Modification of Standardised Construction Contracts for the Adoption of Building Information Modelling: analysing the case of the NSW Government GC21 Construction Contract.

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Statement of Originality

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying subject to the provisions of the Copyright Act 1968.

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Acknowledgement

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Abstract

The emergence of Building Information Modelling (BIM) within the Architectural Engineering and Construction (AEC) sector has triggered reconsideration of the procurement process for constructed assets. Although the benefits of its use -- collaboration, productivity gains and improvements to information quality -- are well understood by the BIM community, adoption rates within the AEC sector remain low. Various ideas have been advanced to explain this, ranging from high implementation costs, low returns-on-investment, sector-wide risk aversion and low innovation uptake, through to the legal implications of implementation within current contractual frameworks.

This research addresses the last of these by first identifying, and then mapping BIM-related legal and contractual concerns against a widely used standard form of construction contract to determine what changes are required to facilitate BIM integration within the construction procurement process. An analysis of the relevant literature discussing the legal implications of BIM and Information Communication Technology (ICT) implementation identifies 10 significant thematic areas and describes them in detail. These then become the theoretical framework underpinning a Qualitative Content Analysis (QCA) of the GC21 standardised Australian construction contract.

The key findings of the analysis are: a) that the GC21 contract embodies a traditional approach to design and construction that inhibits true collaboration amongst the project stakeholders; b) that by adopting a traditional approach the designer assumes further risk when undertaking and completing the design using BIM without due consideration for the additional efforts or exposure to litigation; c) that the contract does not assign any contractual status to the Building Information Model, and; d) that the contract cannot recognise this model as a contract document. In the case of the GC21 contract, this necessitates the submission of standard hardcopy drawings, specifications and proprietary Computer Aided Drawing (CAD) files, irrespective of the adoption, and subsequent accuracy/functionality, of a BIM system of work.

The significance of this research is threefold: firstly, it maps the range of legal concerns as expressed by various industry stakeholders; secondly, it develops them as a tool to analyse existing contracts and propose changes, and; finally, it provides
a reliable platform for further research – particularly the assessment of other standard conditions of contract.
Publications directly relating to this thesis

The following papers were written during candidature, reporting upon various components of the research. This was undertaken in order to a) obtain confirmation - using double blind peer review - of the relevance and currency of the research topic, and b) obtain expert feedback and endorsement of research outputs.

The candidate acknowledged the supervisory guidance he received through the co-authorship of these papers. The co-authors confirm that their contribution to these papers were limited to guidance and editing, and that the core intellectual content was generated by the candidate.


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1 INTRODUCTION

1.1 Overview of the Study

The emergence of Information and Communication Technologies (ICT) specifically tailored for the Architectural Engineering and Construction (AEC) sector has offered one means of both improving the quality of service and information provided to clients and increasing productivity for various project delivery tasks (Ahuja, Yang, & Shankar, 2009; Duyshart, Walker, Mohamed, & Hampson, 2003). However, within the AEC sector there remains a persistent reluctance to adopt many of the ICT systems and processes available to the industry (Davis & Songer, 2008). This limited adoption has been attributed to a range of issues including the risk-averse nature of the industry (Skitmore & Lyons, 2004), the costs for implementation in an environment with fluctuating profit margins (Aranda-Mena, Crawford, Chevez, & Froese, 2009; Ormerod, 2006), a general lack of awareness and understanding of ICT, changes required to existing practices (Sebastian, 2011b), pure resistance to change (Arayici et al., 2011) and the legal implications on current contractual frameworks and relationships (Haynes, 2009b).

As project budgets become tighter, the drive for efficiency and increased productivity has become vital. The adoption of appropriate ICT business solutions is one means of improving productivity. For example, Egan (1998), in the widely quoted report into the UK construction industry, set an aspirational goal of a 30% increase in productivity in the sector and singled out the use of ICT as one means of achieving this level of improvement. In Australia, the Information Integration Group (1994) identified the need for the AEC sector to take up new computer technology so it could remain capable of delivering projects in the national and international markets. At an Australian state level, the NSW State Government (NSW Public Works and Services, 1998) published a discussion paper and strategy outlining how construction processes could be improved using Information Technology (IT) and singled out the “virtual project” as one process that would be highly beneficial.

Building Information Modelling (BIM) is one example of an ICT that has emerged, which has the potential to address a variety of the criticisms of the AEC sector. Whilst the benefits of implementing BIM, particularly in a collaborative environment, have been well documented by authors such as Demian and Walters (2013), Eastman, Teicholz, Sacks and Liston (2011), Jung and Joo (2011) and Azhar (2011), its widespread adoption within

To overcome this reluctance to adopt BIM, clients, governments and their various agencies are mandating the use of BIM throughout the project delivery process. For example, the UK government requires the use of BIM for all major projects by 2016 (HM Government, 2011). In Australia, the South Australian Department of Transport Industry and Infrastructure has set out a roadmap of BIM integration into its projects (Holzer 2012). Other examples include NSW Procurement requiring the innovative use of design technologies such as BIM, to achieve a rating of “superior” as one of its matrix criteria for rating contractor performance (NSW Procurement 2012), and the Transport for NSW BIM roadmap (Transport for New South Wales, 2014).

The drive towards industry-wide adoption of BIM has triggered the establishment of a range of BIM working groups whose aim is to facilitate the transition to a digital collaborative environment. As a result, there has been a significant amount of research examining the various barriers to adoption, including the legal aspects of integrating BIM into the procurement cycle (Ashcraft, 2008; Larson & Golden, 2007; McAdam, 2010b; Olsen & Taylor, 2010). From this research, coupled with the mandating of BIM by government, one key issue that has confronted the implementation of BIM in the procurement process is how the perceived BIM legal issues will influence existing standardised contracts.

1.1.1 BIM Research Focus

This study approaches the investigation of the legal barriers facing Building Information Modelling from a different angle; this research categorises the current perceived legal risks and uses these categories to analyse and identify the possible changes to a standardised construction contract, which would facilitate collaborative BIM deployment. As governments and clients move towards mandating the collaborative integration of BIM into the construction process, a clear understanding of how the legal issues will change the various participants’ risk profile, obligations and liabilities is critical to ensure the achievement of fair and equitable outcomes for all project participants.

1.2 Key Terms

To establish a coherent framework for this research a number of key terms are defined in this section. It firstly defines the term Building Information Model and differentiates
between the concepts of Building Information Model, Building Information Modelling and Building Information Management. The concepts of Construction Procurement and Construction Contracts are described in the final part of this section.

For the purposes of this study, it was considered unnecessary to create new definitions of common terms and concepts relating to the topic. Instead, a review of the literature was undertaken and appropriate definitions adopted which fit the overall relevancy in relation to the topic under investigation. In some instances, the subtle differences between competing definitions are acknowledged prior to the adoption of a specific definition for a term.

The nomenclature Building Information Modelling has now largely replaced the plethora of terms and acronyms associated with the underlying concept (Succar, 2009). However, confusion still remains as to what BIM actually is, due to the wide variety of definitions in both the academic and the wider AEC sector (Race, 2012). Aranda-Mena et al (2009) attribute the variety of definitions as a reflection of the authors’ perspective, experiences and expectations of BIM and proceed to group the various definitions into three broad categories that describe BIM as:

1. A Technology or software solution
2. A design, documentation and information management Process
3. An entirely new approach to existing practices with significant changes to procurement Policy and Methodology.

To add further, Succar (2009) considers that the value of maintaining such a wide range of terms and definitions is questionable, however, Race (2012) believes alternative definitions will continue to emerge as new and innovative uses for BIM are identified.

1.2.1 Building Information Model

Ashcraft (2008) provides one of the simplest definitions of Building Information Model, noting it is simply a “simulation of a facility”. Many other definitions build on this simple concept by describing the extent of the information embedded in the simulation and its overall function.

The National Institute of Building Sciences (2007, p.149) and later, Building SMART (2012), label the model as

“a digital representation of physical and functional characteristics of a facility.”
The Associated General Contractors of America (2006) consider a Building Information Model to be:

“a data-rich, object-orientated, intelligent and parametric digital representation of the facility, from which views and data appropriate to various users’ needs can be extracted and analyzed to generate information that can be used to make decisions and improve the process of delivering the facility.”

Van Nederveen, Benshi and Gielingh (2010 p. 2) describe a Building Information Model as:

“a model of information about a building (or building project) that comprises complete and sufficient information to support all life-cycle processes, and which can be interpreted directly by computer applications. It comprises information about the building itself as well as its components, and comprises information about properties such as function, shape, material and processes for the building life cycle”.

Song et al (2010 p. 382) detail a Building Information Model as:

“a digital representation of physical and functional characteristics of a building often based on CAD models. Construction and management of buildings and building-elements involves many stakeholders. A BIM provides for one logical place for all actual building project data (objects with attributes and interrelations, 3D representations, visualizations etc) which relevant stakeholders can share and manage during the entire lifecycle of a building”.

To ensure the definition of a Building Information Model for this research remains broad enough to encompass all of the possible uses and applications of the model, the adopted definition is the one proposed by the National Institute of Building Sciences (2007, p. 149):

“a digital representation of the physical and functional characteristics of a facility”.

1.2.2 Building Information Modelling

Examining some of the earlier definitions of Modelling, Galle (1995) used the term Computer Modelling of Buildings to describe the system which would support the digital
modelling of a facility to assist design, construction and maintenance of buildings. The system would enable the gradual generation and modification of a representation of a building. He goes further to mention that this could be an integrated system, which could support a range of tasks, users and building types.

The Associated General Contractors of America (2006), in its first edition of the guide to BIM for contractors, described it as:

“the development and use of a computer software model to simulate the construction and operation of a facility”

It further describes the resultant model as computer based, rich in data that can be used for a wide variety of analysis processes and project decision-making. The AGCA also characterise BIM as being applicable to the entire facility lifecycle.

The National Institute of Building Sciences (2007 p 150) focuses on the use of the model, defining BIM as:

“The act of creating an electronic model of facility for the purpose of visualization, energy analysis, conflict analysis, code criteria checking, cost engineering, as-built product, budgeting and many other purposes.”

Succar (2009, p357) expresses Building Information Modelling as:

“a set of interacting policies, processes and technologies generating a methodology to manage the essential design and project data in digital format throughout the building’s lifecycle”.

BuildingSMART (2012) explicitly describes Building Information Modelling as a process that considers the entire lifecycle of a facility, describing it as:

“A business process for generating and leveraging building data to design, construct and operate the building during its lifecycle.”

As highlighted by Aranda-Mena et al (2009), these definitions focus on Modelling as an Information Technology process relating to a digital depiction of a facility. Other common key phases are sharing, lifecycle and simulation. Therefore, the definition of Building Information Modelling, which is adopted for this study, is the one proposed by BuildingSMART:
“A business process for generating and leveraging building data to design, construct and operate the building during its lifecycle.”

1.2.3 Building Information Management

At a methodological level, the term Building Information Management has emerged to link the various levels of BIM implementation and coordination. The Norwegian Home Builder’s Association (2012 p 5) describes Building Information Management as the:

“Information and resource management of a project process based on BIM technology and methodology.”

BuildingSMART (2012) defines Building Information Management as:

“the organisation and control of the business process by utilizing the information in the digital prototype to effect the sharing of information over the entire lifecycle of an asset.”

1.2.4 Construction Contract

Within the confines of the AEC sector, the term “construction contract” has come to develop its own specific meaning and characteristics but still maintains the general intent of contracts (Bailey & Bell, 2011). Loots and Charrett (2009 p 23) define it as:

“any contract where one person [or corporation] agrees for a valuable consideration to carry out construction works which may include building or engineering works for another”.

A more detailed definition is the one proposed by Goldfayl (2004 p 7) which includes reference to characteristics which are specific to construction contracts:

“an agreement between an owner and a contractor that the contractor will construct a specified structure for the owner, to a specified standard within a specified time, in exchange for a specified sum of money which the owner will pay to the contractor”.

Goldfayl’s definition does however limit the contract consideration to money only and no other forms of payment.
1.2.5 Construction Procurement

The meaning of procurement with the construction sector has taken on a specific definition. The Oxford Dictionary (G. Turner, 1987) describes procurement as the process to “obtain by care or effort, acquire”. In general, this broad definition of procurement reflects the process to describe how the industry views procurement (Rowlinson & McDermott, 1999). Within the actual AEC sector, various definitions have emerged to describe the mechanics of obtaining goods and services such as Mohsinini and Davidson’s (cited in Rowlinson & McDermott 1999. p.4) view of construction procurement as:

“the acquisition of new buildings, or space within buildings, either through direct buying, renting or leasing from the open market, or by designing and building the facility to meet a specific need.”

This definition is somewhat limiting in its application as it refers purely to buildings and ignores the vast array of works which is encompassed by the AEC sector, such as bridges, roads, airports and various services required to obtain such facilities. Walker and Rowlinson (2008) note how the Counsel International du Bâtiment (CIB) Working Commission (W92) acknowledged the need for a definition broad enough to cover all aspects of the construction process which is applicable to different cultures and countries. The CIB describes procurement as:

“the framework within which construction is brought about, acquired or obtained”

1.2.6 Public Procurement

Telgen, Harland and Knight (2007) note that while the private and public sector share a common definition of procurement, there are significant differences between the sectors. These differences can be attributed to the varying demands and obligations placed on the public sector, which are over and above the general ‘value for money’ driver of procurement requirements, adding a level of complexity to the process of defining public procurement.

Prier and McCue (2009 p 329) acknowledge this complexity but propose a definition in order to provide a starting point for transcending the difficulties commonly associated with public sector procurement:

Public procurement is the designated legal authority to advise, plan, obtain, deliver, and evaluate a government’s expenditures on goods and
services that are used to fulfil stated objectives, obligations, and activities in pursuant of desired policy outcomes.

The concept of Public Procurement is examined in detail in the chapter Procurement Contracts and BIM.

As the preceding discussion of the terms BIM, contracts and procurement has shown, the adoption environment BIM is facing is complex. The inclusion of BIM into projects and contracts at a technical level requires an understanding of the environment in which the public sector operates at an operational and strategic level. The contractual implications of BIM need to be interpreted from a multifaceted perspective to ensure that the original intent of the public sector policies, objectives and obligations are achieved.

1.3 The Research Context

1.3.1 Overview

The expanding use of BIM in the construction- and facility-maintenance process, both internationally and domestically, requires an appreciation of the legal and contractual implications associated with BIM’s implementation and integration. The discussion in the following section provides a review of the existing literature focusing on the BIM legal challenges. In order to provide a context in which BIM operates, a brief history of BIM technology, its implementation, and the changes it has triggered to the design and construction process and methodologies, are discussed. The first part of this section highlights the restrictive environment in which construction operates. In addition, this section identifies various governments’ reviews and inquiries that have identified the means of improving productivity and efficiency. The goal of the discussion in this section is multifaceted; it facilitates an understanding of the current knowledge of the perceived BIM legal challenges facing the AEC sector, to enable specific gaps in the literature to be identified, and provides a context for both the investigation and the findings of this research.

1.3.2 Industry Characteristics

The AEC sector is often described as fragmented, risk averse, frequently beset by conflict and characterised by low productivity and efficiency (Eastman et al., 2011; Keung & Shen, 2013; Phua & Rowlinson, 2004). These conditions have triggered a number of government reviews, both globally and domestically, that confirm there exists an underlying culture that inhibits the operation of the AEC sector to its full potential (Egan,
1998; Gyles, 1991; Information Integration Group, 1994; Latham, 1994; Royal Commission into the Building and Construction Industry, 2002). Three recommendations common to the majority of these inquiries are the streamlining of current work practices to improve productivity (Royal Commission into the Building and Construction Industry, 2002), a shift to relationship-based procurement methods and contractual agreements (Egan, 1998; Fulford & Standing, 2014) and the adoption of Information Communication Technologies to improve project team communications (Egan, 1998). In spite of the well-known benefits of ICT, including improved productivity and increased quality of project data and communication, the AEC sector remains reluctant to adopt innovative project-based technologies (Davis & Songer, 2008).

1.3.3 BIM Challenges

Building Information Modelling is one example of an Information and Communication Technology that can act as a catalyst for positive and productive changes to the construction industry procurement processes. Contrary to the well-known advantages and benefits (Becerik-Gerber & Rice, 2010; Demian & Walters, 2013; Khanzode, Fischer, & Reed, 2007), there still remains a reluctance to adopt Building Information Modelling amongst many AEC participants (Demian & Walters, 2013). At a company level, this adoption reluctance has been attributed to the risk-averse nature of the construction industry (Skitmore & Lyons, 2004) especially when confronted by an innovation (Fox, 2011; Mitropoulos & Tatum, 2000). However, as Brewer (2008) points out, this is a prudent position to adopt when past deployments of ICT innovations have not lived up to expectations, particularly in an industry that has fluctuating profit margins and spectacular boom-and-bust cycles (Collins, 2012; Hillebrandt, 2000; Myers, 2004).

The significance of Building Information Modelling and ICT adoption has been widely acknowledged by governments of all persuasions, including at an Australian federal and state level. For example, the New South Wales Department of Public Works and Services (1998) published a discussion paper outlining the benefits and disadvantages of virtual projects including the use of digital models to convey project information between designers and the building contractor. More recently, the federal government-aligned Built Environment Digital Working Group circulated an issues paper highlighting the challenges facing the implementation of Building Information Modelling in the construction industry. (Built Environment Industry Innovation Council, 2010). In addition, the Working Group formulated a number of initiatives that would contribute to the adoption of BIM in the Australian Built Environment industry. For example, tasks that would complement existing activities such as the development of standards, training and
awareness programs and possible changes to government procurement policy that would facilitate BIM integration.

1.3.4 BIM as a Technology

As highlighted in the previous section, there is no consensus on a single BIM definition, and describing BIM is dependent on the user’s experience and perspective of the technology, processes and methodologies associated with construction procurement and BIM deployment. From a technology perspective, the formation of a Building Information Model requires the use of BIM authoring tools. These BIM authoring tools evolved from the early Computer Aided Design (CAD) systems developed in the early 1960s and the ability to digitally represent complex polyhedral forms (Eastman, Teicholz, Sacks, & Liston, 2008). Although the theory for digital building modelling emerged in the late 1970s and ‘80s its widespread integration was hindered during this time by the capacity and capability of computer hardware and software.

In spite of the technological limitations, the implementation of CAD in the AEC, aerospace and manufacturing sectors followed two dichotomous paths. The AEC sector simply moved towards replacing two-dimensional hand drafting with CAD with little or no consideration to possible changes to existing work or information management practices. Conversely, the aerospace and manufacturing sectors worked with the various CAD companies to develop integrated computer based systems to leverage the full potential of the emerging technology. It is only recently that the AEC sector has come to realise the benefits of deploying an integrated approach to managing digital information (Eastman et al., 2011).

BIM authoring tools differ from CAD software packages in one key area. Instead of drafting building elements as a combination of lines and surfaces, BIM authoring tools model the facility using objects. Specifically, the applications use Object Based Parametric Modelling to produce a model or digital representation of the built environment (Eastman et al., 2008). The objects are controlled by a set of parameters and rules that controls their geometry. For example, a window could be inserted into a wall located in the centre of the room; a rule governing its insertion could be that walls on all sides must bind the window. Other non-geometric information can also be added to the object and using the window example again, it may have to be manufactured by a specific company that has atypical costs associated with its delivery to site.
Several features characterise a parametric object. Firstly, objects are defined geometrically with rules and other associated data. Objects, when inserted into the model or undergo some form of modification automatically update the surrounding objects or geometrics based on the embedded parametric. Objects can be defined on different levels of aggregation. Objects can automatically "know" when a modification or insertion breaches a rule. Object geometry is non-redundant and is a true representation of the object (Eastman et al., 2008). In general parametric modelling views objects as intelligent and able to ‘know’ what they are and ‘how to behave’ in certain situations (Lee, Sacks, & Eastman, 2006).

1.3.5 BIM as a Process

From a process perspective Howard and Bjork (2008) note that the consensus amongst AEC industry professionals is that major changes are needed to the current design-, construction- and facilities management processes to ensure the maximum benefits of BIM are achieved. For example, new position specialisations have emerged with the implementation of BIM that specialise in the application of the technology and the management of the information workflow process (Barison & Santos, 2010; Howard & Bjork, 2008). Secondly, how information is controlled and when it is required and disseminated for decision-making in a BIM-enabled project now occurs earlier in the design process. Thirdly, Kymnell (2008) highlights how, as various BIM authoring-, analysis- and management tools steadily become integrated into the project lifecycle, many previously manual tasks and processes have become automated, thereby reducing the level of resources needed to document and manage a project. Tasks such as updating various schedules and drawings can now be automatically processed revised and distributed to the project team. Fourthly, the implementation of various BIM tools and project-analysis software requires efficient data-transfer protocols that address the limited interoperability that can exist between the various software and systems used by the project team members (Howard & Bjork, 2008; Redman, Hore, Alshawi, & West, 2012; Wong, Wong, & Nadeem, 2010).

1.3.6 BIM as a Business Process

From a methodology perspective, to achieve the full benefits of BIM requires a collaborative environment where certain design- and decision tasks are undertaken concurrently and earlier in the project delivery process (American Institute of Architects, 2007; Eastman et al., 2011; Kent & Becerik-Gerber, 2010; Sinclair, 2012). As Kent and Becerik-Gerber (2010 p. 815) point out:
“BIM is not only a tool but also a process that allows project team members an unprecedented ability to collaborate over the course of the project from early design to occupancy”.

It is widely accepted that traditional procurement methods and the fragmented nature of the AEC sector do not facilitate collaborative behaviours. There is a need to adopt relationship-based procurement methods as a means of addressing industry culture and to facilitate holistic ICT implementation (Egan, 1998). Two examples of relationship-based contracting are the Australian use of project alliancing, and the American version, called Integrated Project Delivery (IPD). Both alliancing and IPD aim to create a collaborative environment that integrates all aspects of the project including its people, systems and technology throughout the lifespan of the venture. One key aspect of the IPD approach is the implementation of concurrent and multilevel processes that encourages early contribution of information, experience and knowledge in a trusting and open forum (American Institute of Architects, 2007). Therefore, the IPD methodology facilitates BIM’s need for early collaboration and free-flowing information between project participants.

1.3.7 BIM as a Legal Issue

One issue that is considered a barrier to widespread BIM adoption is the perceived legal risks associated with BIM technology-, process- and methodology implementation (Arensman & Ozbek, 2012; Ashcraft, 2008; Built Environment Industry Innovation Council, 2010; McAdam, 2010b). While BIM execution plans, standardised collaborative IPD contracts and BIM addendums that address a number of the legal risks have emerged in the last few years, these documents have not been tested over time. In addition these documents do not consider the AEC industry’s culture of slow innovation adoption as shown in the low rates of IPD usage in the American AEC Sector (Kent & Becerik-Gerber, 2010).

To understand how and where the legal risks associated with BIM and ICT implementation are more generally perceived, an appreciation of the varying transformation- and integration phases which construction ICT has undergone over the last several decades, is necessary. A useful framework for understanding the development of ICT in the construction section one proposed by Froese (2010) where there has been three board eras of ICT development and implementation. Paradoxically, these three periods roughly equate to the three levels of BIM definitions – Technology, Process and Methodology. The first period focused on the development of stand-alone
ICT tools that assist with completing project-specific tasks such as estimating, Computer Aided Drafting (CAD) and structural analysis. Following on from the tool/technology period was an era of construction ICT that focused on computer-aided communication and process management including the emergence of email and document/drawing management systems. Froese notes that the AEC sector is still experiencing this era as new tools and features continue to emerge and business processes are still adapting to the changes generated due to ICT implementation. The final and latest construction ICT era is one that is focusing on integrating the tools, technology and processes into a collaborative approach to project delivery that requires a change to the current range of procurement methodologies. This is reflected in the move towards relationship-based procurement methods such as alliances and Integrated Project Delivery.

Ashcraft (2008) categorises the origins of the perceived legal issues associated with BIM as either emanating from the technology or the way in which the technology is deployed within a project setting, such as a collaborative procurement framework. At a technical level, Ashcraft highlights a number of key legal issues that directly relate to the BIM technology and the way in which BIM authoring tools produce and manage the model. For example, the need for a communication protocol to ensure that corruption of the critical information does not occur during data-transfer procedures or when the information is imported into other BIM applications or analysis tools. Other legal issues associated with the technology include ownership of the information embedded in the model and adequate protection against data loss.

Thomson and Miner (2006) add that there are a number of copyright- and information-licensing issues such as proprietary design and equipment that can impact on the use of BIM technology during the project design phase. They note there is no simple answer to the issue of who will ultimately own the data and that each project may require a unique response to ensure there is a fair and equitable distribution of copyright protections. Another technical issue highlighted by Thomson and Miner is determining who is in control of data entry and therefore takes ultimate responsibility for any errors or omissions in the model. One final technical issue is how BIM authoring tools can automatically update many aspects of the design and how project staff need to be mindful of these changes, including the need to not only notify other stakeholders of these changes but also to ensure there is explicit acknowledgment and acceptance of any alterations to the approved design.

Returning to the comments made by Ashcraft (2008) regarding the framework in which the technology is implemented, he highlights how there is link between the alternative
methods of project delivery and perceived legal risks associated BIM implementation within these frameworks. For example, the allocation of project risks alters the project roles and responsibilities and consequently, the process and workflows implemented during the project lifecycle. Another intertwined process- and methodology risk is how a collaborative design process will change the current risk profiles of the professional controlling the design and those stakeholders that contribute to the design. To elaborate further, even the simple task of determining what the ‘contract’ design is, can be difficult, particularly determining if that design, or reiterations of the design, comply with building regulations. Finally, determining the actual responsible designer in a collaborative environment is critical, especially if the designer is statutorily required to hold some form of professional licensing.

1.3.8 Impact of BIM on Procurement

Sebastian (2011a) reports on discussions in the Netherlands on the use of BIM in four types of project-delivery method and how each approach triggers various legal and regulatory aspects. He adopts two broad categories of legal issues. The first category includes the general legal aspects relating to the law and regulations on information and communication. The second category includes project-specific aspects that relate to the project delivery method and project contractual arrangement. His report focuses on the second category, the methodology of BIM project delivery, noting that the laws and regulations in many countries are yet to deal with the BIM information-exchange process. However, in Australia, the CRC for Construction Innovation (2008), has investigated the more broader issue of contracting and communication in the digital age and proposed a number of recommendations for resolving many of the perceived legal risks.

Sebastian (2011a) discusses four project delivery methods, Design-Bid-Build (DBB), with early contractor involvement in the DBB process, Design and Build (DB) and Integrated Project Delivery (IPD) and how the use of BIM in the project changes the allocation of tasks and contract requirements between the various project participants. There are two key issues for BIM implementation in the DBB method, the minimisation of data loss between the head designer and contractors’ BIM systems and clarity of the intellectual property rights. For early contractor- or tenderer involvement in the DBB process, there needs to be a guaranteed level of transparency, access rights and confidentiality for any knowledge provided by, and to, the various contractors or tenderers. When using the DB method, careful consideration is required for determining the use and format of the BIM for tendering, construction and any Facilities Management (FM) processes. The use of standardised formats is critical in ensuring information is not lost or corrupted during
transfer. Sebastian highlights that there is no standardised IPD method used in the Netherlands that includes a tendering process. IPD tendering typically involves a protracted negotiation process with a limited number of parties.

McAdam (2010b) reiterates the spectrum of BIM uses in construction procurement, from advanced CAD software through to a platform for collaboration that encourages multi-participant involvement in the design and construction process. McAdam proposes that the real legal issues emulate from the use of BIM in a collaborative environment that requires a high level of trust amongst participants, but more importantly, a transparent allocation of risk and liabilities. In addition, relationship-based contracting goes some way to addressing the issue of Privity, that is, only the parties named in the contract obtain any legal rights or incur any form of legal liabilities (Bailey & Bell, 2011). However, ensuring a fully collaborative methodology will work may require the entire supply chain to be party to the contract.

McAdam (2010b) also discusses the various collaborative contracts that are used in the United Kingdom (UK) such as the NEC3, JCT Constructing Excellence and PPCC200 contracts. These contracts adopt a management framework structure for encouraging collaboration, using a ‘less is more’ approach by leaving the detailed aspects of how the contract will be implemented to individual negotiations within the overall management framework. Irrespective of BIM implementation, collaborative contracts are still considered innovative and may give rise to novel actionable liabilities outside of the intent of the actual contract that were not considered at time of contract drafting or agreement. However, the UK contracts are generally drafted with the end-user in mind and adopt a simple structure with straightforward processes. Adopting such an approach may increase the likelihood that collaborative procurement will become more mainstream, but could still be resisted due to the prevailing market conditions and culture of the AEC sector (McAdam, 2010b).

1.3.9 Conclusions

Within the Australian context, although there are industry groups working towards developing standardised relationship-based contracts that address the interaction between IPD and BIM (Australian Institute of Architects & Consult Australia, 2012), these documents are still to be published. Industry-wide adoption of BIM is expected to take a considerable amount of time, considering the existing risk-averse culture and fragmented structure of the AEC sector. In addition, the current procurement methods such as traditional, design and build, and management contracts will remain popular, particularly
in the public sector institutions that lack the authority to revise their procurement policies to adopt IPD methodologies (Kent & Becerik-Gerber, 2010). Therefore, a review of the current perceived BIM legal risks and challenges is justified, as this will provide a framework for analysing both current contracts and new contracts as they emerge for use in the AEC procurement process.

1.4 Outline of the Study

The intent of this research is to identify the perceived legal risks associated with Building Information Modelling and using these risks, analyse a standardised contract to propose changes that will facilitate a collaborative digital environment. Using the existing literature, the study will develop a conceptual framework of the legal concerns commonly associated with using BIM within the confines of the project setting and the wider legislative and statutory environment. The research will use this framework to analyse an Australian public sector standard form of construction contract. In the context of this investigation, a standardised contract is one that has been developed by the public sector in collaboration with other industry stakeholders and the access to the documentation is unrestricted. As this research is exploratory in nature, only one contract will be analysed: the New South Wales Government GC21 2nd edition suite of Contract Documents. This research will scrutinise the typical standardised documents that constitute the GC21 contract and propose a number of amendments in order to facilitate the successful integration of Building Information Modelling into a public sector project, using this contract.

The research uses a mixed-method approach to investigate the issue of amending public sector contracts for BIM adoption. First, a thematic analysis of the existing literature will be presented to identify core themes and associated subthemes. The range of literature referenced includes opinion pieces, theoretical analysis and practice-orientated case studies of BIM implementation in the AEC Sector. Second, Qualitative Content Analysis (QCA) will be used to analyse a standardised construction contract, which uses the core thematic areas and subthemes as the coding framework. In the final sections of this research, the range of BIM legal issues not directly addressed in the contract will be discussed and possible changes to the standard conditions will be proposed. This research will provide an insight into the various legal BIM concerns and a framework for analysing the suitability of standardised contracts for BIM implementation.
1.5 **Research Question**

With reference to the knowledge gap, the research question is:

*How might the legal and contractual issues associated with Building Information Modelling implementation affect standardised construction procurement contracts?*

1.6 **Research Aim**

The aim of the research is to:

*Identify the changes needed to Standard forms of Contract to enable successful collaborative Building Information Modelling integration into the construction procurement process.*

1.7 **Research Objectives**

The following objectives will assist in answering the research question and meeting the requirements of the research aim. Each of the objectives has a dual purpose of laying the groundwork for answering the research question and providing a framework for achieving the proceeding research objective. The objectives for this study are:

1. To identify the contractual and legal issues associated with the implementation of Building Information Modelling
2. To thematically map by developing a conceptual model, the contractual and legal issues of the domain
3. To conduct a detailed analysis of an Australian standardised construction procurement contract
4. To determine the extent of changes required to a standardised contract to enable BIM integration

1.8 **Justification of the Research**

At this point, it is appropriate to discuss the significance of this research in regards to the contribution it makes to the existing BIM body of knowledge, and its usefulness to the research community and the wider AEC sector. This research adds to the existing knowledge pertaining to the topic of BIM legal issues by:
1. Consolidating a wide variety of case-orientated data, opinions, and experiences of the BIM legal issues into core thematic areas

2. Developing a framework for contract analysis within the context of BIM use and implementation

3. Providing the basis for future exploration, identification and analysis of the underlying legal and contractual issues associated with the formal integration of BIM into public-sector projects and the wider industry in general.

As clients and governments progress towards mandating the use of BIM in project delivery, the two key obstacles commonly identified are the perceived legal risks, and new legal frameworks required for successful integration into the procurement process (Built Environment Industry Innovation Council, 2010; HM Government, 2012). Further, McAdam (2010b) notes how many standard conditions of contract do not consider the BIM legal issues. This study draws together the current documented legal barriers, to examine the issue from the perspective of the public sector and thereby address this research gap.

From the perspective of applied research, current studies into the underlying issues have only made recommendations for contract amendments (Porwal & Hewage, 2013) and have not investigated the impact of BIM on standardised contracts or specifically the ones used for public sector procurement. This research will provide a framework for analysing public sector contracts and a foundation for future research, which scrutinises standardised construction contracts widely used in the AEC industry. It is also believed that the underlying qualitative methodological process will be applicable for any contractual analysis.

Finally, the outcomes of this research have the potential to provide the foundations for supplementary research into the legal issues encountered by the various collaborators and contributors to the project procurement process. It also provides an immediate insight into the contractual issues, which could influence the effectiveness of BIM implementation, usage and collaboration within the project team.

1.9 Structure and Content

This study is structured to enable the research aim and objectives to be achieved. The overall structure of the research is shown in Figure 1.1 which outlines how the literature review will be used to examine the changes needed to public sector contracts, to enable the integration of BIM, using Qualitative Content Analysis.
Immediately following this introduction section, Chapter 2 presents a review of the literature associated with the legal implications of BIM usage in the construction sector. It draws together a wide range of knowledge to facilitate an understanding of the topic and to provide a contextual background to the research relating to the legal repercussions of BIM, public sector procurement and the development and use of standardised construction contracts. The review draws not only upon the writings on BIM, but it also references generic information relating to e-contracting and e-communications. Chapter 2 also reviews expert opinion pieces written by practicing construction lawyers with experience of BIM from a legal perspective.

