com/knowledge/a-brief-introduction-to-fidic-contracts

The 1999 edition of the Red Book, is intended for construction works where the Employer, with help from professional consultants, is responsible for the entire project, or at least most of it (Uff, 2009). Of the multiple FIDIC-books, it is the Red Book that comes closest to the conditions of the Danish SFC AB92.

Before 1999, the type of contract chosen was determined by what the project was, whereas today the deciding factor is who is responsible for the design i.e.. the choice of standard contract is now based on who bears the responsibility, instead of what kinds of works are involved. In the new Red Book, the Employer is responsible for the design, whereas in the new Yellow Book the Contractor is responsible for the design (Driver Trett, 2013).

3.2 The Danish AB Standard Forms of Contract

3.2.1 History of the AB Agreement

The first construction contract conditions that came to be known under the AB abbreviation were created back in the 1800's and were intended for the use of the railways and harbour facilities, which were the fastest growing sectors in the country (Aagard 2015). Although the State was the biggest builder in the country, it was actually an architect from Aalborg[24] who produced the first standard form that, probably as a result of its very lengthy title became known simply as AB1890 (Aagaard, 2015).
Following discussions with people from the industry, the Ministry of Public Works, , prepared a completely new set of conditions in 1915, which became applicable to construction projects. This was the first of several revisions that have been published. In 1951, AB 1951 was published as a full set of conditions produced jointly by the authorities, municipalities, private employers and contractors.

In 1972, following six years of development, a further revision was published[25]. This was required because changes within the industry were causing a level of amendment to AB 1951, and the deletion of so many of its clauses, that it could no longer be considered to be a 'standard form' of contract.

In 1986 the former Society for Construction in collaboration with the Ministry of Construction began discussions for a further revision. That discussion ended with a conference "Skal AB 72 revideres?" The conference concluded that revision was required, because AB72 had too many unclear conditions, many of the conditions were out of date or changed by case law, and some of the conditions were no longer necessary. In short, exceptions from AB72 had become common, and the system and definitions needed improving. Subsequently, a taskforce was formed to revise AB72, and a new set of conditions was agreed in 1992[26]. These conditions i.e. AB92, are still in use today.

3.2.2 What is AB92?

AB92, is the abbreviation for the 1992 edition of "Almindelige Betingelser for Arbejder og Leverancer" (Johansen, 1999), and is a set of standard conditions applicable to construction projects, or to the supply of materials. It is not a law, but what is known as an agreed document, created by negotiations between Employers, Contractors, Consultants and the Ministry of Housing (Bygge- og Boligstyrelsen, 1994 b) The AB-system effectively consists of two distinct forms of contracts, namely the traditional bid-and-build, and the design-and-build contract. AB92 is characterized by a strict separation between design and construction, whilst ABT93 is used where the same company carries out the main design and construction[27].

When used, AB-system SFCs regulate the contractual relationship between both parties, unless some specific amendment has been agreed on. However, as with all SFCs, the AB-system forms only answer the most important questions within Construction Law. In effect, each acts as a framework that places some specific contractual obligations on the parties, and provides guidance, within which the parties must adhere to all laws

[24] Søren Henrik Hoffmeyer (1839-1912)
[25] See http://www.ythat.dk/wp-content/uploads/AB72.pdf
[26] See http://www.ythat.dk/wp-content/uploads/AB92-Betænkning.pdf
[27] http://udbudsportalen.dk/ab92-og-abt93/

outside of the form itself. Rules do exist that regulate construction projects outside of AB, and AB refers to these, or presupposes their existence[28].
The conditions in AB-system SFCs can be excluded if, and when they have been clearly identified, and the reasons accord with the relevant paragraph in the SFC. In the cases of both AB92 & ABT93, this is § 1, subs. 3.(Bygge og Boligstyrelsen, 1994 a)

3.3 Joint Contracts Tribunal Standard Form Contracts

3.3.1 The History of the JCT

The Joint Contracts Tribunal (JCT) was established in 1931 and has produced standard forms of contract for construction, guidance notes and other standard documentation for use in the construction industry ever since.[29]
The term 'standard building contract' first appeared in Hudson's Building and Engineering Contracts, which pre-dates JCT and its predecessor bodies. In 1903 a standard form was produced "*under the sanction of the Royal Institute British Architects (RIBA) and in agreement with the Institute of Builders and the National Federation of Building Trades Employers of Great Britain and Northern Ireland*."(JCT, 2016 para 3): a revised version was published in 1909. In 1931 the RIBA formed the Joint Contracts Tribunal and the first JCT standard form of building contract was issued. The original SFC was revised in 1939, 1963, 1980, 1998, 2005, 2011 and again in 2016. Apart from these revisions, numerous new forms for use with different procurement methods and types of project have also been added e.g. Design & Build Contract; Intermediate Contract; Intermediate Contract with or without Design; Minor Works with or without Design; Major Projects (MP); Framework Agreement, non-binding and binding and various sub-contracts.

Following severe criticism from Latham (1994), the JCT underwent a major reorganisation and became a Limited Company in 1998 (Murdoch and Hughes, 2000). The reconstituted JCT comprises seven member bodies. Even though the name of the company suggests it, the JCT is not an actual tribunal that sits in judgement of others, but a standing committee with members that represent both the public and private sectors of the UK construction industry and who are key participants in the contract drafting process: (http://corporate.jctltd.co.uk/about-us/) :each of the member organisations nominates a Director to the Company Board. In addition, The JCT Council contains 47 representatives from across its member bodies, which comprise the company's five 'Colleges'. It is through the Colleges that new forms of contract and amendments to existing contracts are produced.

4. Building Information Modelling

4.1 Changing visual media in the construction industry

Throughout history, visual media have been used to conceptualise, design and convey information about new buildings, and for the last 500 years the most common technique has been drawings made by pen and ink. However, this tradition began to change in the 1960's, when architects and engineers first began to use Computer Aided Design (CAD) systems. This more sophisticated method attracted increased interest and use in the 1980's (Volk et al., 2014). The CAD system has helped designers of construction works to illustrate geometric information about projects (Kam et al., 2013b), but the drawings produced by these early computerised methods continued to be in a 2 dimensional (2D) format, with little attempt being made to innovate and develop 3D models (Singh et al., 2011). As a result the CAD system attracted considerable criticism. For example, Eastman et al., (2011) highlighted its poor documentation, and considered it to be a labour-intensive process that was prone to error. Arayici et al., (2011) highlighted CAD's lack of effective design management and communication, whilst Azhar et al., (2008) pointed to CAD's production of separate 2D drawings of the building's various plans, elevations and sections, which then have to be updated and checked individually instead of being intelligently connected (Azhar et al., 2008).
Criticisms of CAD led to discussion of its limitations, with Shepherd and Richens (2012) suggesting that the system was just an electronic piece of paper, which allowed easy editing, storage and printing, when it should

[28] http://www.statensnet.dk/betaenkninger/1201-1400/1246-1993/1246-1993_pdf/searchable_1246-1993.pdf (p.16)
[29] About JCT at: http://corporate.jctltd.co.uk/about-us/

have been developed as an analytical tool, as was the case in other more innovative industries e.g. aerospace. Thus, there was a call for new technology and innovative design methods.

4.2 The new age of BIM

In response to the criticism of CAD, and with rapid technological developments in recent years, a new method of handling information and communication in the design and construction of buildings has developed i.e. Building Information Modelling (BIM) (Damian & Walters, 2014, Utiome et al, 2014). Instead of producing individual 2D drawings, BIM applies models representing the geometric data of building projects, in 2D and 3D, along with non-geometric information, where the BIM is integrated with the work schedule (referred to as 4D), measurement of the quantities of required materials for the project from the BIM (5D) and the ability to use BIM in the management of the completed building (6D), commonly known as Facilities Management (Harvard University Construction Management Council, n.d.). One of BIM's biggest advantages is that it consists of elements that each have a high level of information within them, and have an intelligent relationship with each other. (Zhang et al., 2013).

BIM has sparked considerable interest among construction professionals, within the academic community and in governments. In 2011, the British Government's Construction Strategy group decreed that by 2016 all publicly funded projects would be required to adopt Level 2 BIM - based on a BIM maturity model (Ngo, 2012). The BIM maturity model incorporates evolutionary levels ranging from Level 0 utilising the basic CAD system, up to Level 3, with its integrated and interoperable data; referred to as iBIM (see Figure 1). A specifically established task force has supported the British government's strategy, and this has led to greater awareness and implementation of BIM in the UK's industry, with the National BIM Report for 2016 (NBS, 2016), showing that 54% of UK construction professionals are aware of, and are currently using, BIM (the figure was only 13% in 2011). Following the UK's initiative, the EU has issued a Public Procurement Directive, to all 28 Member States, stipulating that by 2016 they must "*encourage, specify or mandate the use of BIM for publicly funded construction and building projects*" (Travaglini et al., 2014, cited in Sanchez et al., 2016). Along with the UK, the Nordic countries (including Denmark, with the aid of EU Social funds) are all engaged in major information management research work related to BIM. (Sanchez et al., 2016).

The table 1 on "BIM Maturity Model adopted from Bew-Richards model. Cited in Månsson & Lindahl (2016)" has been deleted by the editors of Rettid in order to respect the copyrights.

A number of researchers have concluded that BIM is, among the most important recent developments in the construction industry (Azhar, 2011), a powerful technology (Yan & Damien, 2008) and is responsible for effectively reshaping both the design and construct processes in construction projects. BIM-related academic studies have most commonly explored its advantages, such as enabling substantial savings in time (Popov et al., 2010) and costs (Gilkinsin et al., 2015), improvements in stakeholder collaborations (Bryde et al., 2013), its use as a communication tool throughout the project's life cycle (Gómez-Romero et al., 2015) and its ability to increase efficiency, quality and productivity in the construction industry (Arayici et al, 2011).

4.3 Defining BIM

A key issue in the discussion on BIM concerns its definition. Some writers consider BIM to be modelling or management (Rave, 2012), whilst others see it is as an evolution (Yan & Damian, 2008) or revolution (Azhar et al., 2012; Hackett, 2016). At a more fundamental level, as shown in Figure 2 below, the abbreviation itself is even subject to different interpretations e.g. Building Information Modelling, Building Information Model and Building Information Management. So, whilst there is an abundance of publications focusing on BIM, its definition still gives rise to disagreement.

Figure 2 with the title "Interpretations of BIM: Source (NIBS, 2007) as cited in (Ahmad, 2014) has been deleted by the editors.

