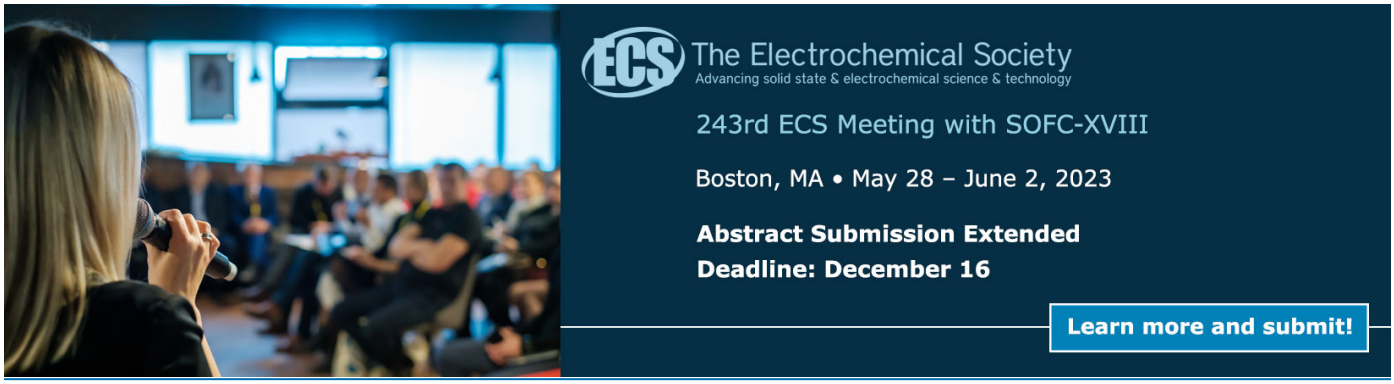
Building Information Modelling (BIM): insights from collaboration and legal perspectives



Building Information Modelling (BIM): insights from collaboration and legal perspectives

P Wong [1] and J Lai [2]

[1] Department of Law and Business, Hong Kong Shue Yan University, Hong Kong, China
[2] Department of Building Environment and Energy Engineering, The Hong Kong Polytechnic University, Hong Kong, China

ylwong@hksyu.edu

Abstract. With the advent of the BIM technology, related guidelines have been formulated by project owners, governments and professional bodies. As an information sharing platform, BIM is applied to various kinds of construction projects for better management and collaboration. Yet, the existing off-the-shelf BIM application software does not fully consider the potential legal liabilities among the collaborating parties. In view of the above, we conducted a review of the relevant literature and legal cases to examine issues including ownership, liability and information reliance, and duty to warn from the perspectives of collaboration and laws. Common procurement initiatives were discussed in relation to BIM application. Drawn from the review and comparison, key legal issues of concern in BIM applications and the way forward for tackling the issues were identified. In conclusion, a collaborative approach under the BIM environment will work better under a project federated committee. Further research on the operation of this committee is recommended in order to make its authorities and liabilities clear.

1. Introduction

A building design is the result of a multi-professional effort. Designers of each profession used to independently develop their works for a project. Building information modelling (BIM), which changes the culture of independence in building design [1], is an integrated approach adopted from design through construction to maintenance. In such an approach, communication of information among different stakeholders becomes critical as each stakeholder possesses different sets of knowledge and skills. BIM supports collaboration between different disciplines of a building project.

