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# Contractual issues for Building Information Modelling (BIM)-based construction projects: An exploratory case study

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**Abstract.** Building Information Modelling (BIM) enables close collaboration among project stakeholders to visualize what is to be built in a simulated environment by identifying any potential design, construction or operational issues. Despite the fact of its well-documented benefits, the extensive integration of BIM throughout the project lifecycle remains sporadic. The conventional contracts used in the Malaysian construction industry were established before the development of BIM. As BIM becoming ingrain in the delivery process, the inadequacies of these existing contracts have become visible. This paper presents the results of an exploratory case study using Qualitative Content Analysis dedicated to a BIM project and discusses a procurement approach of BIM to establish the contractual context by addressing the legal and contractual impediments namely; intellectual property, liability and process related risks-allocation in a Malaysian public construction. This paper also outlines the reasons why the implementation of BIM will foster the evolution of integrated contract delivery methods.

## 1. Introduction

Both positive and negative outcomes have over the years been observed in the area of building construction. Such outcomes have been associated with the Building Information Modelling (BIM). Building information modelling (BIM) promises outstanding results of the construction process. The results can be determined through the measurement of the yardstick and an international benchmark for efficiency in Architectural, Engineering, and Construction (AEC), and host of other building services [1,2]. The process of BIM can enhance knowledge sharing for information of a building or facility. It forms a strong fundamental for decision making throughout the life cycle phase from the conceptual design to demolition [3,4]. BIM is a useful multidisciplinary integrated source of information technology that posts benefits and disputes in the construction industry. This model is well recognized as fragmented, adversarial and possibly significant for or during the process of cultural revolution [2,5]. The legal issues of BIM are considered challenges that need to be addressed accordingly. One of the issues is the need to establish contractual arrangements to accomplish BIM positive outcomes [5]. The current laws, regulations and the contractual model lack relevant provisions for the integrated design and the information versions of all stakeholders collaborated in the construction project could not cooperate extensively [3,4]. It has significant impacts on how project stakeholders collaborate and the legal implications that can emerge from any disputes.

BIM has become the potential risk to construction projects contracts because there is no legal status of electronic information and electronic versions could not be filed, which results in duplication of information gathering work [4]. It is essential to form the viable approach of contract document by outlining the goals of implementing BIM and the way it benefits a project [5,6]. The outline of this paper is as the followings; section 2 aims to provide a theoretical background that are minimized administratively or contractually relating to BIM procurement. Section 3 establishes the research methodology that details out the significant aspects of the proposed research. Subsequently, section 4 analyses and synthesizes the case study supported by the literatures towards developing a new framework and strategy to contract delivery may necessarily need to expand.

## 2. Theoretical background of BIM

BIM is usable for multiple purposes, which requires the source of interrelating information by providing the structure, format and relevant content [7] where the model and the data can be extracted and reused to prevent rework or the need to reproduce work. Kuiper et al.[5] indicates that there appears probable risk scenario for owners' responsibility in building/infrastructure assets with regards to traditional contracting delivery methods and to be applied at each stage of the built environment cycle. Alternatively, an industry may differentiate the terms between 'Design Intent BIM' (known as Design BIM) and 'Construction BIM'. In particular, 'Design Intent BIM' encompasses the information commonly originated by designers or consultants, while 'Construction BIM' incorporates the mechanical, architectural and structural details for assembly and installation as prescribed by trade contractors [2,3].

### *2.1. Comparisons between AIA E202, consensus docs 301, NSW Government GC21 construction contract and contract for complex projects (CPC2013)*

Based on the literatures reviewed, there are similarities between the two BIM contracting forms (AIA E202 and ConsensusDOCS BIM 301 addendum). The documents are among the widely used standard form contracts in the global construction industry. The forms have provisions for model ownership, copyrights, information and model management, and model standards are also addressed. However, the contents and the level of details are different. McAdam [4] justifies that the documents published by the American Institute of Architects (AIA E202) contains less detail than ConsensusDOCS 301 in many elements. For instance, both forms require an information manager (or model manager), but "its obligations are delineated in more detail" in the ConsensusDOCS 301 [4]. Some importance differences identified between the two standard forms are as follows:

- ConsensusDOCS 301 considers a liability waiver for using the model information, and it provides licenses to use the intellectual property. AIA E202 separates the process of using BIM from contents of models. In the process portion of the document, the process and responsibilities for model ownership, the model standard, model management, conflict coordination and model archiving are clearly explained in the protocol.
- Levels of Detail (LOD) are defined for the modelled elements in handling the model substance [5,8].
- In ConsensusDOCS 301, project participants have to develop a BIM Execution Plan (BEP), but AIA E202 does not have such a requirement [1,4].