Table 2: Various definitions of BIM has been deleted by the editors of Rettid

Within the literature, BIM is commonly considered to be the digital representation of the physical and functional characteristics of a building project that provides a reliable and shared source of information knowledge for informing decisions throughout the project's life-cycle (Aranda-Mena et al., 2009; McAdam, 2010; Vanlande et al., 2008). This understanding of BIM focuses on the BIM model's use as a source of knowledge throughout the project's life cycle
However, a more comprehensive and integrated way to understand BIM is through the multi-dimensional model presented by Succar et al. (2009) who argue that BIM is a set of interacting processes, technologies and policies (see Figure 3).

The editors have delited figure 3. It was a figure on BIM definitions from Succar et. al

With so many definitions and views of BIM it is understandable if the various professional disciplines in construction, e.g. architects, engineers, quantity surveyors etc. each define BIM differently, and dependant upon their personal and professional perspectives, experiences, roles and involvement with BIM.

5. BIM: Key Legal Issues

5.1 Key Areas of Legal Concern

Although BIM is a relatively new concept and approach within the construction industry, it has already created considerable interest amongst, industry professionals, lawyers and academics. Articles, papers and books on BIM, and issues related to it, cover a multitude of subject areas and it is beyond the scope of this study to consider them all. Instead, this section serves as a short review of the key legal issues relating to the adoption and implementation of BIM, based on those derived from Eadie et al (2015) in their survey of 100 UK construction firms. Table 3 provides a summary of the key authors that were identified, from a search of the literature, as being most prominent in each area.

Table 1: Key Legal Issues & Main Authors on adopting & implementing BIM

Legal issues	Key Authors
Model Ownership	Arensman and Ozbek (2012),Hurtado and O'Connor (2008)Larson & Golden (2008), Haynes (2009) AIA (2007), Bedrick (2006), Hamil (2006), Thomas (2013) , Thompson & Miner (2006), Porwal & Hewage, (2013)
Incorporation of BIM into contractual relationship of the parties	Mosey (2014), Ashcraft (2008) , Eadie et al (2015), McAdam (2010), Lowe and Muncey (2009), McAdam (2010), Lowe and Muncey (2009), Lahdenpera (2012), Kent and Becerik-Gerber (2010)
Potential conflict resulting from corrupted electronic data	Arensman and Ozbeck (2012), Al-Shammari (2014), Olantunji (2010), Ashcraft (2008),Ashcroft and Hurtado (2009)
Responsibility during evolution of the model	Lip (2012), Sieminski (2007), Ballesty et al. (2007), Aranda-Mena et al (2008), Thomas (2013), Hartmann & Fischer, (2008), Ashcraft (2008), Azhar 2011
Sharing copyright data & IP rights	Bryde, et al. (2013), Lowe & Muncey, (2008), Thomas (2013), UK BIM Working Party (2011), Rosenberg (2007), Azhar et al. (2008) Sebastian (2010), Chao-Duivis (2011)
Additional project insurance & Risk	Sieminski (2007), Earley (2013), Brodsky (2006), Thomas (2013), O'Brien (2007), Ashcraft (2008), Lesny & Reidy (2013), Mosey (2016), Lewis (2014)
Standard of care	Arensman and Ozbek (2012), Haynes (2009), Ashcraft (2008), Simonian & Korman (2010), Sieminski (2007), Wheatley & Brown (2007), Sebastian (2010)
Design Liability	Glover (2012), Lip (2012), CIC and BIM Task Group (2013), Dossick & Neff (2010), Wheatley & Brown (2007), Hurtado and O'Connor (2008), Ashcraft (2008), Haynes (2009 & 2010), McAdam (2010)
Software Liability	Haynes (2009), Larsen & Golden (2007), Wheatley & Brown (2007), Eadie at al. (2014), Lip (2012), buildingSMART (2012,) Dossic & Neff (2010), CIC and BIM Task Group (2013), Thomas (2013), Mosey (2016), Joyce & Houghton (2014)

5.1.1 Model Ownership

The issue of model ownership is subject to considerable debate. On the one hand some authors (e.g. Arensman and Ozbek, 2012; Hurtado and O'Connor 2008; Sebastian 2010; Haynes 2009) hold the view that ownership of the BIM model, once the project has been completed, lies with the designer/creator of that model. This argument is supported by Larson and Golden, (2008, p. 22 cited in Arensman and Ozbek 2012) who say that the legal principle is clear: ''*Absent contract language to the contrary*, *the party that creates the model owns* it.'' However, they qualify this by acknowledging that as multiple parties will contribute to the overall model, each of them will want to own the part they have contributed. On the other side of the argument, others (e.g. The American Institute of Architects 2007, Bedrick 2006 & Hamil 2006) argue that ownership of the model once the project is complete lies with the client. Somewhere in between these two polarised standpoints lies a third view of ownership. Both Thompson and Miner (2006, cited in Manderson et al, 2015) and Porwal and Hewage (2013), point out that ownership of a design might be ambiguous when it has been created as a collaborative endeavour, and is a combination of derived models and trade-sensitive information.

The research conducted by Arensman and Ozbek (2012) clearly illustrates the differing viewpoints on the matter of ownership. They interviewed three architects, three clients and four contractors, all of who had been involved with BIM projects. They found a general consensus between the architects and contractors that all models belonged to the client, since the model is a normal artefact of the architects' and contractors' work and is created for the client. Here, it was clear that the architects would willingly give their model to the owner, but that they were worried about protecting their intellectual property applied in making the model.

Architects clearly find intellectual property to be a crucial part of their work, and have concerns that it would be easily accessible to clients who used the model. This would mean that their model could be repurposed or reused, and the architects therefore wished to take steps to prevent the reuse of their ideas, that are embedded in the model, for other projects.

The contractors clearly distinguished between the ownership of the actual model and the information contained within it, believing that the information within the model belonged to the parties that created the information. Additionally, and in agreement with the architects, the contractors held that regardless of the entities that have contributed to the development of a model, the actual model itself only belongs to the client for a limited use. Specifically, clients should not be allowed to use a model for other projects than the one for which the architect created it.

Two of the interviewed clients expressed the opinion that the issue of ownership of the model was unimportant and that ownership of the model could rest with the architect, if the client maintained the right to use the model in perpetuity. In this case, access to the model, and all the files would be in a form of licenses, specific to the project at hand, but the client would not own the model itself. Thus, ownership would be defined in terms of accessibility. When a licence is permanent, the model is open for future use, maintenance and publicity, but not for the purpose of reproduction of the model/structure in new projects.
The third client in the study did not agree with the two former clients, arguing that the owned model was developed as a result of the BIM process, and so includes the intellectual property from which the model was created. This client commented that in their projects, the architects and the contractors were forced to give up any ownership of the intellectual property, so that the model could be reused on new projects without further compensation

Given the strength of beliefs held by those who argue for either the client or the designer in this matter, it might be sensible to take the advice offered by Thomas (2013 p.11) who states that, *"It should be made clear in the contract who owns the data on the site, who controls the data, and how data are to be protected and archived."*

5.1.2 Sharing copyright data & IP rights
As with the issue concerning ownership of the model, there are a variety of views and thoughts on the matter of Intellectual Property (IP) rights. Generally speaking, IP is an area of law that deals with products and creation through human ingenuity and creativity. In the EU the laws on protection of IP rights have been harmonised[30], so that they meet certain standards. In Denmark this comes under the Copyright Law and the Danish Trademark Law. The USA has its own sets of laws to protect IP rights, but they are similar to the EU. The traditional copyright law grants ownership to the individual who creates the information, not the party that pays for its creation. Ashcraft (2009) states that even though the issues on intellectual property are similar to those that existed prior to BIM's invention, the issues have been amplified by the amount of information contained in BIM. If the information in the BIM model is the result of the collaborative work of a team, ownership might not rest with the individual.
Supporting the idea that the IP rests with the designer, Thomas (2013 p.37) states that except in specific circumstances, *"… under the copyright laws, it is the creator of an original design and any model based thereon who has exclusive rights to the model, including the right to make derivative models."* and, *"unless otherwise provided by contract, an owner's involvement simply by virtue of its ownership of or participation in a project does not render the owner a joint author." (p.38)* However, others consider this idea as too simplistic, given the joint nature of design involved. The UK BIM Working Party (2011) are of the opinion that joint authorship probably does not apply at a Level 2 BIM maturity, because in cases of work being amended by someone who is not the original creator, then both parties will probably own copyright of their individual contribution to the work. However, they go on to acknowledge that joint authorship is more likely on projects at Level 3 BIM.

Certainly it appears that the central issue revolves around determining 'who has contributed what?' Azhar et al (2008) believe there is no simple answer to the issue of IP and BIM data, and design ownership. They suggest that a unique response is required for each project, based on the specific needs of the project participants. This is supported by Thomas & Miner (2007), who say that when the client pays, he is likely to feel that he should own it by right, but where members of the team contribute proprietary information, their property should also be protected. Chao-Duivis (2011) says that the important thing when working with BIM is to make clear arrangements concerning the qualifications of their work and the legal consequences.

[30] Directive on the enforcement of intellectual property rights, 2004/48/EC

However, Sebastian (2010) believes the current IP laws can be applied to the ownership and copyright of the model and intrinsic data; in particular the application of IP law for collaborative works. He also suggests that each individual's contribution could be tracked by means of a computer model server with an automatic authorship registration function.

Determining who holds the IP is important, because in discussing the problem of using the data in the model for projects, and in ways not licensed by the owner of the IP, Lowe & Muncey (2008) point out that although the standard form document that specifically deals with BIM (Consensus DOCS 301 BIM Addendum) permits each party a limited, non-exclusive use of the models for the purposes of that project only, this is not widely accepted practice in the industry.

As a result of the difficulties and complexity in determining the allocation of IP rights, Rosenberg (2007, cited in Azhar, 2011) suggests that each contract should explicitly detail the requirements for on-going intellectual property and access to information project rights. This would seem to be a sensible approach until there is case law to provide guidance on the matter.

5.1.3 Procurement issues in dealing with BIM

The introduction of BIM has a number of implications for the assignment of risk, reward and responsibility, which are core elements of construction contracts. In response to this, the UK's Construction Industry Council (CIC) and the BIM Task Force have published a Standard Protocol as a legal addendum, which also acts as a contract document, for use on all BIM Level 2 projects (CIC and BIM Task Group, 2013), with the intention of introducing the minimum number of changes possible to pre-existing contract provisions. Whilst the intention is well meant, the idea of a 'one-size-fits-all' protocol is not necessarily appropriate. For example, Mosey (2014) found that the procurement route affects the use of BIM, with early contractor involvement being more suited to BIM contracts, than single stage tendering.