The collaboration disestablished the conventional supply chain concept of construction and the fragmentation nature of building design. According to Autodesk [2], BIM is a software designed for enhancing efficiency and accuracy across the project lifecycle. It is an intelligent 3D model-based database from conceptual design, visualization and analysis to fabrication and construction. As a process of creating and managing information for a built asset, BIM is an intelligent model and enabled by a cloud platform. It combines multi-disciplinary and structured

data to produce a digital representation of an asset throughout its lifecycle. A BIM manager coordinates and manages all the information of a BIM process for the designers of various stages such as architects, engineers and contractors. With their assigned authorities in the database, designers contribute their respective inputs. Referring to Figures 1 and 2, BIM changes the conventional supply chain of a building construction through the flow of information. The conventional supply chain of building construction is divided into individual stages, namely substructure, superstructure, building services and finishing. Traditionally, each of these stages is often fragmented [3, 4]; coordination in a project is formally developed among the architect, engineers (e.g. structural, building services), main contractor, subcontractors and resident engineers. Instructions are given formally from the project client or its representative to the architect, engineers, main contractor, and so on. The main contractor instructs his subcontractors. With BIM, all relevant parties share design and construction details on the same platform. BIM sounds a suitable tool for large and complicated projects.

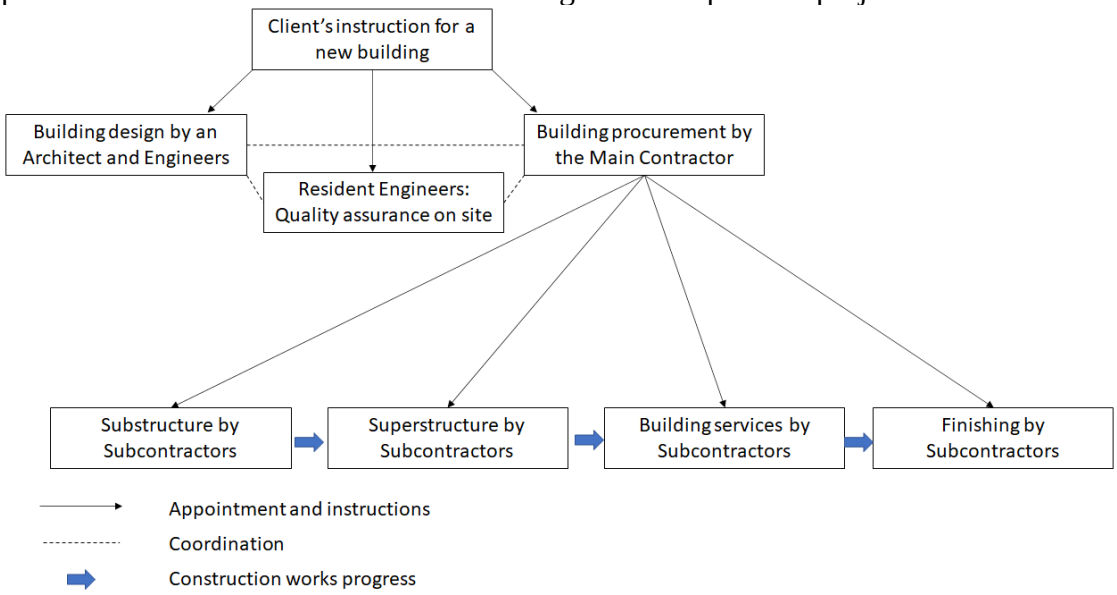


Figure 1. The conventional supply chain of building construction (Adapted from Briscoe *et al.* [5])

