Contractual Governance of BIM-Enabled Projects: Where Are We?

Yuxing Jiang, Pei Ma and Shuibo Zhang*

Abstract: Clear and effective provisions in contracts for Building Information Modelling (BIM) are proposed as one of the critical issues in the development and promotion of the adoption of BIM. However, a widely accepted contractual governance for BIM-enabled projects has not been established. This research provides a review summarising issues addressed in publications as well as literature released by organisations, governments and scholars. Those publications include contracts and agreements, guidelines and manuals, of which this research mainly addresses the standard forms of contracts. In addition, the literature mostly addresses legal considerations and contractual features. The current research discusses these issues classified in two categories: (1) issues clarified in contracts; (2) issues unclarified but needed in contracts. The main focus includes liabilities, status of the model, BIM management and execution plan, risk allocation, intellectual property rights and electronic data exchange. Finally, a preliminary investigation is conducted to investigate the status of contractual governance of BIM in China. This study provides proposals about contractual governance for BIM-enabled projects, and demonstrates that contractual structure and provisions should be improved further incorporating more detailed issues in the development of BIM.

Keywords: Building Information Modelling, contractual governance, status in China

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1 INTRODUCTION

Currently, the governments of many countries and regions are actively promoting the adoption of BIM; however, this process meets barriers. Working conventions need to be different because the adoption of BIM changes methods of cooperation and collaboration among organizations from traditional projects, and the degree of information sharing among parties’ increases. Contrary to its benefits and effectiveness, BIM adoption also brings challenges to project participants. To maximise the benefits of BIM in projects, efforts towards improving technology as well as a series of related issues about organizational structure, process of teamwork and so on are needed (Porwal 2013). Furthermore, in developed countries, where BIM has been more deeply adopted into projects, BIM is mostly market-driven (Holzer 2015), and the standard forms of BIM contracts can improve parties’ efficiency of collaboration in that they standardise commercial and technical issues. Accordingly, the establishment and study of contractual governance has an important influence on further application of BIM. An increasing number of countries and regions release policies or standards to regulate BIM usage when they are pushing its adoption.

The level of BIM adoption is different among countries worldwide, and so is the depth of study about standard forms of BIM contracts and their application. Countries and regions set their goals, for example, the United Kingdom requires projects of governmental departments to reach BIM Level 2; GSA of the USA requires BIM use in fiscal 2007; BCA of Singapore aspires to reach 80% of industry using BIM by 2015; mainland China encourages the use of BIM in the 12th National Five Year Plan; Hong Kong aims to apply BIM in new projects from 2014, etc. (Cheng 2015). Though those countries and regions have actively adopted and used BIM, standard forms of contracts do not readily resolve problems concerning BIM in law (Shammari 2014). They are not widely used, only a few people know of their existence, and custom manuscripts about BIM are more commonly incorporated into contracts. The study of contractual governance issues falls far behind the technology (Ashcraft 2008). Therefore, the content and structure of standard forms of BIM contracts needs further study, and this should alter during different stages of adoption.

This research aims to: (1) Review BIM-related literature and existing noteworthy publications about BIM, especially standard forms of contracts; (2) Summarise issues that have been addressed in documents above and then discuss those issues divided into two categories, which are issues clarified and unclarified in standard forms of BIM contracts; (3) Research the status of BIM contractual governance in mainland China.

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2 RESEARCH METHODOLOGY

Two main methods are used in this review: content analysis and semi-structured interviews. The content analysis is used to summarise key points in standard forms of BIM contracts and literature, concerning execution process, legal consideration and requirements and contractual features of BIM (Mooi and Ghosh 2010). The semi-structured interviews are designed to discuss relevant issues in depth and also to organise the whole structure of the current situation. To study the points concerning contractual governance in the context of applying BIM in projects, this research reviews BIM related documents from regions and countries worldwide, including guidelines, protocols and mandates (Kassem et al. 2013; Kassem, 2016). In addition, it also reviews recent literature on the subject of contractual governance of BIM that ought to be focused on, to explore the points raised about how to stipulate them and what kinds of issues are needed to be clarified. Considering that contractual governance of BIM enabled projects is a relatively new research subject and the amount of relevant literature is small, this research does not place too much restriction on the source of the literature. It conducts a comprehensive search on Google’s academic search engine, using key words including “BIM legal issues”, “BIM contract”, “BIM risks”, “BIM law” etc.