Single-stage tendering is where a prospective supplier in response to an invitation to tender submits their tender for the project. Invitation to tender is common in both restricted and negotiated procurement procedures and covered by Articles 28 and 29 of the Public Procurement Directive, which is mandatory for public procurement projects in the EU if the costs of the project exceed the threshold in Article 4 of the Public Procurement Directive. In cases where the project is not in the public sector, an invitation to tender is sent out to whomsoever the client wishes to receive an offer from. This invitation may follow an assessment of a pre-qualification questionnaire (PQQ) received by the Client in response to an open advertisement calling for expressions of interest. The PQQ avoids time being wasted by assessing inappropriate tenders from contractors or parties that cannot fulfil the standards sought by the Client.

Single-Stage tendering is the common route for selecting a contractor and consists of the following steps:

- An invitation to tender is issued to prospective suppliers (perhaps following completion of a pre-qualification questionnaire and/or a pre-tender interview). The invitation to tender will include information describing the goods or services required in sufficient detail to enable prospective suppliers to prepare an accurate tender.
- Tenders are prepared and returned by prospective suppliers (this may involve questions and answers and a mid-tender interview to clarify the client's requirements).
- Submitted tenders are then assessed and compared (this may involve further interviews).
- The preferred tenderer is selected and negotiations opened.
- Subject to the outcome of those negotiations the preferred tenderer may then be appointed.

Mosey (2014) explains how BIM exposes the failure of the single-stage procurement system where sight of the project design details is restricted to the design team consultants until contractors' bids are invited late in the pre-construction phase, and where cost information supporting the winning bid is not subject to transparent client review and analysis. This approach denies each of the parties both the time and opportunity necessary to attain improved value through use of the data generated in the BIM models. BIM has the potential to build bridges between clients and their teams and thus realize their potential through partnering as an approach to project procurement and delivery that sits logically alongside BIM.
Mosey (2014) reports on a trial project with the UK Ministry of Justice at the Cookham Wood Young

Offenders Institution, where they tested the application and benefits of BIM Level 2. Three different types of procurement procedures in which the contractors entered the process earlier than usual were tested. Mosey concludes that the best option, is the Two Stage Open Book procedure, describing it as, *"a client-led EU-compliant system for public sector construction projects designed to develop cost savings and other improved value, through early contributions by the main contractor and by tier 2/3 subcontractors and suppliers"* Mosey (2014, p. 8). This supports Ashcraft's earlier belief (Ashcraft, 2008) that the development of protocols, procedures and the allocation of responsibilities for the deployment of BIM will be dependent on the type of procurement method selected.

Ashcraft (2008) also makes the point that designers can use the existing software to prepare traditional plans and specifications without providing the digital model to the contractor, its sub-contractors and suppliers, or even to the client. In the same way contractors can create models for estimating, fabricating or construction simulation, but not share the information. This, he sees as reducing BIM's strength in terms of being a collaborative framework, and removes the benefits that can be accrued from single entry, multiple use in respect of cost and quality.

Fragmentation and disputes are well-established characteristics of the construction industry and are, in part at least, results of clients wanting guaranteed prices for projects, generally accepting the lowest bids in a competitive tender, and with individual contractual arrangements between the client and the design team, and between the client and the contractor. As far back as 2004 the Construction Users Roundtable (CURT 2004) concluded that the industry needed to move towards Integrated Project Delivery along with requirements for collaboration and the use of latest technologies to be required in the invitation to tender, thereby forcing the contractor and designer to comply. This proposal was in many respects an extension of the call made (in the UK) by Latham (1994) and Egan (1998) who both advocated collaboration as a solution to reduce inefficiencies within traditional construction, especially on public projects, and in order to provide best value to end users. Whilst methods of achieving collaboration on projects have been developed, their use remains particularly difficult on public projects, where transparency is required, usually through competitive bidding and acceptance of the lowest price (Meijers, et al., 2014; Akintoye & Main, 2007). Consequently most construction projects still use the traditional design-bid-build delivery method and associated contract forms, which results in an adversarial environment, conducive to disputes, inefficiency and waste (Meijers, et al., 2014; Akintoye & Main, 2007).

Whilst recent studies identify the relationship between the client, and contractor as being critical to successful project delivery, the main factors in achieving collaboration and meeting project budgets, schedules and quality requirements are respect and support toward the other parties' positions and interests; appreciation for risk positions; trust; communication; consultation; willingness toward attitudinal changes; and establishment of clearly defined roles and responsibilities (Akintoye & Main, 2007; Wang & Huang, 2005). For Akintoye and Main (2007 p.612): *"A critical step towards collaboration in construction is to overcome the common culture of conflict, and adopt more ethical behaviour marked by honesty and integrity."*

Honesty and integrity as the basis for contracts is not a new idea, indeed it is central to the concept of good faith, which can be described as "open and fair dealing" between parties (Akenhead, 2014 p.7; Williams, 2012 p.1), but as noted earlier (Setion 2.1.3) the concept does not exist in Common Law. Mason (2007; 2008) and Dagenais (2007) suggest that formalising the doctrine of good faith would bring clarity and solid footing to the parties' expectations and reduce the dependence on literal contract interpretation. However, Jackson (2007) and McCamus (2004) doubt that formal inclusion of a good faith clause in contracts will provide any additional benefits beyond those already existing in law, and express concern that such a move would in fact increase uncertainty in terms of the freedom of contract allowing parties to act in their own best interests within the confines of the contract.
Generally, the courts of England & Wales, along with others in Common Law jurisdictions have avoided formal recognition of a doctrine of good faith, and have used other recognised doctrines to arrive at the same decision when considering cases (Akenhead, 2014). However the decision in a recent English case (*Yam Seng Pte Ltd. v. International Trade Corporation Ltd. 2013)* did recognise changes in respect of good faith in other Common Law jurisdictions, making reference to other international cases and proposing that as a minimum,

contracts be performed honestly. Since then, the decision of Supreme Court of Canada (SCC) in *Bhasin v. Hrynew (Nov, 2014),* can be seen as a move towards including the principle of good faith in Canadian Common Law through a general duty of honest performance towards contractual obligations. According to Singleton & Guevara (2015) the decision changes the law of contract by:

- Clarifying that good faith is a "general organizing principle" in the Common Law of contracts
- Recognizing a new Common Law duty, applicable to all contracts, to honestly perform contractual obligations

Finally, a further indication of the problem of using the Protocol across all forms of construction contract is illustrated by the separate guides for incorporation of BIM that have been prepared by CIC& BIM Task Group (2013), The Institute of Civil Engineers (2013) and The British Standards Institution (2013). That such guides are necessary goes some way to demonstrating a lack of standardization, and with (at this time) no case law to settle disputes or provide guidance it is perhaps understandable that Eadie et al (2015) find this area to be the second highest level of concern among users of BIM and claim that, "*the existing protocols are not enough to meet all the legal requirements."* (ibid. p.6)

5.1.4 Potential conflict resulting from corrupted electronic data

Corruption of the electronic data generated in BIM projects is a potential source of conflict (Arensman & Ozbek, 2012; Al-Shammari, 2014). Whilst such corruption may be simply due to software and/or interoperability issues (see the Software Liability section below), Ashcraft (2008) warns of the need to guard against deliberate acts of sabotage. Olatunji (2010) agrees and raises the issues of liability for cyber security, and of the vulnerability of electronic files to viruses, theft, hacking etc.

According to a study by Loveland and Lobel (2012) almost 32% of cyber attacks in the USA are aimed at the theft of Intellectual Property and 11% result in a loss of shareholder value to the company. Given the amount of intellectual embedded in a BIM model, these figures suggest that the protection of digital data and information is a serious matter for those involved in BIM projects, as any breach of security has great potential for resulting in conflict if the parties dispute liability. There are different views on this matter amongst those concerned with cyber security, and a study undertaken by Information Security magazine (2003) showed that liability is difficult to assign, as there are at least five possibilities; hardware/software developers, service providers, deploying organisations, users, perpetrators/attackers. The results of this study showed such a widespread range of views that they concluded that everyone involved may be liable depending on the details of the incident.

Dutta and McCrohan (2003) argue that it is no longer enough for senior management to view the issue of cyber security as a technical issue to be dealt with it by their IT department or systems managers, but need to place a greater focus on the securing of data that goes further than the commonly utilised firewalls, intrusion-detection tools, content filters, traffic analysers, and virtual private networks.

Regardless of the specific details of particular incidents, Dutta & McCrohan's comments imply that organisations need to have policies and procedures that provide evidence that they follow best practices for continuous risk assessment and vulnerability testing if they are to avoid being held liable.

5.1.5 Responsibility during evolution of the model

BIM requires a collaborative contractual approach amongst those on the team (Azhar et al 2012) and this is supported by Larson & Golden (2007), who point to the integration of BIM within the entire project-delivery process as being one of the most important variables of success within BIM. This approach is different to the traditional contractual structure in which individuals are assigned specific obligations and duties that tend to discourage collaboration and result in waivers, disclaimers and restrictions concerning reliance on information (Ashcraft 2008; Azhar 2011). The challenge here is in overcoming the conventional bipartite approach so prevalent throughout the history of construction contracts, and thus achieving the benefits that can be accrued from BIM. The risk involved with collaboration is not a standard part of the contract, and that risk is borne by the client; consequently it is the client who needs to address this issue within the contract

From the literature, it is clear that collaboration in the development of the model leads to a number of issues concerning responsibility. Lip, 2012 (cited in Eadie et al 2015) identifies the importance of responsibility being held by the correct person at different stages as different data inputs are added. This is important,

especially given the potential for errors and inaccuracies. Aranda-Mena et al (2008) point out that inaccuracies can be transmitted from one modeller to another, possibly affecting the final project outcome. Moreover, it is likely that accuracy will vary according to different adoption and implementation capabilities held by individual collaborators (Ballesty et al. 2007), and that determining the identity of the individual responsible for errors, as data changes during the development of the model, presents difficulties (Sieminski 2007). As a safeguard against these problems, Thomas (2013) argues that the contract should allocate responsibility for (the increasing number of) non-licensed professionals who are entering information into models.

Finally, as the degree of integration increases, so conventional processes are altered, which leads to an increase in potential legal issues. If unaddressed, this may increase the risk to the project participants. For example, when adopting BIM, the primary fear (Larsen & Golden, 2007) is that the collaboration enabled through the tools BIM provides, may result in responsibility for design services passing to the contractor, whilst responsibility for means and methods passes to the designer, which results in a loss of potential legal protection. This issue is discussed further in Section 5.1.8 on Design Liability.

5.1.6 Additional Project Insurance & Risk

Early commentators expressed a number of doubts and concerns about how BIM would be likely to change exposure to risk and therefore the insurance needs of parties involved. Sieminski (2007) went as far as questioning whether what is insurable or non-insurable in regards to BIM was even known.