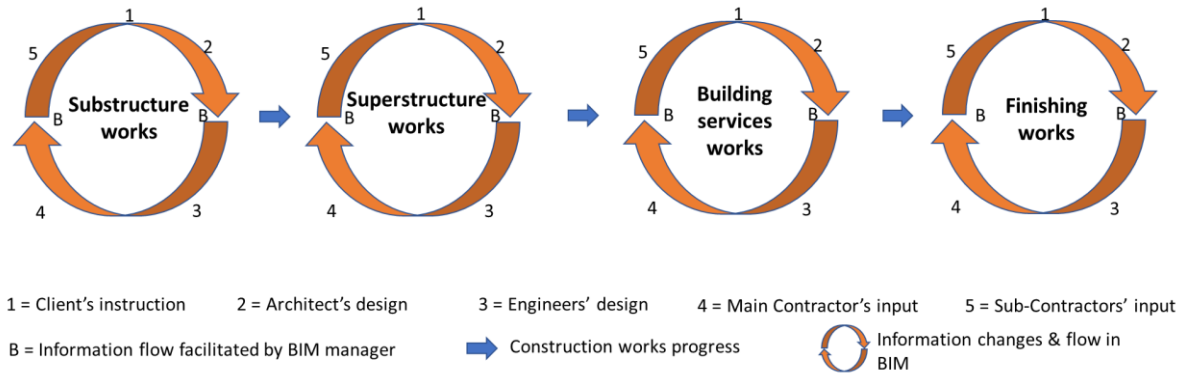


Figure 2. Construction works information flow using BIM

As Singh et al. [6] noted, most complicated projects involve multi-disciplinary collaboration and the exchange of just-in-time building information. In the past two decades, some BIM-like

applications, e.g. analysis tools, model checkers and facility management (FM) applications have been developed. As illustrated in Figure 2, the flow of information about design and works progress etc. is managed by a BIM manager. Besides handling BIM authoring and coordination, a BIM manager is responsible for ensuring the compliance with the approved BIM execution plan and verifying seamless integration of design and construction. Most importantly, he facilitates the use of composite design models in design coordination or clash detection meetings and provides detection reports.

Despite the continued growth of BIM in the construction industry, investigations into the legal concerns about the use of BIM remain limited. In this paper, we examine the legal implications of BIM to building design and construction. The aim is to help understand the current level of legal maturity of BIM application and explore the contractual uncertainties, including information ownership, liability and reliance, and duty to warn from the perspectives of collaboration and law. The research objectives of this study are: (1) to investigate the interoperability between parties in a BIM environment; and (2) to propose a BIM framework involving the new roles of architects, engineers, BIM managers and contractors.

2. Literature Review

There are five main contracting protocols that incorporate BIM in the construction industry: ConsensusDOC 301 BIM [7], Architects Engineers and Contractors BIM Protocol [8], American Institute of Architects E203 [8], Construction Industry Council BIM Protocol [9], and Chartered Institute of Builders, Time and Cost Management Contract [10]. The analysis of the contracting systems is conducted using two dimensions, as shown in Table 1. With reference to Holsapple and Joshi [11], the first dimension is derived from the variables used in knowledge management to classify the protocols as prescriptive or descriptive frameworks. The main difference between the two is the direction in which the operation proceeds. With a prescriptive framework, designers make decisions and expect contractors to comply with the relevant requirements. While under the descriptive framework, designers seek input and feedback from the contractors. Prescriptive frameworks prescribe methodologies for information flow within BIM. Descriptive frameworks describe and attempt to simplify its knowledge domains. In the second dimension, the protocols are examined according to the domains of knowledge addressed by each protocol. The BIM domain coverages are different between the protocols. The common domains of knowledge are process, collaborative principles, risk management and technology application. Similar analysis was carried out by Kassem et al. [12]. The current study considers risk management and collaborative principles of the updated protocols.

Table 1. Summary of the analysis of the BIM protocols

	Process	**Collaborative principles**	**Risk management**	**Technology application**