During the review process, this body of knowledge is synthesised to identify core thematic areas and associated subthemes that are then used in subsequent analyses to examine standardised contracts. Chapter 3 presents the synthesised thematic areas as a conceptual model.

Chapter 4 describes the overall research design, methods and methodology, focusing on how the research question, aim and objectives will be answered within the context of the Australian public sector. It describes how the research will collect and analyse the data using a case study approach, implementing a Qualitative Content Analysis tool. It also discusses the limitations and validity of the selected method and justification of the number of cases selected. In this instance, the analysis ad

Chapter 5 presents and discusses the results of the content analysis that was described in the previous chapter. The core thematic areas and subthemes are overlaid on the standard contract form to identify specific changes required to the contract to enable BIM integration in a collaborative environment.

Chapter 6 provides an interpretation of the results and discusses the significance of the changes to the contract in relation to the core thematic areas. This chapter answers the research question as stated in Chapter 3.

The final section of this research, Chapter 7, draws together the previous research and the findings of the current investigation to recommend changes to public sector contracts to enable successful BIM integration into the construction procurement process. In addition, it highlights the possible limitations of this research and suggests future strands for investigation.
1.10 Summary

This chapter provided an overview of the research including a background to the topic, the research question, aim and objectives and the structure of the study. The next chapter undertakes a comprehensive review of the existing literature associated with BIM legal issues.
2 LITERATURE REVIEW

2.1 Introduction

This chapter focuses on reviewing the literature related to the legal issues and concerns associated with the implementation of Building Information Modelling into the design and construction process, by categorising the issues into logical thematic areas. A wide variety of legal issues have been identified including concerns that directly relate to BIM implementation, electronic contracting and communication or the overarching framework in which the facility is procured. To assist in understanding the implications for contracting, the various legal issues are grouped into thematic areas; this chapter commences with a brief discussion of the thematic analysis process, and the main themes discussed in the literature review. The middle section of this chapter is devoted to discussing the thematic areas in detail, including the identification of subthemes. The final section of this chapter discusses the key gaps in the literature and the implications for this research. Particularly how there has only been a general discussion focusing on particular BIM legal issues and the various contractual responses. There has been little attention paid to conducting systematic analysis of current standard forms of contract and how they could be impacted by the implementation of BIM in the project setting. This investigation builds on the existing literature by firstly consolidating the range of BIM legal concerns followed by a systematic analysis of a standardised contract, to determine the changes required to current contractual approaches in the light of BIM project implantation.

2.2 Systematic Review and Analysis of the Literature

This section provides a brief overview of the techniques used to review and classify the literature including the major findings of the review process. The process of thematic analysis is briefly examined, followed by the presentation of the main thematic areas that will be discussed in the main body of the literature review.

2.2.1 Sources of Literature

As shown in figure 1.1, the literature examined in this investigation is gathered from three sources:

1. Expert opinion pieces,
2. Existing academic literature focusing on theoretical models of BIM legal issues, and
3. Case orientated research.

The AEC industry and legal fraternity have taken an interest in the topic of BIM, particularly how its implementation will influence existing contract structures and strategies. This interest has manifested itself into an ever-increasing body of literature, which focuses on describing possible impacts on existing contract documents. The next types of literature reviewed are the emerging BIM legal conceptual models such as the ones proposed by McAdam (2010) and Olatunji (2011). These existing models shall undergo further analysis in the next chapter. The final type of literature reviewed is case-orientated research. As the concept under investigation is considered relatively novel, the case based literature focuses on electronic contracting and virtual teams.

2.2.2 Thematic Analysis

Boyatzis (1997 p. 4) defines thematic analysis as a "process for encoding qualitative information. This may be a list of themes; a complex model of themes, indicators and qualifications that are casually related, or something in between these two forms". At its simplest, a theme is a pattern, which delineates and organises potential observations and at its most complex, interprets certain aspects of the topic under investigation.

For this research, the themes are generated inductively from the literature and deductively from previous research and thematic investigations. In addition, the thematic grouping uses a combination of directly observable data and underlying phenomena, which relate to the legal implications of Building Information Modelling implementation.

2.2.3 Theme Identification

Drawing on the previous thematic identification undertaken by authors such as Ashcraft (2008), McAdam (2010b), Olatunji (2011), Kuiper and Hulzer (2013), ten themes have been identified comprising a combination of both manifest and latent issues. The themes have been grouped in this form to allow for a qualitative analysis of the issues affecting Building Information Modelling integration into construction projects. Using such an approach enables the condensing of a vast array of legal issues, which have been identified from various sources such as trade literature, books, journal articles, the internet and government agencies.

The ten themes are:
2.2.4 Exploration of the Identified Themes

The following section details each of the themes identified and the associated sub-themes, which make up each theme. The themes are presented in alphabetical order and are bounded rationally by the themes identified in the source. Subthemes that were data driven from the Qualitative Content Analysis process are marked in brackets.

Table 2.1 Issue Mapping

<table>
<thead>
<tr>
<th>ISSUE/THEME</th>
<th>SUB-THEMES</th>
<th>REFERENCES</th>
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<tr>
<td>Compensation &amp;</td>
<td>Implementation Costs</td>
<td>Ashcraft (2008); Arensman and Ozbek (2012); Azhar, Hein and Sketo (2008);</td>
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<tr>
<td>Consideration</td>
<td>Project Costs</td>
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<td>Payment Schedules</td>
<td>and Golden (2007); McAdam (2010b); O’Brien (2008) Olsen and Taylor (2010);</td>
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<td>Effort Rewards</td>
<td>Rezgui, Beach and Rana (2013); Sebastian (2010); Thompson and Miner (2006);</td>
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<td>Wheatley and Brown (2007).</td>
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<td>Collaboration</td>
<td>Ashcraft (2008); Azhar, Khalfan and Masqsood (2012); CRC Construction</td>
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<td>Model Status</td>
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2.3 Compensation and Consideration

The first legal and contractual issues associated with the use of BIM relate to the costs of implementation at a project and business level (Ashcraft, 2008; Azhar et al., 2012; Larson & Golden, 2007). Further, due to the uncertain economic conditions the AEC sector typically experiences, companies tend to decrease their investment in technology and innovation in periods of economic downturn (Collins, 2012). Paradoxically, this has not stopped governments and private sector clients from contractually mandating the use of BIM for project delivery (Porwal & Hewage, 2013) without a clear indication of how the costs of implementation will be covered (Azhar et al., 2008). Therefore, how firms and projects will recoup the costs of BIM implementation is a key issue requiring attention in the development of project fee proposals. This section describes the process for determining fees/prices for design and how this fits into the contract formation and administration process to provide context for the issues associated with compensation and consideration.

2.3.1 Definition of Consideration

For countries with a common law system such as Australia, one of the key elements in determining the existence of a binding contract is the presence of Consideration. Bailey and Bell (2011, p. 83) define Consideration as the “value or benefit given or promised by one party in return for the other party’s promise”. Whilst there are a number of factors a
court will use to determine if ‘something of value’ has been, or will be, exchanged as a means of determining the existence of a binding contract, the court does not reflect on the actual amount of the Consideration proposed. The amount of Consideration agreed upon and enforced by a court, only needs to have some form of legal value (Bailey & Bell, 2011; Goldfayl, 2004).

Examples of Consideration in construction contracts comprise of the completion of work including the supply of goods usually in exchange for the payment of money. In a typical construction contract, payments are made based on the progress of the works over time, but the actual Consideration is the total amount promised at the time when the parties entered into the Contract (Bailey & Bell, 2011; Goldfayl, 2004).

2.3.2 Consultant Fee Proposal Methodologies

In the typical project lifecycle, the first stakeholder that needs to implement BIM is the architect or head designer (Smith & Tardif, 2009). While the need for fair and equitable compensation for BIM adoption is considered appropriate, there is no clear method of remuneration apart from the traditional payment structures used to recover indirect project costs. The traditional approach is that the business applies a percentage markup or amount to the raw project price, which covers the costs of items that are indirectly required for the project. These items are typically included in the preliminaries section of a project budget (Smith, 1995).

In the last thirty years, there has been a shift in the methods used by consultants to bid on work, from a strict fee scale to a competitive market-driven process (Nicholson, 2003). Hoxley (2000) states that the market-driven economic activity involves a tradeoff between the cost to complete the works and the quality of finished product. Initially, there were concerns that using competitive tendering would negatively impact on the quality of the design (Nicholson, 2003) however, clients quickly realised price alone cannot be the sole criteria for consultant selection, and introduced a number of non-price criteria that are used to select the design consultant (Hoxley, 2000). For example, NSW Procurement developed a prequalification scheme for consultants, which focuses on assessing the skill base and experience of the consultants. This allows the client to focus on developing a comprehensive scope of works and setting aside the need to specify non-price criteria (NSW Procurement, 2011). Further, many governments include ‘value for money’ tendering conditions which shift the focus away from purely the cost to complete the works (Miller, Furneaux, Davis, Love, & O'Donnell, 2009).
The three typical methods for determining a consultant fee are:

- Time charge in combination with an upper lump sum limit – the consultant charges for the work completed, based on an agreed hourly rate
- Lump sum for a clearly defined scope of works with little risk of scope changes or variations
- Ad valorem – a fee percentage of the final cost of the project.

There are a number of issues that require deliberation when preparing a design consultant fee proposal. Firstly, the process of ‘building up’ design-professional fees is a combination of historical data, analysis of the project brief, design practice operating costs, market conditions/risk appetite and the experiences of the people preparing the bid (Nicholson, 2003). The actual structure of the bid will also be dependent on the payment methodology adopted by the client, which is reliant on the degree of certainty in the project scope and the actual services required.

2.3.3 Costs of Implementing BIM Technology at the Firm Level

Some of the first costs which need to be recouped are the expenses incurred implementing the technology within the business. These costs relate to the upfront purchasing of the BIM authoring- and analysis software, upgrades to computers and system hardware, staff training, reviewing and revising workflows and the implementation of BIM standards (Wheatley & Brown, 2007). Typically, these costs are extremely high and considering the predominance of Small to Medium Enterprises (SME) in the construction industry that have small operating budgets, the adoption costs can be quite prohibitive (Larson & Golden, 2007).

Sher et al (2009) note that staff training will need to go beyond the technical training of how to use BIM authoring tools, to include development of higher level collaborative skill sets which can be used to exploit design and BIM to its full potential. Ashcraft (2008) also notes that the costs associated with increasing collaboration skills will impact upon all project stakeholders. However, as more businesses adopt the technology, the need to cover the transition costs will recede.

2.3.4 Costs of Implementing BIM at the Project Level

The next group of costs relate to the implementation of BIM at a project level. In the case of limited interoperability, the costs for data re-entry will need to be recovered. Other costs relate to the emerging roles and responsibilities within the project, such as a
BIM manager (Wheatley & Brown, 2007). Finally, the technology costs needed to enable data sharing and security for a specific project must also be recouped (O'Brien, 2007).

### 2.3.5 Payment Schedules and Performance Payment Systems

Sebastian (2010) notes that, dependent on the overarching procurement method, there may need to be changes to the payment schedules, features and schemes. For example, the bulk of the design component of the project is billed during the detailed design stage of the Works. If a collaborative-, integrated project delivery method is employed, the traditional design phases are compressed or occur concurrently, requiring the various tasks to be undertaken earlier in the project and therefore the costs are incurred at a different stage in the project lifecycle. This change in workflow will affect the business cash flow, requiring a recalibration of the typical payment percentages normally experienced in the industry.

Sebastian (2010) goes further and discusses the need to implement an incentives- and payment-based system to reward contractors who implement and use BIM to meet or exceed the requirements of the contract. Such a system would require the definition and quantification of Key Performance Indicators linked to specific bonuses and penalties. NSW Procurement (2012) has developed such a system, but this is only linked to its Contractor Performance System and does not include any additional bonuses or payments.

### 2.3.6 Risk and Reward Distribution

Holzer (2007) highlights how designers could be exposed to a higher level of risk for little or no additional rewards because of the increased information and detailing capacity of BIM. If the designer populates the model with additional information that goes beyond the current practice of drawings only conveying design intent, this can implicitly take on more professional liability. This added risk is not rewarded within current Consideration arrangements. Further, if the level of reliance allocated to the BIM model has not been negotiated, downstream project participants may use the model that is outside of its originally intended use (Larson & Golden, 2007; Thomson & Miner, 2006; Wheatley & Brown, 2007).

Olsen and Taylor (2010) have identified the imbalance between the high level of design coordination responsibility (risk) foisted on to the design professional and the lack of reward for taking on this risk. For a design professional, a project using BIM requires an increased level of detail, integration of information, accuracy and coordination that has
traditionally been undertaken by the contractor. Schematic designs have sufficed for traditionally documented projects, however high-level BIM requires coordination and the insertion of objects into the building simulation or model. The contractor has usually been relied upon to document the construction drawings to ensure the viability of the design (Olsen & Taylor, 2010; Sebastian, 2011b). From a risk perspective, it may be better to include as little detail as possible to limit liability, which goes against the underlying intent of BIM. Additional liability insurance may be required to cover this task if a design professional is willing to take on this responsibility (Haynes, 2010a).

Contrastingly, Holzer (2007) believes this task is in the domain and the responsibility of the design professional as the traditional role of the project coordinator. The reason this task is not currently undertaken is that the design professional simply does not gain any advantage from completing this duty. However, this may be a short-sighted view because as Ashcraft (2008) points out, clients may simply bypass the design professional, in particular, an architect, and engage a party who is willing to take on this responsibility. By engaging another party, for example a contractor directly, the role of the architect as the centre of the design process could diminish.

As discussed above, the costs of BIM implementation at a firm and project level, the process for paying the consultant/contractor and the balance between risk and reward are all questions that influence the amount and application of contractual consideration.

2.4 Conditions of Contract/Contract Documents

The legal implications of BIM implementation and the impact on construction procurement contracts continue to receive widespread attention throughout the construction and academic community (Built Environment Industry Innovation Council, 2010; Eastman et al., 2011; Hamdi & Leite, 2013; Kuiper & Holzer, 2013; Manderson, Jefferies, & Brewer, 2012; Sweet & Schneier, 2013). Ashcraft (2008) notes that the legal concerns relating to BIM implementation originate from either the technology or the context/methodology in which it is employed. This perspective is shared by Eastman, (cited in Hartmann & Fischer, 2008) who highlighted the need to develop two levels of BIM implementation language, the first level being the implementation of the technology and the second level referring to the overall BIM working processes. Further, it is this second level language that will generate, and interact with, the actual construction contract.
While it is acknowledged that standard conditions of contract lag behind technological developments, there is a view that the need to amend the conditions for any specific technical requirements is limited (Hartmann & Fischer, 2008). Changes are required to the processes inherent in the contract to ensure the successful implementation of the technology into the project delivery methods (Hartmann & Fischer, 2008). This model for addressing the various legal barriers has been adopted by the AEC industry and is reflected in the emergence of BIM execution plans for detailing the technical requirements (Jung & Joo, 2011; McAdam, 2010b), and ‘BIM friendly’ contracts (Haynes, 2009c; Lowe & Muncey, 2009) that focus on the overall BIM process and workflows. However, BIM workflows are highly dependent on the type of procurement method adopted and while BIM can be integrated into any type of procurement, a collaborative-based method enables the leveraging of BIM to its full capacity (American Institute of Architects, 2007).

2.4.1 Collaboration

There is wide consensus that to enable BIM to be used to its full potential requires a collaborative/relational contractual approach amongst the team members (Azhar et al., 2012; Eadie, Browne, Odeyinka, McKeown, & McNiff, 2013; Grilo & Jardim-Goncalves, 2010, 2011; Ning Gu & London, 2010; Kuiper & Holzer, 2013; McAdam, 2010b; Sebastian, 2011b). Traditional contractual frameworks create specific obligations and duties for the different participants in a project. These boundaries usually inhibit collaboration and are the source of disclaimers, waivers and restrictions on reliance of information (Ashcraft, 2008; Azhar et al., 2012; Kent & Becerik-Gerber, 2010; McAdam, 2010b; Parrott & Bomba, 2010). Paradoxically, Eastman (cited in Hartmann & Fischer, 2008) notes that these boundaries tend to be ignored and project teams work in a collaborative manner irrespective of any contractual barriers.

One example of relationship-based procurement methods is the Australian Alliance model and some of the key elements of this type of contract, as identified by Thomas (2007) include:

- An overarching alliance board made up of senior agents from each of the participants in the alliance. The board provides strategic control of the project and resolves any disputes through the process of unanimous agreement
- An alliance management team that focuses on the day-to-day running of the project
A ‘no fault, no dispute’ condition which requires the surrendering of the right to commence legal proceedings, confining the resolution of any disputes to the board

Payment is structured around a performance-based arrangement

An ‘open book’ accounting approach for project costing

An explicit obligation to act in good faith.

The American Institute of Architects has incorporated the key aspects of alliance contracting and acknowledges the critical role technology plays in a collaborative environment to produce a procurement method called Integrated Project Delivery (American Institute of Architects, 2007). Table 2.2 presents the nine principles of IPD with one of the key values being the use of appropriate technology. The next chapter discusses collaborative- or relationship-based procurement in detail.

Table 2.2 - The Principles of IPD

<table>
<thead>
<tr>
<th>1. Mutual Respect &amp; Trust</th>
<th>5. Early Goal Definition</th>
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<tr>
<td>3. Collaborative Innovation &amp; Decision Making</td>
<td>7. Open Communication</td>
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<tr>
<td>4. Early Involvement of Key Participants</td>
<td>8. Appropriate Technology</td>
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<td>9. Organisation and Leadership</td>
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While IPD can be applied to any type of procurement model, the traditional methods constrain the possibilities for early contractor involvement and collaboration amongst team members (American Institute of Architects, 2007).

2.4.2 Status of the Model

A traditional construction contract will consist of several documents including hardcopy, two-dimensional drawings and specifications (Goldfayl, 2004). During the design development, consultants will exchange electronic drawings usually in some form of CAD file. As described in the introduction, CAD files are limited in the information that is embedded in the document, focusing on lines, shapes and surfaces that are two-dimensional. These are digital representations of the contract drawings that aim to convey the design intent to the contractor. However, these files are issued with a caveat that they cannot be relied upon for accuracy or completeness.
BIM improves the accuracy and quality of information between project participants (Demian & Walters, 2013) and by restricting the level of reliance on information embedded in the model, the advantages for using BIM diminish. Ashcraft (2008) notes the importance of detailing the legal status of the model in the conditions of contract to ensure there is no ambiguity as to its use in the procurement process. For example, Ashcraft (2008) discusses the several options available for specifying the legal status of the model, absent of it being a contract document:

1. the BIM is a ‘co-contract document’ which is not submitted to approval agencies but is issued to project participants
2. as a method transmitting the design intent or as an ‘inferential document’ or
3. the model can be used in the information transfer process but not relied upon for accuracy or as an ‘accommodation document’.

2.4.3 Contractual Deliverables

Worldwide, clients and governments are mandating BIM as a contractual deliverable; however, there is a high level of ambiguity as to what is specifically required under the contract (Holzer, 2012). Ashcraft (2008) discusses the need to clearly articulate what needs to be delivered under the contract. For example defining what is required for the design content, the timing for delivery and the type or format of the electronic media.

2.4.4 Head Contract and Subcontract Alignment

Large portions of the contract works are now subcontracted out to specialist firms and the head contractor manages the overall process (Ashworth & Hogg, 2002). This requires the coordination and alignment of the head contract BIM deliverables and requirements with any subsequent subcontract with subcontractor and/or suppliers (Larson & Golden, 2007). This will require the purpose and level of reliance to be coordinated; the level of reliance, the format of the information and the timing for delivery are examples of some of the items to be reflected in other contracts and agreements under the contract.

2.4.5 E-Collaboration

In many jurisdictions, there is a requirement for guarantees to be in writing in order to be legally binding. Further, the status of electronic communication, in particular email, may be ambiguous if it includes a request to change the contract and may not have the same evidential weight as paper records (Bailey & Bell, 2011; CRC Construction Innovation, 2008).
2.4.6 Punitive Measures for Non-Performance

With any contract, there are consequences if a party does not meet its obligations (Bailey & Bell, 2011; Hughes & Greenwood, 1996). Therefore, Sebastian (2010) recommends a range of measures linked to the performance of the contractor in delivering the BIM requirements under the contract.

This section identified a number of key issues associated with the process of BIM implementation within the project framework. It focused on the particular issues that have the potential to influence the conditions of contract and the overall project delivery framework. At the methodology- or procurement-method level, a collaborative environment is the most beneficial setting for implementing BIM. At a process level, the status of the model and the capacity to e-collaborate are conditions that can influence the effectiveness of BIM collaboration. In addition, there is a need to include punitive measures for not achieving the BIM deliverables, for both the contractor and the client. Finally, any project subcontracts associated need to reflect the conditions of the head contract to ensure BIM integration throughout the project delivery framework. The function, structure, and the process for developing standard conditions of contract and emerging BIM-enabled contracts are discussed in the next chapter.

2.5 Data Security

The shift towards using digital media for communication and information transfer between project stakeholders has seen an increased focus on appropriate levels of safety and security of project data (Pean supap & Walker, 2005). At a project level, a number of ‘cloud’ based project-management software applications have emerged that automate the capture and distribution of project information using online collaborative platforms. This may be one or several software applications that store the project information in a central database using a host-or-remove system that is managed by a third party (Grilo & Jardim-Goncalves, 2011). Two examples of companies that produce such applications are Nexus Point Solutions that produces the INCITE platform (Nexus Point Solutions, 2014) and Aconex, which has created a wide range of construction- and project-management tools and platforms including an application for managing and distributing BIM (Aconex, 2014).

The ease in which sensitive project information can be transferred and the use of external control and storage systems has created a number of scenarios where there may be unauthorised access to the data, the information is unavailable or it becomes
corrupt. This section describes the need to protect the model and the embedded data against loss, corruption or manipulation, using appropriate mechanisms for controlling access and information sharing. It also highlights the need to ensure against the need to undertake data rework if the model is lost or corrupted.

2.5.1 Protection of Data from Corruption and Loss

Digital models are susceptible to corruption and loss of data. Measures are required to ensure the information residing within the model is preserved for, and beyond, the lifetime of the project. This protection needs to consider accidental data loss through power-, hardware- and software failure as well as deliberate corruption through viruses and deletion of data (Ashcraft, 2008; Sebastian, 2010).

2.5.2 Data Protection against Manipulation

Larson and Golden (2007) note how there is a fear relating to the ease in which a model can be easily manipulated by any party involved in the design and documentation process if they have access to the digital files. Ashcraft (2008) identifies the need to guard against the deliberate sabotage of data which can include the issues outlined in the previous paragraph.

2.5.3 Access and Sharing

Anumba & Ruikar (2002) discuss the requirements to protect data and confidential information from unauthorised access and users. Any party that accesses information needs to be easily identifiable to ensure the specific requirements for data protection are not breached, so that trade secrets and the integrity of the data remains complete.

The accidental or inadvertent sharing of information during the project lifecycle is another legal item requiring consideration. Digital information can now be easily shared and if appropriate protocols and mechanisms are not properly implemented or followed then confidential information may be inadvertently shared with a third party. Further, how the data can be retracted if it has accidentally been issued, needs to be addressed (Simonian & Korman, 2010).

2.5.4 Insurances against Loss/Corruption

To cover the costs for undertaking any rework associated with the loss or corruption of data in the model, Ashcraft (2008), Haynes (2010b) and O’Brien (2007) all recommend the acquisition of appropriate insurance to cover the costs for rework resulting from data
loss. However, taking advice from insurers is suggested, as current insurance could already cover data loss (Haynes, 2010a).

This section examined the need to protect data against loss, corruption and deliberate manipulation by implementing suitable means of controlling the flow of information amongst the various project stakeholders. As a precaution, the project may consider insuring for any losses caused by data loss or corruption.

2.6 ICT Protocols, Processes and Responsibilities

The theme of ICT protocols, processes and responsibilities is discussed in this section of the literature review. It commences with a brief discussion of how contracts have evolved to the status of process manuals and the need to differentiate between technological requirements and the contractual responsibilities of project participants. The BIM issues associated with this thematic area are then identified. In the final segments, Level of Development and the relationship of the BIM execution plan to the head contract are examined. The function and characteristics of construction contracts are discussed in more detail in the next chapter.

Over time, construction contracts have taken on the status of a manual for managing the processes associated with the contractual transactions. Contracts provide mechanisms to manage or administer the works and in some cases prescribe and control the behaviours of the parties to the agreement (Hughes & Greenwood, 1996; Uher & Davenport, 2009).

Eastman (Cited in Hartmann & Fischer, 2008) believes the BIM community needs to develop two levels of language, one for the implementation of BIM and one to describe the BIM working process. It is this second language which is incorporated into the contract. From the perspective of the technological delivery of BIM, execution plans have emerged that aim to address many of the technical issues associated with project delivery, such as technology compatibility and model Level of Development (LoD) (Jung & Joo, 2011; McAdam, 2010b).

Conversely, there is a concern that due to the rapid advancement of technology the inclusion of any contract conditions targeting BIM usage in a project will become obsolete in a short period of time (Hartmann & Fischer, 2008). Therefore, it is critical that the contract addresses the process and allocates the responsibilities at an operational level and does not simply focus on the technology. The BIM execution plan focuses on
the technological- and associated procedural requirements of the contract (Ahmad, Demian, & Price, 2012).

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), however, the general consensus is that BIM change management and process management need to be detailed in the contract (Hartmann & Fischer, 2008). Further, the allocation of responsibilities and liability for these changes, including how these are communicated to the project participants, are critical components of the contract. Finally, the BIM execution plan can be incorporated as a contract document to ensure the requirements become a contract obligation (Jung & Joo, 2011).

2.6.1 Process/ Change Management

Hughes and Greenwood (1996) note one of the key functions of a construction contract is as a management-procedures manual. The specific requirements for inclusion in the contract need to focus on the process management rather than the technical requirements, which can be included in a BIM execution plan. The execution plan can then be annexed to the main contract (Hartmann & Fischer, 2008). These processes relate to changes to the model, how this is documented, who is notified, and the consequences of change, be it client- or contractor initiated (Amor & Faraj, 2001).

2.6.2 Responsibilities

Sebastian (2010, 2011b) believes the key changes to the process will occur within the organisation, with the creation of new roles such as a Model- or Process Manager. The process management requirements are delegated to this individual, dependent on the type of procurement method implemented.

2.6.3 Communication

Communication protocols are critical for the successful delivery of any project. From a contract language perspective, the lines of communication need to be clearly identified and the information required needs to be clearly documented. The CRC Construction Innovation (2008) identified a number of security- and contractual concerns relating to the use of electronic communication. For example, determining and agreeing upon the process for sending, receiving and acknowledging communication.
2.6.4 Model Level of Development

The Level of Development is defined as the level of detail or granularity to which a model or its component elements are developed (Mokbel, Salazar, Aboulezz, & Tocci, 2007). The American Institute of Architects (2007) has developed a specification of the different Levels of Development, which specifies the detail of the graphical and non-graphical information residing in the model. This LoD directly affects what the model can be used for and the types of analysis tools which can be plugged into the model (Leicht & messner, 2008).

2.6.5 BIM Plan

On a technical level, various BIM execution plans have emerged which address the various technical and administrative issues associated with a BIM-enabled project (Ahmad et al., 2012) such as the Penn State University (2010) BIM Execution Plan and guide material and NATSPEC (2013) BIM Management Plan. These cover specific topics relating to the process for applying information technology such as data sharing, software updating, model sharing BIM uses and communication protocols. While not purporting to be a contract document, many of the issues discussed within these documents will influence the level of success of the project. However, these can be included as a contract document to reflect the requirements of the various procurement strategies (Penn State University, 2010).

This theme identified a variety of ICT protocols, processes and responsibilities associated with the implementation of BIM into the project setting. It focused on the operational contract requirements of process- and change management, the responsibilities and the communication protocols needed to facilitate successful BIM integration. It highlighted how BIM execution and implementation plans detail the technical aspects of BIM usage and how the contract should reference this document.

2.7 Intellectual Property

Intellectual Property rights and the subsequent copyright of the design, objects, and information embedded in the model are a major concern of designers and suppliers of proprietary information for use in a project (Ashcraft, 2008; Fan, 2014; McAdam, 2010b; Samuelson et al., 2012). This section examines the concept of Intellectual Property and the implications for BIM. After a brief introduction to IP in the Australian setting, the various IP issues associated with BIM use are examined, such as IP of the design and
digital model, particularly with a model developed in a collaborative environment. Other considerations include the protection of confidential information and the ongoing protection of data. A number of suggestions for addressing IP, to enable its fair and equitable distribution, are presented.

Theoretically, the model can be an exact virtual replica of the real world. In view of the ease in which digital information flows between project participants, the exchange of digital information requires careful consideration of how project data is exchanged, protected and restricted (Simonian & Korman, 2010).

2.7.1 Defining Intellectual Property

Intellectual Property (IP) refers to the rights bestowed to creations of the mind, such as artistic and literary works, designs and images (Ricketson & Creswell, 2006). The World Intellectual Property Organisation (2011a) declared intellectual property should be applied to:

- literary, artistic and scientific works
- performances of performing artists, phonograms, and broadcasts
- inventions in all fields of human endeavour
- scientific discoveries
- industrial designs
- trademarks, service marks, and commercial names and designations
- protection against unfair competition
- all other rights resulting from intellectual activity in the industrial, scientific, literary or artistic fields.

Intellectual Property (IP) consists of two broad categories: copyright and industrial property. Figure 2.1 provides an overview of the separation of IP into the two categories (World Intellectual Property Organisation, 2011b).
Within Australia, there are seven types of IP: Patents, Trade Marks, Designs, Copyright, Circuit Layout Rights, Plant Breeder’s Rights and Confidentiality/Trade Secrets. Table 2.3 provides an outline of the types of IP, how long the rights last, the associated controlling legislation, and the agency responsible for administering the Legislation (IP Australia, 2011).


### Table 2.3 IP Legislation in Australia

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<th>Type of IP</th>
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<tr>
<td>Patents</td>
<td><em>Patents Act 1990</em></td>
<td>No</td>
<td>20 yrs²</td>
<td>IP Australia</td>
</tr>
<tr>
<td></td>
<td><em>Patents Regulation 1991</em></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Trade Marks</td>
<td><em>Trade Marks Act 1995</em></td>
<td>No</td>
<td>10 yrs²</td>
<td>IP Australia</td>
</tr>
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<td></td>
<td><em>Trade Marks Regulation 1995</em></td>
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<tr>
<td>Designs</td>
<td><em>Designs Act 2003</em></td>
<td>No</td>
<td>5 yrs²</td>
<td>IP Australia</td>
</tr>
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<td></td>
<td><em>Designs regulation 2004</em></td>
<td></td>
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</tr>
<tr>
<td>Copyright</td>
<td><em>Copyright Act 1968</em></td>
<td>Yes</td>
<td>70 yrs³</td>
<td>Attorney-General’s Department</td>
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<tr>
<td>Circuit Rights</td>
<td><em>Circuit Layouts Act 1989</em></td>
<td>Yes</td>
<td>10 yrs²</td>
<td></td>
</tr>
<tr>
<td>Plant Breeder's Rights</td>
<td><em>Plant Breeder’s Rights Act 1994</em></td>
<td>No</td>
<td>20-25 yrs</td>
<td>IP Australia</td>
</tr>
<tr>
<td></td>
<td><em>Plant Breeder’s Rights Regulations 1994</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confidentiality/Trade Secrets</td>
<td>Common Law</td>
<td>Yes¹</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

All Legislation and Agencies are federal unless otherwise noted
1. A common method for maintaining confidentiality is a Confidentiality Agreement.
2. Initial registration followed by an additional period
3. Varies according to the type of work

### 2.7.2 Architectural Copyright in Australia

Copyright of architectural design is covered by federal legislation *Copyright Act 1968*, and is treated as an artistic design. McDonald (2009) has provided a guide for Australian architects and the application of copyright in regards to building and facility design. Although silent on the specific use of digital models and project databases, the application of copyright and Intellectual Property could be seen as similar to the hypothesis proposed for the American context – subject to any contract conditions, the person who creates the work is the first owner of the copyright, or the ‘author’.

The Act usually treats design as an artistic work whether it is hand drawn or generated within a computer programme, such as CAD. It can also be related to the underlying copyright of any information, which is provided by stakeholders, be it trade information or a design style. There are two main themes relating to the design copyright:

1. the copyright of the actual design style/concepts
2. the copyright of the design used on a specific site.
The person who creates the work is defined as the Author and is classified as the person/persons whom were actually responsible for realising the design, such as physically creating the design. People who contribute ideas or comments are not usually seen as authors. If there is more than one person working on the design, for example groups of architects, then the group members are considered authors. People who simply generate the design are not considered authors. The employee, if responsible for producing designs, may also have a condition in his or her employment engagement, which allocates all designs to the company. The copyright of any item generated for, or on behalf of, the Australian federal or state governments belongs to these entities and covers all departments and statutory bodies (McDonald, 2009).

Ownership of the actual physical plans is a separate issue and is covered by general property law. Typically, if a person pays for a physical item then he or she owns that item, such as the final plan. Unless it is a condition of engagement, all other documents such as notes, concept plans and sketches are owned by the author (McDonald, 2009).

2.7.3 Copyright for Public Sector Projects

Within Australia, the government (or Crown) is exempt from intellectual property laws and can use certain information and designs for specific purposes. In addition, the intellectual property rights for works undertaken for the Crown are automatically attributed to the government. These requirements are only applicable to federal and state governments. (IP Australia, 2011).