Meanwhile, the New South Wales GC 21 2nd edition contract document represents a typical construction contract and is widely used in New South Wales, Australia for educational, corrective services and infrastructure projects. It is a standardized contract that has been developed in consultation with a wide range of industry stakeholders including contractors, subcontractors, suppliers and client groups [9]. However, from the findings of the literature, a number of recommendations are tabled that address the perceived legal and contractual issues associated with BIM implementation [4,5]. In a similar vein, the Chartered Institute of Building's Complex Projects Contract (CPC 2013) have been suffered from a release date prior to the United Kingdom's publication of key documents to support BIM and consequently, key documents are not present in the contract[10]. Far too little attention has been paid that this novelty in BIM implementation within

global and Malaysian context raises distinct legal and contractual issues, the notion of multidisciplinary collaboration related to intellectual property (IP) from the stance of BIM are depicted, for example, design and digital IPs, especially those models build with consolidation [5]. Meanwhile, comprehensive considerations of BIM's legal issues in contract documents namely; security of data confidentiality, safeguarding data and liability related to IP issue are strongly urged, particularly for an equal and seamless information dissemination, due to the complexity of integrating BIM-use regulations and terms within projects [11,12]. These issues could lead to uncertainty that hinders effective collaboration among project participants from early design and continues through facility management (demolition and reconstruction).

### *2.2. Implications of BIM on procurement*

Procurement can be described as an organizational setting, that is vital in managing the designing process of a constructing a project. In most organizational forms, it is widely employed to facilitate building demands, dispersion of roles, jobs, and risks [13]. Further investigation, in terms of the benefits and drawbacks of BIM were observed by Holzer [14] by means of employing procurement approach in Australia. It was argued that the implementation of BIM was best fit particularly for integrated project delivery (IPD) procurement model. The characteristics of BIM in several contract procurement practices adopted in the industry are delineated in the following subsections [5,8,14].

#### *2.2.1. Construct only*

The 'Construct Only' approach is the commonly utilized contract papers in regulating projects within the construction industry, which appears to distinguish the roles from risks. Even though it does not represent the best mode of communication between BIM contractors and facility management (FM) consultants, the 'design-bid-build' method employed in this type of procurement helps add to the aspect of competition in bidding.

#### *2.2.2. Design and construct (DnC)*

Clients have the tendency to request for lower risks by means of appointing a Head Contractor who will supervise the designing and building phases. Consequently, The DnC is the most well known approach in medium and magnate projects. Moreover, DnC is beneficial due to the transparency of data flow as the specialists can trail their BIM models that are employed by others. Nevertheless, it has to be noted that there is no guarantee of flawless BIM transition from consultants to contractor or to others.

#### *2.2.3. Managing contractor / ECI*

Among the allied project players, the opportunities for BIM collaboration are relatively higher with regards to the method of 'Managing contractor / Early Contractor Involvement (ECI). It is also worthy of note that at the early conceptual design, such an approach integrates dual phases and contractors will supervise the costing matters.

#### *2.2.4. Public private partnership (PPP)*

The PPPs refer to project finance and not as a method of delivery. The PPP is widely adopted for massive projects involving infrastructure that is similar to the DnC approach through the integration of designing and constructing services in the contracts, together with the FM services. Therefore, BIM is employed to collaborate in reducing the lifecycle costs towards maximizing the project sustainability [5].

#### *2.2.5. Alliancing / integrated project delivery (example: Project Alliance)*

Based on the contractual correlation concept, numerous studies were identified that Alliancing or IPD enables displaying smart digital data sharing amongst all project players owing primarily to the elimination of legality. These relational contracts are comprised of procurement, which is communal, including impartial benefits and drawbacks of project stakeholders for which data sharing is considered as transparent throughout all parties.