1. ConsensusDOC 301 BIM (Descriptive framework)	No detailed process is suggested. The 301 BIM Addendum is issued as a descriptive framework in 2017 for guiding all kinds of project participants.	A collaborative organizational structure should be developed. Decisions are made by a multi-disciplinary team for the best interest of the project.	Integrity of model data and partitioning is mentioned. However, the responsible persons and methodology are not prescribed. Project team members are expected to identify material project risks at the early design stage.	Model sharing and networking infrastructure are suggested with application of databases, websites, emails, hyperlinking, and project management platforms.
2. AEC BIM Protocol (Prescriptive framework)	Implementation plan with parties' role and responsibilities is given. Modelling methodology and structure are covered.	Based on BS1192:2007, it stresses communication, re-use and sharing data without loss or misinterpretation.	The risk about access to up-to-date information and that data loss was mentioned.	It foresees software development and problems of interoperability between applications.
3. AIA E203 (Descriptive framework)	It clearly specifies what can and cannot be done with the digital data at different stages of protocol establishment.	It defines project parties' obligations about digital data and their ongoing responsibilities.	It points out the data ownership issue: the transmission of digital data constitutes a warranty by the transmitting party. It is important to the risk of reliance and copyright.	It considers the services and data application post construction.
4. CIC - BIM Protocol (Descriptive framework)	It stresses about the importance and application of Common Data Environment (CDE) Process. CDE is the core of BIM.	It puts into specific contractual obligations that the owner and other project members are responsible for the updates of specified project information.	It specifies various issues about data security. Project owners have to define what sensitive information and specific security requirements are.	It indicates a "Responsibility Matrix" which sets out responsibility for model or information production in line with defined project stages. Different technologies and modelling techniques may be specified in the matrix.

5. CIOB - Time and Cost Management Contract (Prescriptive framework**)**	A Design Execution Plan is suggested. It covers the design contribution of various parties.	The collaborative approach requires all project members to have continuing roles in design, administration and quality control.	The collaborative approach requires all project members to appraise project risk and minimize any delay or loss.	All project members should update and maintain the hardware, software and data.

Apart from AEC BIM Protocol and the Time and Cost Management Contract of CIOB, the other protocols are generally descriptive in nature. It leaves freedom for the BIM managers and architects on BIM development. Despite the emphasis on collaboration in all of these protocols, the computer–human interactions are inputs to a large BIM database. Although the project members may intend to collaborate, they may not be aware of giving support to other parties in the computer–human interaction environment. Sufficient support from the BIM managers is important. They need to collect requirements and describe awareness support in BIM systems. In the rest of this paper, two representative court cases are discussed to support the above submissions.

3. Analysis of court cases

The above examination of the BIM protocols indicates that BIM execution plans should cover process, collaborative principles, risk management and technology application. Ideally, BIM managers act as an information facilitator who implements the flow of information. As proposed by the CIC BIM Standards [13] of the Construction Industry Council of Hong Kong, a BIM manager should be appointed to lead and support the BIM process. He or she could be an architect, engineer, surveyor, contractor, or an independent BIM professional with relevant practical construction knowledge and design coordination experience. They are the decision makers about workflows, and which BIM standards for a project to be applied. This makes BIM managers the core project members of an architect or an engineering design consultant. In practice, the development of a BIM is under another subcontract. BIM communication is handled through texts and graphics. By analysing the following court cases, we identify the legal issues and uncertainties when using BIM. Some suggestions follow.

3.1 North American Mechanical, Inc v Walsh Const. Co II (No. 12-CV-598, 2015 WL 5530190 (E.D. Wisc. Sept. 18, 2015)*)*

Walsh Construction Company II (i.e. Walsh) was the project general contractor. North American Mechanical, Inc. (NAMI) was a subcontractor for the installation of the heating, ventilation, and air conditioning (HVAC) systems. The project demanded some of the subcontractors to participate in BIM. NAMI was one of them. The argument of the case is about the status of BIM in the project.

Conventionally, construction contracts are drawings and specifications. These documents are the primary tools used for project administration. Under such an administration, BIM information is not considered as a contractual tool. NAMI claimed additional costs for changed work resulting from omissions and errors in the BIM database. NAMI argued that information of BIM was not a contract document, because it was merely a coordination tool.