This research also conducts a preliminary survey to find the current status of BIM adoption and contractual governance in mainland China. Based on the content of the standard forms of contracts and literature discussed above, a semi-structured interview has been conducted, aiming to obtain information about content and structure of contracts regarding BIM. Three persons accepted the semi-structured interview, one of them representing the designer, one representing the contractor and the third representing the consultant.

3 ANALYSIS AND RESULTS

According to BIM-related documents released by governments and organizations around the world, this research has identified a large number and considers more than 70 of them, from 13 countries and regions; namely Australia, Canada, mainland China, Hong Kong, Denmark, Finland, Japan, South Korea, the Netherlands, Norway, Singapore, the United Kingdom and the United States. Of these there are nine documents related to requests to connect BIM particular agreements with general agreements, and the specific situation is shown in Table 1. In addition to those nine, a new Condition of Contract for Construction (second edition) released by FIDIC in 2017 indicates that the provision may need to be modified if BIM is used, and they will release a Technology Guideline about BIM as well as a Definition of Scope Guideline Specific to BIM (FIDIC 2017). Among those nine standard forms of contracts, four of them are relatively complete in that they address further aspects of legal issues and execution process about BIM and they can be directly served as particular conditions or addenda in contract systems, namely, AIA (2008, 2013a, 2013b), ConsensusDOCS 301 (2008), CIC BIM protocol (2013) and BCA BIM particular condition (2012). After reviewing and content analysis, this research finds issues regulated in standard forms of contracts and discussed in research articles, according to the criteria stated above, into six categories as shown in Table 2, and the number of each category appearing is shown in Figure 2. Among them, the general principle, risk allocation and intellectual property rights have attracted more attention, and BIM management and execution plans as well as electronic data exchange have received less attention. Subsequently, the issues not involved in the BIM contract standard format were extracted and discussed, and are mainly classified into four categories as shown in Table 3.
Table 1. Specific information about nine standard contracts relating to BIM

<table>
<thead>
<tr>
<th>Issuer</th>
<th>Document Title</th>
<th>Release Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Institute of Architects</td>
<td>E202 Building Information Modelling Protocol Exhibit</td>
<td>2008</td>
</tr>
<tr>
<td></td>
<td>E203 Building Information Modelling and Digital Data Exhibit</td>
<td>2013</td>
</tr>
<tr>
<td>Associated General Contractors of American</td>
<td>G202 Project Building Information Protocol Form</td>
<td>2013</td>
</tr>
<tr>
<td>Construction Industry Council</td>
<td>Consensus DOCS 301 Building Information Modelling</td>
<td>2008</td>
</tr>
<tr>
<td>Building and Construction Authority</td>
<td>BIM Particular Conditions Version 2</td>
<td>2015</td>
</tr>
<tr>
<td>Institution of Civil Engineers</td>
<td>Use BIM with NEC3 Contracts</td>
<td>2013</td>
</tr>
<tr>
<td>Joint Contracts Tribunal</td>
<td>Public Sector Supplement: Fair Payment, Transparency and Building Information Modelling</td>
<td>2011</td>
</tr>
<tr>
<td>State of Ohio</td>
<td>Building Information Modelling (BIM) Protocol</td>
<td>2010</td>
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</tbody>
</table>

Table 2. Issues regulated in standard contracts and literature

<table>
<thead>
<tr>
<th>Categories</th>
<th>Detail issues</th>
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<tbody>
<tr>
<td>General principle</td>
<td>liabilities</td>
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<tr>
<td></td>
<td>status of BIM model and digital data</td>
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<tr>
<td></td>
<td>priority of particular conditions</td>
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<tr>
<td></td>
<td>scope and requirement</td>
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<tr>
<td>BIM management and execution plan</td>
<td>BIM manager</td>
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<tr>
<td></td>
<td>variations</td>
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<tr>
<td>Risk allocation</td>
<td>reliance</td>
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<td></td>
<td>standard of care</td>
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<td></td>
<td>insurance</td>
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<td>privity of contract</td>
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<td>costs</td>
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<td></td>
<td>spearin doctrine</td>
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<td>Intellectual property rights</td>
<td>the ownership and IPR</td>
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<td></td>
<td>license authorising</td>
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<tr>
<td>Electronic data exchange</td>
<td>interoperability and compatibility</td>
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<td>security issues</td>
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</table>