## 3. Research methodology

The focus of this paper is on BIM contract documents conceptualization and implementation. Databases were searched for construction projects articles using the key words, 'building information modelling (BIM)', contracts, legal risks, issues, and procurement with further subcategories. The inclusion criteria of studies were searched in the following electronic databases namely: Elsevier, Emerald insight and ACM Digital Library. Every study was independently peer reviewed and its suitability was determined with the agreement of acceptance standards. The literatures were analysed to identify the implications that are practical for BIM execution, especially upon developing a contract form for BIM-based construction projects.

This case study relied on a Malaysian public construction project procured under a design and build (D&B) contract with the consultants being hired by the main contractor and the contractor holding the single contract with the client. The collaboration in BIM-based construction networks from contractual aspects was evaluated to enhance the project lie cycle throughout the organizational. The first step of the empirical research consists of a review of the project documents the project team made available to the researchers. The reviewed documents include the project's BIM execution plan, the project organization chart, and the appendices dedicated to the BIM processes. Some other documents related to the BIM modelling activities have also been reviewed by the researchers. The exploratory case study is performed with aims at extending the understanding of BIM-based contracting that are considered as complex. It is used as "a sound and sensible first step" when extensive empirical research has not been yet dedicated to the topic of interest [15]. The aim of the study reported in this paper is not to generate final or definitive evidences, but to suggest some hypotheses to be investigated later, in future works. The investigation adopted an exploratory case study strategy using Qualitative Content Analysis as a means of generating recommendations for amending contracts for BIM implementation rather than testing some form of theory for BIM implementation in the contractual and legal context. The framework for coding in a content analysis uses the thematic topics derived from the literature review, which is comprised of a hierarchical order of domains (thematic distinctions) and subcategories, as delineated in section 4. Besides, the framework of coding is driven by data, where domains will be added while performing the coding process based by using Nvivo 12 on the extent of the definitions attributed to the classifications.

Following the project documents review, semi-structured interviews were then carried out to deepen various aspects of the implementation of BIM in this project. The aim was to confront the project actors with certain inconsistencies between the planned practices (from the project documentation). A total of six project participants were interviewed. The topics discussed mainly revolved around the organization of work in the project, the management and the sharing of information in the BIM processes, related contractual challenges, and the potential individual recommendations each interviewee could provide. Moreover, the key aims and objectives of this paper are to provide a better understanding of BIM to conceivably evolve the construction industry's avenue of approach to the current challenges of contract delivery methodologies in both theoretical and practical aspects. The challenges involve people, policy, process, and technology that determine the stakeholder roles, their information rights and liabilities, their BIM access (read, write) or their obligation to provide a special functionality or data output [16].

## 4. Findings of the case study

Besides considerable benefits of BIM for project stakeholders, there are several risks and barriers to implementing BIM. However, for the purpose of this study, these hindrances are categorized according to specific aspects namely; BIM legal and contractual impediments, intellectual property (IP), liability and process-related risks. The results include a conceptualization of typical barriers to collaboration in BIM-based construction networks and how to deal with the identified barriers. Among the findings of the exploratory case study, the trade contractors were asked how much they think BIM has contributed to their works. The project participants acknowledge the added value of BIM in reducing the average delay of a construction period, and the additional construction cost. This exploratory case study revealed the effective digital collaboration in construction through the case

study of a BIM-based hospital construction project. A set of significant key factors namely; legal and contractual impediments with BIM implementation, intellectual property (IP), liability, process related risk allocation were identified in promoting digital collaboration, including change agents, BIM contracts, a cloud computing infrastructure, and new roles and responsibilities different from the traditional ones.