There was a lack of clarity over the status of information being adjusted in the BIM system. It is vague whether BIM is a contractual tool or a coordination platform. For example, some case analysis pointed out that some subcontractors were not bound to participate in the BIM process [14]. It is submitted that the BIM manager should have decided the level of priority of information in the BIM system among the set of contract documents as a process of contract administration. It is preferential to place BIM on a high priority as BIM is widely applied for works execution [15]. In the construction contracts, the function of BIM should be delineated. In case of contractual adjustments, relevant

information should be managed clearly. The ANZ guide to ISO 19650 pointed out that information management as a defined function was typically overlooked as part of a specific contract. ISO 19650 highlights the need for the appointing parties to eliminate vague information and fulfil the potential benefits BIM has promised for all actors throughout the entire lifecycle of a built asset.

All the five BIM protocols discussed above can solve the uncertainty of the information in BIM system. BIM records the time and transmitting parties of the digital information. The BIM records will show negligent acts and liabilities of project members, if any. As regards the future BIM application development, an important argument is about the liability of omissions and errors in the BIM environment: a party (i.e. Walsh, in this case) had done nothing to clarify the changes in the BIM system. Will that party be held liable? In the case, NAMI contended that it was a breach of implied duty of good faith and fair dealing under the subcontract.

BIM is well-known for its capability to detect design "clashes", which enhances the standard of works performance. However, it is subject to accurate data input on time, and it relies on the execution of the BIM plan. In the case, this BIM capability could not help much owing to a party's omission. As pointed out by McAdam [16], sharing of responsibility and tortious liability are the main legal issues of BIM application. Better management of the BIM process, and the messiness in practice may solve the legal challenges. Further discussion is to be made in Section 4.

3.2 Trant Engineering Ltd v Mott MacDonald Ltd ([2017] EWHC 2061 (TCC))

This case was about an injunction application for accessing the design data stored in the BIM. The project was to construct a power station on the Falkland Islands. Trant engaged Mott MacDonald Ltd (MML) for design services, while Trant was in the process of tendering for the full contract with the UK government. The dispute arose from the scope of the work and payment. Finally, MML changed the BIM passwords and Trant could not access the design data. Trant, therefore, sought the injunction for accessing the design data. The judge decided that an injunction should be granted since the court found that it was impossible to determine conclusively whether there was a contract.

As noted by Ashworth *et al.* [17], ownership of the data and information requests by the project owner should be clarified for BIM implementation in the development of contractual agreements. This case is important because it helped clarify various parties' obligations and risk allocation in a BIM project.

In the case of *Plant Constructions plc v Clive Adams Associates* ([2000] BLR 137), a duty to warn of defects in design was established as an obligation in the following conditions: the works were dangerous and imposed a threat to safety; and a subcontractor had knowledge concerning the defective design. Walsh [18] noted such a trend and observed that a concept of good faith is an important element in establishing the duty to warn.

According to the survey by Eadie *at al.* [19], possible breach of a duty to warn was found to be the 14th serious legal issues with BIM application in the UK. However, it is highly likely that the duty to warn is expected to attract more attention as BIM application becomes popular. The reasons include:

1. From the management's perspective and at the international level, a duty to warn is considered an approach of proactive risk management in dealing with project problems [20]. Project parties are obliged to inform each other of any matter which could affect costs, completion, progress or quality of the project. With the availability of BIM information to project members, design and works errors become easier to be found by one's peers than before. Project members with more information may be liable to warn their peers.
2. From the perspective of contract law in construction, there is an early warning system. Notifications are to be discussed at an "early warning" meeting and recorded on an Early Warning Register. For example, the New Engineering Contracts (NECs) introduce an "early warning interval" into contract data. The clients will state the interval that they are proposing to have early warning meetings about the project duration. BIM may integrate all available project data from all stakeholders to estimate the project duration. Therefore, both designers and contractors should be able to warn the client and one another regarding the possible project obstacles. Project delay may be avoided.