Table 3. Issues needed regulated in contracts

<table>
<thead>
<tr>
<th>Category</th>
<th>Issues needed incorporated</th>
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<tbody>
<tr>
<td>evaluation system</td>
<td>evaluate quality of cooperation</td>
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<tr>
<td>on-site managemen</td>
<td>BIM compensation</td>
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<tr>
<td>on-site managemen</td>
<td>evaluate quality of model functions</td>
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<tr>
<td>payment</td>
<td>landscaping and site requirements</td>
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<tr>
<td>payment</td>
<td>BIM staff on-site co-location</td>
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<tr>
<td>staff</td>
<td>type of contract price</td>
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<td></td>
<td>payment time</td>
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<td></td>
<td>staff competencies</td>
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4 FINDINGS

4.1 Issues Clarified in Contracts

4.1.1 General Principle

Liabilities: The liabilities mainly refer to issues such as which project participant or participants ought to design and be responsible for the BIM model. In the context of BIM, the employer has the possibility to provide design parameters, and the contractor and subcontractor may add details to the model on the basis of the model provided by the designer to enhance constructability.

Therefore, liabilities may also involve employer, contractor, subcontractor, supplier and facility manager, and not only the designer. The highly collaborative nature of BIM and contribution from multiple project participants leads to inseparable liability, which is contrary to the single point of responsibility imposed by the law and code of design management (Joyce 2007). Apart from that, there is another problem arising; participants often use disclaimers to avoid liabilities in the changes to the model they have made and thereby seeking to avoid liability (Larson and Golden 2008). Thus, Kuiper and Holzer address whether liability arises in contract or negligence (either as a duty to a client, contractor/consultant or to a third party), which necessarily has to be determined in the context of collaborative and integrated approaches or contracting methodologies and the factual matrix (Kuiper and Holzer 2013).

Nevertheless, others argue that collaboration in BIM would not change liabilities in contract, especially at levels above Level 2 (where 3D information models are used by all key team parties in an integrated way but where separate models may be used) (BSI 2013), although working methods may differ. The liabilities regulated in common law and main contracts can be used in the BIM context.

Standard forms of BIM contracts usually do not change liabilities and principle in main agreements (BCA 2012; AIA 2008; AIA 2013b; CD301 2008) specifically addresses the point that the designer will not be relieved from its obligation and contractors or other parties’ participation will not constitute design service unless particular clauses are signed. CD301 (2008) states each party should be responsible for their own contribution, which also means the main principle of liabilities has not been changed.

Status of BIM model and digital data: Whether or not digital data is recognised by the law differs between countries and regions. For example, Reynis (2011) states that in France digital data is accepted as evidence. However, in the UK, electronic communications kept on a receiver’s computer does not satisfy such definition because impulse representing information is not visible (Edwards and Waelde 2000). Because digital data has not been recognised by law as equal to that on paper, Orifowomo (2012) indicates that it is necessary to provide a paper format to serve as evidence.

In practice, whether to put the BIM model and digital data into contracts is still in debate. First of all, digital data is
easy to modify but difficult to detect, making the approval of any data content or BIM model difficult. Thus, introducing BIM models and digital data into contracts needs an effective method of approval, especially for changes and modifications in BIM models (Hsieh et al. 2015). Furthermore, BIM models cannot contain all the details needed in project construction, and additional information based on 2D documents is required in contracts as further explanation (Sebastian 2011). Although putting a BIM model and digital data into contracts increases their status in law and decreases disputes, there are still obstacles to contend with.

In CPC (2013), electronic documents are served similar to those in the common environment. Most standard forms have no specific demand to incorporate model or digital data into contracts except for CD301 (2008), which states that the model shall constitute part of the documentary record.

Priority of particular conditions: If there is any conflict or inconsistency between the provision of BIM-particular conditions and any other documents contained in contracts, most choose to give priority to BIM-particular conditions (CIC 2013; BCA 2012; AIA 2013b; CD301 2008). However, CPC (2013) is different: It states when this situation happens, the general condition ought to be complied with.

Scope and requirements: As BIM is still in development from 3D to 4D, 5D and even 6D, it is necessary to define clearly each participant’s scope and the requirements of work at the commencement of the project. For example, LOD (level of development) of all elements necessary is recommended to define each stage of the project in the contracts, serving as the employer’s requirement. (Mutai 2009) argues that a design intent model and an installation intent model ought to be assigned respectively to the designer and contractor or subcontractor, because the design intent model is usually used to depict the design concept, whereas the installation intent model is usually used to describe methods and the plan to complete the work. Thus the work of building models should be divided into two parties’ scope of work. Clear scope and requirements of work are the basis for tender, and furthermore are vital proof for subsequent variation, management and claims. The employer and inspector also rely on this to inspect whether the physical construction is qualified with the objective (Ashcraft 2008).