2.7.4 Collaborative Design Ownership

As a general rule, subject to any specific designation in the contract documents, copyright and ownership is determined by the concept of ‘the person who creates the design, owns the design’ (Ashcraft, 2008; Haynes, 2009b; Larson & Golden, 2007; Sebastian, 2010). However, the complexity of ownership and copyright can be ambiguous when the design is undertaken in a collaborative environment and the final design is a mixture of derivative models and trade-sensitive information (Thomson & Miner 2006). Further, the amount of information generated and the ease of data transfer exacerbates the difficulty in determining ownership and copyright (Ashcraft, 2008). Therefore, a single party may not own the final collaborative design.
2.7.5 Ownership of the BIM Model and Data

Separate to the ownership of the design is the issue of ownership of the actual BIM and data. This issue is similar to the concern regarding ownership of the design in that, unless it is covered by the contract, the party which creates the model is the owner of the model (Haynes, 2009a, 2009b). In some instances the client in the project includes the requirement for the supply of a Building Information Model as part of the contract (Simonian & Korman, 2010).

2.7.6 Confidential Information and Trade Secrets

Another barrier relating to IP is the concern of suppliers in providing proprietary information for inclusion in the BIM which may be passed on to its competitors (Azhar, 2011; Larson & Golden, 2007; Thomson & Miner, 2006). This may be information relating to specific plant, items or methods of construction. Another example is sensitive information, such as restricted information relating to a project. The overarching copyright may be of concern to the suppliers of this information (Ashcraft, 2008). Amor and Faraj (2001) believe there is a requirement to define what constitutes public and private data so that there is no accidental sharing of private data outside those individuals who have access authorisation.

2.7.7 Ongoing Protection

Due to the nature of the construction industry with its short-term project relationships, where competing businesses come together to form a team for the duration of the project, Rosenberg (2006) highlights the need to explicitly detail the requirements for ongoing intellectual property and access to information project rights. Further, these rights, obligations and consequences need to be understood by all project participants, in particular inexperienced team members who may not have pervious exposure to intellectual property and copyright laws (Rosenberg, 2006).

Finally, if the project contains data which must remain confidential, how it is treated after the completion of the project, is another issue, especially in the case of public sector projects which can require the documents to become public archives (Cooperative Research Centre for Construction Innovation, 2007).

2.7.8 Recommendations in the Literature

Azhar et al (2008) believe there is no simple answer to the issue of Intellectual Property and BIM data and design ownership; and a unique response is required for each project,
based on the specific needs of the project participants. Based on this assumption, Ashcraft (2008) recommends using the contract as a method for allocating and determining ownership, drafting rights and obligations within the body of the document. However, at the commencement of the project the type of procurement strategy needs to be considered, especially its effect on IP and design/data ownership. For example, the effect on IP rights if selecting an open or collaborative strategy. At a procurement-method or contract level, due consideration is needed as to who owns the model, who owns the information in the BIM and who has access to the model/data. At a lower level, as Ashcraft (2008) suggests, a project protocol could be developed which sits under the contract and allocates access and usage rights. This approach could also be used to manage confidential information identifying which parties have access to specific information or models. In addition, a confidentiality agreement could be proposed for this information, as an added precaution (Ashcraft, 2008).

How and what the end model will be used for, as noted by Ku and Pollalis (2009), will also affect the determination of model ownership and its use by project participants. For example, if the model will be used as the basis of a Facilities Maintenance system. They also suggest the allocation of access and usage rights to the model for specific purposes as a means of controlling sensitive information. This discussion and agreement needs to be completed as early as possible after the commencement of the project.

Larson and Golden (2007) provide a detailed list of the items which could be considered when negotiating the ownership and use of the model and associated data. As part of the negotiating ownership and reuse of the model, such things as the rights to use, reproduce, develop derivative models/works, how information is distributed and how/if the model can be displayed in public, need to be agreed and need to be consistent with the proposed end use of the BIM. In addition, further details relating to the rights for the production of derivative models must be discussed, such as who can create them, when they can be created and what information can be used to create the models. Finally, the derivative models could also be sanctioned for marketing or educational purposes. In relation to information control, the downloading rights from, and control of, shared websites are also issues which require consideration.

In the absence of a contract, 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. For example, the party which created the portion of work in question owns that specific section/information. He suggests tracking
of ownership can be achieved using a computer model server with an automatic authorship registration function (Sebastian, 2010, 2011b).

This section considered the issue of Intellectual Property and its application to BIM design and data content including projects delivered in a collaborative environment. It discussed the need to protect confidential information and the requirements for ongoing protection of this information, in an environment where large amounts of information can be easily transferred between project stakeholders.

### 2.8 Interoperability

This section investigates the issue of interoperability and the implementation of BIM into the construction lifecycle. It commences with an introduction and brief history of interoperability, the effect on workflows if there are constraints on interoperability between BIM tools, applications and environments and the identification of various efforts to achieve an acceptable level of information exchange between systems.

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). Interoperability emerged as an issue for the AEC sector with the introduction of CAD applications in the 1970s and the need to exchange information between CAD applications that had differing file structures and formats. These applications were based primarily on geometry and the transfer of information between systems was achieved by using file-based exchange formats structured around the geometric information. Further, translators were developed that allowed information to be imported into the CAD application’s native format (Eastman, Jeong, Sacks, & Kaner, 2010).

The process for transferring information between systems has become complex as CAD systems have evolved into three-dimensional and parametric object-based modelling. The use of file-based exchange formats based on geometric entities limits the extent of information that can be exchanged, thereby losing the data richness that is critical to the overall BIM process. The manufacturing sector acknowledged this issue and through significant cost and effort, developed product-model exchange technologies that defined object attributes, relations between objects and geometry. The same issues that constrained the information transfer process in the manufacturing industry are also apparent in the AEC sector. As Eastman et al (2010) have pointed out, unlike the manufacturing industry where the supply chain can enter into long-term relationships, the
development of exchange technologies by the AEC industry is restricted by the short-term, fragmented nature of the sector. The development process may take years, whereby a typical construction project may only last up to three years (Becerik-Gerber & Kensek, 2010; Eastman et al., 2011).

In Chapter 1 the differentiation between three types of BIM applications was established, namely BIM tools, BIM platforms and BIM environments. From an interoperability perspective, Eastman et al (2010) believe it is critical to understand the workflow process between these tools, platforms and environments so that information mapping can be targeted to the specific project requirements, to achieve an acceptable level of interoperability. Therefore, there are two components to achieving this level, the mapping of information within a model and the workflow associated with the exchange of information. Internationally, a number of projects, some with a long history, have been undertaken to create a range of consistent data representations of building information for distribution between software applications and the varying requirements relating to the project stages. For example, ISO-STEP Industry Foundation Class based on the ISO-STEP Express programming language, OmniClass, and COBie (Eastman et al., 2010; Eastman et al., 2011; Sacks, Kaner, Eastman, & Jeong, 2010).

The issues relating to interoperability as it relates to BIM refer to the issues of compatibility of data transfer between software packages (Haynes, 2009b), and allocating responsibility for ensuring interoperability (Larson & Golden, 2007) and audit trails for recovering data (Haynes, 2009b). Other issues relating to interoperability are the selection of project standards (Wheatley & Brown, 2007) and open protocols (Sebastian, 2010) especially for public sector projects (Holzer, 2007).

2.8.1 Technology Compatibility

As McAdam (2010b) points out, at a pragmatic level there needs to be a compatibility between the BIM authoring-, analysis- and auditing software. Software vendors have developed their own standard file formats and model exchange information, but the issue is when the project participants use different software packages or later software versions (Haynes, 2009b). Identifying, and then mandating what software will be used, is the first step in solving the interoperability issue.

2.8.2 Information Transfer Procedures

To overcome the incompatibility issues commonly experienced between different software packages, Larson and Golden (2007) believe the development and inclusion of
transfer protocols for exchange files is a critical component for project success. These procedures can cover such issues as the format of the file exchange, a process for monitoring the information exchange and the correction of errors. Finally, the protection of data during the exchange can also be considered, be it by means of encryption or the use of a security file exchange server (Ashcraft, 2008). If information will be submitted for code compliance, it will need to be issued in an open standard (Holzer, 2007).

2.8.3 Responsibility

The responsibility for the management of the process and the rectification of any errors will need to be included in the contract protocol. This includes who will pay the costs for the management process, file servers and the rectification of errors (Ashcraft, 2008; Thompson & Miner, 2006).

2.8.4 Auditing

Finally, a recording- and auditing process will need to be developed to track the changes and the information transferred between the parties to enable the cross-checking of information. This auditing will enable a check of the information transfer process to ensure error are minimised during the data transfer (Haynes, 2009b).

This section considered interoperability and the effect of constraining the information transfer process between BIM tools, applications and environments on the project workflows. This restriction has created a number of contractual issues such as ensuring compatibility between software applications, designating responsibility for maintaining an acceptable level of interoperability between project stakeholders and regular audits of systems and processes to confirm the contractual compliance.

2.9 Legislation and Judicial Precedence

This section investigates the theme of legislation and judicial precedence, and how it relates to the implementation of BIM in the project lifecycle. It commences with an examination of the origins of Australian common law, enacted and unenacted law\(^1\) followed by a discussion of the implications for BIM implementation. The overarching

\(^1\) Enacted law is rules and regulations passed by a legislative or administrative body, unenacted law is rule and regulations originating from other sources such as court decisions (Bailey & Bell, 2011).
issue for the theme of legislation and judicial precedence is identification of the contract jurisdiction (Sebastian, 2010). Further, there may be some ambiguity relating to the status of e-contracting practices (Cooperative Research Centre for Construction Innovation, 2007). Examples of doctrines and legal precedences identified in the literature which could have an effect on BIM use such as standard of care, Privity and third party reliance (Ashcraft, 2008). The concept of standard of care is related to professionalism, which is covered in more detail in the next section. Finally, there is a general lack of precedence-based case law involving BIM (Rosenberg, 2006) for a comparison against current legal concepts and doctrines.

Bailey and Bell (2011) describes “law” as the entire legal system encompassing the institution, participants, court mechanisms, rules and the people who operate them. However, the use of the term “law” is dependent on its context and typically, its uses refer to the rules and legislation created to govern the jurisdiction it was created in. Australia’s legal system is based on the English common law system, which as its basis has the doctrine of precedence. For example, a Judge’s decision can be used to determine the rule of law for other decisions and rulings for other cases or lower courts (Adriaanse, 2010; Bailey & Bell, 2011; Cooke, 2010).

There are two sources of law in a common law system, statute law which is legislation passed by a parliament, either directly or by delegated legislation, and case law – laws emanating from judicial decisions. Two examples of delegated legislation are ordinances or regulations. Specific building industry examples are Work Health and Safety regulations and the Building Code of Australia (building ordinances). A significant portion of the law governing the AEC industry flows from delegated legislation (Bailey & Bell, 2011). Generally, within Australia the enacted law will overwrite un-enacted/case law. In addition, the Statute can only apply to the jurisdiction in which it is created, for example NSW OHS laws can only be applied within NSW (Adriaanse, 2010; Bailey & Bell, 2008; Bailey & Bell, 2011).

### 2.9.1 Legislative Jurisdiction

Advancements in technology now allow team members to be located throughout the world, all under different jurisdictions and legislative protections. Kog (2010) notes there needs to be an explicit declaration of which jurisdiction the virtual team will operate under.
A large percentage of literature on BIM intellectual property rights has focused on the USA construction industry (McAdam, 2010a, 2010c). Mcadam has identified that a number of these comments on the application of law relating to BIM implementation may not be applicable to other countries. As BIM is essentially a collaborative process, with the design team spread worldwide, the relevant legislative jurisdiction needs to be identified in the contract documents (Barlow, 2011; McDonald, 2009; Ricketson & Creswell, 2006).

2.9.2 E-Contracting and E-transactions

As Hartmann and Fisher (2008) point out, standard contract conditions lag behind the emergence of technology and the associated risks such as the processes conducive to e-contracting which are not covered by existing legislation and precedents. For example, confirmation that the authority to contract exists, the status of electronic notices and the ability to amend a contract electronically (CRC Construction Innovation, 2008).

2.9.3 Privity Third Party Reliance

Ashcraft (2008) raises the dual issues of Privity of Contract and Third Party Reliance on the information embedded in the model when using BIM for project delivery. In a common law system only the parties to a simple contract obtain legal rights or incur legal liabilities – this is referred to as Privity (Bailey & Bell, 2011). The issue is that any third party, such as a subcontractor, has a lack of Privity for the head contract or that any model supplied to the contractor is for its use only and any third party uses the model at its own risk (Ashcraft, 2008). The risk for the designer is that, the increasing use of collaborative BIM coupled with the fact that the model will be passed onto subcontractors, increases the likelihood of the designer being held liable for errors in the design.

2.9.4 Archiving

If one of the contracting agencies is a government agency, it must comply with the statutory obligation to retain public records. Further, a third party service provider is responsible for the maintenance of the project database; the agency must make arrangements for the safe keeping, proper preservation and return of the records. Other technical issues relating to archiving include ensuring the records remain accessible and the integrity of the records is maintained, and ensuring the digitisation of information conforms to the statutory requirements (CRC Construction Innovation, 2008).
This section discussed how legislation and judicial precedence would affect BIM usage in the project setting. It highlighted the need to identify the legal jurisdiction in which the project will operate in, and the status of e-contracting. In addition, a number of legal precedence- and tort law concepts were discussed, focusing on how they may affect the implementation and use of BIM. Finally, the need for public sector agencies to archive project information to comply with government policy and legislative requirements was highlighted.

### 2.10 Professional Liability

This section investigates the concept of Professional Liability and how it relates to the design professional, operating in a BIM-facilitated collaborative environment. It describes what a ‘profession’ is within the AEC sector and the additional roles and responsibilities that professionals such as engineers, architects and quantity surveyors must adhere to when contributing to design activities. For example, the head design consultant is responsible (and therefore liable) for the design. With the shift to collaborative design and procurement methods, the head designer may become liable for the input of ‘non-professionals’ or the automatic update of the design by software. Therefore, there is an increasing need for insurances that cover the emerging BIM professional liability issues.

Bailey and Bell (2011 p. 281) describe professional liability as “the legal duties imposed by a society upon those who perform work which involves intellectual skill and special qualifications, and which is judged to a higher standard than applies to ordinary persons”. While there is no strict legal definition of what constitutes a ‘profession’, Santow (cited in McEniery, 2012) developed a working definition of a ‘profession’ and ‘professional activities’ as one that would:

> “Embrace intellectual activity, or manual activity controlled by the intellectual skill of the operator, whereby services are offered to the public, usually through not inevitably for reward and requiring professional standards of competence, training and ethics, typically reinforced by some form of official accreditation accompanied by evidence of qualification”

Critically, Santow also notes that such a definition does not remain static and is highly dependent on the general community’s use and understanding of the term ‘profession’.
In addition to society’s perceptions, there can also be a variety of boundaries placed on how professionals conduct themselves, by both professional organisations/associations and legislative requirements. These can include the types of qualifications needed to assume professional status, codes of practice and ethical behaviour, and the determination of disciplinary action for conduct breaches, independent of any court proceedings (Bailey & Bell, 2011). Architects, engineers and quantity surveyors are three professions that typically have the most involvement in a construction project. In Australia, there exist professional bodies that are associated with the three previously mentioned professions.

Similar to the UK findings of McAdam (2010a), within Australia only the use of the title ‘architect’ is covered by statutory regulations i.e. persons who practice under the title of architect must be registered. This legislation is at a state level and in NSW, it is the Architects Act 2003. It sets out the minimum expected standards that a person practicing as an architect must adhere to. It does not place any restrictions on the design of buildings, only the regulation of persons who practice as architects. It describes the minimum standards/qualifications and professional behaviour of architects (Cooke, 2010).

Within Australia, Queensland is the only state where there is formal regulation of engineers (National Engineering Registration Board, 2009, Cooke, 2010). A range of state and federal Acts covers the various services provided by engineers. Typically, however, clients tend to require any consultant engineer working on a project to be certified and qualified with its relevant industry association.

Similar to the USA, most Australian states are responsible for legislating building requirements and this is described in more detail in the section Public Sector Agency. However, the design does not have to be certified by a registered architect or engineer. Certifying bodies such as local government or a Principle Certifying Authority are responsible for conformance of designs to acceptable design and building practices. Each state in Australia has its own legislation that controls the certification of design and construction (Cooke, 2010). In NSW the controlling legislation is the Environmental Planning and Assessment Act 1979, the Building Professionals Act 2005 and, for residential work, the Home Building Act 2001. The only mention of the requirements of designers is the Building Practitioner in the Building Professionals Act 2005. It defines who is a practitioner and that the only requirements are for that person to have appropriate current insurance. Certification of the design is undertaken by a Certified...
Authority under the Building Professionals Act 2005 for conformance to the Environmental Planning & Assessment Act 1979.

While the digital exchange of design data between project participants has always occurred formally or informally, with the advent of CAD (Hartmann & Fischer, 2008) designers have always been reluctant to formally issue these files due to the possible retained liability for errors in data used for developing detailed documentation for construction (Lapp, Ford, Bryant, & Horlen, 2004). This liability concern has continued in the age of BIM where digital models have evolved from conveying design intent to being virtual representations of the built environment. Further, the development of the design is involving ‘non-professionals’ and the head designer may have the ultimate responsibility for his or her input.

This theme broadly consists of two subthemes – the professional liability associated with the generation of the design information inherent in the model and the use of the model information throughout the project lifecycle. The issues associated with the generation of the model are; who is the designer (Ashcraft, 2008); who is in charge and therefore is liable for the design (Ashcraft, 2008) and what are the legislative design licensing requirements (Allen et al., 2005), particularly in a collaborative environment (Sweet & Schneier, 2009) where non-professionals contribute to the design. As the BIM authoring tools develop in capacity, the issue emerges as to how to treat the contributions of the software (Ashcraft, 2008) and the reliability of the software (Greenwood et al., 2010) in developing the design.

From the perspective of the use of the model during the project lifecycle, some of the key issues are the reliance (O’Brien, 2007) of project participants on the model to use it to generate project information, and who is responsible for the maintenance of the model and project information (Larson & Golden, 2007) during the operational period of the facility. What the liabilities are for determining the currency and accuracy of the model during construction, and the limitations placed on reliance due to contract waivers, (Ashcraft, 2008) are two other issues associated with the subtype of use of the model.

McAdam (2010a, 2010b, 2010c) discussed the topic of design responsibility within the context of the USA and the UK, specifically how design professionals such as architects and engineers have legislated responsibility in the USA for design control. Except for minor developments, in the USA projects must be designed and certified by a registered architect or engineer. Implemented at a state jurisdiction level, these two roles have specific definitions as to who can call themselves an architect or engineer. It includes
requirements relating to qualifications and level of experience. However, there are mechanisms available to allow individuals, who are not ‘registered’ as professionals, to certify designs if they are under the ‘responsible control’ of an approved person.

2.10.1 The Spearin Doctrine

The Spearin Doctrine refers to a 1918 court case in the US Supreme Court which allocated the liability for defects which occurred during the construction phase of a project (Ashcraft, 2008). The ruling determined that the person or parties that supply drawings and specifications warrant that those documents are free from defects, and if a contractor adheres to the design, it cannot be held liable for any defects caused by the documentation.

In the USA, the federal courts created the Spearin Doctrine, which is that an owner or client implicitly warrants the information, specification and plans it supplies to a contractor to complete the works associated with a project (Ashcraft, 2008). The name of the doctrine refers to the actual case of United States v. Spearin and determined that the contractor will not be liable to the owner for any loss or associated damage that is solely the result of defects or insufficiencies in the specification, plans or information supplied by the owner.

Larson & Golden (2008) believe there are no new legal issues created, in regards to Spearin, with the use of BIM. The designer/owner is still providing information to the contractor; the difference is that the model can provide exact information as to sizing and quantities. Also Haynes (2009) notes that the Spearin Doctrine is nullified if the contractor is involved in the design process, such as a collaborative procurement environment.

2.10.2 Design Control

Hurtado and O’Connor (2008) highlight the need to determine who is in overall control of the design. In a typical project, there are multiple contributors to the design such as subcontractors, suppliers and even the client. In some instances, the subcontractor will unwittingly assume this design control. Further, with the advent of collaborative procurement methods, the designation of design control increases in importance (Ashcraft, 2008; Haynes, 2009b).
2.10.3 Design Liability

Determining who is professionally responsible for the design, particularly in a collaborative project environment, is another concern associated with the theme of professional liability. In some instances, the head contractor may also have a design firm novated as part of the contract and may have no control over its earlier contribution but be ultimately responsible for its contribution (Ashcraft, 2008). Finally, subcontractors may also inherit some design responsibility as part of completing the required documents for construction and consequently take on a portion of design liability. The key issue is a subcontractor may unwittingly take on this liability without considering the ramifications to its risk exposure (Haynes, 2009b).

2.10.4 Standard of Care

With the increasing level of detailing possible within a model, designers will need to exercise a higher standard of care (Ashcraft, 2008). Sebastian (2010) believes an agreement between project participants on the standard of care is an integral part of a contract for completion of the works. This may include a clear definition of the professional services, deciding if the standard of care will change, the effect on the design process and if a model is a design product or an instrument of service (Wheatley & Brown, 2007). Finally, the standard of care will have a direct relationship to the level of reliance detailed in the contract, for example the higher level of care a designer takes in detailing the model will allow for a greater amount of reliance on the model (Simonian & Korman, 2010).

2.10.5 Design Delegation

For the majority of projects it is impossible for the design professional to individually complete all aspects of the design, therefore delegation of the design work will always occur, be it to other persons within the business, or subcontracted out to other firms. How this delegation is treated, with due consideration to the risk posed to the project participants and legislative requirements, is critical to ensuring a reasonable exposure to risk (McAdam, 2010b). The project participants, particularly subcontractors need to be aware of the contractual delegation of design and the consequences for assuming this risk (Haynes, 2009b). Once again, this can be difficult to quantify in a collaborative procurement delivery methodology (Haynes, 2010a).
2.10.6 Software Generated Design Liability

BIM authoring software continues to advance at a phenomenal rate (Eadie et al., 2013). However, there are a number of issues associated with the level of reliance on software to accurately record and amend the design. For example, Ashcraft (2008) notes that there may be inherent errors within the software but the software wholesalers typically limit their liability through the use of ‘shrink wrap disclaimers’. Therefore, any errors in the design caused by these software bugs remain the responsibility of the designers. In addition, the efficiencies of BIM software, such as the automatic generation/updating of elevations and sections, is a form of design delegation, which raises the question is there a responsibility for the design professional to track and check these changes?

2.10.7 Design Professional Licensing

In some jurisdictions a designated licensed professional must be in charge of the design, for example, in the USA it is either a registered architect or engineer (Allen et al., 2005; Ashcraft, 2008). This individual then assumes all of the liability for all of the contractual design requirements. This individual is assuming a significant amount of liability considering the changes software can make in updating the design and that the design is undertaken in a collaborative environment by non-licensed professionals (O’Brien, 2007; Thompson & Miner, 2006).

2.10.8 Professional Liability Insurances

The various matters discussed in the previous section highlight the extent of professional liability designers are exposed to, when undertaking a BIM-enabled project. To cover against these risks, engineers and architects typically take out Professional Indemnity insurance. As BIM is a relatively new process, insurance companies are still coming to terms with the liability and risk associated with such projects. This is further exacerbated if the project is delivered using a collaborative method (Ashcraft, 2008; Haynes, 2009b, 2010a, 2010b). Other issues to consider with insurances include, the level of explicit design delegation and the level of reliance on the software to automatically complete portions of the design.

This section covered the issue of professional liability and how it relates to design input and responsibility when BIM is used in a project and non-professional stakeholders have input into the design.
2.11 Public Sector Agency

The structure of the AEC industry consists of a number of interrelated actors’ activities, regulatory frameworks and supporting infrastructure. The former Australian Federal Government Department of Industry Science and Resources (1999) developed a multidirectional cluster framework to assist with understanding the various participants involved in the wider sector. Critically, the structure identifies the role of the ‘regulatory framework’ and the various activities and actors that monitor, manage and regulate the construction process, as shown in Figure 2.2. This section examines the capacity and capability of the Public Sector to process, review and approve developments based on BIM submissions.

![AEC Cluster Map](image)

There are three levels of government in Australia: Commonwealth, State/Territory and Local, and all have varying levels of input into legislation and regulation of the construction sector. The state and territory governments are chiefly responsible for the planning approval process and construction regulation, although certain segments of the approval process are delegated to local government (Bailey & Bell, 2011; Department of...
Industry Science and Resources, 1999). This multilayered system has led to a vast collection of Acts and Regulations that potentially apply to the construction lifecycle. In addition, differences between the various states' legislation have introduced a number of inconsistencies in the planning, approval and construction process that the industry considers as “complex and confusing, and often fails to provide a reasonable level of certainty” (Department of Industry Science and Resources, 1999 p. 11). Recently, there has been a concerted effort to harmonise the regulatory environment to increase the level of certainty for project approvals and construction standards, and a successful example is the National Construction Code that has largely removed the state-based inconsistency in the manner in which the actual construction work is undertaken (Bailey & Bell, 2011).

One of the common characteristics of the state and territory legislation applicable to construction is an approval/certification process for developments to ensure they are in accordance with current legislation, regulations and standards. However, this process has largely been delegated to local government (Bailey & Bell, 2011). This requires the preparation and submission of drawings, specifications, specialist reports and consultations with stakeholders in order for a project to receive approval. The drawings typically consist of two-dimensional plans, elevations and sections (Maitland City Council, 2004). Allen et al (2005) highlights how government authorities do not currently have the capability or the capacity to process virtual models in lieu of the two-dimensional drawings of a facility, and consequently hardcopy documentation must be generated for the approval process.

For example, government legislation may require the submission of hardcopy documents (Allen et al., 2005) or submission in writing (Sebastian, 2010) for it to be accepted and stamped as approved. Further, public sector agencies may not have the capacity and capability (Allen et al., 2005) to process or assess digital project information for conformance with building codes. When the project is in construction, public sector authority inspectors (Ashcraft, 2008) refer to the hardcopy documents to determine conformance with the approved design. All of these issues form the theme of public sector capacity and capability.

2.11.1 Building Regulations and Authority Approval Requirements

Ashcraft (2008) notes the importance of ensuring building officials and inspectors have a stable document to compare to the actual onsite construction. The issue relates to the shift from hardcopy drawings in which only the design intent is captured and submitted
for approval, to a dynamic process where the model can be digitally reproduced to a high level of detail. If the actual contract or design documents are the model, the requirement is for the generation of reference material which the inspectors can easily access and review for comparison with the actual construction, if they cannot process a digital model (Sebastian, 2010).

2.11.2 Approvals in Writing – Model versus Drawings

Allen et al (2005) emphasise how public sector agencies have not contemplated the submission of digital information or models for development/construction approval and conformance checking. The regulatory requirements stipulate the submission of hardcopy drawings and specifications for review and approval. Further, the issued approvals also need to be in writing to meet the legislative requirements (McAdam, 2010b; Sebastian, 2010). In addition, many public sector agencies may have the capacity or the technical capability to process digital information or models. Therefore, hardcopy documents are typically produced for the approving agency. The issue then becomes what is the legal status of the model compared to the ‘approved’ hardcopy documentation and which document takes precedence? (Allen et al., 2005; Ashcraft, 2008).

This section explored the constraints public sector regulatory frameworks place on the use of BIM in an integrated setting and how current approval processes require the submission of hard-copy documentation to public authority for certification. Further, many agencies do not possess the capacity to accept, review or compare a model against the actual construction work occurring onsite.

2.12 Risk Allocation

This section reviews the issue of risk and the effect on the implementation of BIM in the project setting. It begins with a definition and description of risk allocation and how various procurement methods apportion risk amongst the various stakeholders. From the perspective of BIM implementation this section discusses the allocation of risk and liabilities (Greenwood, Lewis & Lockley 2010) in a fair and reasonable manner (Ashcraft, 2008). In addition, the current concern is that the increased risks and efforts need to be matched by contractually agreed payments (Holzer, 2007) as discussed in the compensation and consideration section of the literature review. As BIM is an innovative process and technology, the risks need to be identified (Thomson & Miner, 2006) to determine the changing roles and responsibilities (Simonian & Korman, 2010) in a
traditional and collaborative procurement (Thomson & Miner, 2006) situation. In addition, the insurances that cover risk allocation (O’Brien, 2007) need to evolve to address these emerging risks and concerns.

Risk is defined as “the effect of uncertainty on objectives” (Standards Australia, 2009p. 1) The ‘effects’ of risk usually incur a deviation from the required outcome, which can be positive, negative or neutral (Smith, Merna, & Jobling, 2006). Risk is characterised and categorised by references to potential events, the likelihood of the event occurring and the potential consequences of the event (Bozeman & Kingsley, 1998). Figure 2.3 depicts a typical risk categorisation matrix. Depending on the rating and the overarching risk strategy, the risk may be avoided, accepted and/ or transferred to a third party (NSW Department of Commerce, 2006).

![Figure 2.3 Risk Matrix](image)

Construction projects face a number of risks, which invariably affect the final cost of the project (Nahapiet & Nahapiet, 1985). Table 2.3 highlights some of the risks commonly associated with construction projects (Smith, Mena & Jobling (2006).

<table>
<thead>
<tr>
<th>Table 2.4 Common Sources of Construction Project Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial</td>
</tr>
<tr>
<td>Social</td>
</tr>
<tr>
<td>Geographical</td>
</tr>
<tr>
<td>Technological</td>
</tr>
<tr>
<td>Supply</td>
</tr>
</tbody>
</table>

Typically, the contract will attribute liability for each of the potential risks, as identified in the above table, between the contractor and the owner. In addition, the distribution of risk is a function of the type of contract or procurement method employed (Zaghloul &
Hartman, 2003). For example, Figure 2.4 provides a generic description of the various risk allocations for Traditional-, Design and Build- and Management procurement methods.

![Figure 2.4 Contract Risk Allocations](adopted from Nicholson, 2003)

At the commencement of the project, the client or proponent will conduct a risk assessment process to identify and evaluate the various project risks. Based on the assumptions of the risk assessment, the client determines its level of risk exposure and looks to eliminate, transfer or insure against the risk. Various methods of allocating risk in a project are available, apart from explicitly allocating the risk in the contract documents. Specific clauses are used to assign the risks to certain parties, irrespective of the likelihood of their occurrence. The procurement method provides an overarching risk allocation strategy. Risk allocation can also be controlled through the payment mechanism, such as lump sums or as admeasures incorporating a bill of quantities (Smith et al., 2006).

### 2.12.1 Allocation of Risk Liabilities

At a general level, there will need to be an allocation of the liabilities specifically relating to the risk in using BIM in a project. This would include the identification of the different
types of risks unique to the project and the allocation process. Ashcraft (2008) believes an Abrahamson risk allocation is the best method for the distribution of the risks. According to Abrahamson (1984) the allocation of a construction risk to a specific party should be based on the following conditions:

1. It is in his control, i.e. if it comes about it will be due to wilful misconduct or lack of reasonable efficiency or care; or
2. He can transfer the risk by insurance and allow for the premium in setting his charges to the other party (or to his customers) or spread it directly in his prices, and it is most economically beneficial and practicable for the risks to be dealt with in that way; or
3. The preponderant economic benefit of running the risk accrues to him; or
4. To place the risk on him is in the interests of efficiency (which includes planning, incentive, innovation) and the long-term health of the construction industry on which that depends; or
5. If the risk eventuates, the loss falls on him in the first instance, and it is not practicable or there is no reason under the above four principles to cause expense and uncertainty, and possibly make mistakes, in trying to transfer the loss to another.

The various risks can be regulatory risks (Kog, 2010), as in who is responsible and liable for adhering to regulations, process risks, and risks which emerge during the project. Sebastian (2010) believes the BIM collaboration reduces traditional project risks but introduces new risks such as inexperience with novel procurement methods, business practices and staff. Collaboration also blurs the line of risk allocation and liabilities for tasks, such as design, especially where there are multiple contributors to the design (Rosenberg, 2006).

2.12.2 Risk Insurance

Depending on the contract structure and the allocation of risks using the contract conditions, there may be the need for some form of additional risk insurance for the designer, client and contractor (O’Brien, 2007). For BIM projects, this general risk insurance could cover, for example, the costs of data loss and rework, errors in the model and system failures. The amount and scope of the insurance would be a direct reflection of the actual risks incurred by the project stakeholders (Ashcraft, 2008).

This section investigated the allocation of certain risks associated with integrating BIM into the project delivery methodology. It described the risk management process and the
imbalance between risk and rewards of additional liabilities for completing a digital representation of the facility for little or no additional financial gain. Further, there is a need to implement a risk management process that identifies and distributes the risks particular to the use of BIM in the project setting. Finally, as innovative uses for BIM emerge, insurance coverage needs to safeguard project participants and the projects against the risks, liabilities and possible financial losses these issues may cause.

2.13 Summary

The discussion in this chapter has characterised BIM legal concerns into ten thematic areas. These themes broadly relate to the control, protection and dissemination of information to project participants, including the risks associated with its distribution.

A number of models have emerged over the last few years (Ashcraft, 2008; Fan, 2014; Larson & Golden, 2007; McAdam, 2010b; Olatunji, 2011) that provide general taxonomies of BIM legal limitations. The main aim of these models is to identify and classify the legal issues and constraints associated with BIM project implementation. The earlier models such as Ashcraft (Ashcraft, 2008) and Hurtado and O’Connor (2008), also postulated as to the possible impacts on roles, responsibilities and liabilities of the various project participants and the changes needed to existing contracts to enable BIM implementation. Later models such as Olatunji (2011) have classified and grouped the range of BIM limitations under a limited number of themes.