3. In tort law, the scope of liability for negligence may cover more project members through sharing of BIM information. As a boundary of the liability, the extent of liability of "a duty to exercise reasonable care in the construction" was argued in many cases of construction. To name a few:
    - *Brookfield Multiplex v Owner's Corporation Strata Plan 61288* (High Court of Australia, Case S66/2014)
    - *Cleightonhills v Bembridge Marine Ltd & Others* (UK, [2012] EWHC 3449)
    - *Michael Hyde & Associates Limited v J D Williams & Co Ltd* (UK, [2001] BLR 99. Court of Appeal)

Imposing liability in negligence for cases with application of BIM may involve establishing a reasonable duty of care of warning. It is expected that BIM may lower the threshold.

4. Findings and Discussion

With reference to the above literature review and case analysis, we have identified the legal issues of using BIM, namely, data ownership, responsibility sharing among project members and a duty to warn of defects in design. Better management of the BIM process by adherence to the protocols may solve the challenges. In this section, we attempt to propose how it can be achieved.

Attrill et al. [21] pointed out that industry players were often confused about the requirements of the varying levels of BIM maturity. While some governments' standards (e.g. the UK, Hong Kong SAR of China) emphasise BIM implementation in public sector projects about skillset consistencies among project members, project coordination should also be improved. Attrill et al. [21] proposed developing an adoptable standardised system for project owners to communicate their Information Requirements to reduce potential disputes over sharing of information. The difficulties of an adoptable standardised system development are how to coordinate the sub-models in a complicated BIM for a large construction project. A BIM federated committee is therefore proposed to oversee the standardised system, as shown in Figure 3.

The idea of federation was found with the model proposed by Autodesk [22]. A federated model with 3D models and sheets is a combined BIM. It is compiled from several BIM models of different disciplines into a master one. As BIM is becoming commonly used and project owners are demanding for BIM technology, they participated more during different stages of a project. One of the primary roles of the proposed BIM federated committee is to monitor the BIM process throughout the stages of design, construction and operation. The committee may use federated models to validate the BIM projects. A smooth operation of the committee is expected to integrate multidisciplinary models, data server or network-based technologies among the construction stages [23]. Prescriptive BIM protocols, such as AEC BIM Protocol and the Time & Cost Management Contract of CIOB, may adopt the formation and operation of a federated model.