CIC (2013) requires IR (information requirements) to be incorporated in the appendix, such as MPDT (model production and delivery table), and others exist in Execution Plan (CD301 2008; BCA 2012) or in the clauses (AIA 2013b), all contents of which in detail need to be decided by both sides of the contract. Furthermore, many documents have specific definitions of “elements” level of detail”, explaining the content and level degree and authorised scope of use (NBS 2015; BSI 2013; CIC 2013; AIA 2013a).

4.1.2 BIM Management and Execution Plan

BIM manager: The responsibilities of the BIM manager, also titled information manager or model manager, are defined in many BIM documents. Main responsibilities are coordinating all project participants into one consensus in the area of contributions to the BIM model, and supervising the model’s building, updating, reservation and so on. This position is usually assigned by the employer, and the designer or architect often holds this position on the condition that no particular party is identified in the contract. Model managers should be experts in both IT and construction. Some designers or architects may not be suitably qualified for this position of model manager, as they may not have the necessary expertise in IT, and undertaking the BIM manager role involves additional liabilities and risks.

However, a BIM manager is essential in any project involving BIM and most standard forms of BIM contracts require this qualification. The liabilities are concerned with coordinating parties regarding protocols and roles to reach a consensus as well as change (BCA 2012; CIC 2013), coordinating processes of BIM building among parties (BCA 2012; CIC 2013), reserving, updating and integrating data and models (BCA 2012; AIA 2013b; CIC 2013) and so on.

Variation: Lack of appropriate change management methods is another reason why projects do not readily adopt BIM. Variations arise when the parties’ involvement in the project changes, such as work content, requirement of products, or schedule times are added or modified.

Current standard forms of contracts do not have specific policy concerning variation in the process of BIM, and most of them only state that when there is any modification in the BIM execution plan or MPDT, participants should be subject to a change in management procedure under the general conditions (CIC 2013; BCA 2012). An agreement to vary should involve prior written consent from the counter participants before activities (BCA 2012), and all project participants’ MPDT should be consistent after any variation (CIC 2013). Note, that if a party fails to provide notice of variation for the counter parties, this will be regarded as a waiver of any claims for variation (AIA 2013b).

4.1.3 Risk Allocation

Reliance: Contractors may or may not completely rely on the model provided by designers and may complement the model which gives rise to issues. From the contractors perspective, their expectation is to rely on the model working without omission or defect. However, from the designers perspective, they sometimes refuse to permit reliance on the model they have provided where others have also contributed to the project, because they don’t want to be responsible for the model following other parties’ modifications to it within the collaborative process. This brings additional risks (Ozbek 2012; Kuiper and Holzer 2013). As a result the potential benefits arising from the application of BIM are wasted, since parties receiving and using this model need to recreate a new one, possibly from 2D drawings (Larson and Golden 2008).

On the other hand, some designers embrace this right as an effective method to reconfirm and modify the model as opposed to rebuilding it (Arensman and Ozbek 2012), as it is in keeping with the collaborative and integrative nature of BIM. Another method of dealing with reliance is to put different levels of reliance on different parts or parameters of the model for specified model users (Fan 2014). Thus, defining the reliance level in the contract is appropriate and necessary.

Some standard forms of BIM contracts hold that participants should only rely on the level of element or model defined in the BIM execution plan, license authorised, or other
documents, and provide that any issues arising from reliance beyond permissible levels should be at their own risk (BCA 2012; AIA 2013b; CD301 2008; CIC 2013). AIA (2013b) also states reliance before agreements should, likewise, be at their own risk.

**Standard of care:** In law, the standard of care is the degree of prudence and caution required of an individual who is under a duty of care, and the requirements of the standard of care are closely dependent upon the circumstances. Projects applying BIM require participants to adhere to a higher standard of care. An example is in the context of rough BIM software, if the contract requests participants to inspect whether there is any conflict between outputs of BIM, that indicates a higher standard of care (Hsieh et al. 2015). Participants need to be capable of handling problems arising from rough software.