More recently, as contract amendments and execution plans have emerged to address certain aspects associated with BIM implementation, authors such as Haynes (2009c), Olsen and Taylor (2010) and McAdam (2010b) have undertaken a general discussion as to how effective these documents are in addressing the BIM legal concerns. Haynes, for example, compares two contract addendums, the ConcensusDOCS CD301 and the American Institute of Architects E202 BIM Protocol Exhibit, against the legal issues of model reliance, risk allocation and level of detail. Haynes notes that each document is a major step towards addressing some of the legal concerns, but it is still too early in the contract evolution cycle to determine which addendum would be the preferred document. Further, features within the CD301 and E202 documents have slightly different emphasis on addressing BIM issues and as new uses for BIM emerge, new issues are certain to surface.

Therefore, this investigation seeks to extend upon the existing literature to illuminate the contractual complexities of BIM implementation within the context of construction
procurement. The next chapter investigates the concepts associated with procurement, which will contribute to understanding of the contractual link that exists between the client and contractor, including the structure and contents of standardised construction contracts. Even though a number of procurement systems and methods exist in the AEC sector, the common characteristic shared amongst all systems is the contract link between the client and contractor. It is proposed that by understanding the structure and characteristics of standardised contracts the impact of BIM implementation can be fully appreciated when mapped against the various BIM legal concerns, as identified in this Chapter’s Literature Review.
3 CONCEPTUAL MODEL - CONSTRUCTION CONTRACTS & BIM

3.1 Introduction

The previous chapter identified a range of legal and contractual issues associated with the implementation of BIM into the project-delivery process. It also identified a knowledge gap in determining how the legal concerns could influence Australian standardised construction contracts. This chapter discusses the different types of construction procurement systems, methods and mechanisms that are used to examine the impacts BIM could have on standardised construction contracts. Highlighting the structure of procurement and the technical aspects of construction contracts, including the mechanisms embedded in the contract conditions, adds a systematic rigour and validity to the overall research structure. Further, the mapping of common traits of construction contracts against the thematic areas identified in the previous chapter constructs an all-encompassing conceptual framework for this investigation.

The first section of this chapter discusses five types of procurement system commonly found in the AEC sector. It commences with a definition of a ‘procurement system’ and models the five main types of procurement. The overall structures of these systems are discussed to highlight the contractual links that exist between the various participants within the procurement process.

The next section of this chapter examines the documents and mechanisms that reside within a standardised construction contract. A working definition of what constitutes a construction contract provides a logical starting point for examining the function, characteristics and the preparation of standardised construction contracts. This section also identifies the common mechanisms embedded in the conditions of contract that are used to manage the work and behaviours of the various individuals that are party to the actual contract. The identified contractual mechanisms are then mapped against the legal concerns and thematic areas identified in the previous chapter and this is used as the conceptual model for analysing a contract and exploring the possible impacts BIM implementation could have on an existing standardised construction contract.

The final part of this chapter concludes by summarising graphically the overarching conceptual model that forms the framework for investigating impacts of BIM on standardised Australian construction contracts.
3.2 Construction Procurement Systems

This section investigates construction procurement systems and the typical delivery methods employed in procuring facilities. It details the five major types of procurement method and identifies the major contractual connections between the client, designer and contractor.

3.2.1 Procurement Systems

Love, Skitmore and Earl (1998) highlight the proliferation of procurement system definitions within the AEC sector and note how the terms 'contractual arrangement' and 'procurement system' are used interchangeably. At its simplest, Ashworth, Hogg & Higgs (2013 p. 203) define AEC procurement as the “process that is used to deliver construction”. Extending on their definition to describe the overall system, Masterman (2002, p. 27) describes a procurement system as:

“the organisational structure adopted by the client for the implementation, and at times, operation of a project”.

However, Love, Skitmore and Earl (1998 p. 222) earlier definition adds detail by describing a procurement system as “an organizational system that assigns specific responsibilities and authorities to people and organizations, and defines the relationships of the various elements in the construction of a project”. This definition of ‘procurement system’ is adopted for this research.

Extending the earlier work of Fellows (1993) and Perry (1985), Love, Skitmore and Earl (1998) have formulated a model of the various construction procurement systems and methods consisting of two main levels as shown in Figure 3.1 and discussed in the proceeding section. The first level is classified as the Formal System and relates to the overarching procurement system consisting of the three main types of procurement: Traditional-, Design and Build- and Management Systems. The next level is the Formal Subsystem or Procurement Method. This level describes the different contractual approaches associated with the three main procurement systems.

Since the development of the Procurement Model in the late 1990s, additional construction procurement systems have emerged that provide alternative systems for the procurement of facilities in the AEC sector. For example, relationship systems that focus on formulating positive relationships, such as Alliancing and Integrated Project Delivery contract models (Akintola & Jamie, 2007; Ashworth et al., 2013; Prins & Owen, 2010). In addition, Privately Financed Initiatives (PFI) have provided an alternative means of
funding public sector projects (Ashworth et al., 2013; Li, Akintoye, Edwards, & Hardcastle, 2005).

Figure 3.1 Procurement Systems

3.2.2 Traditional Systems

The Traditional- or Design-Bid-Build approach to project procurement involves two separate contractual arrangements; the first contract is between the owner/client and the design professional. Typically, this is either an architect or an engineer, but in recent times, the owner may also engage a project manager to control the process. However, even if a project manager is engaged to manage the process, the design contract is still between the owner and the design professional. Other consultants are engaged on an ‘as needed’ basis and may be either directly engaged by the client or subcontracted through the head design professional. The key feature of the Traditional approach is the separation of the design and construction phases (Ashworth, Hogg & Higgs (2013).

At the completion of the documentation phase, the project is priced through some form of tendering process and a contractor is engaged to build the project. Similar to the design process, the owner may engage the design professional to manage the design process,
but once again, the contract for construction is still between the owner and the contractor. The design professional simply acts as a representative of the owner. Figure 2.2 shows a typical traditional contract layout highlighting the functional and contractual links between the key project participants.

![Figure 2.2 Traditional Contract Structure](image)

### 3.2.3 Design and Build Systems

Design and Build procurement systems emerged as an approach to overcoming the inherent weaknesses associated with the traditional Design-Bid-Build method. These weaknesses include the lack of contractor involvement in the design process, depriving the owner of knowledge of construction methodologies, scheduling and market conditions. Further, it creates a divide between design and construction, hindering the opportunities to create a team (or collaborative) environment (Sweet & Schneier, 2013).

The Design and Build system aims to overcome the disadvantages of the traditional approach by combining design and construction under one contract or organisation, typically the Head Contractor. The client will initially engage a designer to develop a concept design and detailed brief, such as a performance specification. Contractors then tender for the works based on the concept design and the performance requirements. In some instances, the client will also mandate the use of the original designer, referred to
as novation. Figure 3.3 illustrates the basic contractual and functional links of a Design and Build procurement method (Ashworth, Hogg & Higgs 2013).

![Diagram of Design and Build Contract Structure]

### 3.2.4 Management Procurement Systems

Similar to the Design and Build system, Management Contracting emerged because of the perceived weaknesses and inefficiencies in the Design-Bid-Build method, particularly the inability of contractors and designers to employ efficient management skills (Sweet & Schneier, 2013). This approach is suited to large complex projects where there is a need to reduce the contractor’s risk exposure. The various forms of management-based contracts are differentiated by their varying contractual links and the scope of management provided to the client (Ashworth, Hogg & Higgs 2013).

In a Management Contracting system, a contractor acts in a professional management capacity, only providing high-level management expertise and constructability advice. The contractor does not directly engage or employ any labour, plant or materials apart from the works associated with the preliminary works, such as site establishment. The works are tendered on a package basis with the contracts between the management contractor and the works contractor (Ashworth et al., 2013; Sweet & Schneier, 2013).

The Construction Management system shares similar characteristics to the Management Contracting version in the appointment of a construction manager, but the main
The Design and manage procurement method is also similar to management contracting in that the management contractor is engaged to control both the design and construction portions of the project (Ashworth et al., 2013). Figure 3.4 shows the typical contractual and functional links in a management contracting structure.

3.2.5 Relationship Based Procurement Systems

In response to the ‘win-lose’ outcomes commonly associated with other procurement approaches, relationship contracting has emerged aimed at managing the owner-contractor relationship. These methods recognise that there is a mutual benefit in ensuring a collaborative relationship between the client and the contractor. The aim is to create a win-win scenario where the best outcome for the project and stakeholders is achieved (Jones, 2001). A typical alliancing structure is shown in figure 3.5.

Alliancing Contracting is one example of relationship-based contracting (Jones, 2001) and is based on four interdependent success factors:

1. An integrated collaborative team
2. The project solution
3. The agreed commercial arrangements
4. The agreed Target Outturn Costs.

The seven key features of alliance contracts are:

1. Risk and opportunity sharing
2. Commitment to ‘no-disputes’
3. Best-for-project, unanimous decision-making processes
4. ‘no fault – no blame’ culture
5. Good faith
6. Transparency expressed as ‘open-book’ documentation and reporting
7. A joint management structure.

(Department of Infrastructure and Transport, 2011)

![Diagram of Alliance Contract Structure](image_url)
Another example of a relationship-procurement method is Integrated Project Delivery (IPD). It takes a similar approach to alliancing contracting, and is underpinned by nine key principles:

1. Mutual respect and trust
2. Mutual benefit and reward
3. Collaborative innovation and decision making
4. Early involvement of key participants
5. Early goal definition
6. Intensified planning
7. Open communication
8. Appropriate technology
9. Organisation and leadership

The American Institute of Architects’ IPD guide mentions the use of BIM as a means of achieving a high level of collaboration and project team integration, but requires the development of protocols and contract language specifically aimed at BIM (American Institute of Architects, 2007).

### 3.2.6 Public-Private Partnerships/Privately Financed Initiatives

Public-Private Partnerships (PPP) are defined as “a cooperative venture between the public and private sectors, built on the expertise of each partner that best meets clearly defined public needs, through the appropriate allocation of resources, risk and rewards” (Ke, Wang, Chan, & Cheung, 2010p 1076). It is described as a service contract between the private and public sectors where the government pays a consortium to construct infrastructure or provide services over a set period. The consortium is usually responsible for financing the project and the condition and performance of the assets throughout the agreement period (Commonwealth of Australia, 2008). Figure 3.6 outlines a typical structure for a PPP.

For a typical PPP project, the government will prepare a performance-based specification for the asset or services required and then engage a provider over a period of 20 to 40 years to provide the facility or services. The provider will be responsible for financing the design, construction and operation of the asset for the set period. The government will not make any payment prior to the commissioning of the asset, but commences performance-based payments once the facility becomes operational. After the specified period of operation, the government takes ownership of the facility. At handover, the facility must be in a specified condition or standard before the government will accept ownership (Commonwealth of Australia, 2008).
The key characteristic common to all procurement systems and methods is the presence of a contractual link between the client and the contractor. This contractual link is discussed in detail in the next section.

This section discussed the procurement systems commonly encountered in the AEC sector. In the next section, the additional demands typically encountered in public sector procurement are examined.

### 3.3 Construction Contracts

This section examines the structure, characteristics and functions of construction contracts. It focuses on describing the contractual link between the client and the contractor concentrating on the Traditional-, Design and Construct- and Management procurement systems as described in the beginning of this chapter. It also highlights the contract formation process, common mechanisms found in contracts and the standard contract drafting process. This section commences with the identification of a working definition of a construction contract.

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**Figure 3.6 Private-Public Partnership Structure**

This section discussed the procurement systems commonly encountered in the AEC sector. In the next section, the additional demands typically encountered in public sector procurement are examined.

### 3.3 Construction Contracts

This section examines the structure, characteristics and functions of construction contracts. It focuses on describing the contractual link between the client and the contractor concentrating on the Traditional-, Design and Construct- and Management procurement systems as described in the beginning of this chapter. It also highlights the contract formation process, common mechanisms found in contracts and the standard contract drafting process. This section commences with the identification of a working definition of a construction contract.
Loots and Charrett (2009 p 23) define a construction contract as:

“any contract where one person [or corporation] agrees for a valuable consideration to carry out construction works which may include building or engineering works for another”.

Goldfayl (2004 p 7) follows a similar view but adds a reference to time and quality, thereby considering a construction contract to be:

“an agreement between an owner and a contractor that the contractor will construct a specified structure for the owner, to a specified standard within a specified time, in exchange for a specified sum of money which the owner will pay to the contractor”.

From a jurisdictional perspective, the NSW Building and Construction Industry Security of Payments Act 1999 (NSW) considers a construction contract to be:

“a contract or other arrangement under which one party undertakes to carry out construction work, or supply related goods and services for another party”

Of significance is the latter definition’s inclusion of the supply of goods and services such as building materials or design/consultant services.

### 3.3.1 Construction Contract Theory and Contract Documents

Generally, construction contracts can be seen as having a number of purposes ranging from a means of recording a business deal, planning for the effect of unforeseen events by apportioning risk to project participants, a procedures manual for managing the project, a reference point for industry experience and finally as a schema for legal action (Hughes, 1997; Hughes & Greenwood, 1996).

Typically, the contract will consist of a range of graphical and non-graphical documents, that as a whole will form the official agreement between the parties. Some common contract documents include:

- The completed Contract Form
- The project specification
- The project drawings
- Specific Conditions of Contract (based on a standard contract or purpose-drafted)
- Articles of Agreements
Appendixes such as project communication protocols

### 3.3.2 The Function of Construction Contracts

A construction and building contract performs five key functions. It records a business deal, allocates risk, provides mechanisms to administer the transaction, outlines a process for taking legal recourse and acts as an industry reference point.

#### 3.3.2.1 Recording a Business Deal

It records a business deal, allocating the main obligations of the parties to the contract namely: the Contractor builds the work and the Principal pays for the work completed (Hughes & Greenwood, 1996; Uher & Davenport, 2009).

#### 3.3.2.2 Contingency Planning/Risk Allocation

The Implementation of a formal contract allows for the adequate planning of contingencies or to describe this process in another form, the allocation of risk to the different parties to the contract. This is achieved through a process of agreement using either a standard form or detailed negotiation (Bailey & Bell, 2011; Hughes & Greenwood, 1996).

#### 3.3.2.3 Management Procedures Manual

Over time, construction contracts have taken on the status of a manual for managing the processes associated with the contractual transactions. This manual provides mechanisms to manage or administer the contract, and in some cases prescribes and controls the behaviour of the parties to the agreement (Hughes & Greenwood, 1996; Uher & Davenport, 2009).

#### 3.3.2.4 A Process for Litigation

Turner (1994) notes construction contracts should take into account the possibility of disagreements amongst the parties and should therefore ensure there is some recourse through the legal system, for defective performance. It needs to be reflective of the courts’ approach to the doctrine associated with contracts (Hughes & Greenwood, 1996).
3.3.2.5 As an Industry Reference Point

When a standard form is used it allows for industry professionals, and those associated, to become familiar with the procedures and risk allocation. Standardisation also develops consistency in roles and responsibilities which allows for the development of an established view of contract practice related to a standard form (Hughes & Greenwood, 1996; Murdoch & Hughes, 2008).

3.3.3 The Characteristics of Construction Contracts

Construction contracts have a number of specific features that are unique when compared to other forms of contracts. In addition to the contract doctrine associated with contract formation there are typically additional layers of obligations and characteristics of construction, which relate to the project process and protection of the client. For example, Loots and Charrett (2009) have identified three key differences:

1. construction contracts can include the ability to alter the agreement,
2. the multifaceted interdependence of contracts and sub agreements that form a construction project for example head contracts, subcontracts and consultant agreements and
3. the complexity of documents which can constitute the contract.

3.3.3.1 Formation of a Simple Contract

The formation of a simple contract requires the presence of four typical characteristics for it to be enforceable by a court of law. These are:- an intention to create a legal relation, a process of offer and acceptance, some form of consideration, be it payment or some form of goods or services, and finally the capacity to contract (Bailey & Bell, 2011).

3.3.3.2 The Ability to Change the Contract

In most contracts, the Principal has the right to increase or decrease the extent of works directly related to the agreement. This is achieved through the process of issuing a variation to the contractor. The contractor is then obliged to complete the additional works (Loots & Charrett, 2009).

3.3.3.3 Complex multi-Contract Project Relationships

A large construction project can consist of several contracts between multiple parties. This interrelated and interdependent web of contracts consists of agreements between the Principal/Consultants, Principal/Contractor, Contractor/Subcontractor,
3.3.3.4 Insurance

The contract form will typically require some form of insurance and will mandate its currency before any work is undertaken, be it design or construction/building works (Loots & Charrett, 2009).

3.3.3.5 Document Complexity

Many of the contract documents are inherently complex and may require technical expertise to enable comprehension. For example, the inclusion of geotechnical reports relating to the subsurface conditions or structural design performance parameters require significant discipline knowledge to understand and interpret the details contained within (Loots & Charrett, 2009).

3.3.3.6 The Provision of Security

The contractor is often required to submit some form of security for its performance, be it a deduction from payment or a guarantee from a financial institution (Loots & Charrett, 2009).

3.3.3.7 Liability Allocation

The allocation of liability for damage or loss arising from a failure to exercise a duty of care can be apportioned incrementally by statute when there is more than one party responsible (Loots & Charrett, 2009).

3.3.3.8 Assumption of Long-Term Obligation

A construction contract can often include the assumption of a long-term obligation, for example, the liability for defects or the maintenance of the built facility (Loots & Charrett, 2009).
Podvezko, Mitkus and Trinkuniene (2010) have used nine criteria for evaluating contracts, as shown in Table 3.1.

Table 3.1 Contract Evaluation Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Customer’s Obligations</td>
<td>The Customer’s obligations as detailed in the Contract</td>
</tr>
<tr>
<td>Contractor’s Obligations</td>
<td>The Contractor’s obligations as detailed in the Contract</td>
</tr>
<tr>
<td>The right to vary the Contract</td>
<td>The right to vary the contract works and price</td>
</tr>
<tr>
<td>Guarantees</td>
<td>The warranty of the works by the Contractor</td>
</tr>
<tr>
<td>Payment Conditions</td>
<td>The conditions in which the Customer pays the Contractor</td>
</tr>
<tr>
<td>Subcontracting</td>
<td>The conditions associated with subcontracting the works</td>
</tr>
<tr>
<td>Contract Insurance</td>
<td>Specific insurance requirements for the works.</td>
</tr>
<tr>
<td>Contract Suspension</td>
<td>The conditions in which the Contract can be suspended</td>
</tr>
<tr>
<td>Contract Termination</td>
<td>The conditions in which the Contract can be terminated.</td>
</tr>
</tbody>
</table>

3.3.4 Preparation and Standardisation of Construction Contracts

Within the Australian context, there are no rules which govern the content of the documents which constitute a construction contract (Loots & Charrett, 2009). The parties to the agreement are responsible for negotiating the terms and conditions, and in the case of large projects this leads the documents to be extensive and complex. Written construction contracts can be in the form of a standard form contract, a standard form which has been modified, or a custom-made or bespoke contract unique for a particular project (Loots & Charrett, 2009).

In addition, construction contracts typically contain a form of Agreement, the General Conditions of Contract, the Special Conditions of Contract, technical specifications, drawings, the Bill of Quantities and schedules (Ashworth, 2002).
3.3.4.1 Standard Forms of Contract

Standard forms of contract have become the norm within the construction industry and one of the main recommendations of the Latham (1994) report was the adoption of one standard suite of forms for the entire sector. While a worthwhile recommendation, the actuality of implementing one form for all types of construction was unrealistic due to the varying levels of complexity, risk allocation, and types of work inherent in construction projects, and therefore industry has moved on from such thinking (Murdoch & Hughes, 2008).

Standard forms of contract emerge from one of two processes, the first being a process of industry consensus, where a number of parties come together to draft a document which is usually fair and reasonable for all parties involved. The alternative process involves one party drafting a set of standard conditions for use industry wide. In addition, different sectors of the industry draft standard conditions, which reflect the type of work associated with their sector. Two objectives of standard conditions are the provision of a preset risk-allocation model and a framework which reflects the desired outcome for the project sector (Bailey & Bell, 2008; Murdoch & Hughes, 2008).

The advantages of developing and using standard forms include the obviation of the need to draft conditions which cover routine matters, thereby allowing more time to focus on project-specific conditions (Uher & Davenport, 2009). If the standard form has been in use for several years, it reduces the likelihood of disputes over the interpretation of conditions. It expedites the tendering process if contractors are familiar with the risk allocation and requirements associated with particular standard conditions (Uher & Davenport, 2009). Further, tender sums can be reduced as there would be minimal contractual uncertainties to allocate a risk price against. Using a standard increases familiarity with the administration processes, roles and responsibilities typically allocated to the parties of the contract (Loots & Charrett, 2009). Finally, if a consensus standard form is used, the risk allocation is likely to be fair for all parties (Bailey & Bell, 2008).

There are however, several disadvantages relating to the use of standard forms, such as the document possibly containing compromises, anomalies and ambiguities due to the difficulty in forming a consensus (Bailey & Bell, 2008). There is a danger a contractor may not read the contract documents in their entirety and they may contain changes to the default risk allocation, resulting in incorrect pricing (Bailey & Bell, 2011; Goldfayl, 2004). The choice of standard form may be inappropriate for the project at hand thereby failing to allocate appropriate risks, roles and responsibilities (Murdoch & Hughes, 2008).
Finally, due to the long timeframes in drafting standard forms, mechanisms within the contract do not keep pace with advancement in technologies (Hartmann & Fischer, 2008).

Within Australia, there are a wide range of standard forms published by an array of industry associations and bodies, such as the Australian Standards suite of contracts (Bailey & Bell, 2008).

3.4 Conceptual Model of BIM and Construction Contracts

This section presents the conceptualisation of the construction contract, the BIM legal concerns and proposes a conceptual model of the impact of BIM on construction contracts. A criterion is presented for analysing conceptual models. The existing BIM models are critiqued and the strengths and weaknesses identified. In the final part of this section a new conceptual model is presented that combines the BIM legal issues identified in Chapter 2 and the contract formation process in this chapter.

3.4.1 Framework for the Analysis of Conceptual Models

A conceptual model is defined as “a simplification of reality” that provides a stylised representation of the core variables/concepts and the assumed causal associations between these core elements (Doorewaard 2010). A typically model is represented by a diagram and complemented by a detailed description of the elements, which includes the links and relationships between the various concepts. Three criteria, as proposed by Fawcett (2005), are used to analyse and evaluate the BIM legal issues conceptual models. The criteria are comprehensiveness of content, logical congruence and conceptual clarity and a brief description with examples of their application to the assessed models are provided below.

The assessment of the comprehensiveness of content refers to the breadth and depth of content residing in the conceptual model (Fawcett 2005). To expand, the breadth of a model is deemed suitable if the extent of the detail provides guidance in both practical situations and as a structure for undertaking research and education. A model has depth when it provides adequate descriptions of its elements and reasonable links between these concepts. For example, Olatunji’s (2011) taxonomy model shown in figure 3.7, provides a breath of detail by identifying a number of key elements, describes each of the elements in the supporting paragraphs, and identifies some link between the concepts.
Assessing a model for logical congruence involves reviewing the internal logic of the model using critical reasoning (Fawcett 2005). The process of critical reasoning involves making judgments on how the model reflects varying worldviews and topic categories. It determines the strengths of the model in reflecting more than one worldview, the diversity of views and explores problems in specific lines of reasoning. Olatunji’s model provides logical links between concepts he describes the constructs in detail in the body of his model justification.

The final criteria that will be used to review the existing conceptual models is conceptual clarity. Extending on the concept of logical congruence, conceptual clarity focuses on the concepts and relationships embedded within the model. It aims to identify the main concepts in addition to direct and casual relationships between the model elements. A model with a high level of conceptual clarity will have explicit statements describing the
elements, the types of relationships between concepts, assumptions or theory that is used as a framework to developing the conceptual model (Fawcett 1195).

3.4.2 Analysis of Existing Models

This section provides an analysis of two existing conceptual models that focus on the concept of BIM legal issues. The review is presented in table format, as shown in tables 3.2, 3.3 and 3.4 respectively, using the criteria described in the previous section. The two frameworks analysed are the conceptual models presented by McAdam (2010) and Olatunji (2011). The findings of the chapter 2 literature review as used as a benchmark for the BIM legal issues.

Table 3.2 Review of Model Comprehensiveness of Content

<table>
<thead>
<tr>
<th>Author</th>
<th>Comprehensiveness of Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>McAdam (2010)</td>
<td>The model provides guidance to researchers and educators by identifying the main legal areas.</td>
</tr>
<tr>
<td></td>
<td>The model provides a general guidance to the practical legal issues associated with BIM implementation.</td>
</tr>
<tr>
<td></td>
<td>This model does not have adequate depth when compared to Table 2.1 and does not develop reasonable links between the elements. The model does expand on implementation and procurement models but develop an integration model.</td>
</tr>
<tr>
<td>Olatunji (2011)</td>
<td>The model provides guidance to researchers and educators by identifying the main legal areas.</td>
</tr>
<tr>
<td></td>
<td>The model provides a general guidance to the practical legal issues associated with BIM implementation.</td>
</tr>
<tr>
<td></td>
<td>This model does have similar depth when compared to Table 2.1 and does describe the elements in detail including links and relationships. However, it does not extend to integration with procurement models.</td>
</tr>
</tbody>
</table>

Table 3.3 Review of Model Logical Congruence

<table>
<thead>
<tr>
<th>Author</th>
<th>Logical Congruence</th>
</tr>
</thead>
<tbody>
<tr>
<td>McAdam</td>
<td>This model is limited in how it reflects the world view of the topic of BIM</td>
</tr>
</tbody>
</table>
legal issues as most of the perspectives discussed are from an American background. This is to be expected due to the newness of the topic and the age of the model.

<table>
<thead>
<tr>
<th>Author</th>
<th>Conceptual Clarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>McAdam (2010)</td>
<td>There is limited Conceptual Clarity in this model as it focuses on developing the legal issues with explicit statements, but does not extend to the procurement process. It does not explore any direct or causal relationships between the model elements.</td>
</tr>
<tr>
<td>Olatunji (2011)</td>
<td>This model does have some Conceptual Clarity between the model elements but does not extend to the procurement process. It provides explicit statements of the identified elements.</td>
</tr>
</tbody>
</table>

Table 3.4 Review of Model Conceptual Clarity

3.4.3 Strengths and Weaknesses of Existing Conceptual Models

The review of the two BIM legal conceptual models identified strengths and weaknesses using the three criteria of comprehensiveness of content, logical congruence and conceptual clarity. In summary, both models identified and included explicit statements describing key elements they were not as comprehensive when compared to the thematic areas presented in table 2.1. Further, they did not present a model of how the elements could affect the legal structures used to manage and deliver projects.

3.5 Conceptualisation of the Impact of BIM on Contracts

This section presents the conceptual model, which will be used as a framework for the analysis of a standardised construction contract. It firstly develops a model of the typical construction contract and how the conditions could be impacted by the ten thematic areas identified in chapter 2.

Figure 3.8 is a stylised representation of the structure of a construction contract focusing on the typical conditions encountered in the Conditions of Contract. The assumption adopted by this research is that a contractual link will exist between the client and the contractor no matter what type of procurement system the client adopts to deliver the
In addition, this link is based on a written contract that includes the majority of the key contract documents/items including the signed Contract Form, Conditions of Contract, drawings, specifications and schedules, Appendices and a Bill of Quantities.

Figure 3.8 Construction Contract Structure

This study seeks to determine the impacts of BIM implementation on construction contracts by focusing on the Conditions of Contract embedded within the contractual link between the client and the contractor. The current conditions of a standardised contract are filtered through the lens of BIM legal concerns as identified in Chapter 2 to identify if the issues are adequately addressed by the contract in its current form. Figure 3.9 is the proposed conceptual model that is adopted for this study.
3.6 Summary

This chapter investigated the concepts associated with construction procurement systems such as the systems, methods and contractual structures used to deliver a construction project. At the centre of the procurement process exists a contractual link between the client and the contractor. The characteristics and function of this contractual link has evolved into a number of standard items collectively called a contract. Embedded within the contract are a number of documents, which over the years have been standardised to ensure a level of consistency. One such document is the Conditions of Contract. A range of standardised conditions has emerged, which aims to manage and encourage consistent, predictable behaviours and outcomes during the project delivery process. Based on this premise, a typical standardised contract includes clauses based on nine thematic areas, as shown in section 3.3.

The next chapter proposes a pragmatic methodological approach to apply the conceptual model developed in this chapter to a real-world construction contract.
4 METHODOLOGY

4.1 Introduction

The research methodology outlined in this chapter has been formulated to achieve the research aim and objectives that were detailed in Chapter 1. The literature review in the previous two chapters has established an understanding of both the legal challenges facing BIM implementation and the contractual environment in which construction procurement operates. The methodological approach described in this chapter creates the framework for determining if current standardised construction contracts are addressing the BIM legal challenges within the context of the Australian AEC sector. Central to this research is ascertaining whether the legal issues identified in Chapter 2 are adequately addressed in current standard conditions of contract or if changes are needed to ensure an integrated approach to BIM implementation is achieved.

The previous two chapters have firstly, identified the current legal challenges facing BIM implementation in the AEC sector and secondly, established the construction procurement contractual environment. Revisiting the findings of Chapter 2 and the conceptual model adopted for this investigation as shown in figure 3.8, ten thematic areas were used to categorise a number of legal and contractual challenges associated with BIM implementation. The ten thematic areas are:

1. Compensation and Consideration
2. Conditions of Contract/Contract Documents
3. Data Security
4. Intellectual Property
5. Interoperability
6. Legislation & Judicial Precedence
7. Professional Liability
8. Protocols and Processes
9. Public Sector Agency
10. Risk Allocation

From a contractual perspective, the process for acquiring a facility is based on five types of procurement systems: Traditional, Design and Build, Management, Relationship or Public-Private Partnerships. Common to all types of procurement systems is a contractual agreement between the various parties and this agreement creates a range of obligations and liabilities. Further, the contract formation process is based on long-standing legal principles. Through the methodology described in this section, the ten BIM legal areas are used as a framework for analysing a contractual agreement within
the Australian AEC sector context, to determine if changes are necessary to standardised construction contracts.

While the review of the current literature in Chapter 2 has identified the contractual challenges facing BIM implementation, thereby addressing the research objectives 1 and 2, the methodology described in this chapter has been formulated to address the third research objective. Critical to determining the changes needed to a standardised contract is to identify firstly if and how the contract already addresses the possible BIM contractual challenges. It is through the process of determining the presence or absence of such contractual mechanisms that the AEC sector can then modify standard contracts to establish a contractual environment that is favourable to BIM implementation.

This chapter is divided into two sections. The first section is focused on examining the research problem and how the different research paradigms and ontologies affect the research approach. It outlines the justification for adopting a pragmatic ontology and the application of a qualitative research method. This section also investigates the nature of research and the need for an explicit values statement from the researcher.

The second section of this chapter is devoted to describing the qualitative research method that is used to analyse a standard Australian construction contract. The strategy of enquiry adopted for this research is a case study approach using Qualitative Content Analysis as the basis of data analysis and interpretation. The case study approach in the context of the Australian AEC sector is described in this section. The final part of this section focuses on describing Qualitative Content Analysis and the use of the ten thematic areas as major categories for the coding frame. This section concludes with a brief discussion of the limitations of the research methodology and the use of computers in the qualitative analysis process.

4.2 Philosophical Research Assumptions

This research has employed a qualitative/interpretive framework with an overarching Ontologically pragmatic stance. The reasoning behind the use of pragmatism to explore the research problem is explained in this section. Providing clear reasoning behind the decision for approaching the research from an ontologically pragmatic stance and detailing how this stance affects the methodological framework was a critical step in answering the research question. In addition, it provided the research with a necessary level of validity, credibility and rigour (Garman, 1996) that ensures the findings of the
study contribute to the overall body of knowledge relating to the legal challenges confronting BIM implementation in the AEC sector.

The concept of the research paradigm, widely attributed to Kuhn (1970) for its inclusion in the research vocabulary, is central to determining the methodological structure of a research project. In the terms of research, a paradigm is defined as a “cluster of beliefs and dictates which, for scientists in a particular discipline, influence what should be studied, how research should be done, how results should be interpreted and so on” (Bryman, 1988 p 4). Paradigms define how science should be conducted and the boundaries within which legitimate knowledge can be produced (O’Leary, 2007) by providing a theoretical framework that can be used as a template for conducting research (R. Miller & Brewer, 2003).

To add further, Huff (2009) notes the importance of understanding and clearly articulating how various paradigms shape research and highlights how it influences the research process in three crucial ways. Firstly, it shapes how the investigation will frame the research question. Secondly, particular assumptions are attributed to certain scholarly communities and it is important to know what assumptions apply or ones that can be openly discussed or challenged. Finally, the researcher needs to be aware of the research audiences’ assumptions, to ensure that the target community accepts the findings of the research because the study has been based on credible assumptions.

Paraphrasing the writings of various authors over the last twenty years, Creswell (2013) has identified four philosophical assumptions that underpin the various research paradigms; ontological, epistemological, axiological and methodological. Table 4.1 illustrates the key findings of Creswell’s consolidated review of philosophical assumptions. These four assumptions are used as a framework for outlining the assumptions adopted for investigating BIM legal challenges and their possible effects on standard conditions of contract.

Table 4.1 Philosophical Assumptions and Implications for Research

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontological</td>
<td>What is the nature of reality?</td>
</tr>
<tr>
<td>Epistemological</td>
<td>What counts as knowledge? How are knowledge claims justified? What is the relationship between the researcher and that being researched?</td>
</tr>
<tr>
<td>Axiological</td>
<td>What is the role of values?</td>
</tr>
<tr>
<td>Methodological</td>
<td>What is the process of research? What is the language of research?</td>
</tr>
</tbody>
</table>
This research has adopted a pragmatic ontological stance. Paradoxically, pragmatism rejects the narrow world view that is associated with other paradigms as limiting and restricting (Patton, 2002). Pragmatism considers the value of a study is evaluated against “its intended purposes, available resources, procedures followed and the results obtained, all within a particular context and for a specific audience” (Patton, 2002 p 72).