*4.1. Legal and contractual impediments with BIM deployment*

From a theoretical point of view, the BIM execution plan places a particular emphasis on the responsibilities of the BIM managers. These responsibilities are mainly related to the management of the models' content, quality control and 3D coordination. In practice, the architecture firm and the MEP (mechanical, electrical and plumbing) firm have designated dedicated actors (other than the project manager) to hold this role in their organization. The BIM manager designated by the structural engineering firm seems to have a more general role that can be likened to that of a project manager. He is assisted by a BIM coordinator who is responsible for internal BIM model management. In practice, the BIM managers' roles are not really similar from one discipline to another. The BIM manager designated by the architecture firm has both technical and managerial roles. He is responsible for the weekly upload of the architectural models and their integration with the other models. He defines in advance the elements to be checked for intra- and interdisciplinary clash detection. However, the unclear contract clause regarding such the design professional could recognize when information needed to be preserved was perceived as having a significant impact by the interviewed project participants. Significant efforts have been devoted on the implementation of BIM in the AEC sector to boost the development of Information and Communication Technology (ICT) in Malaysia and other countries [17]. However, Steward et al.[16] stresses that many industry players are unable to gain the benefits of BIM besides technological and cost hurdles from the context of BIM legal issue [1,18]. Research on BIM legal challenges has focused on two primary aspects. The first aspect is to identify the legal issues [1,18,19] and potential challenges in the construction industry. The second aspect is to develop a procurement framework for delivering a BIM in the light of collaborative work-practices [1,5]. Nevertheless, the time-lapse of previous research is quite long where the current contract documents fall off behind technological advancements that do not extensively consider the interrelation between legal issues and the procurement approach faced by the project stakeholders [4,5,16]. Therefore, there is the necessity and feasibility of establishing contracting document management system that allow the deployment of an integrated BIM.

*4.2. Intellectual property (IP)*

The protection of intellectual property is crucial for project stakeholders to identify and define in any event that requires consideration to regulate the ownership of IP (and any licensing arrangements, either actual or implied) in a BIM contextual setting [5]. Particularly, for this case project, the client regularly has access as it is being developed. However, the client of the project confirms that there is no explicit contractual provision on how extensive care must be taken into consideration to ensure that the intellectual property rights are not obscured due to the transparent and collaborative setting of model development. To distinguish IP in the model, areas that need considerable attention include element parts, trade secrets such as construction techniques and sequencing embedded data or databases, file formats in an integrated system, and private information [4,18]. Given that the demand for BIM is increasing, Azhar et al. [3] asserted that the development of more sophisticated platforms is imperative to enhance the level of achievement by delivering IP in a collaborative environment, then it increases the complexity of IP allocation. As far as the authors are concerned, significant efforts have proposed the need to define IP in integrated BIM models and the virtual collective working environment. Due to a lack of determination of ownership of the BIM data, the protection of ownership is needed regarding copyright laws and other legal channels [3,5]. When BIM is adopted by the project stakeholders or contracting parties, it is essential for them to develop specific agreements or contractual provisions to address any contractual interfaces, BIM-related requirements, and the limitations of contractual documentation in the current Malaysian market. The best solution for the

disagreement over copyright issues is to set forth the documents ownership rights, responsibilities, authorized users, and sensitive information in integrated project delivery (IPD) [2,5,11].

*4.3. Liability*

Professional Indemnity (PI) is a primary concern for design authorities who are involved in a BIM collaborative atmosphere [19]. These authorities are obliged for the design contributions to non-professionals, including automatic changes by software. The promising multidisciplinary platform where information is provided by an author or BIM contributor (as a recognized professional) and adopted (or relied upon) by other BIM contributors or another party were acknowledged as part of a process related risk [3]. The issue could arise in contract negligence (either as a duty to a client, contractor/consultant or to a third party) which was not foreseeable [5,18]. Moreover, issues related to the quality control processes were notified by multiple practitioners. For the structural engineering firm, too many quality control processes described in the execution plan that were not adapted to their situation. They are required for an effective quality control as described would take about four weeks, which is totally unrealistic which such a fast track project where the models were continually evolving. The participants adopted the collective idea of advancing the models and performing interference detection at planned moments when the appropriate elements had been modelled properly. Another aspect of quality control is related to the contractor who, according to the execution plan process, had the responsibility to audit the models and their compliance to the Uniformat standard. This process, planned to be managed by the contractor, raised some contractual liability questions. While it was not possible to validate these assertions during the case study, some stakeholders suggested that BIM managers should be responsible for interdisciplinary quality control. Therefore, it is necessary to develop collaborative and integrated contracting methodologies to avoid disputes among project teams involved. Hence, future research should highly consider the design delegation to non-professionals and subcontractors, as well as the effect of software on design updates.