In formal contracts, if no particular clause is defined, the standard of care is defined by common law. Those states which regulate professional practices of architecture/designer and engineer require that they should have licenses and should be designated as the architect/designer or engineers of record (Simonian 2010).

Furthermore, for reaching a higher standard of care, participants who have contributed to the BIM model are responsible for the data they provided (Olatunji and Akanmu 2014). When the model is in unauthorised use, parties who have made a contribution will not assume responsibility, although they still have a duty of care to perform with due diligence regarding the integrity of the information they have provided (Alwash et al. 2017). Besides, the higher standard of care also includes avoiding parties who have access to and use the model to bear economic loss, where there is causal relationship between negligence claims and consequential damages (Alwash et al. 2017).

AIA (2008, 2013b) doesn’t change the standard of care adopted in the common law (Lowe and Muncey 2009), and CD301 (2008) uses the terms such as “reasonable endeavours” which is less clear to some extent. If no particular definition of the standard of care is specified in the contract, each party should adhere to local standards (BCA 2012). Furthermore, each party should immediately inform the author or BIM manager of errors or omissions it discovers to reduce risk and loss (BCA 2012; CD301 2008).

**Insurance:** Projects applying BIM still give rise to disputes and claims, and these issues can be divided into design liabilities and software liabilities. For the former, when participants are under conditions where the third party has access to and could modify the model for which they are responsible, they need additional policies for self-protection. For the latter, the security of data, as well as software crush, need insurance to cover loss (Manderson et al. 2017).

**Costs:** Issues about the costs of BIM also include reward (Chong et al. 2017). In general, contracts only state the basic provision that the BIM manager and related costs should be paid by the employer (BCA 2012; CD301 2008). However, controversial legal issues arise where there is silence as to wider costs and which party should be responsible for them and whether parties should get compensation, such as the

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**Spearin doctrine:** The Spearin doctrine is usually applied by contractors in defending employers’ claims where there exist defects and disqualification in projects. United States v. Spearin (248 U.S. 132), also referred to as the Spearin doctrine is a 1918 United States Supreme Court decision, which indicates that contractors will not be liable for damages or losses arising from information, plans or specifications provided by the employer. The Spearin doctrine transfers liabilities to the employer. This means that the contractors will not generally be liable for structural defects if they comply with the BIM model, and liability rests with the designer (Foster 2008).

However, the Spearin doctrine will not apply if the contractor has contributed information towards the project’s design (Austin Co. v. United States 314 F.2d). No particular case has arisen which considers how the Spearin doctrine is affected by BIM, but a contractor’s indemnity is likely to be reduced in those circumstances (Ashcraft 2008) because of the essential collaborative nature of BIM. It follows that with the design phase of BIM it remains undecided whether a Spearin doctrine defence will survive.

**Privity of contract:** The privity of contract in common law stipulates that a contract cannot confer rights or impose obligations on any person or agent, except the contracting parties (Hsieh et al. 2015). This has raised a question whether parties are protected by policy in reliance on the designer’s model (Ashcraft 2008).

Under the privity of contract, contractors or other participants in projects with traditional procurement methods have no right to charge designers for their defects or omissions, because there is no contracting relationship between those two parties. However, when a contractor or other participant has contributed to the model, the designer’s reliance upon privity of contract as a means of protecting himself against claims may be affected (Simonian 2010). Recent case law has eroded the defence based on privity of contract. Many jurisdictions have allowed claims between designer and contractor or other participant, even where there exists no contract between these two parties, but designer defects or omissions have led to contractor’s or other party’s loss where the contractor or other party has the right to use the model, in the context of collaborative use (Simonian 2010). As to the crash of software, if the mistakes cause loss to users, users don’t have the right to claim according to privity of contract (Hsieh et al. 2015).

CD301 (2008) states clearly that it is not intended to create privity of contract among any project participants beyond that which otherwise exists at law or in accordance with the terms of the governing contract.

**CD301 (2008)** states that each party should procure insurance covering all parties’ contributions.

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costs involved in the adoption of hardware and software, staff training for BIM etc. (Ozbek 2012). Besides, BIM can decrease variation by collision detection prior to construction, which brings about cost reduction when it is mature, thus, Post (2006) advises that the measurement of BIM additional value is needed to allow parties who have contributed to the model obtain compensation. BCA (2012) indicates that each participant should benefit from the deduction of costs.