The origins of pragmatism evolved from the writings of Charles Pierce, William James and John Dewey, but can be traced back to the ancient Greek and Roman sceptics and later to Immanuel Kant’s “Pragmatic belief” (Ormerod, 2006).

Pfeiffer (2003) summarised the characteristics of pragmatism in six key points:

1. Investigations into the meaning of language are best resolved by focusing on the practical consequences of the statement or the ideas that are central to the research.
2. The extent to which an idea achieves significant human objectives clarifies the idea and provides evidence, for or against, the likelihood of truth.
3. The need for a philosophical perspective underpinning the research is not required and there is little value in pursuing such an endeavour.
4. Discrete fixed categories are not a true reflection of nature: concepts overlap and blend into one another, theories which tentatively illustrate this chaotic reality are the logical means of providing clarity in thought.
5. Answers to questions and even the definitions used to frame the question are in a constant state of flux and may need revision during the research process.
6. Whatever means the research process adopts, that promotes a reasoned approach to inquiry, dialogue and understanding, is a positive, and applying anything that suppresses these outcomes are considered a negative.

These six characteristics are in direct opposition to the traditional view that philosophical assumptions should structure the methodological approach to a research problem and that there is a clear divide between competing ontological and epistemological paradigms.

The adoption of a pragmatic ontological stance is appropriate for this research due to the multifaceted nature of BIMs application in the procurement and facilities management process and the continuing evolution of the concept of BIM, procurement methods and contracts. This evolution is reflected in the subtle but substantial changes in BIM definitions since researchers in the late 1960s first contemplated the possible uses of BIM in the construction procurement process. In addition, pragmatism accepts the
complexity of nature and research, with overlapping, intertwined and evolving concepts. Pragmatism will allow the researcher to acknowledge this complexity, particularly when the application of BIM is still evolving and maturing, while focusing on the practical consequences of the investigation, such as determining appropriate changes to a standard contract. This study is contextually based in that it captures the current BIM legal issues and determines possible changes to a standard contract at a single point in time within the Australian AEC sector. Further, the findings will not be considered the essential truth or that they are watertight, but the outcomes are a reflection of the method used to achieve the results and are considered the most appropriate view of the current situation. In addition, due to the very nature of research, it is accepted that other researchers using alternative methods may achieve conflicting results.

From an epistemological stance, pragmatism accepts that understanding reality is achieved through the use of many tools that reflect both inductive and deductive evidence (Cherryholmes, 1992; Creswell, 2013). This research is considered the first stage of a wider investigation into BIM contractual changes generated by BIM implementation. This first stage used a qualitative method to examine the current structure and applicability of a standard contract for use with BIM and the extent of possible amendments. Further research possibilities, including the extension of the method employed in this investigation and additional quantitative and qualitative methods, are detailed in the Conclusion chapter of this research.

As Creswell (2013) points out, all researchers bring some form of values and/or assumptions to a study; his or her axiological assumptions. Pragmatists not only accept the existence of the researcher’s values, but also consider the prior identification of these values important in determining the sources of human action and interaction. Critically, the isolation of these values needs to occur before the researcher commences the search for meaning. Therefore, the researcher has provided a value statement to declare explicitly his values, beliefs and experiences of both BIM and standard contract forms.

Based on the pragmatic assumptions discussed in the previous paragraphs, the initial strand of this research has implemented a qualitative methodology. Pragmatism allows for any reasoned methodological approach, including multiple methodologies as long as it provides clarity to the problem under investigation (Cherryholmes, 1992). Bryman (2012) generalises the differences between qualitative and quantitative research, pointing out that qualitative investigations emphasise the generation of theories, while quantitative studies place an accent on testing theories. This investigation adopted a
case study strategy using Qualitative Content Analysis as a means of determining if changes are needed to a specific standard construction contract to facilitate collaborative BIM project implementation. The outcome of the research focused on generating recommendations for amending contracts for BIM implementation rather than testing some form of theory for BIM implementation in the legal context.

4.3 The Researcher - Axiological Assumptions

This section discusses the researcher’s axiological assumptions, focusing on his experiences with BIM, construction project teams and contracts and how these experiences could influence the outcomes of the research process. Specifically, this section identifies the researcher’s assumptions, values and biases that could influence the outcome of the investigation based on these previous experiences.

Firstly, the researcher has extensive design consultant experience including the use of BIM authoring tools in the project setting. This experience with BIM has been both positive and negative. The researcher could see the benefit of implementing BIM and the value of information capture and dissemination amongst the project team. The negative aspects experienced by the researcher are the current limitations of the technology coupled with the risk adverse and fragmented nature of the AEC sector which restricts the level of collaboration amongst project team members. Therefore, the possible biases that could be introduced into the study are:

- A belief that the full integration of BIM into the project lifecycle is positive and the negatives can be overlooked
- Collaboration should be encouraged no matter what the situation or procurement strategy.

4.4 Research Strategy - Case Study

In keeping with the pragmatic ontological stance that encourages the adoption of a research process that is both reasoned in its justification and focuses on practical consequences, this study applied a qualitative case study strategy to examine the topic under investigation. This section of the Methodology chapter describes the case study approach and how it was employed as the overall strategy of inquiry. It outlines the reasoned justification for investigating the research problem using this mode of inquiry, followed by a description of the implementation process with reference to relevant literature explaining the case study strategy. In particular, it defines the case and unit of
analysis, illustrates the types of cases and the sources of data, all within the context of investigating standardised contracts and how they could be influenced by the BIM legal issues.

4.4.1 Case Study Justification

Case study research is defined as an “empirical inquiry that investigates a phenomenon within its real life context” (Groat & Wang, 2013 p 418). A case study strategy focuses on the phenomenon or topic under investigation to come “to understand its activity within important circumstances” (Stake, 1995 p xi). The aim of the case study approach is to develop as much understanding of the ‘case’ as is possible while acknowledging the context and complexity of the situation (Groat & Wang, 2013; Punch, 2005). The ‘case’ may be a person, a group of people, an event or an organisation but must be restricted or bounded to ensure the researcher achieves a certain level of understanding (Stake, 2005).

Case study research was an appropriate means of investigating the research problem due to three key reasons. Firstly, case study strategy focuses on a contemporary topic within a real life context (Yin, 2009) that engages the researcher to develop an in-depth understanding of what is actually going on (Stake, 1995). Previous studies have focused on identifying the legal issues associated with BIM implementation, or general discussions on the industry’s contractual response to these issues, or the most appropriate procurement method for BIM facilitation. There has been limited analysis of the effects of BIM on the internal contractual mechanisms. A critical component of these environments is the formal contractual arrangements between the various stakeholders involved in the project, contract documents that tend to be long and complex. Not only do these documents create a legally binding record of the business transaction, they also detail how a project will be managed and delivered. Therefore, a case study research approach was suitable for this study because it investigated the contemporary issue of BIM legal challenges to develop an in-depth understanding of how it could transform legal agreements in the context of the construction procurement process.

Secondly, case study research is appropriate when the study outcomes seek to explain some present topic using ‘how’ and ‘why’ questions (Yin, 2009). To date, there has been limited empirical research into the possible effects BIM legal challenges could have on standard construction contracts. The case study strategy was appropriate for investigating the BIM legal- and contractual issues as this investigation focused on
describing ‘how’ and ‘why’ existing contractual mechanisms could be affected by BIM and how they can be amended to facilitate collaborative BIM implementation.

Finally, case study research allows the researcher to select cases that provide an in-depth insight into the issue that is under investigation (Stake, 2005). As stated previously, there has been limited empirical research into the possible effects on BIM in the existing contractual mechanisms or the analysis of specific standard contracts. As Stake (2005 p 445) points out “the case [can be] of secondary interest, it plays a supporting role and it facilitates our understanding of something else”. The use of a case study mode of inquiry allows for the research problem to be approached from different perspectives or avenues of enquiry (Groat & Wang, 2013). While previous studies have highlighted the complexity of BIM legal issues and general industry concerns, these investigations have provided very little insight into how existing contractual mechanisms need to be transformed to facilitate collaborative BIM implementation. Further, for the Australian context, there are limited examples that illustrate how contracts may change or the means of addressing industry concerns. Therefore, case study research was an appropriate strategy as it allowed the researcher to select a ‘case’ that developed an in-depth understanding of the research problem. For this investigation, an Australian standardised construction contract was used as the ‘case’.

In accordance with the pragmatic ontological stance, this section provided a reasoned justification for using a case study mode of inquiry for examining the research problem. It has highlighted the selection of a specific, or bounded, case that will be used to illustrate the research problem with the aim to provide clarity in understanding how the BIM legal issues could affect an Australian standardised construction contract.

4.5 Selection of the Case and Sources of Data

This section describes how the case was selected. At the centre of case study research is the case; a topic of some description that is contained within a ‘bounded system’ (Punch, 2005; Stake, 2005). The system can be simple or complex and may comprise of an individual or group, an event or entity, decisions, programs or a process (Yin, 2009). While defining what constitutes a case under investigation is useful, it is not necessarily an easy task to undertake, especially when the boundaries between the case and its context merge and are difficult to differentiate (Stake, 2005). Based on the above definition, the intention of case study research is to provide clarity about a certain topic, therefore the ‘case’ or ‘unit of analysis’ needs to be clearly determined to provide both
clarity and direction to the research. Yin (2009) highlighted that the most common approach to determining the case is to refer to the research question to define the extent and context of the case, thereby bounding the system in which the topic resides.

With reference to the research question discussed earlier in this chapter, the focus of this research was on the impact that the various BIM legal issues could have on Australian standardised construction contracts. Therefore, based on the research problem and question, the case for this investigation was the contractual link between the contractor and the client, as outlined in the previous chapter. In a formal situation, the contractual link is represented by the ‘contract documents’. The context of the case is the type of procurement method with reference to the five main approaches, also detailed in the previous chapter. For this research it was a hybrid traditional/design and construct procurement method.

The unit of analysis for this investigation will be defined as the formal documented contractual relationship between the client and the contractor in the context of a hybrid traditional/design and construct procurement method. Figure 4.1 illustrates the case and the overall context.

![The Case - Context and Unit of Analysis](image)

The system comprises of the Client and Contractor as the key actors in the process. These two entities will be referred to in the singular even though there may be several client or contractor personnel involved in the project. Figure 2.5 outlined the environment
in which the construction industry operates and these are reflected in the context of the case under investigation, such as the legislative requirements, professional associations, approving bodies and the available technology.

4.5.1 Types of Case Study

Stake (1995) has identified three main types of case study – ‘intrinsic’, ‘instrumental’, and ‘collective’. The intrinsic case study approach is adopted when the researcher needs to learn about a particular case. In some instances, the researcher does not have a choice in the focus of the investigation or the case selects itself; it exudes an intrinsic attraction to the researcher, and is therefore categorised as an intrinsic case study. Alternatively, the instrumental case study focuses on providing insight, general understanding of the focus of the study or refining of a theory (Punch, 2005). “The use of [an instrumental] case study is to understand something else” (Stake, 2005, p. 3) and is used to accomplish something other than understanding the intrinsic nature of the case. Finally, in a collective case study, several cases are examined concurrently to understand the topic. The selected cases can be a combination of intrinsic or instrumental cases but need to contribute to a general comprehension of the topic (Stake, 2005).

For this investigation, an instrumental case study was adopted, as the focus of the research was on a single contract and there was the need to learn more about BIM effect on a commonly used Australian public sector standard contract. It is assumed that focusing on the single contract will enable a better understanding of the possible impacts BIM could have on standardised construction contracts.

4.5.2 Case Selection and Sources of Data

The selection of a case is one of the most critical aspects of undertaking a case study strategy, as the choice of the case or cases will have a direct impact on the level of understanding the researcher will develop of the topic under investigation (Stake, 2005; Yin, 2009). As described in the previous section, instrumental cases are used to develop an understanding of something else rather than the actual case under investigation. However, the selected case should still in some way be a representation of the majority population from which the case is selected (Flick, 2009; Miles & Huberman, 1994a).

While it is important to select a case that best represents a population, the chosen case should also provide the best opportunity for the researcher to learn about the topic under investigation. As Stake (2005) points out, case researchers try to uncover both what is common and what is particular about a case, selecting a case in which the researcher
can learn the most about the topic. This may mean that the case is one that is readily accessible and one that the researcher can spend the most time with.

While case study literature does not specifically detail how many cases should be included in case study research, or the process for selecting a case (Patton, 2002; Stake, 2005), the investigator still needs to formulate a sound rationale for determining the number of cases and the overall structure of the case study design (Yin, 2009). For example, Yin (2009) describes the reasoning for selecting a single case can be justified if the case is representative or typical of the cases available in a population. Further, single cases allow for a more detailed analysis of the case and topic under investigation.

One contract was selected for this research. The contract comprises of five documents, the Conditions of Tendering, Tender Schedules, General Conditions of contract, Preliminaries and Comments on the general conditions of contract. It is envisaged that one contract will provide sufficient information to achieve an in-depth response to the research aim of exploring the contractual implications of BIM implementation in project delivery.

The selected contract document is the New South Wales GC 21 2nd edition. The reason for selecting this contract was because it represents a typical construction contract and offers the ability to learn about the topic under investigation. This contract is widely used in New South Wales for educational-, corrective services- and infrastructure projects. It is a standardised contract that has been developed in consultation with a wide range of industry stakeholders including contractors, subcontractors, suppliers and client groups (NSW Department of Commerce, 2012).

Secondly, the GC21 contract has been selected due to its accessibility. The contract, including ancillary documents is available free from the NSW Procurement website. The documents are in a Microsoft Word format that can be altered to meet the needs of specific project requirements.

The contract documents that formed the case were downloaded from the NSW Procurement website and were analysed using qualitative content analysis that is now discussed.

4.6 Qualitative Content Analysis

This section describes how the research method of Qualitative Content Analysis is used to analyse a construction contract. The section commences with a description and
justification of Qualitative Content Analysis. In the final part of this section the structure of the Qualitative Content Analysis process and means of reporting the results are presented.

4.6.1 Content Analysis Theory

Weber (1990 p 9) defines content analysis as "a research method that uses a set of procedures to make valid inferences from text". Mayring (2004 p 266) extends this definition, considering it to be an all-encompassing “systematic examination of communicative material”. The extension of the focus of content analysis to other forms of communication material can therefore include, for example, pictures and music. The key factor is that the material needs to be recorded or fixed in some form. Examples of the uses of content analysis include examining the differences in international communication content, the comparison of communication content against set objectives and the tracing of cultural patterns (Berelson, 1971).

Content analysis in research may be either quantitative or qualitative but both approaches can be applied to the same data sets (Pierce, 2008). Quantitative Content Analysis is characterised by a linear and systematic approach to data analysis using statistical means of verifying or confirming a hypothesised relationship (Altheide, 1996). Based on the works of Berelson (1971), Bierschenk and Bierschenk (1976) and Weber (1990), Popping (2000) has listed the steps required for undertaking a quantitative analysis as shown in Figure 4.2.
Consider the research problem thoroughly

Develop testable hypotheses, and decide how you want to operationalise the set of concepts that will be used. A qualitative pilot study can be part of this process. The operationalisation starts as you note phrases that recur.

Evaluate the relevance of the representative sample of texts you have obtained for the research project. Define the recording units.

Collect and do the initial coding of the data. In many situations coders are indispensable, therefore the investigator must take care to ensure that coding rules are applied in a consistent way. To realise this, coders must be trained. The investigator must guarantee that inter – and intra coder agreement is high. It is also useful to evaluate the coding scheme using a sample of texts. When necessary, coding rules may be revised.

Define both concepts as well as a set of coding rules that indicate when texts should be classified according to each concept. Try to synthesise conceptual categories and coding rules; ask yourself what is the rationale for coding the data in this way.

Complete coding the data

Perform statistical analyses on the encoded data. Interpret the results of the analyses: What do they mean? What are their implications?

Write a report on the results.

Consider whether the research objectives have been met.

Figure 4.2 Steps in Quantitative Content Analysis

Qualitative Content Analysis shares its central feature with the quantitative method, which is the systematic categorisation of the data in order to make sense of it (Miles & Huberman, 1994b) or to describe the meaning of the material (Schreier, 2013). The main difference is the process of how the categories are generated and applied to the data, how the results are then analysed (Forman & Damschroder, 2007) and the incorporation of the latent meaning of the data in the result-interpretation process (Mayring, 2004). The qualitative approach focuses on interpreting the latent meaning of the data with references to the context and the use of inductive reasoning. Altheide (1996) summarises the qualitative content analysis process in twelve steps as shown in Figure 4.3. In addition, Table 4.2 contrasts qualitative- and quantitative content analysis.
Step 1 Identify the topic or specific problem that will be investigated

Step 2 Become familiar with the process and context of the information source and explore possible sources

Step 3 Become familiar with relevant sources and select a unit of analysis (may change)

Step 4 List possible categories and develop a draft protocol

Step 5 Test the protocol

Step 6 Refine the protocol

Step 7 Determine a sampling rationale and strategy

Step 8 Collect the data & during this step examine the data to determine any coding changes

Step 9 Perform data analysis including conceptual refinement of coding frame

Step 10 Compare and contrast whilst making textual notes including brief summaries of each category

Step 11 Combine summaries with examples

Step 12 Integrate the findings with an interpretation and key concepts

Figure 4.3 Steps in Undertaking Qualitative Content Analysis

Table 4.2 Differences between Quantitative and Qualitative Content Analysis

<table>
<thead>
<tr>
<th>Quantitative Content Analysis</th>
<th>Qualitative Content Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus on manifest meaning</td>
<td>Focus on latent meaning</td>
</tr>
<tr>
<td>Little context needed</td>
<td>Much context needed</td>
</tr>
<tr>
<td>Strict handling of reliability</td>
<td>Variable handling of reliability</td>
</tr>
<tr>
<td>Reliability checks more important than validity checks</td>
<td>Validity checks just as important as reliability checks</td>
</tr>
<tr>
<td>At least partly concept-driven</td>
<td>At least partly data-driven</td>
</tr>
<tr>
<td>Fewer inferences to context, author, recipients</td>
<td>More inference to context, author, recipients</td>
</tr>
<tr>
<td>Based on deductive reasoning</td>
<td>Based on inductive reasoning</td>
</tr>
<tr>
<td>Strict sequence of steps</td>
<td>More variability in carrying out steps</td>
</tr>
<tr>
<td>Focuses on a description of the data and results</td>
<td>Focuses on an interpretation of the latent meaning of the results and data</td>
</tr>
</tbody>
</table>


4.6.2 Justification of Qualitative Content Analysis

Documents and specifically contracts, allow the client and contractor to detail the expected processes and outcomes of the project delivery process, including the required
level of BIM project integration. The use of Qualitative Content Analysis is appropriate for this research for three reasons. Firstly, the focus of the research is a standardised contract (document) that could be used for project delivery including BIM integration. The use of Qualitative Content Analysis is particularly relevant for this investigation because it allows the researcher to scrutinise the meaning of qualitative material in a systematic way, but still permits a certain level of flexibility in describing and interpreting the material (Popping, 2000; Schreier, 2013).

Secondly, construction contracts can contain a certain number of expressed and implied contract terms that are open to interpretation. This ambiguity in interpretation of terms is one of the root causes of contract disputes (Goetz & Scott, 1985). Qualitative Content Analysis permits flexibility in describing categories, terms and concepts all within a certain context, including interpreting the latent meaning of specific terms that are directly related to BIM (Altheide, 1996; Mayring, 2004; Schreier, 2013). Through the adoption of the systematic nature of defining and refining the coding protocols, ambiguities can be interpreted in the context of the contractual approach to project delivery.

Thirdly, Qualitative Content Analysis provides the researcher with the opportunity to develop a high level of familiarity with the content and the context of the topic under investigation (Altheide, 1996). Qualitative Content Analysis was therefore critical in gaining insight into the status and integration of BIM into the contract under investigation, and the ability to draw inferences for the possible changes required to the GC21 contract. This intimate knowledge of the contract and drafting process also allowed for the framing and bounding of the research process.

4.7 Qualitative Content Analysis Process

This research adopted the Qualitative Content Analysis process outlined by Altheide (1996) including a process for determining the validity and reliability of the coding frame and results. This section outlines how the coding frame was formulated, with reference to the research question discussed earlier in this chapter and in the Literature Review in Chapter 2.

4.7.1 Coding Frame

The coding framework of the content analysis used the thematic areas identified in the Literature Review. It will consist of a hierarchical order of domains (Thematic Categories) and subcategories as shown in Figure 4.4. The generation of the coding
framework was also data driven – additional domains and subcategories are added during the coding process depending on the exhaustiveness of the current category definitions. These definitions will consist of a name, description, decision rules and example of each category (Schreier, 2013).

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>DOMAIN (Category)</th>
<th>Subcategory</th>
<th>Present</th>
<th>Not Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIM LEGAL ISSUES</td>
<td>Category</td>
<td>Subcategory</td>
<td>Present</td>
<td>Not Present</td>
</tr>
<tr>
<td></td>
<td>Category</td>
<td>Subcategory</td>
<td>Present</td>
<td>Not Present</td>
</tr>
<tr>
<td></td>
<td>Category</td>
<td>Subcategory</td>
<td>Present</td>
<td>Not Present</td>
</tr>
<tr>
<td></td>
<td>Category</td>
<td>Subcategory</td>
<td>Present</td>
<td>Not Present</td>
</tr>
<tr>
<td></td>
<td>Category</td>
<td>Subcategory</td>
<td>Present</td>
<td>Not Present</td>
</tr>
<tr>
<td></td>
<td>Category</td>
<td>Subcategory</td>
<td>Present</td>
<td>Not Present</td>
</tr>
<tr>
<td></td>
<td>Category</td>
<td>Subcategory</td>
<td>Present</td>
<td>Not Present</td>
</tr>
<tr>
<td></td>
<td>Category</td>
<td>Subcategory</td>
<td>Present</td>
<td>Not Present</td>
</tr>
</tbody>
</table>

Figure 4.4 Coding Framework

4.7.2 Segmentation of Material

The contracts under analysis are segmented into the following units:

- Unit of Analysis – The Contract
- Units of Coding – will be relative to the subcategory and may consist of contract clauses or sub-clauses
- Context Units – will consist of the surrounding text to the extent in which the latent meaning can be determined

4.7.3 Reliability and Validity

Determining the level of reliability and validity are two key components of ensuring quality of the content analysis instrument. Two techniques were used to assess, firstly the reliability of the coding frame, and secondly that the coding frame has captured the
required data and adequately represents the concepts identified in the Literature Review (Schreier, 2013).

To ensure the reliability and validity of the coding framework, a trial coding was undertaken prior to the main analysis followed by a second trial coding two months later, to undertake a comparison across points in time. A comparison between the two outcomes was reviewed and any discrepancies investigated to determine if a revision of the coding framework was required or if it was the outcome of a change in the researcher’s objective analysis of the subcategory.

\[
\text{Percentage (\%)} = \frac{\text{Number of units of coding on which the codes agree}}{\text{Total number of units of coding}} \times 100
\]

Figure 4.5 Coefficients of Agreement Formulae

In addition, the researcher undertook two full codings of the case and this was used to calculate a percentage of agreement (Krippendorff, 2004). The coefficient of agreement is shown in Figure 4.5. Coefficients were calculated for all of the subcategories and the main categories and the results are illustrated in Appendix A.

4.7.4 Presentation of Results

The results of the data analysis will be presented in the form of a matrix, as shown in Table 4.3, consisting of a reference to the subcategory and if required a description of the context unit. The matrix was segregated along the thematic areas; supportive descriptions incorporating the context unit and quotations from the contract document were included as justification of the classification of the data.

<table>
<thead>
<tr>
<th>Domain (Thematic Area)</th>
<th>Sub-Theme</th>
<th>Present (Y/N)</th>
<th>Reference</th>
<th>Coded Occurrence</th>
<th>Interpretation/Comment (including context if required)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain 1</td>
<td>SC-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SC-02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SC-03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domain 2</td>
<td>SC-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SC-02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SC-03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domain 3</td>
<td>SC-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SC-02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.4 is an example of the coding process. The first column or Domain indicates the thematic category; for the example shown it is the theme of Compensation and Consideration. The next column highlights the subcategory or the subthemes. Table 2.1 lists the various literature-generated themes and subthemes and the example shows three subthemes: Technology Costs, Payment Schedules and Implementation Costs. The third column titled ‘Present’ indicates the presence or absence of the subtheme and is indicated by a Yes or No. The reference column provides a reference to the actual contract document and specific clause that is coded as the ‘Unit of Coding’. The Coded Occurrence column is the Unit of Coding extract from the contract documents. The final column allows for the coder to provide comments on the interpretation of the coding process relating to the subtheme. ‘NA’ is inserted in Reference and Coded Occurrence columns when the subtheme is not considered present in the contract.

This section of the Methodology chapter has justified the use of Qualitative Content Analysis. A summary of the key concepts and how they were applied to the contract is shown in Figure 4.4.
Table 4.4 Example of Content Analysis Matrix Results

<table>
<thead>
<tr>
<th>Domain (Thematic Area)</th>
<th>Sub-Theme</th>
<th>Present (Y/N)</th>
<th>Reference</th>
<th>Coded Occurrence</th>
<th>Interpretation/Comment (including context if required)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compensation &amp; Consideration</td>
<td>Technology Costs</td>
<td>No</td>
<td>NA</td>
<td>NA</td>
<td>The Contract is silent on amortisation of technology costs.</td>
</tr>
<tr>
<td></td>
<td>Payment Schedules</td>
<td>Yes</td>
<td>GCoC C.57.1c9039148</td>
<td></td>
<td>Prepayment is an advance payment against the Contract Price which provides early cash flow to the Contractor. The Prepayment is repaid by the Contractor progressively by deductions from amounts payable under the Contract. Prepayment is secured by Undertakings provided to the Principal in respect of the Prepayment. Prepayment may be utilised for any purpose related to the Contract.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.1 The Contractor may claim Prepayment, as an advance payment against the Contract Price (but not as a Payment Claim), at any time before achieving Completion of the whole of the Works if all the following apply:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.3 No more than one-third of the Prepayment amount is retained by the Contractor and the balance is assigned directly to Subcontractors, Suppliers and Consultants in</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The GC21 Contract Conditions allows for the prepayment of amounts against the Contract Price to enable the Contractor to generate a positive cash flow. The Contractor must submit an unconditional undertaking against any claimed amount and this must be allocated to specific amounts detailed in the Claim. This could allow the Contractor to offset any upfront costs associated with the implementation of BIM, but would need to be built into the Contract Price.</td>
</tr>
<tr>
<td>Domain (Thematic Area)</td>
<td>Sub-Theme</td>
<td>Present (Y/N)</td>
<td>Reference</td>
<td>Coded Occurrence</td>
<td>Interpretation/Comment (including context if required)</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------</td>
<td>---------------</td>
<td>-----------</td>
<td>-----------------</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>the proportions notified to the Principal;</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>.6 The Contractor has assigned to Subcontractors, Suppliers and Consultants their respective shares of the Prepayment by effective written assignments, and has notified the Principal of the assignments, including the amounts assigned to each Subcontractor.</strong></td>
</tr>
<tr>
<td>Implementation costs</td>
<td>No</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Refer to comments in Technology Costs sub-category</td>
</tr>
</tbody>
</table>
Determine the main categories / dimensions that will be the focus of the analysis.

The ten thematic areas will form the Categories for the QCA:
- Compensation & Consideration
- Conditions of Contract
- Data Security
- ICT Protocols & Processes
- Interoperability
- Legislation & Judicial Precedence
- Professional Liability
- Public Sector Agency
- Risk Allocation

There are a number of subcategories for each category but are too numerous to list.

The level of coding frame complexity chosen was medium. The frame consists of two hierarchical levels below each category; a subcategory that is further subdivided into present or not present.

Each of the categories and subcategories is named with a description, has examples and decision rules where required.

A test code frame was reviewed during the pilot phase and subsequently revised to ensure Unidimensionality, Mutual Exclusiveness, Exhaustiveness and Saturation.

The Unit of Analysis will be a contract and the Unit of Coding will be the various clauses and subclauses within the contract. The Context Unit may be the clauses surrounding the unit of coding or guide notes embedded in the contract.

A coefficient of agreement (CoA) is used to determine the level of consistency in coding across two points in time. A high CoA is the aim.

Content validity is used to determine how valid the coding frame using the CoA to determine that all of the concepts are adequately captured in the coding frame.

Figure 4.6 Qualitative Content Analysis Structure
4.8 The Use of Computer Assisted Qualitative Data Analysis Software

It is proposed to use an appropriate Computer Assisted Qualitative Data Software (CAQDAS) package to aid in the management of the research data and assist in the analysis of the standard contracts and interview transcripts. It is noted that the use of Information Technology in qualitative research does not reduce the need for a methodological framework coupled with logical methods which are rigorously implemented and underpinned by a sound philosophical conceptualisation (Patton, 2002; Schreier, 2013).

The use of CAQDAS can remove or streamline some of the menial tasks typically associated with managing a research project and assist with the management and recall of classification and analysed data (StGeorge, Fairbairn, & Holbrook, 2011). Therefore, Nvivo 10 will be used for the Content Analysis of the standard contracts in the following ways:

1. Qualitative Content Analysis -
   - Storage of the various contract documents as separate files
   - Development of the initial coding framework based on the literature (concept-driven coding)
   - Coding of the contracts including the identification of coding emanating from the data (data-driven coding)
   - Provision of context for coded passages – Context Units
   - The provision of frequency information for categories

4.9 Limitations

As this research is exploratory in nature, there are limitations on the scope and extent of the investigation. The case study analysis is limited to one contract. Therefore, the interpretations of the results relate to the GC21 contract and may have limited applicability for other standardised contracts. The GC21 contract is a hybrid document that does not delimitate between the ‘Traditional’ and ‘Design and Construct’ procurement method. However, the application of the qualitative content analysis tool developed as part of this research can be applied to other contract forms. Further research could analyse other contracts including a comparison between the various contract conditions or emerging BIM ‘friendly’ documents.
Another limitation identified during the course of this study, that is associated with document analysis, was the ability to access certain documents associated with the GC21 contract. These documents are the early drafts, background notes and industry feedback provided during the consultation process. While not critical for the analysis process, these documents could provide context for the decisions made on the final wording of the contract documents. In addition, these context documents may provide an insight to the industry’s understanding of BIM or other technological advances in project delivery that would aid in the interpretation of the results. This limitation is addressed in the Conclusion chapter of this study, by recommending further research is conducted through engaging with various AEC professionals to explore industry’s perception and understanding of the various BIM legal issues and challenges.

4.10 Summary

This chapter described the methodological design formulated for investigating a standard construction contract and explored if there is a need to amend the document to enable collaborative BIM implementation. The aim and objectives outlined how the research question requires the investigation of the current legal challenges facing BIM. In addition, the need for an analysis of a standard construction contract to determine if any specific changes are required to the existing conditions is needed to facilitate BIM integration. The methodology detailed in this chapter seeks to address the aim and objectives through the adoption of a pragmatic ontological stance utilising a qualitative method and data analysis tool that has its origins in quantitative research. By using Qualitative Content Analysis in a case study setting, a standard Australian construction contract will be analysed for its appropriateness for use with collaborative BIM or if there are implicit or explicit changes required to the existing conditions. The findings of the Literature Review are used as the Qualitative Content Analysis coding framework that is applied to the New South Wales Government’s GC21 2nd Edition standard construction contract. By using Qualitative Content Analysis the researcher will be able to develop a clear understanding of existing contractual mechanisms and how these mechanisms can be adapted to facilitate the collaborative implementation of BIM.
5 RESULTS

5.1 Introduction

This chapter presents the results of the case study investigation and specifically the outcomes of the Qualitative Content Analysis application to a standardised Australian construction contract. The chapter begins with an examination of the case, describing the history and structure of the GC 21 contract. The next section tables a number of definitions and acronyms that assist in interpreting and understanding both the GC21 contract and the wider context of generic construction contract conditions. The final section of this chapter presents the results in the format as discussed in the previous chapter. The results also include comments on the analysis process, particularly describing how the contract clause may explicitly or implicitly addresses the specific BIM legal issue. The results and comments provided in this chapter are the starting point for determining the extent of contractual changes required for BIM implementation and answering the research question. A brief summary of the results is provided at the end of the chapter. Appendix A presents the coefficient of agreement calculations.

In relation to the research question, aim and objectives, the Qualitative Content Analysis achieved one of the objectives and provided a starting point for achievement of another. The main purpose of the QCA was to conduct a detailed analysis of an Australian construction contract to determine the extent of amendments required for the facilitation of collaborative BIM implementation. The analysis identified the presence or absence of certain mechanisms that address the various BIM legal implications identified in the literature review discussed in Chapter 3. As the GC21 contract was drafted before the mainstream implementation of BIM, it is critical to highlight if the conditions explicitly or implicitly address the BIM legal concerns, to ensure the original intent of the clause is preserved. These dichotomies of presence/absence and explicit/implicit are the starting point for answering the research question and discussing the changes needed to the Contract to enable collaborative BIM implementation.

5.2 The Case – GC21 Contract

The New South Wales (Australia) Government GC21 2nd edition General Conditions of Contract (referred to as the Contract) is a contract suitable for works valued at $1 million or more or works of a lower value but with complex contractual requirements (New South Wales Procurement, 2012). The contract evolved from the findings of the 1992 NSW
Government's Royal Commission into productivity in the Construction Industry, and the identified need for a cooperative form of contracting in the AEC industry. Commencing with the ‘GC21 1st edition’ this contract has gone through several updates, culminating in the latest GC21 2nd Edition (NSW Department of Commerce, 2012).