In respect of the structure of the contract and the allocation of risk, O'Brien (2007) warned that there might be a need for additional insurance to cover risks borne by the designer, client and contractor. However, Brodsky (2006, cited in Arensman and Ozbek, 2012) commented that project insurance could be affected by undertaking projects under legal systems based on the notion of definite responsibility, because such definite roles and responsibilities may not be an integral part of a BIM project. Ashcraft (2008) identified other BIM related areas likely to need insurance cover such as costs associated with the loss of data and any resulting rework, errors in the model and system failures. The need for additional insurance was also discussed by Earley (2013) in considering the matter of 3rd party access and modification of information and notes, which he identified as being an issue for both design and software liability, each of which can be contested separately.

More recent observers, such as Lesny and Reidy (2013) claim that the collaborative nature of BIM combined with recent advances in technology have the potential to actually reduce risk on projects and thus lower insurance premiums. They go as far as to say that, generally speaking, insurance firms have become used to Level 2 BIM and that they do not envisage any material change to consultants' risk profile. However, they do warn that Level 3 BIM raises, "*very different liability issues which will need further consideration*" (ibid. para 11) and identify four reasons why insurance premiums may increase through the use of BIM. First, the conventional boundaries of responsibilities of those involved in construction projects could become blurred under BIM making the allocation of risk more difficult. As an example they describe how, at BIM Level 3, the intelligence of the software used, could potentially pass on any changes made by a designer automatically to the work of another design contributor. Secondly, they suggest that the increasing number of parties using the model and the increased amount of electronic data, increase risk should the data and thus the model become corrupted for any reason. However as with software malfunctions, the application that manages the data will not be liable in the event of the data being corrupted, lost or stolen. As Mosey (2016) points out (see section 5.1.9 on software liability), software vendors hold virtually no responsibility towards the users and cannot be held liable for project costs resulting from malfunction of their applications. To protect against this potential risk, the owner should require data loss insurance for the project.

This point is also picked up by the insurance company Allianz (2015 para 6) who warn that with "…. *so many people working on the same model coupled with multiple incremental versions of models, variations to initial specifications and ongoing changes to software or data structures there are potential challenges around the question of liability*." Lesny and Reidy's third concern is that it becomes much harder to protect intellectual property rights when people are working in a collaborative environment and sharing data. Fourthly, they say that as the BIM model can be used for more purposes than just design and construction e.g. life cycle purposes such as facilities management, liability could be extended for a period long after completion of the building

project itself; another point that is also made by Allianz (2015).

In setting out the rights and liabilities of stakeholders, the Protocol does address some of these worries and clarifies the area of IP rights by confirming that contributions to the model remain the property of the party that designed/developed it. Moreover, the CIC has also published a guide for Best Practice regarding professional indemnity insurance on BIM projects. However, Lewis (2014) points to an area concerning risk that is not adequately dealt with in the Protocol i.e. the ownership of risk throughout the supply chain. A key intention of the protocol is that everyone involved in the delivery, production or use of a project's BIM models should use it. Clause 3.1.1 obliges the Employer to arrange for incorporating a protocol in "*substantially the same terms*" as the protocol in the main contract. At the same time clause 4.1.3, requires the project team members to incorporate the protocol into any sub-contracts into which they enter, "*to the extent required to enable the project team member to comply with the protocol*". The problem here is that the Employer will not enter into direct agreements with everyone that has an input into the project's models, because normally the main contractor will enter into separate agreements with its sub-contractors and will be required to incorporate the protocol, wholly or partly, into the supply chain agreements, which will have been subject to negotiation and which typically transfer risk down through the chain.

Lewis (2014) points out that in relation to the production of models and the relevant level of detail specified in the model production, clause 4.1.1 expressly refers to the level of skill and care "*required under the agreement*", but argues that as far as the supply chain is concerned, there is a lack of clarity as to the meaning of '*the agreement*'. The protocol defines the agreement as being between the Employer and whichever project team member to which the protocol is attached, but as the Employer will not enter into direct agreements with many of those who input parts of the design, one might reasonably assume that the Employer is actually the main contractor, or even a sub-contractor that has entered into an agreement with the yet another party, below them in the supply chain.

A second problem relates to how the Protocol deals with the issue of the level of skill and care required of project team members. Whilst clause 4.1.1 specifically refers to the level of skill and care required under the agreement when producing the specified models, clause 4.1.2 talks of the duty to '*use reasonable endeavours*' when delivering the specified models, using the project team models and in complying with information requirements. Lewis (2014) points out that there is a risk of the levels of skill and care required by the two clauses leading to debate, should a dispute arise concerning the duties and obligations of project team members.

5.1.7 Standard of care

The concept of 'standard of care' is covered in tort and is used to determine the level of negligence required to bring an action to recover damages. In the case of people carrying out a professional role, e.g. architects, engineers and quantity surveyors, this refers to the legal duty to meet the standard that would be exercised by the reasonably prudent professional in that particular line of work. The standard expected of professional people is considered to be higher than the standard applied to other persons.

BIM enables designers to include more detail in the model than has previously been possible, and according to Ashcraft (2008) this will cause an increase in the level of duty of care required of designers. This idea is supported by Arensman and Ozbek (2012) who believe that clients will expect a higher degree of skill and care, because BIM is perceived to be a new standard within the industry (currently designers are only required to demonstrate the care expected of a reasonably competent designer). Simonian & Korman (2010) disagree with these views and argue that the standard of care will be directly related to the level of reliance detailed in the contract, and that any increased level of risk will simply result in an increased use of indemnification agreements and other methods of transferring risk in order to reduce professional liability.
Regardless of whether the standard of care is increased or not, identifying who is responsible for any breach may be problematic in BIM, where the generation of design data is fast, and input to the model comes from a variety of sources, which may, or may not be verified (Haynes 2009).

5.1.8 Design Liability

Numerous issues arise under the general heading of design liability and some of them have already been discussed above e.g. collaborative working, lack of standardization, sharing of copyright data. A key issue in design liability is that of determining who is in overall control of the design (Hurtado and O'Connor, 2008). The importance of this is highlighted by Haynes (2009) who agrees that the introduction of collaborative procurement methods makes the designation of design control increasingly important.

The collaborative nature of the design process in BIM projects is a challenge to the traditional notion of professional responsibility, and thus control within the construction industry, because it is unrealistic to expect a single architect or engineer to check, and take responsibility for, the contributions of all the numerous other 'designers' whose work is integrated and distributed throughout the design process. Ashcraft (2009) is of the opinion that the contract needs to be amended to reflect this new reality and that more shared responsibility for the design, along with suitable waivers and liability limitations should be included. Connected with this are the statutes governing professional registration, which commonly stipulate that work undertaken by a design firm must be undertaken or supervised under the 'responsible charge' of a licensed professional. Fulfilment of this requirement and acknowledgment of this responsibility are then confirmed through the sealing of the contract documents by the responsible professional. Ashcraft (2009) comments that these requirements raise difficulties in the case of designs completed in a BIM project if responsibility for design is distributed and contributions to the design are made by individuals or firms that are not under the control of the responsible professional. He further adds that this issue becomes even more acute in cases where the software itself automatically produces amendments to structural details etc. The BIM Protocol and the professional institutions responsible for the registration statutes have yet to address this problem, so as to adequately reflect the actuality of practices in the case of digital design.

Given the range of elements required in the design of complex things such as buildings, it is rare (if ever) that all of the expertise necessary lies within a single individual. It is therefore normal in the design of buildings for parts of the work to be delegated to others who possess the necessary proficiency. Such individuals may work within the same firm as the lead designer, or the work may be sub-contracted to other firms. McAdam (2010) warns of the need for participants to consider the legal requirements and potential risk to which they are exposed. This warning, particularly in respect of sub-contractors, is also issued by Haynes (2009), who also advises (Haynes, 2010) of the difficulties in quantifying risk when the procurement method is of a collaborative nature.

Associated with the issue of who is in overall control of the design and the bearing of risk, Ashcraft (2008) considers the position of the building contractor, and expresses concern that where a design firm is nominated as part of the contract, the main building contractor may have no control over any earlier contribution made by that firm, and yet will still bear the responsibility for that contribution. In a slightly different, but related vein, Haynes (2009) points out that sub-contractors may also receive some design responsibility as part of completing the required documents for construction. As a result they will be accepting some design liability, but may do so without considering the implications to their risk exposure.

FIDIC, the AB-system & JCT all (along with virtually all other issuers of SFCs) clearly delineate between the Principal (represented by the Architect, Engineer or designated Lead Designer, acting as the client's representative) and the Main Contractor in terms of design liability, changes and the discovery of errors and ambiguities within the contract documents. However, none of the contracts contains anything that specifically deals with the allocation or control of what might be called 'design delegation', whether this is intentional or unintentional. The building contractor has responsibility for constructing the building according to the design provided by the Architect (or other lead designer) and for any additional parts of the design that he (the contractor) undertakes. However, it is likely that the contractor will sub-contract parts of any such additional design, which raises legal issues in terms of the contract between the contractor and sub-contractor, which will have to include clauses related to the process for inputting design into the model and liabilities for any such input by sub-contractors. Such clauses will have to take into consideration the requirement for a qualified, 'responsible' professional to undertake or supervise the design.

A further area of potential confusion regarding design control arises in respect of the different terms used within BIM for the roles provided by different participants. This is of particular concern with regard to the

BIM Information Manager. Whilst the CIC BIM Protocol states: "*The Information Manager has no design related duties. Clash detection and model coordination activities associated with a BIM coordinator remain the responsibility of the design lead*." (CIC BIM Protocol, note 10, Guidance note 4, p.vi.), which is clear enough: the BIM Task Group (n.d. para 4) state that, *"… the role can be undertaken by a Project Team Member with design responsibility such as the Design Team Leader or Main Contractor."* This latter statement is also clear enough if read carefully, but a cursory glance at it, could very easily give the wrong impression that the Information Manager has design responsibility, which is not the case. Glover (2012) picks up on this issue and clarifies the role of the Information Manager as being, "*responsible for the management of information, information process and compliance with agreed procedures, <u>not</u> the coordination of design*." (ibid. para. 15)

Ashcraft (2008) also points to another potential area of concern that may affect design liability, but which is not, of itself, a matter of design. He warns that disclaimers issued by software vendors that relate to software 'bugs' and resultant errors in design and/or automatic updating of design elements are likely to remain the responsibility of the designer. This issue is also relevant in the following section on software liability.

5.1.9 Software liability

The most commonly voiced concerns regarding software liability centre on the issue of interoperability. Interoperability is defined as "the ability of two or more systems or components to exchange information and to use the information that has been exchanged" (Institute of Electrical Electronics Engineers, 1993). In respect of BIM, Haynes (2009) says that interoperability refers to the issues of compatibility of data transfer between software packages and audit trails for recovering data.