### 4.1.4 Intellectual Property Rights

**BIM ownership and intellectual property rights:** Although many authors claim that policy concerning ownership and intellectual property rights (IPR) need no change in the context of Level 2 BIM, still many issues arise. For example, which party may claim the ownership and IPR of the federated BIM model? What are the rights of parties who have contributed to the BIM model? To these issues, many different answers are raised.

Historically, after completion of the project, the ownership and IPR of the design belong to the designers, not the employers. Hurtado and O’Connor (2008) state that BIM should not alter this policy; and Arensman and Ozbek (2012) supports this claim that the party who creates the model holds the ownership and IPR. However, employer and facility manager intend to use and explore the BIM model further for it enhances project maintenance and operation through the abundance of information contained (Hamil 2011). For this to work, the employer reasonably requires the BIM model to be deliverable and assignable and reasonably expects the designer to waive his rights (Simonian 2010). This also permits the employer to use the model for other project use. An alternative view would be that the employer only needs to reserve in perpetuity the BIM model and in that way the ownership and IPR could remain that of the designer (Aljarman 2016). Under the perpetuity, the employer has access to the BIM for further maintenance, operation and marketing management, but would be precluded from copying it for other projects.

The federated BIM model contains contribution or information from several parties and they all expect to reserve IPR of their part of the model, which gives rise to difficulties and disputes in law (Larson and Golden 2008). Hsieh et al. (2015) state that work adapted from one or several works belongs to the party who creates the model holds the ownership and IPR (BCA 2012; CD301 2008; CIC 2013). As to the regulation concerning co-authorship, parties who have contributed to the model should not be deemed co-authors of another party’s contribution (CD301 2008). That is different from what is discussed above.

**License authorising:** Participants ought to state clearly that they have the ownership and IPR of the model or part of the model, or that they are licensed by the owner to use, modify or otherwise use the model, to avoid claims of infringement of IPR from a third party (Lowe and Muncey 2009).

Any license must be authorised by the party who owns the IPR. Although the rights authorised are not just the same among multiple standard forms of BIM contracts (CD301 2008; CIC 2013; AIA 2008; AIA 2013b; BCA 2012), they usually contain the rights of use, operation, display, copy, authorising sub-licenses, and so on. CIC (2013) additionally addresses licensee’s authorisation between parties, except the employer, which need to be accomplished via the employer.

### 4.1.5 Electronic Data Exchange

Electronic data exchange is a significant and an important technical issue affecting the effectiveness of BIM. Five aspects of electronic data exchange are uppermost: interoperability, compatibility, cyber-security, data transfer and collaborative working (Eadie et al. 2015).

**Interoperability and compatibility:** In ideal conditions, BIM is an integrated model containing all the detailed information needed. However, it is hard to achieve in practice for interoperability and compatibility reasons involving multiple software. Because BIM is federated by multiple models, each part of the model is concentrated on a different area and the elements are separately created by multiple parties. In this condition, accurate and faithful transposition of part of the model between parties and cooperation are vital to interoperability of the BIM model (Mcadam 2010). Furthermore, there is diversity among BIM software, thus many specifications are released to standardise the format of digital data for its communication and exchange. However, in fact, not all digital data can be transferred from one to another software perfectly.

Problems, such as file corruption, data loss or data error exist and even failures in data transfer arise due to incompatibility of multiple software packages, and this is an important reason leading to inconsistencies of the federated model. Integrity of the federated model can be improved through a proper design and analysis process, but eliminating all inconsistencies is virtually impossible (Olatunji 2016). These two reasons give rise to confusion and an increased risk of disutility of the model.

Clauses in contracts need to define the BIM software, the specification of data transmission and even the process of cooperation to reduce the risk of interoperability and compatibility issues. (Chong et al. 2017) states that the completion of the BIM model design before all contract stages should be regulated in the contract, to avoid interoperability issues.

The policies about interoperability and compatibility are usually particularly defined by parties in different projects, and no general requirement is defined. They are often set out in addenda (CIC 2013), the BIM execution (CD301 2008; BCA 2012), other conditions signed (AIA 2013b) and so on.

**Security issues:** Security issue is one of the main barriers to the adoption of BIM (Mahamadu et al. 2014), because
the information contained in the BIM model can be easily obtained and copied. Furthermore, the data can be corrupted or information stored on the cloud can be attacked (Olatunji 2016). Li et al. (2010) points out that wireless transmission technology can solve security issues arising from servers being attacked and mechanical errors, but still brings about transport node problems, which is a technical issue. In current BIM specifications or contracts, requirements about security issues have not been addressed (Abdirad 2015). Further consideration needs to be given to the steps that are required to reduce this situation by contractual provision.