The structure of the GC21 does not differentiate between the traditional ‘construct only’ method or ‘design and construct’ procurement methods. The Contract adopts the stance that the Contractor will always have some level of responsibility for completing the design. The Contract therefore only details the level of design the Contractor must complete, ranging from pure design and construct through to the completion of ‘shop’ or detail drawings. This approach avoids the need for separate ‘construct only’ and ‘design and construct’ contract forms and the design ambiguity typically associated with these two procurement methods (NSW Department of Commerce, 2012).

Chapter 4 outlined the typical structure and the several documents that constitute a construction contract. A GC21 contract typically consists of the documentation mentioned in Chapter 4 and specifically includes the following:

- The Letter of Award
- The GC21 Conditions of Contract
- The Contract Information that also includes details of all other documents, correspondence and agreements that are to be included in the Contract such as:
  - The Contract Price
  - Tender documentation that is required as part of the Works
  - Drawings
  - Specifications
  - Bill of Quantities
  - Any Special Conditions of Contract
  - Post tender communication
  - Other formal agreements
  - Other documentation such as site and environmental conditions and investigation reports.

The documents analysed as part of this study focus on the standardised items readily available from the New South Wales Procurement website. There are five documents analysed: the GC21 Clause Commentary, Conditions of Tendering, Tender Schedules, General Conditions of Contract and the GC21 Preliminaries. The last three documents
are the only items that constitute the actual contract. Figure 5.1 provides more detail on the five documents.

Figure 5.1 GC21 2nd Ed Standardised Documents

The standardised documents still require a certain level of modification or input from the contract drafter. This input is typically signified by the symbol “⇥” or prompts in the document formatted in the style of hidden text.

To assist with the interpretation of the Contract, a number of definitions have been extracted from the contractual documentation and for ease of reference are provided in Table 5.1. A full list of definitions can be accessed from the actual contract available from the NSW Procurement website. For extracts from the documents, any word appearing in italics has a specific meaning as defined in the General Conditions of Contract Clause 79 – Definitions of the general conditions of contract.

---

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultant - Consultant</td>
<td>A consultant engaged by the Contractor to design parts of the Works or to provide other professional services. It includes a consultant whose contract with the Principal is novated to the Contractor.</td>
</tr>
<tr>
<td>Contract</td>
<td>The agreement between the Contractor and the Principal constituted by the Contract Documents.</td>
</tr>
<tr>
<td>Contract Documents</td>
<td>All the documents listed or referred to in clause 7.1.</td>
</tr>
<tr>
<td>Contractor</td>
<td>The party named in Contract Information item 8, including successors and permitted assignees.</td>
</tr>
<tr>
<td>Contractor's Documents</td>
<td>Drawings, specifications, calculations and other documents and information, meeting the requirements of clause 39, which the Contractor must produce to design and construct the Works in accordance with the Contract.</td>
</tr>
<tr>
<td>Data</td>
<td>The Contractor’s documents and all other drawings, sketches, specifications, digital records, computer software, data and information relating to the Contract.</td>
</tr>
<tr>
<td>Fault</td>
<td>Ambiguity, inconsistency or discrepancy.</td>
</tr>
<tr>
<td>Intellectual Property Rights</td>
<td>Any copyright, patent right, registered design or other protected right.</td>
</tr>
<tr>
<td>Principal</td>
<td>The entity named in the Contract Information item 4, including its successors and assignees.</td>
</tr>
<tr>
<td>Principal's Documents</td>
<td>The drawings, specifications and other documents provided to the Contractor and containing the Principal's requirements in respect of the Works.</td>
</tr>
<tr>
<td>Statutory Requirements</td>
<td>The laws relating to the Works or the Site, or the lawful requirements of any authority or provider of services having jurisdiction over the Works, the Site, the environment or the Contract, or anyone or anything connected with the Works or the Site or the Contract.</td>
</tr>
</tbody>
</table>
To assist in the coding process a number of abbreviations were formulated and are presented in Table 5.2. These abbreviations refer to specific documents or sections within the analysed documents.

Table 5.2 Coding Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC</td>
<td>The CG21 Clause Commentary</td>
</tr>
<tr>
<td>CI</td>
<td>The Contract Information Section of the General Conditions of Contract</td>
</tr>
<tr>
<td>CoT</td>
<td>Conditions of Tendering</td>
</tr>
<tr>
<td>GCoC</td>
<td>General Conditions of Contract</td>
</tr>
<tr>
<td>Prelim</td>
<td>Preliminaries</td>
</tr>
<tr>
<td>Sch</td>
<td>Tender Schedule</td>
</tr>
</tbody>
</table>

The next section presents the QCA results in the table format described in the previous chapter. Table 5.3 highlights the structure of the results tables.

Table 5.3 – Results Table Structure Explanation

<table>
<thead>
<tr>
<th>Columns 1-3</th>
<th>Thematic Area</th>
<th>Sub theme</th>
<th>Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>The main thematic area as identified in the literature review</td>
<td>Subthemes as identified in the literature review</td>
<td>Determination if the subtheme is either present or absent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Columns 4-6</th>
<th>Reference</th>
<th>Coded Occurrences</th>
<th>Interpretation/Explanation Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>References the location of the subtheme in the contract documents including a clause/sub clause number as applicable. Refer to the abbreviations for the document tags.</td>
<td>Extract of the unit of Coding from the applicable document</td>
<td>Interpretation or comments provided by the coder.</td>
</tr>
</tbody>
</table>
### 5.3 Compensation and Consideration

<table>
<thead>
<tr>
<th>Thematic Area</th>
<th>Subtheme</th>
<th>Present</th>
<th>Reference</th>
<th>Coded Occurrence</th>
<th>Interpretation/Explanation/Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compensation and Consideration</td>
<td>Implementation</td>
<td>No</td>
<td></td>
<td></td>
<td>The Contract does not prohibit amortization</td>
</tr>
<tr>
<td>Project Costs</td>
<td></td>
<td>No</td>
<td></td>
<td></td>
<td>The contract is silent on the treatment of BIM implementation costs.</td>
</tr>
<tr>
<td>Payment Schedules</td>
<td>Yes</td>
<td></td>
<td>GCoC C.57.1</td>
<td>Prepayment is an advance payment against the Contract Price which provides early cash flow to the Contractor. The Prepayment is repaid by the Contractor progressively by deductions from amounts payable under the Contract. Prepayment is secured by Undertakings provided to the Principal in respect of the Prepayment. Prepayment may be utilised for any purpose related to the Contract.</td>
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<tr>
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<td></td>
<td>.1 The Contractor may claim Prepayment, as an advance payment against the Contract Price (but not as a Payment Claim), at any time before achieving Completion of the whole of the Works if all the following apply:</td>
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<tr>
<td></td>
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<td>.3 no more than one-third of the Prepayment amount is retained by the Contractor and the balance is assigned directly to Subcontractors, Suppliers and Consultants in the proportions notified to the Principal;</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>.6 the Contractor has assigned to Subcontractors, Suppliers and Consultants their respective shares of the Prepayment by effective written assignments, and has notified the Principal of the assignments, including the amounts assigned to each Subcontractor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>GCoC C.58.1</td>
<td>Subject to clauses 58.2 and 58.3, the Contractor must submit a Payment Claim each month, on the date in the month specified in Contract Information item 46A, for work carried out up to that date.</td>
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<td></td>
<td>GCoC C.58.5</td>
<td>Every Payment Claim must:</td>
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<td></td>
<td></td>
<td>The Contractor is paid for the work completed in the previous month. Unless the Contractor has submitted a prepayment claim, it is required to supply the funding for any project expenditure up to the end of the month.</td>
</tr>
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<td></td>
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<td></td>
<td></td>
<td>The Contract is structured to pay the Contractor for the Work and Materials completed at the end</td>
</tr>
<tr>
<td>Thematic Area</td>
<td>Subtheme</td>
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<td>Coded Occurrence</td>
<td>Interpretation/Explanation/Comment</td>
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<td></td>
<td>.1 identify the work and Materials to which the Payment Claim relates;</td>
<td>of each month. Any changes to the sequencing and timing of design components can therefore be reflected in the claim submitted by the Contractor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.2 state the value of that work and those Materials;</td>
<td>The Contract mechanism allows for changes in the payment scheduling but is dependent on the actual work done</td>
</tr>
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<td></td>
<td>.3 identify and state the amount the Contractor claims for any other Claim that the Principal has agreed or is required to pay under clause 68 or any other provision of the Contract;</td>
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<td></td>
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<td></td>
<td>.4 state the amount of interest, if any, that the Contractor claims under clause 62;</td>
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</tr>
<tr>
<td></td>
<td>GCoC C.58.6</td>
<td></td>
<td>Every Payment Claim must be accompanied by:</td>
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<td>.1 all relevant calculations;</td>
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<td>.2 a completed and true statutory declaration executed on the date of the Payment Claim, in the form of Schedule 6 (Statutory Declaration);</td>
<td>Each progress payment claim requires the submission of specific documentation and conformance records.</td>
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<td></td>
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<td>.3 all relevant Conformance Records; and</td>
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<td>.4 any other information specified in the Contract.</td>
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<tr>
<td></td>
<td>CC C.57</td>
<td></td>
<td>This Clause sets out provisions relating to Prepayment. Prepayment is an advance payment made to the Contractor to provide early cash flow. Prepayment is intended to assist the Contractor, Subcontractors and Suppliers in meeting the costs involved in preparing for construction, such as purchasing Materials and equipment for which payment will not be made until they are incorporated into the Works.</td>
<td>Explains the principles behind the Prepayment.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CC C57.1</td>
<td></td>
<td>The amount of the Prepayment the Contractor can receive is limited to the amount specified in Contract Information item 45.</td>
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<td>The Contractor is not obliged to take up any or all of the specified Prepayment amount, but may request a portion of the specified amount at any time during the course of the Contract. If Prepayment is claimed late in the Contract period, it cannot be more than the unpaid balance of the Contract Price and must also take into account any moneys owed by the Contractor to the Principal. The latter could include the cost of urgent work carried...</td>
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<td>Thematic Area</td>
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<td>out by the Principal or liquidated damages. That is, the Contractor cannot claim more than the amount that will be paid under the Contract in the future.</td>
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<td></td>
<td>The <em>Prepayment</em> must be used for the purposes of the Contract and this must be established to the Principal's satisfaction. Appropriate purposes could include payment for work, fees, equipment or Materials to be used or related to the work under the Contract.</td>
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<td></td>
<td>The Contractor is not allowed to keep more than one-third of the specified <em>Prepayment</em> amount for its own use. If more than one-third of the Prepayment amount is claimed, the Contractor must assign the balance to Subcontractors, Suppliers and Consultants and must notify the Principal which Subcontractors will receive a prepayment and how much each will receive. The Contract allows the whole of the <em>Prepayment</em> amount to be claimed for Subcontractors, Suppliers and Consultants; the Contractor is not obliged to keep one-third for itself.</td>
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<td>The <em>Prepayment</em> does not represent a risk to the Principal because the Principal receives Undertakings from the Contractor of equivalent value to the amount that is prepaid. Undertakings are to be in the form of Schedule 2 (Undertaking). Note that the Contract does not require the Contractor to have Undertakings from Subcontractors, Suppliers and Consultants. However, this is sometimes required under the Contractor's own management system. Undertakings provided by Subcontractors cannot be handed on to the Principal in lieu of the Undertakings required from the Contractor.</td>
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<td></td>
<td>The Contractor is entitled to be paid progressively for work completed, subject to the provisions of this and other relevant Clauses.</td>
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<td></td>
<td>The Contract requires the Contractor to make Payment Claims monthly. The Payment Claims are to be in writing and are to identify the work carried out up to the reference date of the Payment Claim. This date is usually specified as the last Business Day of the relevant month. As a Payment Claim is to be submitted on the specified date and requires time to prepare, it may, in practice, only include work carried out up to say a week before the specified date. The remaining work carried out in that calendar month would be included in the next Payment Claim.</td>
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<td>Thematic Area</td>
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<td>Payment for work performed as part of a Variation or other agreed adjustment to the Contract Price may be claimed progressively. However, unless design is identified as an item of work in its own right, or is the subject of a Milestone, payment for design work may only be claimed as the associated components are progressively incorporated into the Works. Under Clause 58.2, special provisions may apply to claims for payment for work included in Milestones.</td>
</tr>
<tr>
<td>Thematic Area</td>
<td>Subtheme</td>
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<td>Interpretation/Explanation/Comment</td>
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</table>
|               | Effort Rewards | No      | CC C58.5 | In each Payment Claim, the Contractor must clearly identify the work and Materials that are the subject of the claim. The claim must have a 'bottom line' stating the amount that the Contractor is claiming for the month. In calculating this amount, the Contractor should take into account the value of:  
- work covered by the original Contract Price;  
- work that is the subject of Variations;  
- other Claims that have been agreed or determined;  
- any interest for late payments;  
- retention of the Completion Amount specified in Clause 60; and  
- any amounts payable to the Principal, such as the value of Defects not made good, deduction Variations, deductions required to repay Prepayment amounts, liquidated damages or interest.  
To allow progressive Payment Claims to be easily reconciled and avoid the risk of ambiguity, all Payment Claims should show the total value claimed for all work completed to date, not merely the value of work completed during the past month. This is fundamental to presenting a Payment Claim and forms the basis of the Schedule 3 (Payment Claim Worksheet) template.  
The Contractor is always entitled to claim the cumulative value of the work carried out up to the date of the Payment Claim, less amounts previously paid. This assists in reconciling differences of opinion about the value of work performed up to previous payment dates and allows for adjustment of the Contract Price as the work proceeds.  
These provisions are consistent with the requirements of the NSW Building and Construction Industry Security of Payment Act 1999 (NSW) (Security of Payment Act).  
<p>|               |          |         |           | There are no financial incentives for BIM adoption; the Contractor Performance Reporting |</p>
<table>
<thead>
<tr>
<th>Thematic Area</th>
<th>Subtheme</th>
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<tbody>
<tr>
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<td></td>
<td>system does reward the use of BIM in the project. This system rates the contractor’s performance and the higher the rating the more frequent the Contractor may be invited to tender on projects.</td>
</tr>
</tbody>
</table>
### 5.4 Contract Conditions

<table>
<thead>
<tr>
<th>Thematic Area</th>
<th>Subtheme</th>
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<th>Coded Occurrence</th>
<th>Interpretation/Explanation/Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract Conditions</td>
<td>Collaboration</td>
<td>No</td>
<td></td>
<td></td>
<td>The contract is a Co-operative based contract which does not delineate between Traditional Construct Only and Design &amp; Construct Procurement Methods, but does not recognise collaborative methods. Clause 1 General Responsibilities outlines the obligations of the main parties of the Contract and Clause 3 Co-operation describes the limits to the level of co-operation under the contract.</td>
</tr>
<tr>
<td>Model Status</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>There is no mention of the status of the model within the contract documents</td>
</tr>
<tr>
<td>Deliverables</td>
<td>Yes</td>
<td></td>
<td>GCoC C.40.1</td>
<td></td>
<td>The contract deliverables in regards to the design and documentation refer to standard hard copy documentation and the standard site/floor plans, elevations, sections and details</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CI I.28</td>
<td></td>
<td>The number of copies of the Contractor's Documents to be provided to the Principal is: (&gt;1 electronic copy in a format acceptable to the Principal” applies if not filled in).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CC C40.1</td>
<td></td>
<td>Although the Contractor must assume that the Principal will require the number of copies stated in Contract Information item 28 for all documents, the parties could mutually agree to a different arrangement, such as an electronic copy, for convenience.</td>
</tr>
<tr>
<td>Thematic Area</td>
<td>Subtheme</td>
<td>Present</td>
<td>Reference</td>
<td>Coded Occurrence</td>
<td>Interpretation/Explanation/Comment</td>
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</tr>
<tr>
<td></td>
<td>Subcontracts</td>
<td>Yes</td>
<td>GCoC C.28</td>
<td>Contractual relationships between the Contractor and Subcontractors, Suppliers and Consultants must be on a similar basis to those between the Principal and Contractor. Clause 31 specifies which requirements apply to Consultants and Suppliers.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-collaboration</td>
<td>No</td>
<td></td>
<td></td>
<td>The contract is silent on the status of e-collaboration</td>
</tr>
<tr>
<td></td>
<td>Punitive Measures</td>
<td>Yes</td>
<td>Prelim C.1.7</td>
<td>During the course of the Contract, the Contractor’s performance may be monitored and assessed in accordance with the <em>Performance management system guidelines</em> which are available on the ProcurePoint website.</td>
<td>One of the metrics used to assess the Contractor’s performance and use of innovative design technology ie BIM is detailed in the Contractor Performance Report. Currently this item relates to the achievement of a Superior rating. This rating affects the ranking of the Contractor in the Request for Tender list.</td>
</tr>
<tr>
<td>Thematic Area</td>
<td>Subtheme</td>
<td>Present</td>
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<td>Coded Occurrence</td>
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</tr>
<tr>
<td>Data Security</td>
<td>Data Loss &amp; Corruption</td>
<td>No</td>
<td></td>
<td></td>
<td>The contract is silent on how data loss or corruption would be treated.</td>
</tr>
<tr>
<td></td>
<td>Data Protection - Manipulation</td>
<td>Yes</td>
<td>GCoC C.24.1</td>
<td>The Contractor must maintain all Data secret and confidential and disclose it only to those persons to whom disclosure is reasonably necessary for the purposes of the Contract.</td>
<td>The Contract treats all information as secret and confidential and is a blanket clause for the protection of data. Specific means of protection are not detailed.</td>
</tr>
<tr>
<td></td>
<td>Access and Sharing</td>
<td>Yes</td>
<td>GCoC C.24.1</td>
<td>The Contractor must maintain all Data secret and confidential and disclose it only to those persons to whom disclosure is reasonably necessary for the purposes of the Contract. This provision does not relate to Data which is generally available to the public or which is required to be disclosed by law.</td>
<td>The Contract limits the level of access and sharing to those persons directly related to the project. A pertinent question is how is this monitored and applied in multiple jurisdictions and the ease of accessing and sharing information in the digital age?</td>
</tr>
<tr>
<td></td>
<td>Prelim C.2.4</td>
<td></td>
<td>DELETE THIS CLAUSE AND THE ABOVE HEADING UNLESS SECURITY OF DOCUMENTS IS REQUIRED. DOCUMENT SECURITY IS MANDATORY FOR ALL WORKS THAT INVOLVE SECURITY EG: CORRECTIONAL INSTITUTIONS, ELECTRONIC SECURITY INSTALLATIONS AND THE LIKE. ENSURE THAT ALL RELEVANT DOCUMENTS ARE MARKED “RESTRICTED”. All documents marked “Restricted”, and any other documents the Principal notifies as “Restricted” are classified maximum security documents. No copies are to be made or retained by the Contractor, subcontractors, suppliers, agents or anyone else other than for the Contract. All originals and copies of restricted classification documents are to be returned to the Principal on Completion.</td>
<td>The Contract adds a further level of confidentiality on Documents marked as restricted. These documents are not to be retained or copied. Another pertinent question is how is this policed and what is the definition of a Document i.e. hardcopy or digital and how does it affect the digital model – how is this information controlled if the items need to be coordinated and integrated into the overall model – including derivative models?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Insurances</td>
<td>No</td>
<td></td>
<td></td>
<td>The Documents are silent on the need for insurance for data security and any associated loss</td>
</tr>
</tbody>
</table>
### 5.6 ICT Protocols and Processes

<table>
<thead>
<tr>
<th>Thematic Areas</th>
<th>Subtheme</th>
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<th>Reference</th>
<th>Coded Occurrence</th>
<th>Interpretation/Explanation/Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICT Protocols &amp; Processes</td>
<td>Process/Change Management</td>
<td>No</td>
<td></td>
<td></td>
<td>The process for changing the model is not included in the contract documents.</td>
</tr>
<tr>
<td></td>
<td>Responsibilities</td>
<td>No</td>
<td></td>
<td></td>
<td>The various responsibilities associated with BIM are not included in the standard contract.</td>
</tr>
<tr>
<td>Communication</td>
<td>Yes</td>
<td>Attachment 1</td>
<td>GC21 Startup Workshop</td>
<td>Agenda The agenda should include: development of a communications framework and directory</td>
<td>This point refers to one of the agenda items of the GC21 startup workshop. It is the formalisation of the communication framework. This is aimed at the formal or contractual communication structure but can include informal paths of communication. This item, however, does not specifically reference BIM or the means of communicating project information.</td>
</tr>
<tr>
<td>GCoC 38</td>
<td>Faults in Contract Documents</td>
<td>.1 The Contractor must check the Contract Documents. At least 21 days before the Contractor proposes to use any Contract Document, the Contractor must notify the Principal of any Fault in that Contract Document and any related Contract Documents .2 The Principal must resolve any Fault notified under clause 38.1. .3 If the Contractor has notified the Principal of a Fault in accordance with clause 38.1, then subject to clause 38.4: .1 to the extent that the Principal resolves the Fault by instructing a Variation, clause 48 applies; and .2 to the extent that the Principal resolves the Fault other than by instructing a Variation: .1 if the resolution has an effect on the time to achieve Completion, the Contractor may make a Claim for an extension of time under clause 50 and consequent delay costs due in accordance with clause 51, or the Principal may assess a reduction of time in accordance with clause 50; and .2 if the resolution results in the Contractor incurring costs that are greater or less than the Contractor should reasonably have foreseen at the close of tenders, the parties may agree</td>
<td>This clause details the process for identifying faults in the Principal’s Documents and the communication process for confirming the impact of any required changes to the Contract price and time for Completion.</td>
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<td>Thematic Areas</td>
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<td>in writing on an adjustment to the Contract Price or if not agreed the Contractor may make a Claim for an adjustment to the Contract Price to be valued in accordance with clause 47.</td>
<td>This section details the process for communicating departures from the Principal’s design as supplied in the contract documents. This may also include CAD drawings of the design.</td>
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<td>.4 If the Principal resolves a Fault in the Contract Documents that was not notified in accordance with clause 38.1, the Contractor is not entitled to any costs for delay or the cost of any aborted work.</td>
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</tr>
<tr>
<td>GCoC 39.5.7</td>
<td>Departures from the design provided by the Principal</td>
<td></td>
<td></td>
<td>.5 Subject to clause 39.7, the Contractor must not depart from the design provided by the Principal unless instructed in writing by the Principal.</td>
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<td>.6 If the Contractor considers that some departure from the design provided by the Principal is desirable to ensure the effectiveness and efficiency of the Works, then the Contractor may propose a Variation under clause 48. Where a departure is necessary for the Works to be fit for the purposes required by the Contract, the Contractor must notify the Principal in accordance with clause 48.8.</td>
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<td>.7 In carrying out the design and design development of the elements referred to in Contract Information item 38A.3, the Contractor may depart from the design provided by the Principal, but only:</td>
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<td></td>
<td>.1 to the extent that any such departure does not adversely affect the construction, operation or maintenance of the Works or their performance or fitness for the purposes required by the Contract; and</td>
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<td>.2 provided that the Contractor has notified the Principal in writing of the proposed departures and the Principal has not notified the Contractor of any objection within 7 days after receiving the notification.</td>
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</tr>
<tr>
<td>Model Level of Development</td>
<td>No</td>
<td></td>
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<td>The contract does not explicitly include a BIM implementation plan in the standardised contract form.</td>
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<tr>
<td>BIM Plan</td>
<td>No</td>
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<tr>
<td>Thematic Area</td>
<td>Subtheme</td>
<td>Present</td>
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<tr>
<td>Intellectual Property</td>
<td>Collaborative Ownership</td>
<td>No</td>
<td></td>
<td></td>
<td>All IP ownership stays with the Principal of the contract, which is either a government agency or department, and a license is only granted to the Contractor/Subcontractor/Design Consultants for the duration of the project and any information generated during the process remains the IP of the Principal.</td>
</tr>
<tr>
<td></td>
<td>BIM Model &amp; Data Ownership</td>
<td>Yes</td>
<td>GCoC C.23.1</td>
<td>The Contractor assigns or otherwise transfers <em>Intellectual Property Rights</em> in all Data created specifically for the Contract, upon its creation, to the Principal. The Contractor, at its own cost, will do all things necessary, including execution of all necessary documentation, to vest ownership of all such <em>Intellectual Property Rights</em> in the Principal.</td>
<td>All Data and IP as defined in clause 79 which includes the Design remains the property of the Principal of the contract</td>
</tr>
<tr>
<td></td>
<td>Confidential Proprietary Sensitive Information</td>
<td>Yes</td>
<td>GCoC C.24.1</td>
<td>The Contractor must maintain all Data secret and confidential and disclose it only to those persons to whom disclosure is reasonably necessary for the purposes of the Contract. This provision does not relate to Data which is generally available to the public or which is required to be disclosed by law.</td>
<td>The intent of the clause relates to the completed facility and not related to the actual information. The contract requires all information to remain confidential, except data which is already in the public domain.</td>
</tr>
<tr>
<td></td>
<td>Ongoing Protection</td>
<td>Yes</td>
<td>23.5</td>
<td>Licenses referred to in clause 23.4 apply in perpetuity from the Date of Contract or (if the Data has not then been created) from the date the Data is created.</td>
<td>All IP rights outside of the Project remain with the Principal including the creation of data peripheral to the development of the Design for eternity.</td>
</tr>
<tr>
<td></td>
<td>Licensing for Use</td>
<td>Yes</td>
<td>GCoC C23.3 &amp; .4</td>
<td>The Contractor, Subcontractors and Consultants are granted royalty-free licences to use the Data for the purposes of the Contract.</td>
<td>It requires the contractor to obtain IP licensing for all aspects of the project</td>
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<td>Thematic Area</td>
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<td>.4 For Data not created specifically for the Contract but required to use, operate, maintain, modify and decommission the Works, the Contractor must obtain irrevocable royalty-free licences to allow the Principal to use that Data for those purposes, including a right to sub-licence.</td>
<td></td>
</tr>
<tr>
<td>Insurance or Indemnity</td>
<td>Yes</td>
<td>GCoC C23.7</td>
<td>The Contractor indemnifies the Principal against any claims (including Claims), actions, loss or damage arising out of any failure to make such payments or any infringement or alleged infringement of Intellectual Property Rights in relation to Data created or provided by the Contractor in connection with the Contract, including any related design, materials, documents or methods of working, or otherwise in the course of the Contractor’s performance of the Contract</td>
<td>The contract requires the Contractor to take responsibility for any claims for breeches of IP data provided for the contract</td>
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### 5.8 Interoperability

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<tr>
<td>Interoperability</td>
<td>Technology Compatibility</td>
<td>Yes</td>
<td>Prelim 2.3</td>
<td>Any CAD files submitted must be in DGN, DWG, or DXF format.</td>
<td>This is a CAD file and refers to a proprietary file type and not an open source file extension</td>
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<td>Interoperability</td>
<td>Transfer Procedures</td>
<td>No</td>
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<tr>
<td>Interoperability</td>
<td>Responsibility</td>
<td>Yes</td>
<td>Prelim 2.3</td>
<td>The Contractor must ensure that any CAD files submitted will correctly display and print in Microstation.</td>
<td>This is a CAD file and refers to a proprietary file type and not an open source file extension</td>
</tr>
<tr>
<td>Interoperability</td>
<td>Auditing</td>
<td>No</td>
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<td>Thematic Area</td>
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<tr>
<td>Legislation and Judicial Precedence</td>
<td>Jurisdiction</td>
<td>Yes</td>
<td>GCoC C.10.1</td>
<td>The Contract is governed by the laws of New South Wales, and the parties submit to the non-exclusive jurisdiction of the courts of New South Wales.</td>
<td>The jurisdiction of all legislation is the State of New South Wales.</td>
</tr>
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<td></td>
<td>E-Contracts</td>
<td>Yes</td>
<td>GCoC C.11.1</td>
<td>Notices and instructions</td>
<td>This clause notes that all notices and instructions must be in writing.</td>
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<td>GCoC C.11.2</td>
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<td>.1 Notices must be sent to the relevant persons at the addresses in Contract Information items 4 to 11 or 52, or at the address for service most recently notified in writing by the addressee.</td>
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<td>.2 All notices must be in writing, and all instructions by the Principal must be in writing or, if given orally, must be confirmed in writing as soon as practicable.</td>
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<td></td>
<td>Prelim C1.1</td>
<td></td>
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<td>The parties agree and consent that notices and communications may be by electronic communication in accordance with the Electronic Transactions Act 2000 (NSW).</td>
<td>Refers to the NSW Electronic Transactions Act 2000.</td>
</tr>
<tr>
<td></td>
<td>Privity of Contract &amp; Third party Reliance</td>
<td>Yes</td>
<td>GCoC C.28</td>
<td>Contractual relationships between the Contractor and Subcontractors, Suppliers and Consultants must be on a similar basis to those between the Principal and Contractor. Clause 31 specifies which requirements apply to Consultants and Suppliers.</td>
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<td>Archiving</td>
<td>No</td>
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<tr>
<td>Professional Liability</td>
<td>Spearin Doctrine</td>
<td>Yes</td>
<td>Prelim C5.1</td>
<td>Order of Work</td>
<td>The Principal can direct the Contractor to complete the works in a particular order, but is not directing the methodology for completing the works.</td>
</tr>
<tr>
<td>Design Control &amp; Responsibility</td>
<td>Yes</td>
<td>GCoC C.1.1.1</td>
<td>1. General responsibilities</td>
<td>The extent of the Contractor’s Design obligations is specified in clause 39 and Contract Information item 38A.</td>
<td></td>
</tr>
<tr>
<td>Design Control &amp; Responsibility</td>
<td>Yes</td>
<td>GCoC C.38.1</td>
<td>.1 The Contractor must check the Contract Documents. At least 21 days before the Contractor proposes to use any Contract Document, the Contractor must notify the Principal of any Fault in that Contract Document and any related Contract Documents</td>
<td>Puts the Contractor in control of the design for the completion of the Principal’s Design, This becomes the Contractor’s design.</td>
<td></td>
</tr>
<tr>
<td>Design Control &amp; Responsibility</td>
<td>Yes</td>
<td>GCoC C.38.2</td>
<td>The Principal must resolve any Fault notified under clause 38.1.</td>
<td>The extent of the design responsibility for the Contractor is to check the Principal’s Design and notify the Principal of any Faults. The responsibility is allocated along the traditional lines, the Principal is responsible for the design it has completed and the Contractor is responsible for its design, but must ensure it is fit for purpose.</td>
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</tr>
<tr>
<td>Design Control &amp; Responsibility</td>
<td>Yes</td>
<td>GCoC C.39.1</td>
<td>.1 The Contractor must complete the design provided by the Principal and carry out all other design necessary in connection with the Works, including:</td>
<td>The Principal is responsible for resolving any Faults the Contractor identifies in the Contract Documents.</td>
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The extent of the Design by the Contractor is typical of a traditional Design and Construct project.
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<th>Thematic Area</th>
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<tr>
<td></td>
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<td>GCoC C.39.2</td>
<td>.3 full design by the Contractor of elements referred to in Contract Information item 38A.2.</td>
<td>The Contractor is responsible for ensuring the constructability/buildability and ensuring the completed works conform to the intended purpose of the Project.</td>
</tr>
<tr>
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<td></td>
<td>GCoC C.39.2</td>
<td>The Contractor must carry out its design responsibilities so that the Works are fit for the purposes required by the Contract and comply with the other requirements of the Contract.</td>
<td>The contract adopts a traditional allocation of design responsibility – the Principal is responsible for its portion of the design it completed and must rectify any Faults. The Contractor is responsible for its portion of the design.</td>
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<td>GCoC C.39.3</td>
<td>The Contractor’s design responsibilities are reduced to the extent that the Works are not fit for a purpose required by the Contract because of the design provided by the Principal.</td>
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<td>GCoC C.39.9</td>
<td>The Contractor must produce Contractor’s Documents which:</td>
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<td>.1 will ensure that the Works are fit for the purposes required by the Contract; and</td>
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<td>.2 meet the requirements of all of the following:</td>
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<td>.1 the Contract;</td>
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<td>.2 Statutory Requirements;</td>
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<td>.3 the Principal’s instructions;</td>
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<td>.4 the Building Code of Australia (if stated in Contract Information item 38B) and relevant Australian Standards; and</td>
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<td>.5 if no other standard is specified in the Contract, good industry standards applicable to the Works.</td>
<td>The Contractor’s Documents refer to hardcopy drawings and specifications with no reference to a model. Further investigation is required to identify if there may be statutory requirements which need to have hardcopy documents issued for approval, how does the model relate to these documents?</td>
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<td>Thematic Area</td>
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<td></td>
<td>CI 38 – A.1</td>
<td>A - Design by the Contractor</td>
<td>OBTAIN THE ADVICE OF THE PROJECT MANAGER. CAREFULLY DOCUMENT THE EXTENT OF THE CONTRACTOR’S DESIGN OBLIGATIONS.</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>1 Items, services and components of the Works for which the Contractor is responsible for developing the design provided by the Principal (clause 39.1.2):</td>
<td></td>
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<td></td>
<td></td>
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<td>CI 38 – A.2</td>
<td>.2 Items, services and components of the Works which the Contractor must fully design (clause 39.1.3):</td>
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<td>CC C.1</td>
<td>The Contractor’s obligations are:</td>
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<td>• to meet its design responsibilities described in the section on Design (Clause 39) and in the Contract Information (Item 38);</td>
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<td>• construct the Works (Clause 43) as described in the Contract Information (item 3) and the Contract Documents; and</td>
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<td>• perform its obligations in accordance with the Contract.</td>
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<td>The Contractor's primary obligation is to perform any Design activities specified in Contract Information item 38 and construct the Works to Completion in accordance with the requirements of the Contract.</td>
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<td>The Contractor’s design responsibilities may arise as:</td>
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<td>• developing a design provided by the Principal for the Works (Contract Information item 38A.1);</td>
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<td>or</td>
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<td>• fully designing the Works (Contract Information item 38A.2).</td>
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<td>Either way, it is important that the Principal accurately describes in item 38 the extent of the Design activities to be performed by the Contractor.</td>
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<td>The Contractor must not depart from the design provided by the Principal unless the conditions and notification requirements described in clause 39.7 have been satisfied. The works are then described in Contract Information item 38A.3.</td>
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<tr>
<td>CC C38</td>
<td></td>
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<td></td>
<td>This Clause sets out the obligations of both parties when a Fault is found in the Contract Documents including:</td>
<td>This clause commentary explains the process for the rectification of any faults that are found in the documents</td>
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<td></td>
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<td>• the Contractor’s obligation to provide timely notification;</td>
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<td>• the Principal’s obligation to resolve the matter;</td>
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<td>• how to deal with any effects of the resolution on price and time; and</td>
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<td>• the implications if the Contractor fails to notify in time.</td>
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<tr>
<td>CC C39</td>
<td></td>
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<td></td>
<td>This clause describes the Contractor’s Design responsibilities, including:</td>
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<td>• the extent of the Design the Contractor is required to carry out;</td>
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<td>• the circumstances under which the Contractor’s Design may depart from the Design provided by the Principal;</td>
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<td>• Design review requirements; and</td>
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<td>• the requirements for the Contractor’s Documents.</td>
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<td>CC 39.1</td>
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<td></td>
<td>General design responsibilities</td>
<td></td>
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<td>GC21 recognises that the Contractor is always required to carry out some amount of design work. These responsibilities apply regardless of whether the nature of the Contract is described as fully documented; construct only; design, development and construct; design and construct,</td>
<td></td>
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</tbody>
</table>
The Principal’s Design, provided in the Principal’s Documents, will never include every detail of every item that is required to construct the Works. Clause 8 requires the Contractor to carry out ‘all work … necessary to properly carry out and complete the Works’. Completion of the Design is work that is necessary to complete the Works. In essence, the Contractor is required to design every item required for the Works that has not been designed by the Principal.