The need for compatibility between the systems and platforms used by the various collaborators is widely recognised (e.g. Larsen & Golden, 2007; Wheatley & Brown, 2007; Dossick & Neff, 2010; Lip 2012; Thomas, 2013), and associated with this is the need for the allocation of responsibility for ensuring interoperability (Larsen & Golden, 2007; Thomas 2013). The CIC & BIM Task Group (2013) specifically warns of the problems of litigation arising from lack of standardization.

On the matter of litigation arising from the use of incompatible software programmes, and in arguing for standardization, specialist construction lawyers Hawkswell Kilvington (2012 para. 13) believe that, *"It is not clear who would be responsible for such problems. Responsibility could potentially lie with the software provider themselves, the party using the software or even the BIM Co-ordinator (sic.) responsible for managing the model. To avoid this problem, it may be necessary to ensure that the same standard of software is used by all parties involved in the project, although this may have significant financial implications."*

Even when operating systems are compatible, there is always the risk of errors in translation during the conversion of documents between operating systems. BuildingSmart (2012) identify the need for both compatibility between systems and the possible need for a 'translator' in order to achieve this. Thomas (2013 p.38) goes further, warning, *"Users of BIM may encounter interoperability problems. The contract documents for a BIM project should require bidders to have interoperable software and the ability to provide BIM modeling as part of their qualification package. Moreover, the contract documents should include guidance on software and/or interoperability requirements for modeling and a file format for exchanged files so that there is a relatively seamless flow of information."*

The issue of interoperability was also identified by Bryde et al (2013) who collected secondary data from 35 completed construction projects that had used BIM. The data collected were analysed in order to identify both the positive and negative features of BIM, and to determine the specific ways in which these features of BIM showed themselves when aligned with factors considered to be critical to the successful outcome of the projects. Nine critical success factors were identified related to the performance of the project, in terms of meeting the objectives of each project, i.e. cost reduction/control, time reduction/control, communication improvement, coordination improvement, quality increase/control, negative risk reduction, scope clarification, organisation improvement and software issues. Of the nine areas investigated only software failed to show any positive benefits and actually showed negative benefits on 7 of the 35 projects, which was more than double the negative benefits scored by the second worst case (coordination improvement). Among their

findings, Bryde et al, highlighted the issue of interoperability between BIM packages as a key problem area and identified two specific areas in which this was apparent i.e. the inability of software to cope with large amounts of data and a lack of knowledge and experience in terms of software programming. These are, of course, technical rather than legal issues and as they point out, it might be expected that such issues will be resolved once the market for BIM-related software develops and the IT industry becomes more responsive.

In a survey of 96 firms in the UK, Eadie et al (2014) identified 16 different software packages being used, with almost half (44%) of the firms reporting that they had experienced problems of interoperability. The Open BIM Network (2012) likens the problem to that of communication at the United Nations where many countries speaking different languages have to be able to communicate successfully. In order to ensure understanding between all parties, the Open BIM Network identifies 3 possible approaches:

(1) Use a dedicated protocol to translate data between the numerous platforms used on a typical project, and ensure that these are updated every time a new software version is released. They conclude that this is not a viable option.

(2) Implement a system whereby a single software seller is dominant and imposes its own language and functionality on all project stakeholders. They conclude that, as there are more than a hundred BIM 'tools' on the market, this option is impractical.

(3) Implement a system whereby stakeholders use whatever tools they choose and then have all the information translated into a common format capable of being imported from, or exported to, any other BIM tool. This they suggest is the best of the three options, as it requires little or no change for users.

Having suggested the third option, Open BIM then go on to suggest the use of an existing translator known as Industry Foundation Classes (IFC), which they claim is supported by all the main CAD vendors and an increasing number of other related software packages. Open BIM constitutes a free and open system that has been supported by a number of influential construction industry groups, such as the UK's Constructing Excellence in the built environment (2012). However, it has also been subject to criticism on a number of levels, ranging from the general philosophy that underpins it, to questions about the business case and incentives for software vendors to work with the system, and whether the system is even 100% ready regardless of the modelling software used (Epic BIM consultants 2013).

Regardless of the likelihood that the technical translation issues will be resolved in time, they do currently have the potential to become legal problems, as all parties involved will seek to protect themselves and minimise any losses resulting from the use, sale or licensing of incompatible software. Such problems are likely to hinge on arguments about the respective obligations and responsibilities of the software developer, software vendor and the purchaser/user of the software in question.

The problem of software malfunction is raised by Wheatley & Brown (2007) and also by Thomas (2013 p.11), who advises that, *"The contract should deal with responsibility for legal issues arising from the use of a 'broad-based Web site,' (for example, for lost or corrupted data), and state whether users of the site are to provide 'confidential damage waivers.'"* This advice seems to contradict the idea posited by Hartmann & Fischer, (2008) who suggest that rapid developments in technology will make the inclusion of any contract conditions targeting BIM usage in a project obsolete in a short period of time. However, this latter argument seems to be akin to the idea that because the environment is chaotic one should not bother planning for the future.

Regardless of whether problems with software are matters of interoperability/translation or malfunction, the reliability of data is central in enabling all participants in a project to uphold their side of the contract. Although CAD and computer based project management and document control systems have become commonplace in the industry, the existing SFCs issued by FIDIC, JCT & the AB-system say nothing about excluding or limiting liability for the accuracy of computer produced 3D designs or traditional 2D drawings. Mosey (2016) acknowledges that clients will expect a reasonable level of protection and thus advocates for clarification of BIM-related software processes within the contract documents to ensure balanced risk allocation. Similarly, Joyce and Houghton (2014: 115) suggest that BIM software licenses should allow for, "*a reasonable degree of liability on the part of the software provider for losses incurred by participants and losses to the project*

overall attributable to failings in the software." However, Mosey (2016) points out that the exclusion of liability clauses that can currently be found in the software license agreements of main providers effectively prevents any remedy, even in terms of basic functionality. It would appear that it is not only the SFCs that are silent on this matter. The CIC BIM protocol, which one might expect to address the new and key contractual issues, "*excludes any warranty concerning the integrity of electronic data transmission, and also excludes any liability for corruption or alteration occurring after transmission (clause 5). These exclusions place all the excluded risks with the client* …." (Mosey 2016: 14)

5.2 Summary of BIM Issues

This section has considered nine key areas in which legal challenges are expected to arise from the introduction of BIM within construction projects. Issues within some of the areas overlap, which is hardly surprising given the interrelated nature of 'real life'. One example of this is the matter of ownership of the model itself and the IP embedded in the model. An area of potential dispute identified here lies in the idea that whilst the owner of the project may own the model, he/she does not necessarily own the intellectual property within the model. Alongside this, the issue of who owns the model when multiple contributors are involved was discussed.
The relevance of BIM for particular procurement systems was also discussed. Here the propensity for single stage tendering within the industry highlighted the difficulties arising from the requirement for collaborative working, 'in good faith,' (particularly in Common Law jurisdictions) and of early contractor involvement that might be faced, when operating BIM projects,.
The collaborative nature of BIM also raises issues of responsibility that challenge the traditional contractual structure, where individuals are assigned obligations and duties, and which tends to discourage collaboration, often resulting in waivers, disclaimers and restrictions. A key issue here is who should bear responsibility and when; and moreover, whether the contract should assign responsibility to non-licensed professionals who enter information into the models.

Increased standard of care as a result of BIM becoming a 'new standard', was also reviewed because BIM enables designers to include more detail in the model than has previously been possible, which may cause an increase in the level of duty of care required of designers.

Two key areas in this section relate to design and software liability. Concerning design liability, the primary issue is that of determining who has the overall control of the design, because the introduction of collaborative procurement methods, e.g. earlier contractor involvement, makes the designation of design control increasingly important and the collaborative nature of the design process in BIM projects challenges the traditional notion of professional responsibility, because it is unrealistic to expect a single architect or engineer take responsibility for the contributions of all the other 'designers' whose work is also entered into the model. The most commonly voiced concerns regarding software liability centre on the issue of interoperability i.e. issues of compatibility of data transfer between software packages and audit trails for recovering data. The question arises as to who will have responsibility for ensuring interoperability and how can it be achieved? .

These matters are explored further in Section 7.0, which reports the results of an empirical study of construction professionals who have, or will have, to deal with these issues.

6. Incorporation of BIM within standard form contracts

6.1 Recent SFC revisions

As indicated in Section 3, SFC's are revised whenever they become unmanageable in their existing form i.e. when the number of changes and modifications required to clauses make the SFC no longer as useable as originally intended.
In 2016 the SFCs published by the FIDIC and the JCT have been revised[31]. AB92 is currently undergoing revision and not yet published. This section looks at how, if at all, BIM has been included as a part of the most recent revisions.

[31] A lesser known UK SFC published by the CIOB has also been revised in 2016

6.1.1 FIDIC

The FIDIC standard form of contract makes no reference to BIM provisions within the contract terms as it currently stands. The contract does not state whether an additional BIM Protocol is required and makes no provisions for the key aspects of BIM, such as provisions for clash detection, collaborative working, early contractor involvement or agreed mutual deadlines for specific activities.

During April 2016, the treasurer of FIDIC's Executive Committee, Bernd Kordes, announced the launch of a survey of all of FIDIC's member associations in order to gain feedback on a number of questions about BIM e.g. Implementation of BIM in specific countries, timelines for BIM, BIM Strategies etc.[32] The survey was intended to enable FIDIC to address BIM related matters within its suite of SFCs. Eight months later (in December 2016), FIDIC held their annual conference for international users of FIDIC SFCs and announced the changes that they are expecting to make to the three most commonly used books in their suite of contracts i.e. the Red, Silver and Yellow books. However, it became clear at the conference that whilst there will be changes in the SFCs that are related to BIM, they will not include the integration of BIM within the main books, but will deal with it in the Guidance Notes.

6.1.2 JCT

In 2011 the JCT *Public Sector Supplement: Fair Payment, Transparency and Building Information Modelling* was amended. This Supplement amends the SFCs in the JCT suite of contracts, and goes a long way to showing which clauses should be changed and how those changes should be dealt with in the different SFC's. Clause 1.1[33] of the supplement amends the list of what are included as Contract Documents so that many of the JCT standard forms now include *'any agreed Building Information Modelling protocol'*. Furthermore, the supplement requires that the BIM Protocol should be included in the clauses dealing with either Employer's Requirements or Other Suitable Contract Documents.

Among the revisions contained in the 2016 JCT contracts is the incorporation and updating of provisions from the JCT Public Sector Supplement relating to Fair Payment, transparency and BIM into the main JCT SFCs (JCT, 2016: Devonshires, n.d). According to the law firm Ashurst (2016), the JCT believes that there will be an increase in the use of BIM in construction projects, now that the UK government has made it mandatory for all public sector projects to be procured using BIM Level 2; thereby obliging the parties to comply with the BIM Protocol. They (Ashurst) also point out that the JCT contracts allow the parties to choose whether to use BIM, and to agree on and prescribe a BIM Protocol, such as the CIC BIM Protocol. However, whilst any chosen BIM Protocol will constitute a Contract Document, the JCT have noted in Contract Condition 1.3, that the BIM Protocol will not take precedence over the main JCT construction contract.