The BIM execution plan usually defines efforts to be taken to defend security issues in detail (CD301 2008), and the model manager is usually liable (AIA 2013b).

### 4.3 Application Status in China

The mainland of China has been actively promoting the adoption of BIM, and has released several strategies and standards to strengthen regulation over the application. BIM objective and framework are addressed in the 12th National Five Year Plan from the Ministry of Housing and Rural Urban Development, aiming to apply BIM in visualisation, conflicts detection etc., and the Ministry of Housing and Rural Urban Development indicates that enterprises with specific qualification should master and apply BIM in an integrated manner with other informational technology before the end of 2020.

According to the strategy above, some organisations and local governments release series standards, for example, Re-search of Chinese Building Information Modelling Standard Framework (The BIM Research Group of Tsinghua University 2011), Building Information Modelling Design Standard for Civil Building (BJEDA 2013), Deliver Standard of Building Design Information Modelling (CIBSR 2014a), Standard for Classification and Coding of Building Constructions Design Information Model (CIBSR 2014b), Building Information Modelling Technological Application Notes in Shanghai (Shanghai Government 2015) etc. However, no specific standard form of contract about BIM has been released to date.

#### 4.3.1 Level of Application

The three interviewees indicated that BIM level of application is between Level 1 and Level 2 which does not reach all of the requirements defined by BSI (2013). The main uses can be achieved by separate models, including visualisation, conflict detection, demonstration of construction schedule, quantity survey of construction etc.

#### 4.3.2 Contractual Governance

The consultant and contractor state that they usually incorporate policy and requirements of BIM in bidding documents and in specification, and in manuscripts of BIM particular conditions or other forms rarely exist.

As to the status of BIM models and digital data, the three interviewees stated most projects will not serve BIM models as part of the contracts, mainly because it is premature and possibly brings additional risk to the employer and parties, and the BIM model is usually treated as deliverables. This will lead to the legal status of the model being lower than 2D drawings, bill of quantities etc.

Main provisions in the specification are regarding requirements of the models delivered by multiple parties and the delivery process, including the LOD of elements, software, hardware, time to deliver etc., of which the level of detail depends on the employer. Issues discussed above concerning liabilities, risk allocation, intellectual property rights etc., are according to the common law and main agreement. For example, an integrated model rarely exists in projects, and contractors usually

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<th>Category</th>
<th>Outstanding issues</th>
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<tbody>
<tr>
<td>Evaluation system</td>
<td>Evaluate quality of BIM compensation</td>
</tr>
<tr>
<td></td>
<td>BIM will save the client money due to the decrease in variations as the BIM process</td>
</tr>
<tr>
<td></td>
<td>highlights clashes within the model (Post 2006).</td>
</tr>
<tr>
<td></td>
<td>Evaluate quality of model functions</td>
</tr>
<tr>
<td></td>
<td>Define the BIM’s goals and quality checks for different stages of development</td>
</tr>
<tr>
<td></td>
<td>(Chong et al. 2017).</td>
</tr>
<tr>
<td>On-site management</td>
<td>Landscaping and site requirements (iM Studios 2009)</td>
</tr>
<tr>
<td></td>
<td>Requirements for BIM staff at a job-site/co-located office (Abdirad 2015).</td>
</tr>
<tr>
<td>Payment</td>
<td>Type of contract price</td>
</tr>
<tr>
<td></td>
<td>A fixed percentage of the overall project cost, or the types of development,</td>
</tr>
<tr>
<td></td>
<td>models and functions required for the project (Chong et al. 2017).</td>
</tr>
<tr>
<td></td>
<td>Payment time</td>
</tr>
<tr>
<td></td>
<td>Progress payment on the work done, or completion of the models and functions</td>
</tr>
<tr>
<td></td>
<td>required in the project (Chong et al. 2017).</td>
</tr>
<tr>
<td>Staff</td>
<td>Staff competencies</td>
</tr>
<tr>
<td></td>
<td>Including experience, education, professional training etc (Abdirad 2015).</td>
</tr>
</tbody>
</table>

Table 4. Outstanding legal issues
rebuild an independent model, thus the liability and IPR disputes will not happen and risks belong to the party who built it. Also, the BIM manager and additional insurance are not necessary. Due to the lower level of BIM adoption, current contractual structure and contents correspond to the level of BIM development, and there are not many issues arising from the lack of clarity concerning legal issues.