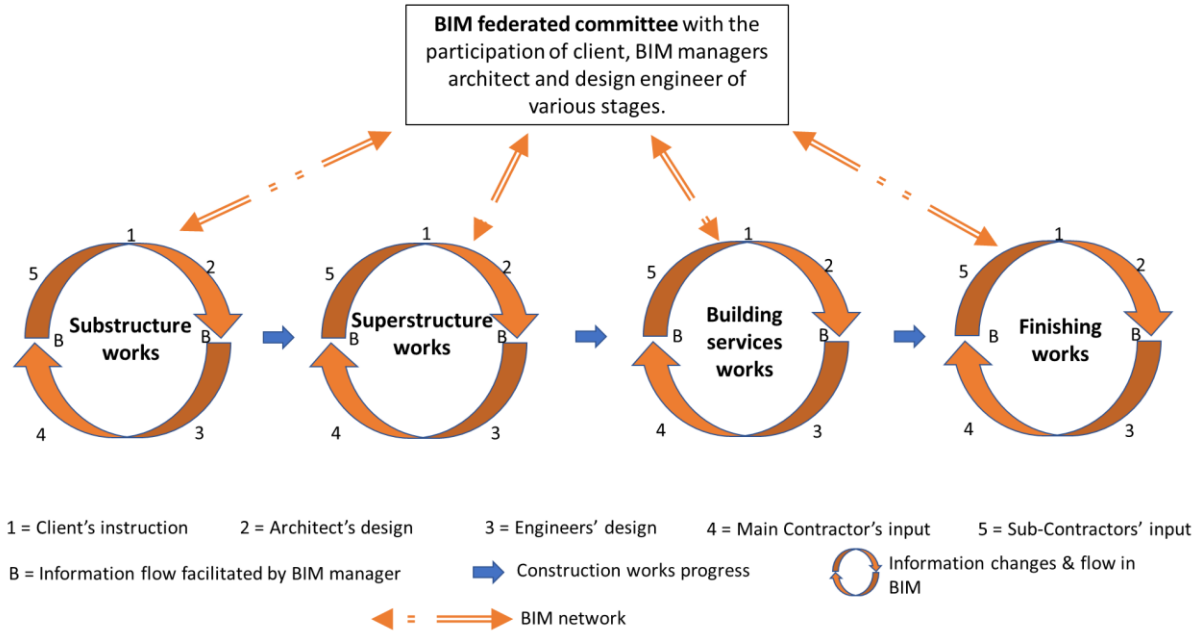


Figure 3. The proposed establishment of a BIM federated committee

The project team including architects, engineers, contractors, and subcontractors may rely on the federated models for different objectives as a project continues: collaboration, coordination, bidding, and reviewing workflows. The project owner may organize a BIM federated committee and specify a single federated model deliverable at any one time of the contract. With a federated committee, the legal issues related to data ownership and responsibility sharing can be resolved. The committee confirms project members' ownership of data and responsibility. The two-way BIM network serves as a vital means for BIM information exchange; instructions are made from the federated committee for works execution. At the same time, the network relays information from the design team, main contractor and subcontractors to the federated committee. The duties and liabilities of the federated committee must also be clear to all project members. A constitution of the committee is necessary, especially regarding the limitation of its liability. While a duty to warn of defects in design is probably on top of the constitution, it is critical for the BIM federated committee to limit its liability to warn through its constitution or article of association.

5. Conclusions and Further Research

In the pre-BIM era, some design clashes were an unfortunate but inevitable fact of construction life. As BIM continues to advance, some unfortunate instances as such may be construed as negligence. A duty to warn of defects becomes an obligation [16]. From the court case analyses, BIM may conditionally introduce a duty of good faith and fair dealing. In the new BIM's sharing information environment, various parties' obligations and risk allocation may be adjusted. Further research on recent cases is necessary to confirm the trend of the obligation and risk changes.

Given the cry for better collaboration and integration under the BIM umbrella, it is proposed to establish a federated committee of BIM. With the duty to oversee a standardized system for BIM data assigned to such a committee, it is expected that the committee will be able to solve legal issues including data ownership, liability sharing and information reliance. In view of the abundance of data handled by the committee, a limitation of its liability is needed.

While this study contributes to minimizing the discrepancies between the advantages of BIM in principle and the difficulties of multidisciplinary collaboration in practice, further research on the limitation clauses in contracts and implications of legal obligation during post-construction stages (e.g. facility management and maintenance) is recommended.

Acknowledgement
We thank Mr. Elvis Lee of WSP Hong Kong Limited for his insights of BIM application in practice, which has helped improve the manuscript.