*4.4. Process-related risks allocation*

Legal, contractual and organizational risks are different forms of risks associated with creating, using and managing BIM-related information. "It is a great effort to have outlined the processes to follow but they are natural and too obvious. [...] Ideally, it would have been useful to show the information requirements at some given moments. Here, nothing is detailed enough", said a BIM manager. Beyond the formalization issues, one of the main criticisms practitioners made about the execution plan is that it does not take into account the particular need in a fast track project for different disciplines to coordinate with each other. "We tried to apply the processes proposed in the BIM execution plan. But the fast track project is not linear with only 60% similarity" noted a BIM coordinator. During the semi-directed interviews, all the interviewed participants acknowledged that the processes recommended by the execution plan were too theoretical, too general and were not adapted to the project. "The processes in the BIM execution plan remain very theoretical, and there are many project participants are not knowledgeable with these documents to work on a daily basis, despite the fact that the recommended processes show the main principles of the project", said a BIM manager. There was a sense of understanding the BIM execution plan specification amongst interviewees whereby the proposed processes are seen as difficult to apply and not close enough to the project's reality. It is encouraging to compare this issue with a study conducted by Lee et al. [20] who suggested that the importance of coordination for safeguarding provisions which could be pre-determined within the timeline of BIM deliverables. Such provisions provide clear procedures, processes, and timing of submittals, and determine the roles of the design coordination manager and the data security manager in establishing the model security and BIM data-base.

## 5. A way forward for BIM-based contracting strategy

Upon exploring and reviewing the significant challenges that are confronting all of BIM-based project stakeholders, the question arise, "What needs to be done?" In this study, various aspects, which are of interest in terms of contractual issues with regards to specific BIM functionalities and contract

delivery procurement methods and recommendations for guiding BIM management process were explained. According to the integrated project delivery (IPD) system, the existence of project procurement systems from the practical, technical and industrial advancements alter the project's delivery to implement effective BIM [5,6,16]. American Institute of Architects (AIA), the Associated General Contractors of America (AGC) and Consensus Docs work on respective contractual guidelines and publish contract samples [6,20,21] in enabling BIM project stakeholders (including contracting parties) to plan, design, review, program, cost or manage projects. However, the standard practice of International Federation of Consulting Engineers (FIDIC) contract documents in Malaysia, the contractor constructs the works; designed, civil, mechanical, and electrical and construction works following the design provided by the employer [22]. Nonetheless, issues relating to legal uncertainties in BIM implementation and fee specifications in the local and international construction industry remain unresolved. Since many processes in FM and deconstruction are not aligned with BIM, there are no specific contracts developed and standardized for integrated practices to date [11,16,17].

Although the updated BIM content is crucial for maintenance, retrofit, and deconstruction planning, the onus of the model and content management during the maintenance has not been addressed by previous studies and legal frameworks [3,5]. The rapid development of new technology combined with the lean principles have also guided the project teams to eliminate waste during the construction process [4,5]. Therefore, it is essential to develop new approaches to and strategy for BIM contractual document frameworks. When these tools are used properly, they can change the way an owner makes a contract with a project team.

## 6. Conclusion

Based on an exploratory case study, this paper explored some obstacles when deploying the integrated BIM contract documents. Several elements such as legal and contractual impediments, intellectual property, liability and process-related risk should be considered in the current projects that are delivered for contractual and administrative purposes, which are expected to align with the optimal use of BIM. It is worthy of note that it depends on the dimension being considered for investigation. For instance, the primary focus can be either on the possible influence of an approach on the BIM technology, which features transformative power. Such a power may not only impact on the design process but on the construction process as a whole. It may also equally impact on the pull of a transformative approach to management to employ this design technology for transcending current constraints for performance. The applicable approach is vital as solution of the perceived fragmented and isolated approach in the current construction practices. This may also represent a new frontier for innovation in the construction industry of Malaysia. In fact, the integrated BIM contracting provides significant opportunities that are yet to be discovered in this particular industry.

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