However, there are limits to the Contractor’s Design obligations. The Contractor is not obliged to design for work or items that are beyond the requirements of Clause 8 without an instruction from the Principal.

Clause 39.1.1 describes the general design responsibilities the Contractor will always have. The extent of design development, detailing and coordination the Contractor is required to carry out will depend on the completeness of the Principal’s Design. Even when the Principal has provided designs for all the elements of the Works, the Contractor will need to design minor items and ensure that they are properly integrated into the Works. Such items could include window fixtures, cornices and skirting boards, or fittings and downpipes for roof guttering. The Contractor will commonly be required to prepare shop drawings for the fabrication of building components.

The Contractor will always be responsible for coordinating the activities required to complete the Design.

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<tbody>
<tr>
<td>Design Liability</td>
<td>Yes</td>
<td>GC03 C.38.3</td>
<td>If the Contractor has notified the Principal of a Fault in accordance with clause 38.1, then subject to clause 38.4:</td>
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<td>.1 to the extent that the Principal resolves the Fault by instructing a Variation, clause 48 applies; and</td>
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<td>.2 to the extent that the Principal resolves the Fault other than by instructing a Variation:</td>
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<td>.1 if the resolution has an effect on the time to achieve Completion, the Contractor may make a Claim for an extension of time under clause 50 and consequent delay costs due</td>
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<td>Thematic Area</td>
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<td>in accordance with clause 51, or the Principal may assess a reduction of time in accordance with clause 50; and</td>
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<td>.2 if the resolution results in the Contractor incurring costs that are greater or less than the Contractor should reasonably have foreseen at the close of tenders, the parties may agree in writing on an adjustment to the Contract Price or if not agreed the Contractor may make a Claim for an adjustment to the Contract Price to be valued in accordance with clause 47.</td>
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<td>GCoC C.38.4</td>
<td>If the Principal resolves a Fault in the Contract Documents that was not notified in accordance with clause 38.1, the Contractor is not entitled to any costs for delay or the cost of any aborted work.</td>
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<td></td>
<td>GCoC C.39.4</td>
<td>The Contractor's design responsibilities are reduced to the extent that the Works are not fit for a purpose required by the Contract because of the design provided by the Principal.</td>
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<td></td>
<td>GCoC C.39.5</td>
<td>Subject to clause 39.6, design or design development does not cause a Variation or reduce the Contractor's design responsibilities under clause 39.</td>
<td></td>
</tr>
<tr>
<td>Standard of Care</td>
<td>Yes</td>
<td>Prelim 1.2</td>
<td>Use of Qualified Designers</td>
<td>Use of Qualified Designers Use persons professionally qualified in the relevant disciplines when completing the Design of the Works. The use of such persons shall not relieve the Contractor of liability for the fitness of the Works for the purposes required by the Contract</td>
<td></td>
</tr>
<tr>
<td>Delegation</td>
<td>Yes</td>
<td>GCoC C.28 &amp;</td>
<td>Subcontractor relationships</td>
<td>.1 The Contractor is solely responsible for all Subcontractors (including Subcontractors engaged in accordance with clause 29.3) and is liable for their acts and omissions as if such acts or omissions were those of the Contractor. Subcontracting of any obligation under the Contract does not affect the Contractor's obligations or liability under the Contract. .2 The Contractor indemnifies the Principal against all claims (including Claims), actions, loss or damage and all other liability arising out of any acts or omissions of Subcontractors.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>GCoC C.31</td>
<td>Consultant and Supplier relationships .1 Clauses 28.1, 28.2, 28.3 and 29 apply to Consultants in the same way they apply to Subcontractors. .2 Clauses 28, 29 and 30 apply to Suppliers in the same way they apply to Subcontractors.</td>
<td></td>
</tr>
<tr>
<td>Thematic Area</td>
<td>Subtheme</td>
<td>Present</td>
<td>Reference</td>
<td>Coded Occurrence</td>
<td>Interpretation/Explanation/Comment</td>
</tr>
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</tr>
<tr>
<td></td>
<td>Software</td>
<td>No</td>
<td>GCoC C.27.3.2</td>
<td>unless the context requires otherwise.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Licensing</td>
<td>No</td>
<td></td>
<td></td>
<td>The GCoC are silent on the requirements for design licensing. Refer to Clause 21</td>
</tr>
<tr>
<td></td>
<td>Insurances</td>
<td>Yes</td>
<td></td>
<td>if stated in Contract Information item 24, a professional indemnity policy of insurance to cover liability for breach of professional duty (whether in contract or otherwise) arising out of any negligence, whether in relation to errors in design, documentation, supervision or other professional duties of the Contractor (whether in contract or otherwise), and extended to include cover for any breach of all such professional duties carried out on behalf of the Contractor by Subcontractors, Suppliers or Consultants; and</td>
<td>Requires the Contractor or its consultants to hold current insurances.</td>
</tr>
</tbody>
</table>
### Public Sector Agency

<table>
<thead>
<tr>
<th>Thematic Area</th>
<th>Subtheme</th>
<th>Present</th>
<th>Reference</th>
<th>Coded Occurrence</th>
<th>Interpretation/Explanation/Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Sector Agency</td>
<td>Building Regulations or Authority Approvals</td>
<td>Yes</td>
<td>Prelim 1.4</td>
<td>Licences and approvals</td>
<td>This clause relates to the approvals and licenses obtained by the Principal, but does not stipulate or qualify the status of the BIM if used to obtain the approval.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The Principal has obtained the following licences, approvals and consents for the Site and the Works:</td>
<td>Note: the status of the BIM and the interaction with the approval process will need to be defined in detail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LIST ALL LICENCES, APPROVALS AND CONSENTS OBTAINED BY THE PRINCIPAL EG:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• DEVELOPMENT CONSENT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• LEASE OF SITE;</td>
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<td></td>
<td></td>
<td></td>
<td>• CONSENT TO ENTER;</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>• BUILDING APPROVAL;</td>
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<td></td>
<td></td>
<td></td>
<td>• EPA LICENCES.</td>
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<td>* *</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The Contractor must provide the Principal with a copy of all other licences and approvals required, and pay all associated fees prior to commencing the affected work.</td>
<td></td>
</tr>
<tr>
<td>Prelim 1.5</td>
<td>Development consent</td>
<td></td>
<td></td>
<td>DELETE THIS CLAUSE AND THE ABOVE HEADING IF THE DEVELOPMENT CONSENT IS AVAILABLE AND INCLUDED IN THE TENDER DOCUMENTS. INCLUDE THIS CLAUSE IN THE TENDER DOCUMENTS WHEN THE CONTRACTOR IS REQUIRED TO LODGE A DEVELOPMENT APPLICATION</td>
<td>This clause relates to the Contractor’s obligations for obtaining development consent. It does not include the status of the model or if it can be used for obtaining building consent.</td>
</tr>
<tr>
<td></td>
<td>Requirement</td>
<td></td>
<td></td>
<td>Prepare and lodge on behalf of the Principal a Development Application for the Works. The Contractor is responsible for all lodgement fees and other costs associated with the Development Application.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Consent Authority Conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thematic Area</td>
<td>Subtheme</td>
<td>Present</td>
<td>Reference</td>
<td>Coded Occurrence</td>
<td>Interpretation/Explanation/Comment</td>
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<td></td>
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<td></td>
<td>In making enquiries for the purpose of preparing the Development Application, no agreement as to consent conditions must be made with the Consent Authority. Upon receipt of Consent Authority's conditions, provide a copy to the Principal immediately. Do not proceed to implement the conditions without a written instruction from the Principal.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prelim 1.6</td>
<td></td>
<td></td>
<td>Certification of compliance with building and fire regulations</td>
<td>Provide a certificate obtained from a consultant appropriately accredited as an Accredited Certifier in accordance with the Environmental Planning and Assessment Act 1979 (NSW) stating that the Works fully comply with all applicable building and fire regulation statutory requirement.</td>
</tr>
<tr>
<td>Approvals in Writing</td>
<td>Yes</td>
<td>Prelim 1.1</td>
<td>Electronic communications</td>
<td>The parties agree and consent that notices and communications may be by electronic communication in accordance with the Electronic Transactions Act 2000 (NSW).</td>
<td>The Act allows for the transmission of approvals in an electronic format. However, other approval legislation may require the submission and issuing of approvals in writing.</td>
</tr>
<tr>
<td>Thematic Area</td>
<td>Subtheme</td>
<td>Present</td>
<td>Reference</td>
<td>Coded Occurrence</td>
<td>Interpretation/Explanation/Comment</td>
</tr>
<tr>
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</tr>
<tr>
<td>Risk Allocation</td>
<td>Allocation of Liabilities</td>
<td>Yes</td>
<td>GCoC 26.5.2</td>
<td><strong>Care of people, property and the environment, indemnities and limitations</strong>&lt;br&gt;Indemnities for property, personal injury or death&lt;br&gt;The Contractor’s liability for loss or damage under clauses 26.3 and 26.4 is reduced to the extent that the loss or damage is contributed to or caused by:&lt;br&gt;any risk specifically excepted in the Contract</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>GCoC 36.2.1</td>
<td><strong>Site information</strong>&lt;br&gt;The Contractor warrants that it:&lt;br&gt;has made its own inquiries concerning the Site, including checking information provided by the Principal;&lt;br&gt;.2 has examined the Site and surrounds and satisfied itself through its own investigation as to the Site Conditions which might reasonably be expected;&lt;br&gt;.3 has made its own assessment of the risks, contingencies and other circumstances which might affect the work in connection with the Contract and has allowed fully for these in the <em>Contract Price</em> (subject to clause 37);&lt;br&gt;.4 did not in any way rely on the completeness of the information identified in Contract Information item 36A other than as a guide for ascertaining what further Site information the Contractor considers it needs to obtain;&lt;br&gt;.5 did not rely on the accuracy, quality or completeness of information identified in Contract Information item 36B; and&lt;br&gt;.6 has made its own interpretations, deductions and conclusions and did not in any way rely on interpretations, deductions and conclusions made by or for the Principal.</td>
<td></td>
</tr>
<tr>
<td>Risk Insurances</td>
<td>No</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
5.13 Summary

This chapter presented the results of the Qualitative Content Analysis for the GC21 case study. The presence of clauses that may relate to the implementation of BIM within the contract framework were identified and coded as per the process for undertaking the QCA process discussed in the Methodology chapter. Table 5.4 provides a summary of the QCA coding outcomes.

Table 5.4 Qualitative Content Analysis Coding Outcomes

<table>
<thead>
<tr>
<th>Theme</th>
<th>Subtheme</th>
<th>Status*</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compensation &amp; Consideration</td>
<td>Implementation Costs</td>
<td>No</td>
<td>No mention of BIM implementation costs but could be amortised in project costs.</td>
</tr>
<tr>
<td></td>
<td>Project Costs</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Payment Schedules</td>
<td>Yes</td>
<td>Payment schedules can be amended to reflect the work actually completed.</td>
</tr>
<tr>
<td></td>
<td>Effort/Reward</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Conditions of Contract</td>
<td>Collaboration</td>
<td>No</td>
<td>The Principal and Contractor are responsible for controlling specific aspects of the design as detailed in the contract.</td>
</tr>
<tr>
<td></td>
<td>Model Status</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deliverables</td>
<td>Yes</td>
<td>There are design deliverables but no mention of specific BIM items.</td>
</tr>
<tr>
<td></td>
<td>Subcontracts</td>
<td>Yes</td>
<td>There are provisions for including BIM clauses in subcontracts, but no specific items mentioned in the</td>
</tr>
<tr>
<td>Theme</td>
<td>Subtheme</td>
<td>Status*</td>
<td>Comment</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>standard form.</td>
</tr>
<tr>
<td>E-collaboration</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Punitive Measures</td>
<td></td>
<td>Yes</td>
<td>These are linked to the Contractor Performance Reporting process.</td>
</tr>
<tr>
<td>Data Security</td>
<td>Data Loss &amp; Corruption</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Data Protection</td>
<td>Yes</td>
<td>There are specific protocols that must be followed for sharing information.</td>
</tr>
<tr>
<td></td>
<td>Access &amp; Sharing</td>
<td>Yes</td>
<td>There are specific protocols that must be followed for sharing information.</td>
</tr>
<tr>
<td></td>
<td>Insurances</td>
<td>No</td>
<td>There are no specific BIM mentioned items.</td>
</tr>
<tr>
<td>ICT Protocols</td>
<td>Process/Change Management</td>
<td>No</td>
<td>There are no specific BIM mentioned items.</td>
</tr>
<tr>
<td></td>
<td>Responsibilities</td>
<td>No</td>
<td>There are no specific BIM mentioned items.</td>
</tr>
<tr>
<td></td>
<td>Communication</td>
<td>Yes</td>
<td>The contract details how information is transferred but no mention of the use of a model.</td>
</tr>
<tr>
<td></td>
<td>Model LoD</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BIM Execution Plan</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Intellectual Property</td>
<td>Collaborative Design Ownership</td>
<td>No</td>
<td>This contract adopts a traditional approach to design development – Cooperation</td>
</tr>
<tr>
<td>Theme</td>
<td>Subtheme</td>
<td>Status*</td>
<td>Comment</td>
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<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>BIM Model &amp; Data Ownership</td>
<td>Yes</td>
<td>Is vested to the Crown.</td>
</tr>
<tr>
<td></td>
<td>Confidential/Proprietary</td>
<td>Yes</td>
<td>There are clear protection requirements detailed in the Contract.</td>
</tr>
<tr>
<td></td>
<td>Information</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ongoing Protection</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Licensing for Use)</td>
<td>Yes</td>
<td>Generated from analysis</td>
</tr>
<tr>
<td></td>
<td>(Indemnity Insurance)</td>
<td>Yes</td>
<td>Generated from analysis</td>
</tr>
<tr>
<td>Interoperability</td>
<td>Technology Compatibility</td>
<td>Yes</td>
<td>Is restricted to ensuring CAD files only.</td>
</tr>
<tr>
<td></td>
<td>Transfer Procedures</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Responsibility</td>
<td>Yes</td>
<td>Is restricted to ensuring CAD files can be viewed.</td>
</tr>
<tr>
<td></td>
<td>Auditing</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Legislation &amp; Judicial</td>
<td>Jurisdiction</td>
<td>Yes</td>
<td>The Contract is executed under NSW jurisdiction.</td>
</tr>
<tr>
<td>Precedence</td>
<td>E-Contracts &amp;Transactions</td>
<td>Yes</td>
<td>The contract is covered by relevant NSW legislation.</td>
</tr>
<tr>
<td></td>
<td>Privity &amp; Third Party</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reliance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Archiving</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Professional Liability</td>
<td>Spearin Doctrine</td>
<td>Yes</td>
<td>The Principal can dictate the order of work, but the Contractor is still left to</td>
</tr>
<tr>
<td>Theme</td>
<td>Subtheme</td>
<td>Status*</td>
<td>Comment</td>
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<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>determine the overall construction methodology.</td>
</tr>
<tr>
<td>Design Control</td>
<td>Yes</td>
<td></td>
<td>The Principal and Contractor are responsible for controlling specific aspects of the design as detailed in the contract.</td>
</tr>
<tr>
<td>Design Liability</td>
<td>Yes</td>
<td></td>
<td>There is a clear delineation of design liability between the Contractor and the Principal.</td>
</tr>
<tr>
<td>Standard of Care</td>
<td>Yes</td>
<td></td>
<td>The Contractor must use professionally qualified designers.</td>
</tr>
<tr>
<td>Delegation</td>
<td>Yes</td>
<td></td>
<td>The Contractor is responsible for all delegated works.</td>
</tr>
<tr>
<td>Software</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Licensing</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insurances</td>
<td>Yes</td>
<td></td>
<td>PI is a requirement of the contract. The contract does not state if BIM-relevant insurance is required.</td>
</tr>
<tr>
<td></td>
<td>Building Regulations/Authority Approvals</td>
<td>Yes</td>
<td>The contract identifies the approval responsibilities, but does not address the use of a model for obtaining said approvals.</td>
</tr>
<tr>
<td></td>
<td>Approvals in Writing</td>
<td>Yes</td>
<td>Approvals between the Principal and Contractor may be issued electronically.</td>
</tr>
<tr>
<td>Theme</td>
<td>Subtheme</td>
<td>Status*</td>
<td>Comment</td>
</tr>
<tr>
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<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Risk Allocation</td>
<td>Allocation of Liabilities</td>
<td>Yes</td>
<td>There is a clear delineation between the Contractor's and Principal's liabilities</td>
</tr>
<tr>
<td>Risk Insurances</td>
<td></td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

* Is identified in the standardised Contract

The next chapter revisits the conceptual model as developed in Chapter 3 with reference to the findings of the QCA, as detailed in this chapter.
6 DISCUSSION

6.1 Introduction

As illustrated in the previous chapter, a standard form of construction contract was analysed using Qualitative Content Analysis with a framework developed using the themes identified in the literature review. The findings discussed in this chapter are the final stage in the analysis process and included a comparison against the findings of the initial literature review and conceptual model as presented in Chapters 2 and 3. In addition, a number of recommendations are tabled that address the perceived legal risks associated with BIM implementation. This discussion chapter seeks to answer the research question that was:

How might the legal and contractual issues associated with Building Information Modelling implementation affect standardised construction procurement contracts?

The contract analysed was the NSW Procurement standard form GC21 edition 2, a hybrid traditional/design and construct cooperative procurement method. The risk, roles and responsibilities allocation follows the traditional framework in that the parties will cooperate to complete the works (including completing any design components) to the extent described in the Contract. The Principal is responsible for the design components it completes and the Contractor is responsible for the design and work it completes. There are a range of mechanisms, financial and non-financial which enable the Contract to be adjusted for non-performance and errors/ambiguities.

6.2 Compensation and Consideration

This section reviews the analysis of the compensation and consideration legal issues. It discusses the QCA findings in relation to the ability of the contract to permit payments for business and project BIM implementation, flexibility in payment schedules for non-traditional workflow completion and equitable payments for designer efforts in modelling the project.

The analysis of the GC21 contract revealed that the financial mechanisms within the contract only allow for payment for work that is directly related to the project. There are no explicit conditions included in the Contract that allow for implementing BIM at a business or project level. To add further, the conditions do not include any financial
inducements for BIM adoption. However, the payment conditions and schedules do allow the Contractor to claim prepayment amounts against the Contract Price. To explain, prepayment is:

“an advanced payment against the Contract Price which provides early cash flow to the Contractor. The prepayment is repaid by the Contractor progressively by deductions from amounts payable under the Contract”.

(Clause 57 guide notes)

Therefore, a prepayment claim for BIM implementation could be submitted, but only if the amount claimed relates to the actual project. The Contractor does not receive any additional payments, only advances on the expected work to be completed and this involves the issuing of an Undertaking, usually in the form of bank guarantees in the favour of the Principal, that are equal to the amount claimed. As the work is completed and the amount paid to the Contractor equals the prepayment amount, the bank guarantees are released back to the Contractor (Clause 57.4).

The GC21 contract conditions of payment do not explicitly cover the issue of recouping the costs of technology adoption within a business framework. As highlighted in Chapter 3, these costs would be considered an ‘overhead’ and a normal part of running the overall business. These overhead costs are typically included in the buildup of rates, or as a lump sum incorporated within the Preliminaries section of the tender price (Ashworth, 2004). Ashcraft (2008), suggests that the costs for BIM business implementation can be amortised over several projects. However, one issue with doing this is the competitive nature of the construction sector, whereby including additional costs on a tender price may make the contractor/consultant uncompetitive, in the short term. In the longer term, once the contractor’s BIM deployment reaches maturity, there will be savings through efficiency and a competitive edge through marketing the company as fully BIM integrated (Demian & Walters, 2013). Generally, concerns relating to the costs of BIM business adoption are considered short-term; as more companies adopt BIM the need for recouping business implementation costs will diminish. (Sebastian, 2010, 2011b).

The Contract is flexible in its ability to meet changing payment schedules, subject to the Contractor justifying any payment claim with evidence of the work completed to date. The information and format of the payment claim is detailed in clause 58 and Schedule 3 of the General Conditions of Contract. Therefore, irrespective of a prepayment claim, the sequence for payment is dependent upon the completion and justification of the works
through the evidence the Contractor submits with its payment claim. In addition, it allows the Contractor to claim for a prepayment amount against the Contract Price to create a positive cash flow. If there are initial costs the Contractor needs to cover for BIM deployment, this prepayment could be used to cover the costs associated with this process.

There are no specific financial incentives for implementing BIM specified in the standard form of the GC 21 contract. However, embedded in the process for monitoring and reporting on the Contractor’s performance is a metric that rewards the use of BIM at a design level. This is part of the Contractor Performance Report completed by the Authorised Person at regular intervals during the contract period. This metric rates the Contractor’s overall performance and has a significant impact on future tendering opportunities (NSW Procurement, 2012).

In summary, the GC21 contract does not financially reward the Contractor for implementing BIM or allow for the explicit recouping of business costs unless the expenditures directly relate to the actual project. Traditional tendering practices allow for amortisation of overheads over several projects, but ability to recoup costs is subject to the prevailing market conditions. The Contract does have flexibility in payment schedules, even allowing for the early payment for future works to ensure the Contractor has a positive cash flow. However, the conditions linked to the prepayment directly relate to the Contract Price and may not provide a mechanism for covering the costs of BIM implementation at a business level.

6.3 Conditions of Contract

This section of the discussion chapter examines the analysis of the BIM-related conditions of contract. It discusses how there are limited opportunities for formal design collaboration, no reference to the model status or the inclusion of any BIM deliverables in the standardised conditions. However, there are mechanisms within the documents that allow for the coordination of conditions between the subcontract and main contract, acknowledges electronic communication, if not electronic collaboration. The Contract also includes a number of punitive measures for nonconformance, but these are generic in nature with no specific reference to BIM. This section commences with a brief review of the standardised documents that are typically included in a GC 21 contract.

Chapter 3 discussed the types of documents that are included in a typical contract. For example, a contract will usually consist of a document that specifies the Conditions of
Contract which details the rights, responsibilities and obligations of the various parties that are privy to the agreement. Hughes and Greenwood (1996) note that, in essence, the conditions provide mechanisms to administer and manage the contract and go some way to control the behaviours of the parties to the agreement. The GC21 Contract Conditions mirror this view and do provide procedures for managing behaviours and detailing obligations for such things as varying the contract scope and price, ensuring payment to the Contractor and detailing the extent of construction. The GC21 adopts a hybrid traditional/design and construct procurement method, acknowledging that the contractor will always have some design work to complete but using a traditional risk allocation structure.

The Conditions of Contract reflect the typical requirements of the traditional, design and construct procurement method in that the contractor must complete the design but is only responsible for the design and construction elements that it has completed. There is only a requirement for the parties to the contract to cooperate rather than collaborate. The contract conditions contain a number of formal processes for implementing change, identifying errors and omissions, all with certain roles, responsibilities and liabilities for the various project stakeholders. This contract-manual approach is a reflection of the characteristics identified by Hughes and Greenwood (1996) including a formal process for litigation if there is a breach of contract. However as Eastman (cited in Hartmann & Fischer, 2008) highlights, in most cases there is a certain level of informal collaboration amongst the project participants, irrespective of the form of contract implemented.

The Contract does not refer to the status of the model, either for any design requirements or for justification of any claims or variations. The actual term Building Information Model does not appear in the standard contract, but it does include a reference to digital records that may be associated with the Contractor's Documents. The reference to digital records is embedded in the term ‘Data’, that is defined as:

“*The Contractor's Documents and all other drawings, sketches, specifications, digital records, computer software, data and information relating to the Contract.*”

In addition, the definition of Contractor's Documents includes:

“*Drawings, specifications, calculations and other documents and information, meeting the requirements of clause 39, which the Contractor must produce to design and construct the Works in accordance with the Contract.*”
While there is no explicit mention of a model or its status in the standard contract, there is an implicit reference to a model via the phrase ‘digital records’ that is embedded in the term ‘Data’. To explain, this link is achieved by referring to the definition of the model as adopted in the first chapter of this study:

*a digital representation of the physical and functional characteristics of a facility*.

Therefore, if a model is developed during the design, and or, construction phases of the project, it does have a status under the contract, but not one that is clearly defined or in line with the overall intent commonly associated with Building Information Modelling.

The Deliverables under the Contract only require the submission to the Principal of a generic “electronic copy” of the Contractor’s Documents. The default format requirement for the Contractor’s Documents is in the form of a Portable Document Format (PDF) or in the propriety ‘Microstation’ CAD format. For the ‘As-built Drawings’ or the drawing issues that show what has actually been constructed onsite, the format and the extent of the requirements are the traditional range of site-, floor- and roof plans, elevations, sections and details, in addition to any specification requirements. Therefore, if a model has been generated then the effort and information inherent in the model is lost with the transfer of information to standard drawings and specifications.

As the Contract does not specifically mention the use of BIM, there are no requirements for any contract condition coordination with the subcontracts. However, the Contract does require the associated subcontract to mirror some of the conditions of the head contract. Therefore, the Contract will need to detail the BIM subcontracting requirements such as information and communication protocols, deliverables, model status and the contract.

If a BIM becomes a deliverable under the Contract then the format of the final model and the structure of the information needs to be detailed in the Contract, such as IFC format. Further, the end use of the BIM needs to be considered, avoiding the generic and confusing “Full BIM compliant” contract requirement which has emerged in recent times (Holzer, 2012). From a public sector perspective, the specific BIM requirements and how they are detailed in the Contract need to be fully understood to ensure the value-for-money category is addressed. For example, visualisations are used to ensure the design meets the performance requirements of the client. To summarise, the Deliverables under the Contract will need to refer specifically to what has to be delivered,
at what point in time, and the format/structure of the information submitted (Demian & Walters, 2013).

There is no reference to the status of electronic collaboration in the Conditions of Contract. However, the Preliminaries section of the standard documents does enable the use of electronic communication in accordance with the Electronic Transactions Act 2000 (NSW).

There are several generic punitive measures incorporated in the Contract, mainly focused on the Contractor Performance Reporting system. However, the contract drafter may develop project-specific key performance indicators for the project. As discussed previously, there is only one peripheral reference to BIM in all of the standard documents and this is in the Contractor Performance Report mechanism.

This section summarised the findings of the conditions of contract analysis of the GC21 contract. In the first instance, the contract adopts a cooperative relationship structure that is typical to a traditional procurement method. There is an implicit reference to the status of the model in the Definitions section of the Contract under the terms ‘Data’ and ‘Contractor’s Documents’. Deliverables under the standard contract are limited to two-dimensional drawings in a proprietary format. As the Contract does not specifically include references to BIM, there are no requirements for aligning subcontracts with the head contract conditions. There are mechanisms within the conditions to include such requirements, if the contract drafter wishes to align and coordinate the various contract conditions. Finally, there are mechanisms within the Contract that allow for punitive measures for non-performance, but they do not include specific references to BIM or any related deliverables.

6.4 Data Security

This section reviews the findings of the BIM data security analysis of the GC 21 contract. The major findings of the analysis were that there were no specific requirements to protect data against corruption or to insure against the liabilities associated with data security. The Contract does include limitations for data access and sharing, that can restrict any unauthorised manipulation of information.

The Contract applies a blanket restriction on data protection, access and sharing. Due to the sensitive political nature of many public sector projects, the Contract has taken a conservative approach to the level of sharing and access of information. In addition, it
applies a further restriction on the confidentiality of information with a ‘Restricted’ category of documents. The issue associated with this is the reference to documents, what constitutes a document, and whether it can be extended to include electronic documents and models. Further, does this blanket restriction inhibit the ability for project stakeholders to collaborate, formally and informally?

The Contract does not include a requirement for the Contractor to hold insurance for the loss or corruption of data for the duration of the project. As previously mentioned the procurement method of the analysed contract is a hybrid of a traditional/design and construct contract and therefore follows the risk allocation associated with such approaches. Generally, the Principal is responsible (liable) for information/items/site access it supplies and the Contractor is responsible (liable) for the works designated to it under the Contract. Therefore, if the information, and or, model are passed to the Contractor at date of contract award, in good working order, the responsibility for data loss or corruption is passed to the Contractor until the end of the project when the ‘As-built’ documentation is provided. It is at the discretion of the contractor/designer if it insures against loss or corruption of data. The emphasis on obtaining this type of insurance could change if a collaborative procurement method is adopted.

Data security can be viewed as a technical and legal issue and will need to be addressed in the Contract and the associated BIM implementation plan. The process for, and level of, data sharing and access between project participants with be dependent on the type of procurement method adopted and will need to be reflective upon the risk appetite of the Client. In the sphere of public sector projects where there is sensitivity to sharing information due to negative political repercussions, how this process is achieved is contingent on the goodwill of the project participants and the understanding of the Client that the rewards will far outweigh the risks.

This section provided a review of the contractual analysis of the data security issues. It highlighted how there are no specific data-protection- or associated insurance requirements. Typical with the risk allocation associated with the traditional, design and construct procurement method risk allocation, the GC 21 contract provides a clear delineation of data protection responsibilities based on who supplied and generated the data. Finally, all data is considered sensitive and there is an additional protection measure for data that is considered ultra-sensitive, such as prison designs.
6.5 ICT Protocols and Processes

This section reviewed the results of the ICT protocols and processes analysis. It commenced with an introduction to the GC21 contract and some of the contextual documents associated with its administration.

As the GC21 contract is based on a traditional approach to contracting, the allocation of protocols and processes follows the traditional framework, in such, the Contractor is responsible for the information it generates and the Principal is responsible for the information it provides. NSW Procurement, an agency of the NSW State Government, has created a range of protocols and procedures including documentation and standardised letters to support the administration of the Contract (New South Wales Procurement, 2012).

The Contract does have a process in place for the handling of change to the ‘design’ only including the consequences and implications relating to the changes generated by either party to the Contract. The Contract does not specifically refer to the changes to the model, only to the updating of Contractor’s Documents, which only require changes to the drawings. For the Contractor to be responsible for making these changes, irrespective of the liability for the changes, a reference to BIM is needed in the Definitions section. This could be included in the definition of Data or as a stand-alone item.

Under the GC21 contract, once the Contract commences the Contractor is responsible for the process management of the contract. There are specific requirements, obligations and liabilities for each party, but these relate to the higher-level contractual management processes and are not BIM-specific or relating to the processes which enable BIM integration into the project. While there is a need to reference BIM in the contract processes, there will need to be a limit on how prescriptive these references are, otherwise it could stifle innovation. Further investigation of the protocols and processes relating to BIM, in particular the ones unique to public sector projects is required. Some of these items may fall into the jurisdiction of the BIM execution plan or may need to be included in the Conditions of Contract.

There is no reference to a BIM execution plan within the contract documents. The plans usually are an agreement between the builder of the facility, the subcontractors and the designers. The Contract will need to focus on the items which it needs as part of the FM process or ‘as-built’ documentation. In the case of novated designers, it may require the BIM plan to form part of the overall contract documents so the initial design/model does
not have to be re-entered into a BIM authoring software package. Completion of, and acknowledgement or submission of, a completed BIM execution plan could be a condition of tendering, to ensure a seamless transition during the contract award process.

The Contract has a formal process for communicating between the stakeholders. In addition, communication is a component of the Key Performance Indicators (KPI) used to monitor the performance of the contract management team. It also acknowledges the use of electronic transactions with the relevant NSW Act. This also relates to communication to subcontractors, suppliers and manufacturers.

This section discussed the findings of the Qualitative Content Analysis associated with BIM ICT protocols and processes.

6.6 Intellectual Property

The GC21 Edition 2 contract follows the typical application of copyright and intellectual protection for government, in that it applies total coverage for all items within the project design, for eternity. The Contract does issue to the contractor a single licence for the duration of the project, which includes the use of the design by its designated subcontractors.

The Contract is silent on the issue of copyright of the model, including any derivative models or design options, which included the production of a model. This ambiguity also relates to any background information sitting in the digital model. The issue is, how is the digital model treated and is it a separate issue from the intellectual property of the design? For example, with the high level of detail possible using BIM authoring tools, does the background information and specific approaches to a design problem prohibit this approach from being applied to either public or private projects? Typically, the design will constitute hardcopy plans and specifications, which convey the design intent and not a detailed digital model of the facility. As noted in Hartmann and Fisher (2008), standard forms of contract lag behind technological developments.