4.4 Implications

Clearly, one of the obstacles in BIM adoption is the lack of a universally accepted standard form of contract and that some legal issues need to be clarified to regulate participants’ behaviour in the process of building models (He et al. 2012). In this situation, BIM cannot be further promoted, especially as it is difficult to achieve an advanced level, such as Level 3 proposed by the British government. Any rush to use and deepen BIM applications will bring additional risks and hidden dangers (Su 2013). Because the three functions of contract: control, coordination and adaptation can regulate the behaviour of each project participant, the operational mechanism of the project (Malhotra and Lumineau 2011; Lumineau 2014) and the control of risk can be better managed by greater collaboration in the process of projects, research about contract issues is of great significance in order to promote adoption of BIM. Some contract principles and contents will need to be changed to some extent, in order to adapt to the changes brought about by BIM, although in the existing standard forms of BIM contracts, almost all of them are written with this special condition to avoid changing the general conditions. From the current situation of BIM in China’s current contract, the provisions are not clear enough (He et al. 2012). Although local regulations have been issued in many versions, most of them are specific technical issues, there is no specific content on the project participants’ responsibilities, rights, risks etc. This has some gaps compared with the British, American and some other countries, which have published a series of related documents. Although BIM is not widely used, or not deeply used currently in China, in the future it will be necessary to make adjustments to adapt to the in-depth application of BIM technology.

This study analyses and summarises the contractual provisions from a number of worldwide organisations, together with related literature, and then proposes the content that should be noted in contract. However, in China’s application, there are still three issues that need attention due to practical matters. Firstly, because China’s economic, legal, institutional surroundings, as well as construction standards are different from those of the countries proposed above, some changes in the content of certain provisions need to be made. Secondly, from the perspective of the use of standard forms in foreign countries, there are still some issues that need to be improved and resolved. The necessity to enhance the collaboration among project participants could serve as an example. Therefore, when learning from the experience of others, these issues which have been neglected need to be addressed and adjustments made.

Thirdly, since many of China’s construction project participants use FIDIC contracts series, and the “Construction Project Construction Contract Demonstration Text” released by Ministry of Housing and Urban-Rural Development is largely consistent with the FIDIC contract, as their guide, they need to consider possible contradictions and incompatibilities with FIDIC terms, such as the principle of risk allocation, having regard to the fact that FIDIC has not made any changes as a result of BIM, nor added any new particular conditions (King’s College Centre of Construction Law and Dispute Resolution 2016).

5 CONCLUSIONS

This research concludes legal issues about BIM that have been stressed in contracts through the use of a literature review, involving 16 issues under five main categories: (1) general principle, (2) BIM management and execution plan, (3) risk allocation, (4) intellectual property rights, and (5) electronic data exchange. Meanwhile, a further seven issues under four categories, which have not been clarified in contract but have been raised by several authors, are identified, involving: (1) evaluation system, (2) on-site management, (3) payment and (4) staff. Finally, a semi-structured interview was conducted to gain knowledge about the current status of BIM usage and contractual provisions in China, finding that even though some legal issues discussed above are not clarified, this method corresponds to the level of adoption now.

A majority of the legal issues are related to liabilities and risk. As BIM changes collaboration relationship among parties and contractor participants in design to some extent, disputes will inevitably arise. Most standard forms of contract of BIM stress in general principle that they make the minimum change in risk allocation and liabilities, or even they do not change them from the main agreement; however, some provisions have that effect. For example, priority of contract limits contractual liabilities of the designer prior to BIM usage, but collaborative working methods weaken this defence. The Spearin doctrine relates to the transfer of risk of construction defects to the employer in some specific circumstances, but BIM encourages contractors to participate in design, and thus weakens the defence for the contractor. Provisions about reliance protect the model author, but sometimes reduce or impact on the efficiency of collaboration. The standard of care demands a higher level from each party for their work. Results arising from these changes and differences among multiple contracts using BIM will need to be observed and monitored in the future.

Regarding the status of BIM contracts in China as compared to other countries, it was found that different levels of BIM adoption correspond to different requirements of individual contracts, due to collaboration, liabilities, rights, risk allocations etc. Hence, along with the development of BIM adoption, its scope of use, structure and provisions will have to adjust to take into account the findings from this research and it is hoped that this will provide guidance and a reference for the drafting of future BIM contracts.

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