References

[1] Sebastian R 2009 Changing roles of architects, engineers and builders through BIM application in healthcare building projects in the Netherlands *Changing Roles, New Roles, New Challenge, Noordwijk Aan Zee, Netherlands*
[2] Autodesk 2021 Overview: Create coordinated, consistent and complete model-based designs. *Avaiable from:* https://www.autodesk.com.au/products/revit/overview?term=1-YEAR&tab=subscription.
[3] Chiu BWY and Lai JHK 2016 Implementing Building Information Modelling in Building Services Engineering: Benefits and Barriers, *Proceedings of CIB World Building Congress 2016* Tampere Finland 30 May – 3 June **3** 332-343
[4] Chiu BWY and Lai JHK 2020 Building information modelling for building services engineering: benefits, barriers and conducive measures *Engineering, Construction and Architectural Management* **27** 2221-2252
[5] Briscoe GH, Dainty ARJ and Millett S 2001 Construction supply chain partnerships: skills, knowledge and attitudinal requirements *European Journal of Purchasing & Supply Management* **7** 243–255
[6] Singh V, Gu N and Wang X 2011 A theoretical framework of a BIM-based multi-disciplinary collaboration platform *Automation in construction* **20** 134-144
[7] ConsensusDOCS 2015 ConsensusDocs Guidebook *Avaiable from:* https://www.consensusdocs.org/wp-content/uploads/2019/02/301_Guidebook.pdf
[8] Architects Engineers and Contractors 2015 AEC (UK) BIM Protocol. *Avaiable from:* https://aecuk.files.wordpress.com/2012/09/aecukbimprotocol-v2-0.pdf
[9] Construction Industry Council 2018 Construction Industry Council BIM Protocol *Avaiable from:* https://cic.org.uk/admin/resources/bim-protocol-2nd-edition-2.pdf
[10] Chartered Institute of Builders 2015 Time and Cost Management Contract *Avaiable from:* https://www.ciob.org/sites/default/files/Subcontract%20Conditions,%202015%20Edition.pdf
[11] Holsapple CW and Joshi KD 1999 January Description and analysis of existing knowledge management frameworks. In *Proceedings of the 32nd Annual Hawaii International Conference on Systems Sciences. 1999* HICSS-32 Abstracts and CD-ROM of Full Papers 15 IEEE
[12] Kassem M, Iqbal N, Kelly G, Lockley S and Dawood N 2014 Building information modelling: protocols for collaborative design processes. *Journal of Information Technology in Construction*, **19** 126-149
[13] Construction Industry Council of Hong Kong 2020 CIC BIM Standards. *Avaiable from:* https://www.bim.cic.hk/Upload/publication/85/download_1/5b21e635ab47429bb5a9c29ba904f4c2.pdf
[14] Dixon JT and Dattilo AV 2020 The Growth of BIM and Its Impact on Contractor Risk. *Avaiable from:* https://www.constructionexec.com/article/the-growth-of-bim-and-its-impact-on-contractor-risk?MvBriefArticleId=51282
[15] Asare KA, Issa RR, Liu R and Anumba C 2021 BIM for Facilities Management: Potential Legal Issues and Opportunities. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, **13** 04521034
[16] McAdam B 2010 Building information modelling: the UK legal context. *International Journal of Law in the Built Environment* **2 (3)** 246-259
[17] Ashworth S, Tucker MP, Druhmann C and Kassem M 2016 Integration of FM expertise and end

user needs in the BIM process using the Employers Information Requirements (EIR) In *Proceedings of CIB World Building Congress* 2016, 942-953

[18] Walsh I 2003 Good faith and the Duty to Warn - the new proactive approach of the courts to construction contracting. *Avaiable from: http://classic.austlii.edu.au/au/journals/AUConstrLawNlr/2003/70.pdf*.

[19] Eadie R McLernon T and Patton A 2015 An investigation into the legal issues relating to building information modelling (BIM) In *RICS Cobra Aubea 2015. Royal Institution of Chartered Surveyors*

[20] Smith PG and Merritt GM 2020 *Proactive risk management: Controlling uncertainty in product development* Productivity press

[21] Attrill R and Mickovski SB 2020 Issues to be addressed with current BIM adoption prior to the implementation of BIM level 3 in L Scott & CJ Neilson (eds) *Proceedings of the 36th Annual ARCOM Conference* ARCOM 336-345 7/09/20

[22] Autodesk 2018 Create a federated BIM model with sheets for owners *Avaiable from: https://knowledge.autodesk.com/support/navisworks-products/learn-explore/caas/simplecontent/content/construction--E2-80-94-collaboration--E2-80-94-create-federated-bim-model-sheets-for-owners.html*

[23] Hasni MIAK, Ismail Z and Hashim N 2019 Contractual aspects in the utilization of level two building information modelling (BIM) within Malaysian public construction projects. In *MATEC Web of Conferences* **266** 05002. EDP Sciences