Further investigation is required to determine the status and application of intellectual property/copyright over the design and the model for government projects and the significance of applying blanket coverage for a design. Such an approach may inhibit the ability to leverage all of the benefits from the model and create an environment where designers are reluctant to provide a detailed model due to the application of strict
copyright provisions. Further investigation of the licence-issuing provisions within the different levels of government is also recommended.

GC21 provides a comprehensive statement for the protection of confidential information, and therefore implicitly, proprietary information. It also applies a further level of protection for any information that is classified as ‘restricted’, such as designs for prisons or other such documents. There is the opportunity to define what constitutes the Contract Documents within the Contract and this could be the location for including a version of the model but it does not cover other information. However, the Contract does clearly refer to the term ‘data’ and the definition does include a reference to digital records, but once again, what is considered a digital record? It would be beneficial to clarify what is a document, what is a digital record and does it cover electronic information and the electronic model.

Finally, the Contract requires the Contractor to indemnify the Principal against any claims for infringement of copyright. How any particular costs associated with this risk are covered is left to the Contractor to manage and there is no specific requirement within the Contract to obtain insurance. Further investigation may be required to determine if current forms of insurance cover the Contractor for any such losses incurred from actions taken associated with the breach of intellectual property rights.

6.7 Interoperability

Interoperability is a critical component in achieving the full benefits of BIM. Essentially a technical issue, it remains important to detail the information-transfer requirements and formalise these requirements within the contract documents. The transfer of information relates to three stages in the project, irrespective of the methodology used to deliver the project, namely: pre-contract, project delivery and operational stages. Detailing the process for information transfer, technical requirements and the means of confirming information integrity is critical. Current approaches to interoperability detail the above requirements in the BIM execution plan. However, these are usually formalised after the signing of contracts (Hurtado & O’Connor, 2008) and can be difficult to reconcile if the project stakeholders use different BIM-authoring technology with limited interoperability. If these requirements were detailed at the commencement of the project or prior to tendering, participants would have a clear understanding of the interoperability requirements and ensure any associated costs with software changes are highlighted upfront.
The GC21 contract is a hybrid combination of a traditional design and construct contract. The interface between the three stages is not overly critical, as the Contractor will be responsible for the control of information and ensuring interoperability between the various consultants and subcontractors. In addition, technology compatibility is limited to the transfer of information at three points in time; contract award, design completion (if any) and contract completion. The technology compatibility requirements of the documents are limited to the production of CAD-compatible files for the ‘as-built’ documentation and PDF copies of the plans, elevations and so forth, thereby losing all of the inherent data embedded within the model. Therefore, to ensure interoperability is maintained for the duration of the project, the technology compatibility of the preconstruction documentation is important. This will require an examination of existing ‘Consultant Agreements’ and the compatibility requirements specified within these documents. Open-file formats such as IFCs could be mandated, allowing for any type of BIM-authoring- or analysis tool with IFC compatibility.

The Contract assumes the Contractor will be responsible for ensuring interoperability between the Client and its consultants/subcontractors as per a traditional contract approach. However, it is obvious that the Principal is responsible for ensuring the information it supplies is free of errors and can be read by the Contractor. Therefore, it is recommended that the various responsibilities are clearly articulated and allocated to the parties within the contract.

There are no specific requirements detailed in the Contract relating to the auditing of information or design information. The Contractor is only to submit design information on an ongoing basis, for review by the Principal. Once again, the Contract could include an auditing requirement, either detailed in the execution plan or the main body of the Contract, especially when BIM software from different manufacturers or IFCs is used.

Finally, there are limited details as to the information-transfer process, which relate to the use of BIM in the project setting. The requirements are for the submission of electronic copies of the documents, generally in PDF form, for review by the Principal. Conversely, it does not limit the format of the PDF and 3D PDFs could be issued, but would need to be clearly part of the Contract. When and how this information is transferred is outlined within the Contract, but the status and form of collaborative design meetings involving the Principal, in which the design intent is discussed, is not clear.
6.8 Legislation and Judicial Precedence

Archiving requirements are not included in the Contract Conditions, but indirectly relate to the format in which the information is submitted to the Principal. The process of archiving would be subject to an internal policy and procedure (Simonian & Korman, 2010). Therefore, further investigation would be required, firstly to identify the legislation and/or policies which detail the requirements for archiving of project information, and then comparing it to the information-submission conditions and format outlined in the Contract. On a technical level, the format would have to consider the storage capacity of the public sector organisation.

The Contract refers to the Electronic Transactions Act, which covers some of the issues associated with E-Contracting, but also requires all directions to be in writing. From the perspective of authorising changes to the design or model, further investigation is needed to identify the process and legal precedence for requesting changes digitally, including digital signatures. These processes could then be included in the BIM plan or covered by the respective conditions of the contract such as reference to the Plan.

The structure of this contract is between the Principal and the Contractor, with the ability for the Contractor to transfer some of the risks and obligations onto its subcontractors. In Ed 1 of GC21, there was a complete complementary subcontract, but this has been removed from Ed 2 and replaced with a list of conditions that must be incorporated into any subcontract of a certain value. Further investigation is required as to the specific privity concerns relating to BIM in the NSW context. These specific conditions could then be included in the Schedule of subcontract requirements.

6.9 Professional Liability

The GC21 contract takes a traditional approach to the application of design liability in that the Principal typically remains responsible/liable for the design components it supplies and the Contractor remains responsible for the design items it undertakes. The Principal’s documents can range from a design brief to fully designed and detailed documents. It does, however acknowledge that no matter what extent of the design is supplied by the Principal, the Contractor will still be responsible for completing the design where required or detailed.

The Contract uses a co-operative procurement approach to the designation of liability. It sets out the process for changing the design, in line with the original design intent, and
allocates the Contractor as the person in charge of the design process, but the overall approval of the final design remains with the Principal. Any change that deviates from the original design intent is subject to a variation claim, which needs to be justified by the Contractor. The contract only refers to the overall control of the design process and it does not detail the management of the model. As Eastman (cited in Hartmann & Fischer, 2008) points out, the conditions of contract should focus on the overall design control process and the actual technical requirements for managing the model detailed in the execution plan. To complement the increasing level of collaboration encouraged by BIM, the Contract could include alternative relationship based mechanisms for controlling the process.

Common to traditional and design and construct contracts (Ashworth et al., 2013), there is a clear delineation between the Principal and the contractor for design liability, changes and the discovery of errors and ambiguities within the contract documents. These liabilities include the cost for the work and changing of the design to address the changes, and or, errors. This is the essence of a co-operative approach. Changes to the intent of the design process, to encourage collaboration and sharing of the benefits and risks inherent in the design process using BIM, may provide a better design outcome. This may be hindered by the risk-averse nature of the public sector and the need to clearly quantify the risks, such as a contract price to address the additional probity requirements of such projects.

The Contract clearly requires the Contractor to hold Professional Indemnity Insurance if it is undertaking a significant portion of the design. This insurance will need to include references to the use of BIM and the risks inherent to its use. Further investigation will be needed to ensure the required insurance does address these issues.

The Contract only requires the Contractor to use professionally qualified designers in the relevant discipline but still allocates the liability to the Contractor. Unlike in the USA, there is limited licensing of design professionals in Australia, and in the case of designers there are restrictions on who can call themselves an architect (McAdam, 2010a). Further investigation into this aspect is required and whether a specific professional, either qualified or titled, should be in charge of the design.

There is nothing specific in the Contract, which covers how the delegation of design, either intentional or unintentional, is allocated or controlled. The Contractor remains responsible for the design, subject to the input of the Principal. From a subcontracting/Contractor perspective, the subcontract will need to include the process
and liabilities for input into the design by subcontractors and consultants. This will need to consider the implications of the requirements for a fully qualified professional to complete the design.

6.10 Public Sector Agency

This section of the Discussion chapter reviewed how the GC21 contract addresses the BIM legal issues associated with public sector agency. The analysis highlighted how the Contract does include requirements for public sector approval, but does not describe the role or status BIM would have in the approval process. The Contract does allow for the issuing of notices and communication electronically, however, there may be specific requirements embedded in other legislative requirements designating the structure and form of the approval submission.

The GC21 contract allows for either the Principal/Client or Contractor to obtain the relevant authority approvals in accordance with the NSW legislation. While the Contract has designated this responsibility to a particular party, it is silent on methodology associated with the approval process. The actual process for obtaining any specific environmental- or planning approvals is enshrined in other legislative instruments. For the GC21 contract, the overriding legislation is the New South Wales Environmental Planning and Assessment Act 1979 and the Environmental Planning and Assessment Regulation 2000 (Bailey & Bell, 2011). While the analysis of this legislation was outside the scope of this investigation, a preliminary review of the Regulation noted that Schedule 1 – Forms, details the various approval submission requirements such as sketches, plans, elevations and sections in a standard architectural format. Further investigation of this legislation and other supporting statutory documents is warranted if a model, rather than hardcopy documents, will be used for any approval submission. In addition, the Contract does not address the issue of authority inspections during construction and the possible differences between the approved model/design and the actual onsite construction.

At a general level, the Contract permits the use of electronic communications through a direct reference to the New South Wales Electronic Communications Act 2000. The object of the Act is to provide a regulatory framework that:

(a) recognises the importance of the information economy to the future economic and social prosperity of Australia, and
(b) facilitates the use of electronic transactions, and

(c) promotes business and community confidence in the use of electronic transactions, and

(d) enables business and the community to use electronic communications in their dealings with government.

While this Act allows for the transmittal of information electronically between contractual parties, the underlying issue of approving the digital model remains. To explain further, the actual transmittal of the model is considered acceptable, but the underlying legislation may still require some form of approval in writing, including the actual information associated with the original submission, as discussed in the previous paragraph. Therefore, it is may be beyond the scope of the Contract to address this issue until legislation associated with the approval process recognises the existence of a digital model and the role it has in the design and construction process.

This section reviewed the analysis of how the GC21 addresses the public sector agency legal concerns. It noted how the Contract can delegate the authority approval process to the Contractor, but does not address the status and role of BIM. The transmittal of information electronically is permitted by the Contract but the approval of such information by a Statutory Authority is unclear due to the form of information required for submission for approval. The actual submission requirements are embedded in a range of legislative instruments that warrant further investigation as this task was considered outside the scope of this study.

6.11 Risk Allocation

This section of the Discussion chapter reviewed the allocation of BIM risks within the GC21 contract. The analysis highlighted how the Contract maintains a ‘traditional’ approach to risk allocation. There is a clear delineation of risk allocation between the Principal and the Contractor. The down side to this approach is that the restrictions placed on the Principal’s ability to influence the design and any significant changes require a variation to the Contract. Specific BIM risks and liabilities are not detailed in the Contract; however, as discussed in the previous sections, many of the issues are implicitly addressed to a certain extent. In the final part of this section, the analysis noted how the Contract does not explicitly require the Contractor to hold BIM risk insurance.
The GC 21 contract adopts a cooperative or ‘traditional’ risk allocation framework. That is, it clearly delineates the Principal’s and Contractor’s responsibilities and liabilities for the various design and construction tasks. For example, the clause 38 Faults, allocates the liabilities for faults in the contract Documents to the Principal and clause 39 Design by the Contractor and Contractor’s Documents allocates liability for these documents to the contractor.

The allocation of risk for the GC 21 contract focuses on the higher-level distribution of responsibilities and liabilities including the level of reliance on the information embedded within the Contract. This follows on from the opinions raised by Hartmann and Fischer (2008) that believe emerging risks relating to technology need not be included in a contract. Technology evolves too quickly and the sector develops an understanding of the risks associated with the use of emerging technology, and acts accordingly. Only the operational risks associated with a project should be included in the contract. However, peripheral to the allocation of risk is the need to identify and quantify the risk in the first instance. The issue with BIM is, since its application to the construction sector is relatively new, the risks are not fully appreciated and the courts have not had the opportunity to set precedents as to the culpability and liabilities for the various stakeholders (Chien, Wu, & Huang, 2014; Larson & Golden, 2007).

Risk insurance is not a mandatory requirement for the Contract and is left to the contract drafter and agency to determine the level of risk insurance. The insurance industry is developing insurances tailored to the use of BIM (Haynes, 2010b) but its coverage and extent is dependent on the level of BIM integration into the overarching procurement method (McAdam, 2010b).

This section of the Discussion chapter reviewed the risk allocation findings of the QCA. It highlighted how the Contract uses a traditional risk framework to allocate the various responsibilities and liabilities based on a cooperative methodology.

6.12 Coefficient of Agreement Results

The coefficient of agreement as described in section 4.7.3 was calculated by comparing the results of coding undertaken in to points of time. The calculated coefficients are shown in Appendix A. The results show a high level of agreement between the two coding instances, therefore inferring a high level of reliability and validity of the coding process. Upon further reflection, one of the main reasons for such a high result could be
that BIM has not yet reached a level of diffusion within the AEC sector thereby triggering a need for a revision of the GC21 contract.

6.13 Summary of Key Findings

Table 6.1 provides a summary of the QCA findings, noting the current contract approach and the model approach as identified in the literature review.
<table>
<thead>
<tr>
<th>Core Thematic Area</th>
<th>Description</th>
<th>Current Approach</th>
<th>Model Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compensation &amp; Consideration</td>
<td>The changes to payment methodologies to facilitate BIM implementation &amp; Integration.</td>
<td>Payments are made against actual design and documentation progress based on a competitive tendered lump sum or schedule of rates amount. The use of BIM is a small component in the consultant performance reporting (CPR) criteria.</td>
<td>The inclusion of non-price criteria for BIM experience to ensure that price alone is used to determine the winning tender. The Contract does not prohibit amortisation of implementation costs at a firm- or project level but is still subject to competitive tendering.</td>
</tr>
<tr>
<td>Contract Conditions</td>
<td>The changes needed to Contract Conditions to enable collaborative integration of BIM into the Project Lifecycle.</td>
<td>The Contract does not recognise digital representations of the facility, relying on drawings and written specifications, and uses the traditional approach to contract relations. This type of contract relationship and reliance on 2D documentation is reflected in the subcontract conditions. Punitive measures for not using BIM are reflected in the CPR and liquidated.</td>
<td>The recognition of digital representations as a contract document. Adoption of a collaborative contractual relationships that is reflected in all subcontract conditions. A transition period is suggested where there are incremental changes to the model becoming a or the main contract document. Clear definition of BIM deliverables in the Contract.</td>
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<tr>
<td>Core Thematic Area</td>
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<td>Data Security</td>
<td>The changes needed to create a secure collaborative environment where information is exchanged freely without the concerns of corruption, loss or misuse.</td>
<td>Each party is responsible for ensuring its data remains secure and available, however, due to the sensitive nature of some public sector projects additional limitations are placed on the distribution of data. The definition of Data provides a general reference to digital records.</td>
<td>The referencing of the term Digital Model in the definition of Data. The inclusion of insurances for loss/corruption of data.</td>
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<tr>
<td>Intellectual Property</td>
<td>The changes needed to allow for allocation of appropriate intellectual property rights in an equitable manner that facilities collaboration.</td>
<td>The government retains ownership of all intellectual property created during the project. The Contractor is bound to maintain confidentially of all data including proprietary information. An IP license is automatically granted for use of information relating to the creating of</td>
<td>Relaxation of the IP conditions to allow the Contractor to use design elements in future projects. From a design perspective, increase the protection of proprietary/confidential information embedded in the model. Mechanisms for determining IP in a collaborative environment.</td>
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<tr>
<td>Core Thematic Area</td>
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<tr>
<td>Interoperability</td>
<td>The changes needed to ensure information is transferred in a seamless efficient manner without significant loss of data richness.</td>
<td>Information is transferred between parties in proprietary formats.</td>
<td>Open formats are adopted, such as IFCs. Appropriate transfer protocols are referenced including regular auditing of information transfers and processes. Clear definitions of Model Views.</td>
</tr>
<tr>
<td>Legislation &amp; Judicial Precedence</td>
<td>The changes to legislation needed to facilitate BIM collaborative integration.</td>
<td>The Contract references the use of electronic communication. Requires the submission of hardcopy documentation for submission to approval bodies. Can designate construction sequencing (means &amp; methods).</td>
<td>References to appropriate archiving of project information requirements in accordance with the relevant government acts, regulations and policies. Inclusion of possible electronic submission requirements for approval bodies.</td>
</tr>
<tr>
<td>Professional</td>
<td>The changes needed to</td>
<td>The Contract adopts a traditional approach</td>
<td>Adopt a collaborative approach to design</td>
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<tr>
<td>Core Thematic Area</td>
<td>Description</td>
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<td>Liability</td>
<td>professional liability that will assist in creating a collaborative exchange of design information.</td>
<td>to Professional Liability. The Principal is responsible (liable) for any design it has undertaken and the Contractor responsible (liable) for any design it has completed. Once the contract is awarded the Contractor is responsible for controlling the design process.</td>
<td>and the allocation of liability for design errors. Maintain one overall controller of the design. Ensure a certain level of competency of designers/contributors in the design development/delegation process.</td>
</tr>
<tr>
<td>Protocols &amp; Processes</td>
<td>The changes to protocols and processes to permit BIM collaborative relationships.</td>
<td>A clear process for communicating design faults exists. A design level of development is detailed in the Contract. Design roles, responsibilities and change-management process are detailed.</td>
<td>Reference to a BIM execution plan. Reflection of any collaborative relationship processes.</td>
</tr>
<tr>
<td>Public Sector Agency</td>
<td>The changes needed to public sector processes to allow for the use of BIM in approval process.</td>
<td>If the Contractor is not responsible for the approval process, the submission of hardcopy information is detailed in the conditions.</td>
<td>Reference to particular electronic/digital information specific to the approval process. Maintaining a digital record of the ‘approved’ facility onsite for reference by any inspector.</td>
</tr>
<tr>
<td>Risk Allocation</td>
<td>The changes needed to</td>
<td>Risk allocation follows a ‘traditional’ contract</td>
<td>Adopt a collaborative risk contractual process.</td>
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<tr>
<td>Core Thematic Area</td>
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<td>Current Approach</td>
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<td>current risk allocation approaches to facilitate the implementation of a BIM-collaborative environment.</td>
<td>format. Risk planning occurs prior to contract tendering/award.</td>
<td>approach including a risk-allocation process during the early phase of the project. Insurance requirements recognising the BIM integration risk profile of the project.</td>
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</table>
6.14 Recommendations

Based on the previous section there are four key recommendations for the enhancement of the GC21 contract: the facilitation of collaborative relationships intertwined with the fair and equitable distribution of the BIM risk and liabilities, the recognition of the building information model as a contract document and the referencing of open standards for data transfer and communication protocols.

6.14.1 Facilitation of Collaboration

The GC 21 contract adopts a cooperative approach to contract management. That is the Principal and Contractor agree to cooperate during the course of the Contract. Therefore, the contract intent adopts clearly defined roles, responsibilities and liabilities between the parties to the agreement, for the design and construction of the project, that are not conducive to a collaborative environment. Eastman (as cited in Hartmann & Fischer, 2008) notes that irrespective of the actual procurement method adopted, informal collaboration between the various parties involved in the project does occur. This type of behaviour does introduce ambiguity for risk and liability.

Therefore, the Contract could adopt a collaborative framework for project delivery that allows all parties to contribute to the design, development and construction of the facility without the associated need to limit contractual exposure (Hartmann & Fischer, 2008).

6.14.2 Equitable Risk and Liability Distribution

As highlighted in the literature review, the facilitation of design collaboration between the various project participants requires a fair and equitable distribution of risk and liability. For example, Ashcraft (2008) suggests the adoption of a risk allocation model as proposed by Abrahamson (1984). This model allocates risk based on due consideration of the person most capable of managing the risk, can obtain relevant insurances to cover any losses if the risk eventuates and any rewards associated with the risk accrue with the person it was allocated to. As Abrahamson points out, balancing the principles to achieve a fair and equitable outcome is extremely difficult when considering, not only where risk and liabilities can emerge, but also at what stage in the project lifecycle they can eventuate.
6.14.3 Recognition of the Model as a Contract Document

The next recommendation is that the contract recognises the building information model as a contract document. As Olsen and Taylor (2010) point out, two dimensional drawings are still the main contract document and if a model is included, then typically the drawings will take precedence over the model. Olsen and Taylor also note that the transition to the use of the model as a contract document will be incremental after considering the barriers to BIM implementation, as highlighted in the introduction chapter. Contract addendums and revised contract conditions are emerging that do introduce this incremental step that follow Ashcraft’s categories of model incorporation:

1. the BIM is a ‘co-contract document’ which is not submitted to approval agencies but is issued to project participants
2. as a method transmitting the design intent or as an ‘inferential document’ or
3. the model can be used but not relied upon for accuracy or an ‘accommodation document’

6.14.4 Process and Communication Standardisation

The final recommendation emanating from this research is the inclusion of contractual language that covers BIM-enabled process and communication standardisation. Eastman (as cited in Hartmann & Fischer, 2008) describes the two types of language that are required for the deployment of BIM within the AEC sector. The first level language relates to the implementation of BIM from a technical perspective that standardises the terms and phrases used during the deployment of the technology. The second level of language relates to the description of the processes and protocols that would be included in a contract document.

A range of BIM execution/implementation plans have emerged over the last few years that address certain aspects of BIM usage during a project lifecycle. However, research by Ahmad, Demian and Price (2012) note there is no single best-fit plan, and choosing an appropriate document is highly dependent on the environment in which BIM is being implemented. This would include the use of standardised information-transfer protocols such as Industry Foundation Classes.
6.15 Summary

In this chapter, a standard public sector contract was analysed using a coding framework developed from the thematic areas identified in Chapter 2. The analysis of the contract identified four key limitations of the GC21 contract, for integrating BIM:

- The Contract limits the formal contractual relations and behaviours to a co-operative procurement method, and therefore
- The design risk and liabilities are allocated along traditional lines; there is a clear demarcation (liabilities and responsibilities) between design and construction information inputs
- The contract does not recognise the building information model as a contract document
- BIM-specific protocols and information standardisation requirements are not referenced.

Firstly, the content analysis highlighted that even though the Contract has adopted a hybrid traditional/design and construct structure and the inclusion of design coordination meetings, there is still a degree of separation (fragmentation) of the client, consultant and contractor. To benefit from the full capabilities of BIM, a collaborative project structure is the optimum environment for conducting the design and construction process.

Secondly, as the GC21 contract has a traditional risk/liability allocation, the ability to collaborate, especially with the design development, is limited to a cooperation model. The overarching procurement method facilitates the risk allocation structure; further, the Contract is silent on many of the legal issues, which inhibit the use of BIM in a project. To explain, there is a clear liability demarcation between the design undertaken by the principal and the design completed by the contractor.

Thirdly, the contract does not recognise the building information model as a contract document. The design intent is conveyed by a combination of drawings and specifications. In addition, the contractor’s design is submitted in as two dimensional drawings and specifications.

Fourthly, the Contract does not refer to BIM-specific protocols and information standardisation, which is critical for enabling the integration of BIM into the project-delivery process. The lack of interoperability is one of the key technical barriers to BIM integration into the procurement and management of facilities. From the perspective of public sector procurement, the use of standards will ensure that a competitive
environment remains for the software vendors and a monopoly does not emerge in the BIM-authoring software market.

The discussion in this chapter has specifically considered the research question posed in Chapter 3:

*How might the legal and contractual issues associated with Building Information Modelling implementation affect standardised construction procurement contracts?*

It has identified the key limitations of a specific public sector, standardised contract using a framework of ten significant categories. The results highlighted four factors that would limit the ability to integrate BIM into public sector construction procurement. It identified the highly rigid structures associated with the traditional/design and construct procurement method. These structures have clear lines of responsibility for the provision and completion of the design and the associated liabilities for any changes to the original design, which inhibit the opportunity for collaboration. The study identified that there is no general reference to various processes, frameworks and protocols needed to facilitate BIM integration. Based on the discussion undertaken in the previous section of this chapter, a number of possible future research strands are highlighted and these are summarised in the next chapter.
7 CONCLUSION

7.1 Introduction

This chapter illustrates the study’s conclusions in relation to both the research problem and how the investigation has built on previous research to refine an understanding of the BIM legal issues in relation to standardised construction procurement contracts. The limitations of the research are then outlined and the chapter concludes with a discussion of the possible future research directions for investigating BIM integration into public sector procurement and contracts.

7.2 Conclusions to the Research Problem

There has been a considerable amount of research and discussion pieces, which have served as a useful backdrop for this study. The chapter investigating the literature identified a number of studies and discussion pieces, which explored several key issues. These issues included the intellectual property rights to the design and model, the objects within the model and the protection of proprietary information, design liability and the need for design-professional licensing, professional indemnity insurance and design delegation to consultants, subcontractors and software. Other key issues included interoperability, protocols for information control, compensation for additional design and risks, risk allocation and the changes needed to legislation and Contract Conditions to enable the use of BIM from an approval and contractual perspective. These studies provided a critical insight into the possible legal issues that would affect the integration of BIM into public sector construction procurement.

Public sector procurement differs from the private sector in that there are additional conflicting and contradictory demands placed on the public sector, beyond the common requirement for ‘value for money’. These demands emanate from internal and external sources, such as legal requirements, policy and political goals and the multiple roles public sector agencies have in the procurement process. Finally, the additional demand placed on public sector procurement relates to the context in which the agencies and governments operate, for example open, mutually dependent budgets all within a specific cultural setting (Telgen et al., 2007).

The key issues identified in the literature review served as a thematic framework for categorising the legal and contractual points of discussion highlighted in the various
studies into BIM legal issues. In addition, the demand placed on public sector procurement provides a context in which the various governments and their agencies must operate. The categorisation then served as a structure for investigating the effect of BIM on a standardised construction contract, to explore the research question:

*How might the legal and contractual issues associated with Building Information Modelling implementation affect standardised construction procurement contracts?*

The data collected was based on a Qualitative Content Analysis method using the key thematic areas and subcategories as a framework for analysing the NSW Government’s GC21 2nd Ed contract. This investigation built on past research by using the findings discussed in previous studies to develop a better understanding of the changes needed to standard contracts, to enable the integration of BIM into the public sector procurement process. This study is located within the broader discussion on BIM and the Regulatory Framework, but with an emphasis on the integration of BIM into public sector procurement contracts. Therefore, this research identified four key conclusions: the need for greater collaborative frameworks, liability allocation, recognition of the model as a contract document and standardisation.

### 7.2.1 Collaborative Contractual Relationships

One of the significant findings of this study is that the GC21 contract limits the stakeholder contractual behaviours to cooperation; it does not permit collaborative design and has a clear demarcation of design responsibilities and liabilities. This use of the traditional procurement approach is a reflection of the risk-averse nature of the public sector and the additional demands placed on its performance. A collaborative-based procurement method requires a mature client with a progressive appetite for risk.

### 7.2.2 Design/ Documentation Risk and Liability Allocation

The GC 21 contract has adopted a hybrid traditional/design and construct method for design and documentation, acknowledging that the Contractor will always be responsible for completing some aspects of the design, irrespective of what stage the contract documents are issued. However, a traditional allocation of risk and liability is employed in that there is a clear delineation between, and consequently liability for, the information created by the Client and the Contractor. Each party is responsible (and therefore the liability remains with that party) for its own information and the Contract details
procedures for notification of mistakes, ambiguities and the consequences of these issues.

This approach has the potential to maintain the fragmented nature of the industry and the need to limit possible liability exposure, rather than achieving the best outcome for the project.

7.2.3 Recognition of the Model as a Contract Document

The third key finding of the analysis was the GC21 contract does not recognise the building information model as a contract document. The contract uses two–dimensional drawings and specifications to convey design intent between the principal and the contractor.

7.2.4 Standardisation

The fourth key finding of the research was the limited reference to information standards, which detailed either a CAD or PDF format for submission during the implementation phase and for work as executed documentation. The limited level of interoperability between software and facilities-management systems is considered one of the main technical barriers to integrating BIM into the procurement process. A contract is one mechanism that can mandate the use of a specific information format or transfer protocol, but does not need to go into specific technical details; this task can be covered in the BIM Execution Plan. For example, the contract mandates the use of IFC as a neutral file transfer format to ensure that the AEC sector does not become reliant on any one single software provider or proprietary system.

7.3 Achievement of the Research Aim and Objectives

This investigation has achieved the research aims and objectives as outlined in sections 1.6 and 1.7 respectively. This study has achieved its overall aim to:

Identify the changes needed to Standard forms of Contract to enable successful collaborative Building Information Modelling integration into the construction procurement process.

The research has identified a number of changes that are required to the GC21 contract to enable collaborative BIM integration and are highlighted in section 7.2. Achieving this aim has, in turn demonstrated the achievement of the research objectives. Chapter 2 reviewed the existing literature and identified ten thematic areas associated with the BIM
legal issues, therefore achieving the first objective. Objective two was accomplished by the presentation of the conceptual model presented in figure 3.8 and discussed in Chapter 3. The NSW Government’s GC21 construction contract was reviewed using qualitative content analysis using the thematic areas identified in Chapter 2, demonstrating the accomplishment of the third objective. The final objective was achieved through the identification and discussion of the changes needed the GC21 contact as presented in Chapters 5 and 6.

7.4 Research Contribution and Justification

This research has contributed to the existing body of knowledge and thereby justified its significance in three ways. Firstly, this research consolidated the existing body of knowledge relating to the various BIM legal and contractual concerns through a comprehensive literature review as presented in Chapter 2. Secondly, it then drew together several exiting models to formulate a highly detailed conceptual framework, which was discussed in Chapter 3 that can be used for analysing contracts within a BIM setting. Finally, based on the findings of this investigation, a number of possible future strands of research have been identified and are presented in detail in this Chapter.

The conceptual model as shown in figure 3.8 extended the existing knowledge in the research area by firstly reviewing the existing understanding of BIM legal concerns and then the wider issues associated with project delivery in the virtual environment. The findings of the review of existing models was then compared and contrasted against thematic areas identified in the literature review. A number of gaps in the current models were found leading to a revised conceptual model as presented in Chapter 3. Through the process outlined above, the various models and concepts are drawn together to formulate a working model that reflects the present-day perspective of the BIM legal issues and consequently making a valuable contribution to the research area.

7.5 Research Limitations

There are two key limitations to this research and it is vital to acknowledge these to ensure the findings are applied to appropriate situations. Firstly, the investigation is limited to one form of one public sector contract, which is used for a certain procurement system approach in a limited jurisdiction. The GC21 contract does not differentiate between a Traditional and Design and Build procurement system, recognising that the contractor will always be responsible for some level of design. Each procurement system has a differing risk profile with a unique allocation of responsibility and liability.
between the project stakeholders. Therefore, this study has investigated only one contractual arrangement used to deliver a project. The risks (issues) identified in the literature review will still be prevalent no matter what procurement system or method is employed; what will change is how they will be eliminated/controlled/allocated using a recognised risk-management process for alternative approaches to construction procurement. The use of the GC21 contract is limited to the state of NSW; other Australian states and the federal government and agencies use alternative contractual arrangements to procure projects.

Secondly, the methodology used to identify the BIM risk factors was limited to a review of the literature and the use of content analysis to scrutinise a contract. The initial coding framework was dependent on the data collected from the literature review and represented a condensed categorisation of the possible risk factors based on past experiences. This approach has only presented one perspective and interpretation of the issue and therefore there will inevitably be gaps between the interpretation and actual experiences of the authors (Denzin & Lincoln, 2011). The study did not seek to gather information directly from the persons involved in the process, such as architects, engineers, clients, contractors or lawyers. It is noted however, that the research focused on a specific situation, which has yet to be exposed to BIM.

7.6 Implications for Future Research

Based on the discussions in the previous chapters, a number of avenues for future research have been identified which include, procurement methods and contracts, main thematic areas and the application of different methodological approaches.

7.6.1 Procurement Methods and Contracts

This study only investigated one contract, the GC21 contract, which is used within the New South Wales state government jurisdiction. From the perspective of this research there are two possible further strands of research; firstly the examination of other contract forms such as the Australian Standard contracts and secondly, the implications to polices and processes if governments and their agencies mandate the use of BIM. The integration of BIM would affect all aspects of the procurement process and in particular, the implications for facilities management would be significant.
7.6.2 Thematic Areas

The research has identified a number of key thematic areas. As this study was exploratory in nature, only a brief contextual discussion of these key areas was provided in the literature review. Each of the themes warrants a detailed investigation aiming to provide a clear context and richness in detail that can be applied to the construction industry.

7.6.3 Methodological Approaches

The methodological approach of this research focused on the development of coding frameworks based on the examination of the current BIM legal issues literature. As the implementation of BIM is constantly evolving, research that examines the expectations, perceptions, experiences and behaviours of a variety of project stakeholders would further expand the existing body of knowledge. This could be achieved through the collection of empirical data using appropriate research methods. For example, using interviews from a number of perspectives could facilitate the formations of wider generalisations based on the findings of this initial research.

7.6.4 Case Studies of Actual Projects

The final implication for future research is the possibility of conducting case studies of actual projects that have implemented BIM in a collaborative environment. This could include an analysis of the contract document and can include alternative methods such as interviews and surveys to gather empirical data. It is expected as BIM integration expands novel legal issues could emerge that have not been identified in the existing literature.

7.7 Summary

This dissertation has identified the contractual changes required to enable Building Information Modelling integration into public sector construction procurement. It examined a standard construction contract used in the public sector and highlighted the need to establish collaborative affiliations, the development of standards and the equitable allocation of risk amongst project stakeholders.
## APPENDIX A – COEFFICIENT OF AGREEMENT RESULTS

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<thead>
<tr>
<th>Category</th>
<th>Subcategory</th>
<th>CoA (%)</th>
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<tr>
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