Savage, (2016 para 5), points out "*that the BIM-enabling drafting incorporated into the new 2016 editions of the JCT suite is very light touch*", meaning that the parties still have to decide upon the terms of the BIM Protocol to be followed. So, it is very clear that the new revision of the JCT suite has not incorporated BIM within the body of the main contract document, but has merely made a point of accommodating the new government requirement for public procurement to comply with BIM; with the parties being free to agree on which protocol to use. There is still therefore a need for a 'bolt-on' protocol, because the main contract does not incorporate the BIM in full.

6.1.3 The AB-System

The Danish AB-system of SFCs is currently undergoing revision. In January 2012, The Confederation of Danish industry (Dansk Industri) sent their suggestions for revision of the AB-system to the Minister of Energy, Climate and Building. The following month, a range of organisations within the construction industry wrote to the same minister with their thoughts on the revision and on what it should contain. In April 2012 there was a hearing on the revision of the AB-system for the organisations in the industry that resulted in a

[32] At the OICE International Forum on BIM held in Milan

[33] Public Sector Supplement – Fair Payment, Transparency and Building Informtion Modelling, 2011 Public Sector Supplement. Published September 2011, updated December 2011, Sweet & Maxwell, London

collective letter being sent, in November, from all of the industry to the Minister of Energy, Climate and Building requesting a meeting, as the signatories were agreed upon the revision.
The then Minister of Energy, Climate and Building, Rasmus Helveg Petersen, formed a committee tasked with revising the AB-system. The revision will only be finalised when the entire committee has agreed on everything, because of the status of 'Agreed Documents' see Section 2.1.5. The committee's mission statement,[34] based on the agreed revisions, was published in September 2014 and sets out the reasons for, and purpose of, the revision, with a timeframe for the project of 3 years.

The revision that the collected organisations had agreed on in 2012, concerned lowering the guarantees for the contractor, adjusting the SFC's for the new statute of limitations, proposals on early delivery, etc. There is nothing in the letter and proposals that directly includes BIM, although they did request that the revision take into account, *'Managing function supply and challenges of the classic division of labour between client's representative, material suppliers and contractors'*. (Sirius Advokater, 2013 p.8). This suggests that collaboration between parties is an area of interest for the new revisions, and perhaps even early contractor involvement in the process. The NBS published their 2016 International report on BIM (NBS, 2016), which shows that Denmark is ahead of other countries when it comes to awareness and usage of BIM, and tops the rankings ahead of the UK, Canada, Japan and the Czech Republic in this area. Indeed, Denmark compares very favourably with the other countries surveyed in every category in which the country provided results. These areas included the likelihood of increased BIM usage in the next 3-5 years, production of 3D visualisations using BIM, appreciation of the need for changes in work flow, practices and procedures and the belief that clients will increasingly insist on the hiring of BIM users. When taking this into account and looking at the recent revisions to both the JCT and FIDIC SFCs, it would seem wise for the committee revising the AB-system to at least mention BIM. This idea is supported by Vedel and Jensen (2012) who express concern that AB92 has failed to keep up with changes in the industry for anything other than simple projects, and call for a new standard form of contract in Denmark more suited to projects of technological complexity that require a higher level of cooperation. Despite efforts to contact the committee in order to ask questions about their intentions in respect of incorporating BIM and collaborative working in the forthcoming AB suite of SFCs, they have rejected my request, because they do not wish say anything about it until they have fully agreed on the new AB-system.

7. Empirical Investigation

7.1 The Research Method in this Study

As mentioned earlier (Section 1.4), the empirical work in this study was undertaken using a mixed methods approach, combining qualitative and quantitative methods.
Qualitative research explores a subject for the purpose of collecting information and data from which theories can emerge (Fellows and Liu, 2008). This study uses qualitative research in the form of a literature review, as a means of identifying key areas of concern, which are later evaluated through a quantitative study; thus ensuring that the quantitative study is as appropriate as possible. Pre-defined areas from the literature review therefore informed the questions in the subsequent quantitative study.

Semi-structured interviews were originally intended in order to bridge the gap between the two extremes and to provide an opportunity to discuss issues and therefore probe them more deeply. However, despite efforts to arrange appointments, these were not possible due to a lack of time on the part of the few informants that have 'hands-on' experience of the subject matter within the Danish construction industry. As an alternative, a discussion was started in two separate Linked-In Groups, but these also failed to generate any substantial contributions to the overall dataset.

Given the above data collection problems, the decision was taken to undertake a quantitative study by means of a questionnaire consisting of closed questions, based on the results of the literature review. The quantitative data collected from a closed-response questionnaire ensures that the results are considerably easier to analyse

[34] Kommissorium for revision af AB-systemet. Fremtidens konkurrencedygtige byggeri via kvalificerede aftaler, 22. September 2014
https://www.trafikstyrelsen.dk/DA/Byggeri/%7E/media/3FAB8605E7494468B732CB01737719BB.ashx

than would be the case if open questions were used (Fellows and Liu, 2008). Although the questionnaire produced quantitative data, the data are from human opinions, experience and decisions. Consequently, the method cannot be said to result in completely objective and accurate observations. However, the reliance of the subject matter on individuals' personal experience and perceptions made it impossible to structure the questionnaire in a way that would produce purely objective data.

7.1.1 Population and Sample

A survey population is defined as, "*all of the individuals, firms etc. that are of interest to the researcher, with the sample being a pre-selected proportion of the population, which will form a representative group for the purposes of the research*" (Marczyk et al, p.18).

"*A sample frame is a population structure from which the research sample is selected*" (Fellows and Liu 2008, p.136). The sample frame for this study was qualified construction professionals currently working in the construction industry.

The participants in the quantitative study were selected through convenience sampling, which is appropriate when "*the nature of the research question(s) and the population do not indicate any particular form of sample*", and it enables the collection of data from convenient and easily accessible respondents (Fellows and Liu 2008, p.162). This technique provides quick data collection and contact with a potentially large sample size and is therefore appropriate for this study.
Potential participants for the survey were all required to be fully qualified (licensed) professionals working in either the public or private sectors and on either side of the contract i.e. employed by either the Client or the Contractor. The professional fields from which they were drawn included architecture, civil and mechanical engineering, quantity surveying and construction project management.

The key legal areas for consideration in this dissertation were initially derived from the study undertaken by Eadie et al (2015), however, the empirical investigation in this dissertation differs from their study. Eadie et al. restricted their survey to the largest 100 contracting firms in the UK. In contrast, this study collected data from the full range of construction professionals who represent both sides of the contract i.e. both contractors and clients, and thus encompasses a wider range of BIM users. Moreover, the survey undertaken for this dissertation targeted individuals working in a wide range of geographical locations, rather than being restricted to firms in the UK. Whilst some, or perhaps even all, of the firms in Eadie's study will have international experience, the study provides no evidence from which this can be confirmed or assessed. On the other hand, the empirical study carried out in this dissertation, should only be considered as a 'rough and ready' snapshot of professional opinions related to key items identified from within this study. As such it does not provide any generalizable results, but rather provides some indicators of acquaintance with BIM across the construction professions, and an insight to the strength of opinions held by those professionals concerning selected potential legal issues.

The sample consisted of 119 individuals currently based in 25 countries, each of whom were contacted by email. The participants were personal acquaintances of a Fellow of the UK Chartered Institute of Building, who facilitated the email contact. The survey itself was formed in Survey Monkey® and uploaded to the Internet. Potential participants received a link to the URL in the invitation email they received. Forty three responses were received, which is considered adequate given the nature of the data and the fact that convenience sampling does not permit anything more complex than descriptive statistical analysis; which is considered suitable for providing the insights required for this study.

7.1.2 The Survey Questionnaire

The questionnaire used to collect data was designed to be as simple as possible for respondents to complete, whilst containing complex information. This is in line with Denscombe's (2002) recommendation that questionnaires should contain different sections and simply structured questions. A copy of the questionnaire is included at Appendix A.

The questions addressed two separate kinds of information; demographic information about the respondent,

along with the individual's familiarity and experience with BIM; and the key legal issues being investigated. The demographic information provides information on the respondent's profession, years of experience in the industry, geographic location and familiarity and experience with BIM. According to Blaxter et al. (2005), this helps to establish the credibility of the participants: although this was in any case ensured by the selective approach taken when initially identifying the participants.

The second part of the questionnaire was designed to collect respondents' views on central issues related to the key legal concerns earlier identified in the literature review. Participants were asked to express their strength of feeling in response to eighteen statements related to the nine key areas. This part of the questionnaire required respondents to indicate their strength of feeling on a 5-point Likert scale, ranging from Fully agree to Completely disagree, which allows for greater nuancing of answers than can be achieved through a simple Yes/No option and thus enables a better quality of analysis. The full data set is attached at Appendix B.

7.2 Data Analysis

7.2.1 Demographic Information

Following the invitation to participate in the survey, a total of 43 responses were received from the 119 invitations sent out: a response rate of 36%. The spread of professional backgrounds was:

Profession	Proportion of Responses
Engineers	36%
Architects & other design professions	24%
Quantity Surveyors & Project Managers	21%
Contractors	19%

7.2.2 Age of respondents

The majority of respondents fell into the 26-40 year age group, with no respondents being under the age of 25 years.

Age Range	Proportion of Responses
16-25 years	0%
26-40 years	55%
41-55 years	33%
Over 55 years	12%

7.2.3 Time employed in the construction industry

The length of time that respondents have been employed in the construction industry shows that two thirds have more than 10 years of experience and one third more than 20 years of experience. This provides some assurance of the validity of responses based on experience.

Employment in construction Industry	Proportion of Responses
0-5 years	5%
5-10 years	25%
10-20 years	35%
Over 20 years	35%

7.2.4 Current country of employment

People working in 15 different countries responded, representing a wide geographical spread and a mixture of Civil and Common Law jurisdictions.

Current country of employment
Canada
Denmark
Ghana
Ireland
Kazakhstan
Kuwait
Libya
Netherlands
Qatar
Saudi Arabia
Tanzania
United Arab Emirates
United Kingdom
Venezuela
Zambia

7.2.5 Familiarity with, and Experience of the BIM Protocol

Only 33 % of respondents were familiar with the BIM protocol and only 12% actually had experience of working with it. This was a disappointing result given the length of construction industry experience that most respondents have. This result suggests that BIM is still very much in its infancy despite the emphasis being placed on its use by some countries e.g. the UK.

This result (through a lower sample size) has weakened the validity of responses to questions that required a response based on actually working with BIM. However, it has not influenced the specific results, as the questionnaire included a "Don't Know / Not applicable" box and these results were not part of the calculation used where respondents had no experience.

7.3 The Key Legal Questions

The second part of the questionnaire related to significant issues within the key legal areas identified in the literature review. Respondents were asked to express the level of their agreement on a 5-point scale ranging from Fully agree to Completely disagree. Responses were weighted such that 'Fully agree' scored 1, 'Somewhat agree' scored 2 and so on until 'Completely disagree' scored 5. Thus, the average weighting for responses to each question determines the overall opinion of the group, and the closer the average is to 1, the greater the respondents' agreement with the statement. "Don't know/ not applicable" are excluded from the calculation, so that only data from those who actually answered the question are included in the weighting.

In the tables reproduced below, the numbers in each of the boxes refer to the number of respondents that ticked that box.

7.3.1 Model Ownership

Table 3.1: Opinions on ownership of the BIM Model

	1	2	3	4	5		
	Fully Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Completely disagree	Don't Know / or not applicable	Average Weighting
The Architect should own the completed BIM model?	10	13	8	6	5	1	2.34
The Client should own the completed BIM model?	16	16	6	3	1	1	1.98
The Contractor should own the completed BIM model?	3	6	14	6	12	1	3.44

Almost 80% of respondents did not believe that the contractor should own the completed BIM model, whilst 76% believed, at least to some extent, that the Client should own the model, which corresponds with the findings in the study by Arensman and Ozbek (2012). Interestingly, only one of the ten responding architects fully agreed that their profession should retain ownership, and with the average overall strength of opinion for this specific professional group at 3.00, the suggestion is that the architects themselves are unconcerned about owning the model, and that for construction professionals in general this is not a critical area of concern. This seems odd, given the considerable debate within in the literature: perhaps it is the distinction between owning the model and being able to utilise, or owning the IP within it that is considered to be the critical issue.

7.3.2 Sharing copyright data & IP rights*:*

Table 3.2: Opinions on sharing of copyright and IP rights

	1	2	3	4	5		
	Fully Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Completely disagree	Don't Know / or not applicable	Average Weighting
It is important for me/my firm that we retain the intellectual property invested in the completed BIM model	10	18	14	1	1	8	2.20

Related to the issue of model ownership is the matter of copyright and IP rights. Respondents generally believe that retention of their IP is important, and is more important than the issue of who owns the actual model; indeed only one of the respondents believed that it was unimportant. However, whilst the four professional groups all tended to agree on the importance of retaining IP, the architects expressed lower concern about this than either the engineers or contractors. Without further evidence it is impossible to determine why this is the case, although one might speculate that architects tend to be more concerned with aesthetic matters and less with those related to business and legal issues. Respondents were not asked whether they were concerned about IP rights only as far as their own contributions are concerned, or how they feel about rights in cases of joint authorship. In retrospect this was an error, as it is in this latter area, identified by Thomas (2013) as problematic in terms of copyright and in connection to overall ownership of the model, that BIM may experience difficulties when Level 3 Maturity is reached, as acknowledged by the UK BIM Working Party (2011).

7.3.3 Incorporation of BIM into the contractual relationship of the parties

The suitability of BIM for different procurement routes was addressed by two questions in order to determine the appropriateness of BIM for both traditional single stage tendering i.e. where the contractor only sees the design when invited to tender, and other procurement routes in which the contractor is involved earlier and often contributes to the design.

Table 3.3: Suitability of BIM under different procurement methods

	1	2	3	4	5		
	Fully Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Completely disagree	Don't Know / or not appllicable	Average Weighting
The BIM Protocol is mostly suitable for traditional dsign-bid-construct projects	4	6	7	10	6	10	3.24
The BIM Protocol is mostly suitable for procurement that involves early stage contractor involvement	4	14	9	5	3	8	2.69

Whilst respondents leaned more towards believing that BIM is more appropriate for projects that involve the contractor early in the process, the strength of the difference of opinion is perhaps less than might have been expected, and only the contractors made a clear distinction between BIM's suitability under different procurement routes. That contractors believe BIM is more suitable for projects in which they are involved early makes sense, as early involvement provides them with a greater degree of certainty and understanding, thus making their job in constructing the building easier. However, the overall result and attitudes of the other groups surveyed is rather disappointing. Half of the architects surveyed responded 'Don't know'. This adds some weight to the suggestion at 7.3.2 above, that this group is less concerned with practical matters. With increasing emphasis being placed on the industry to work in a more collaborative manner (Latham, 1994; Egan, 1998; CURT, 2004), and the introduction of BIM as a means of achieving this, this result could possibly be construed as illustrating the depth of the problem facing the construction industry in attempting to improve its long held image of fragmentation and adversity.

7.3.4 Responsibility during evolution of the model

Table 3.4: Responsibility when entering information into the model

	1	2	3	4	5		
	Fully Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Completely disagree	Don't Know / or not appllicable	Average Weighting
BIM adequately allocates adequate responsibility to everyone that enters information into models?	3	15	8	5	4	8	2.77

With an average weighting of 2.77, overall opinion on whether BIM adequately allocates responsibility to those entering information into the model, does tend to fall on the positive side of the 2.50 midpoint, but not by a great margin: in fact the architects response to this statement was negative. This suggests that there is enough doubt about the issue for it to become a cause for dispute during projects and raises issues concerning design liability. One concern here might be that the difficulties of identifying specific individuals responsible for any errors (Sieminski, 2007) may be increased as non-licensed individuals make contributions to the model (Thomas, 2013).

7.3.5 Additional Project Insurance and Risk

Table 3.5: Project Insurance and Risk

	1	2	3	4	5		
	Fully Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Completely disagree	Don't Know / or not appllicable	Average Weighting
Working with BIM has (or would be expected to) caused my firm to make changes in our professional indemnity insurance	8	14	7	1	0	13	2.03
Working with BIM has (or would be expected to) caused my firm to make changes in our insurance for loss of data, errors in the model or system failures	9	11	6	3	0	12	2.10
Working with BIM has (or would be expected to) caused my firm to make changes in our insurance due to 3rd party access to and modification of the model	7	13	6	2	2	14	2.3

The vast majority of respondents believe that the use of BIM will increase risk to the extent that they as individuals, or their firms have, or will need to, make changes in their insurance policies. This applies to policies covering professional indemnity, loss of data, errors in the model, system failures and any access and modification to the model by a 3rd party. Although this result runs counter to Lesny and Reidy's (2013) suggestion that insurance companies have become used to BIM projects at Level 2 and no material change is expected in terms of the parties risk profiles, respondents were not asked to differentiate between the implications for risk and insurance between BIM Levels 2 and 3. A different picture may have appeared had the survey made such a distinction, as Level 3 BIM projects are likely to raise very different liability issues to those found at Level 2. Regardless of this omission in the survey, we might reasonably presume that any changes to insurance policies will incur additional costs, and so it will be important for the BIM Protocol to address the issues raised in the literature review, not only to deal with potential legal problems, but also to ensure that additional costs of using BIM remain at a level considered to be reasonable enough for engagemnent in BIM contracts.

7.3.6 Standard of care

Table 3.6: Standard of Care

	1	2	3	4	5		
	Fully Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Completely disagree	Don't Know / or not appllicable	Average Weighting
BIM increases the Standard of Care that everyone is expected to apply (from the Client's viewpoint)	12	20	3	0	2	6	1.92

Agreement on the suggestion that Clients will expect a higher standard of care on BIM projects is overwhelming, although not unanimous. This aligns with the findings of Arensman and Ozbek (2012) i.e. that clients will expect a higher duty of care. However, the results from the question about the use of indemnification agreements and other methods of transferring risk in the following section on Design Liability, also suggest that there is likely to be some substance to Simonian & Korman's (2010) view that any increased level of risk will be transferred in order to reduce professional liability.

7.3.7 Design Liability

Table 37: Design Liability

	1	2	3	4	5		
	Fully Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Completely disagree	Don't Know / or not appllicable	Average Weighting
When working on BIM projects, my firm uses an indemnification agreement or other methods of transferring risk, in order to reduce our professional liability	7	7	9	3	1	16	2.41
My/My firm's overall level of design liability is greater under BIM than under other contract forms	4	12	8	5	0	13	2.48

In answer to both statements concerning risk transfer and the overall level of design liability under BIM, results were remarkably similar with no one disagreeing that their design liability is greater under BIM, and only one respondent (from the project management group) reporting that their firm did not use some method of transferring risk in order to reduce their own professional liability. Even though the number of respondents answering "Don't know" was high for both of these questions, the results go some way to supporting the idea that construction industry professionals are risk averse and seek to place liability on others rather than themselves. Such a situation is likely to encourage conflict and to hinder open collaborative working.

7.3.8 Software liability

Table 3.8: Software Liability

	1	2	3	4	5		
	Fully Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Completely disagree	Don't Know / or not appllicable	Average Weighting
I have **not** experienced any interoperability problems between systems when exchanging data and information with others on a BIM project	0	4	10	10	5	14	3.55
I think that BIM contracts should contain a clause that provides a warranty for the integrity of electronic data transmission, or any liability for corruption or alteration occurring after transmission	11	20	4	2	1	5	2.00

Most respondents had either already experienced, or expected to have interoperability problems in the use of software on BIM projects; none believed that this would not occur. Of the four professional groups, only the project managers showed any positive expectations in this regard, and then only just. The vast majority believed that BIM contracts should include some kind of warranty for the integrity of electronic data, which supports Mosey (2016) who advocates for clarification of BIM-related software processes within the contract documents to ensure balanced risk allocation.

7.3.9 Additional Issues

Two final questions were put to the respondents concerning the integration of BIM within SFCs and to check their awareness of the differences likely to affect the application of BIM according to the jurisdiction under which the contract is formed.

Table 3.9: Additional issues

	Fully Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Completely disagree	Don't Know / or not applicable	Average Weighting
I think that the BIM Protocol should be integrated within the standard form contracts rather than being an 'add-on' to them	20	10	4	2	2	5	1.84
There are differences between BIM's application in countries depending on whether their legal system if based on common law or civil law	10	5	12	1	0	15	2.14

The majority of respondents believe that it would be better to integrate the Protocol into the main Standard Form of Contract, with only two respondents completely disagreeing. Although most of those who expressed an opinion were either fully or marginally aware of BIM's different applications depending on legal jurisdiction, the high number of "Don't Know/Not Applicable" responses makes it impossible to properly gauge the extent of this knowledge as there is no means of determining from the data whether a respondent does not know, or only believes that the matter is not applicable, because they only work within their own national boundaries.

7.4 Comment on the Empirical Study

The short empirical study presented above was intended to augment a number of key legal issues raised in the literature review, and determine whether the areas identified in previous academic studies are also considered relevant, and of concern, by qualified and experienced construction professionals drawn from all disciplines, and from both the Client and Contractor sides of the contract. Whilst the sample size and brevity of the survey undertaken make it unrealistic to draw any hard conclusions about the issues, the results do provide a rough idea of the perceptions and experience of those who are employed at the 'sharp end' of the industry and who are likely to have to deal with problems that arise during the execution of projects under BIM.

Overall, interpretation of the results of this small empirical study combined with the literature review suggest that the key legal areas identified in earlier works are of concern to those practising in the industry, and that the integration of the BIM Protocol into any of the SFCs will require a clear structure providing specific understanding of the roles and risk allocation of the parties in order to minimise misinterpretation and unnecessary delays that result from disputes. At the current time the Protocol appears to lack such specificity in the areas identified above.

8. Conclusion

This study was carried out with the intention of providing an assessment of the legal issues that are likely to arise with the use of Building Information Modelling in construction projects carried out under standard forms of contract. For the purposes of this dissertation standard forms published by three organisations have been reviewed i.e. those of FIDIC, JCT and the AB-system. In doing so, the work has considered the implications of both domestic and international usage and the effects of BIM under both Civil and Common Law jurisdictions.

In order to fulfil the overall aim of the study, it was first important to describe and/or clarify the central elements involved i.e. the sources of law under Civil and Common Law jurisdictions; standard forms of contract, both as a concept and more specifically related to three particular forms (FIDIC, JCT and the AB-system), which highlight the differences between agreed documents and adhesion contracts, as well as being contracts designed for both Civil Law (FIDIC & the AB-system) and Common Law (JCT) jurisdictions; and Building Information Modelling in terms of its historical development and the debate concerning whether it should be defined as an activity, a product or a system.

Having established a sound knowledge base in each of the aforementioned areas the dissertation then turned to the main concern of the study i.e. the key legal issues related to the adoption and implementation of BIM

on construction projects. Although BIM is a relatively new concept and approach within the construction industry, it has already created considerable interest amongst industry professionals, lawyers and academics, because of the fundamental changes that it introduces to the design process, work planning, working relationships and potentially to procurement methods. These changes affect not only the main parties to the contract, but also have ramifications across much of the supply chain. However, the technology involved with BIM has developed much faster than developments and updates to the standard form contracts commonly used for construction works, and as a result, numerous legal issues arise that either already have, or could potentially have, implications for all involved. Moreover, the speed at which change has occurred means that at present there is little or no relevant case law pertaining to BIM (Arensman & Ozbek, 2012).
In an attempt to 'plug the gap' and provide the necessary legal cover for contracting parties under BIM, a number of protocols have been developed as addenda to the main contract and have become contract documents in their own right. One of the best known and widely used of these protocols is the CIC BIM protocol that has been developed in the UK. Despite the widespread adoption of this protocol Manderson et al (2015) comment on the need for changes to the actual standard form contracts themselves that reflect the new reality and there is a growing literature expressing concerns about the legal implications of the changes embodied in BIM contracts.

As established in Section 2.1 on sources of law, standard forms of contract are not a law, but they can be considered to be a source of law. Having determined this point and in light of the most recent revisions to the FIDIC and JCT SFC's, we see that *de lege lata* remains adequate for the introduction of BIM and therefore it is not the law that needs to change, *de lege ferenda*, but rather, the developing nature of BIM and the legal issues that arise from BIM's introduction as a model, process and contract document, that need to be addressed in the SFC's. In this respect *de lege ferenda* does relate to SFCs in their role as a source of law. Until BIM matures it is probably safer to retain the protocol as a 'bolt-on' addendum to ensure that BIM and its protocol do not take precedence over the main contract.

Nine key areas of legal concern were derived from an earlier study by Eadie et al (2015) and these were subjected to a literature search and critical review in order to determine the nature and extent of the concerns voiced from within the legal profession and academic commentators about potential inconsistencies, confusion and gaps in liability due to a lack of express terms dealing with the process and risk allocation in BIM projects. Following the literature review, the research departed from the normal doctrinal (legal dogmatic) approach to legal scientific study and employed an empirical methodology based in legal sociology. This was necessary in order to gain the views and opinions of professionals within the construction industry who are, or will be, actually affected by the legal issues identified. This approach has been successfully used in other recent legal scientific studies in Denmark by Henschel (2016) and in Finland by Sund-Norrgård (2016).

The empirical study collected data from 43 fully qualified construction professionals representing all the main disciplines and based in 15 countries, in which both Civil and Common Law jurisdictions prevail. The results indicated that the issues identified in the literature are of concern to those practising in the industry.
The main question asked by this dissertation (Section 1.2) was *"Does the BIM protocol provide adequate specificity of the role and risk allocation required for the legal safeguard of contracting parties using standard form contracts for construction work?"* Results from the literature review and empirical study make it clear that the integration of the BIM Protocol into any of the SFCs will require a well-defined structure providing specific understanding of the roles and risk allocation of the parties, in order to minimise misinterpretation and unnecessary delays that result from disputes. The evidence suggests that the answer to the question is that such specificity is currently lacking from the Protocol.
Whilst serving a useful purpose as a contract document, the protocol is still an addendum to the main standard form contract. At present this may not seem to be a problem, but with very rapid technological change and developments in the industry, one might wonder how long it will be before the existing standard forms e.g. JCT, FIDIC and perhaps even the AB-system etc. are littered with addenda designated as contract documents, in order to ensure that the legal implications of all new developments are covered. It is to be hoped that the Protocol will be a temporary 'patch' until BIM has matured sufficiently for future revised editions of the standard forms to fully integrate BIM, thus removing the need for such a 'bolted-on' protocol.

From the above it can be concluded that the overall aim of this study has been achieved i.e. to identify & investigate the potential legal issues associated with BIM that will need to be addressed if standard form contracts for construction projects are to function without the need for a separate protocol.
However, although both FIDIC & JCT have issued revised SFCs in 2016, neither of them has fully integrated BIM or the protocol within the contracts. FIDIC have consigned BIM to the guidance notes rather than incorporating it within the main contract clauses, and whilst the new JCT SFCs incorporate the use of BIM in their main contract, the parties are still required to agree on a protocol. At present, the AB-system is still undergoing revision and no information is available concerning the manner in which the revised AB-system will deal with BIM.

Limitations of the Study

This dissertation has focused on the legal issues related to the implementation of BIM at a basic level. In doing so, it has not considered the fine detail of all the increasingly wide range of delivery methods available to clients. This limits the extent to which we can identify specific legal issues that may apply when using BIM within varying procurement systems.
In terms of the empirical work, the failure to arrange interviews reduced the amount of quality data collected. Whilst the closed-question survey provided interesting and relevant data, it is no substitute for the in-depth material that can be gained from interviews in a study such as this. Moreover, the small size of the sample, and the high number of respondents without experience of BIM, suggests that in spite of good intentions and effort, this method of data collection was not wholly successful and may have influenced the reliability of the results. However, the purpose of the survey was simply to gauge the perceptions of those who are employed at the 'sharp end' of the industry and who are likely to have to deal with problems that arise during the execution of projects under BIM. Thus no testing for statistical significance was required, and a 'snapshot' of opinions related to predetermined sets of issues is considered to make at least a small contribution.
In respect of the key legal issues investigated, the choice can be criticised for being derived from an earlier study, rather than being composed from scratch. However, in the time available for the preparation of this dissertation there was little option, which is unfortunate because in adopting and adapting a previously identified list, this work may well have omitted other issues (although none that were more than sub-elements of the issues chosen were uncovered during the literature search).

Recommendations for Future Study

One lesson learned from this study is that both the technology and use of BIM are still developing, and it is clear that BIM is not yet a finished 'product'. Furthermore the empirical study suggests that despite the rapid development of BIM and the move by several governments to mandate its use for public sector projects, current awareness and implementation of BIM is not geographically uniform and varies greatly from country to country.
Thus, pushing for the incorporation of BIM into the standard form of contract as it currently stands is possibly premature, as amending or revising any standard form contract requires great care to ensure that minor changes do not inadvertently alter the risk allocation. However, the limitations of the current study as identified above, do show that there is clearly room for a deeper analysis, as this study is far from conclusive. Such a study might identify and review a wider range of legal issues and perhaps even link those issues to their implications for the working practices of those working on BIM projects as well as for the companies that employ them e.g. the legal implications of BIM for human resources management.

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APPENDIX A

The Survey Questionnaire

CONTRACTUAL ISSUES ASSOCIATED WITH BIM

Please indicate your professional background

Architect	Engineer(of any type)	Other designer	Contractor	Construction Manager	Other construction profession

Please indicate your age

16-25 years	26-40 years	41-55 years	Over 55 years

How long have you been employed in the construction industry?

0- 5 years	5 - 10 years	10 - 20 years	Over 20 years

Please state the country in which your current work is based

Are you familiar with the CIC BIM Protocol?

YES	NO

Have you had experience of working with the CIC BIM Protocol?

YES	NO

Please indicate your strength of agreement with the following statements:

	1	2	3	4	5	
	Fully Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Completely disagree	Don't Know / or not applicable
The Architect should own the completed BIM model?						
The Client should own the completed BIM model?						
The Contractor should own the completed BIM model?						
The BIM Protocol is mostly suitable for traditional dsign-bid-construct projects						
The BIM Protocol is mostly suitable for procurement that involves early stage contractor involvement						
The BIM Protocol is equally suitable for all proucrement metthods						
My firm has policies and procedures to ensure the security of electronic data						
My firm conducts regular continuous risk assessment and vulnerability testing of its computer system						
BIM adequately allocates adequate responsibility to everyone that enters information into models?						
It is important for me/my firm that we retain the intellectual property invested in the completed BIM model						
Working with BIM has (or would be expected to) caused my firm to make changes in our professional indemnity insurance						
Working with BIM has (or would be expected to) caused my firm to make changes in our insurance for loss of data, errors in the model or system failures						
Working with BIM has (or would be expected to) caused my firm to make changes in our insurance due to 3rd party access to and modification of the model						
BIM increases the Standard of Care that everyone is expected to apply (from the Client's viewpoint)						
When working on BIM projects, my firm uses an indemnification agreement or other methods of transferring risk, in order to reduce our professional liability						
My/My firm's overall level of design liability is greater under BIM than under other contract forms						
I have **not** experienced any interoperability problems between systems when exchanging data and information with others on a BIM project						
I think that BIM contracts should contain a clause that provides a warranty for the integrity of electronic data transmission, or any liability for corruption or alteration occurring after transmission						
I think that the BIM Protocol should be integrated within the standard form contracts rather than being an 'add-on' to them						
There are differences between BIM's application in countries depending on whether their legal system if based on common law or civil law						