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A Contractual Framework on Legal Obligations for Professional Designers in Building Information Modelling

Lee Yuan Jun[1], Zul Zakiyuddin Ahmad Rashid[1], Mohd Hanizun Hanafi[2], Mohd Nasrun Mohd Nawi[3,*], Norazian Mohamad Yusuwan[4], Shuaib Muhd Rabiu[5]

[1] School of Housing, Building and Planning, Universiti Sains Malaysia, 11800, Penang, Malaysia
[2] Faculty of Architecture and Ekistics, Universiti Malaysia Kelantan, Karung Berkunci No. 01, 16300, Bachok, Kelantan, Malaysia
[3] School of Technology Management and Logistics, College of Business, Universiti Utara Malaysia, Sintok, 06010 Sintok, Kedah, Malaysia
[4] Centre of Studies for Quantity Surveying, Faculty of Architecture, Planning and Surveying Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia
[5] Faculty of Earth and Environmental Science, Bayero University Kano, Nigeria

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ABSTRACT

Building information modelling (BIM) had been adopted in the architectural, engineering and construction (AEC) industry since 2000's owing to the increasing complexity of construction projects. Despite BIM had been proven in leading towards a more effective and efficient design process, Malaysia is still struggling with low BIM adoption rate professional designers in the construction industry particularly due to the absence of legal contractual agreement in dealing with BIM legal issues. This research aims to identify the potential legal issues faced by the industry and to propose BIM legal contractual provisions as BIM addendum into local contracts in Malaysia. Two objectives underpinned in this research, namely, (1) to determine the potential legal issues towards Malaysian professional designers in Building Information Modelling and (2) to propose preliminary legal framework clauses with reference to Building Information Modelling into current local standard form of contracts. Survey questionnaire method using selective sampling was adopted in this research in Malaysia. Thirty-one valid questionnaires were analysed. The results identified 28 BIM related legal clauses that could be included into the local contracts. As a result from in-depth analytical discussion, these potential legal variables were then taken into consideration as contractual framework for legal obligations of professional designers with reference to BIM. While providing a better paveway towards the proposal of BIM contractual provisions in Malaysia, this research helps to fill up the research gap of BIM legal provisions in the Malaysian construction industry.

1. Introduction

Professional designers in AEC (Architecture, Engineering and Construction) industry had been experiencing through the evolution of design and drafting works since the last century, from manual

* *Corresponding author.*
E-mail address: nasrun@uum.edu.my

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approach to Computer-Aided Design (CAD) and in the current trend, to Building Information Modelling (BIM) [17]. BIM undoubtly is an advanced technology that could possibly increase the productivity among designers as it acts as a tool in translating, visualising and presenting ideas in a 3D working environment and enhance the interaction among stakeholders in the project [22,29]. Project is assured on its effectiveness and efficiency in terms of costs and quality with the ability to carry out clash detection, project scheduling, cost estimation, and coordination among multi-disciplinary parties such as architectural, structurual, mechanical, electrical and plumbing fixtures in an integrated model shared among all parties [20,29,33].

In recent years, Malaysian government had been initiating various BIM-related programmes under the Construction Industry Transformation Programme (CIPT) 2016-2020. In Malaysia Building Information Modelling report 2019, BIM adoption in Malaysia increased from 17% to 49% and awareness rate from 45% to 74% from year 2016 to 2019 [15]. Despite of the increment in the level acceptance in Malaysia, the adoption rate is still low compared to other developed country such as The United Kingdom with 69% of adoption rate. Nevertheless, BIM adoption by region showed majority of the BIM adoption was within the central region whereby there is an increasing demand of complex projects. Unclear contractual framework and legal standards or guidelines especially on the obligations of the professional designers are one of the main legal barriers that hinders the implementation of BIM technology in the literature [21,26,27,39]. Unclear roles and responsibilities of designers also leads to low BIM adoption rate in AEC industry [23]. Uncertainties in the legal obligations especially in terms of ownership of data, interoperability issues, insurance and risks allocation among professional designers give significant impact towards the liabilities of designers [27]. From the literature, it is well noting that there is a research gap of BIM legal contractual framework that should be filled with because there is no standards or contracts that addresses the legal obligations of the professional designers in BIM-related project [4,8].

Moreover, previous research focused on the proposal of BIM legal contractual requirements and clauses into contracts between contractors and clients [37,39]. Local contracts such as PWD Form of Contract 203A, PAM Form of Contract 2018 and CIDB Standard Form of Contract for Building Works 2000 were studied to provide solutions in addressing legal and contractual issues relating to BIM. From these, it can be concluded that the works related to BIM legal contracts were still in an infancy stage and due to limited works related to contractual requirements on professional designers' legal obligations, it is crucial to extent the scope of research in studying the potential legal issues and legal requirements of professional designers during project initiation stage that focuses on contracts between clients and consultants.

Therefore, the research aims to propose a preliminary contractual framework to address legal obligations of professional designers in BIM. The research objectives are: (1) to determine the potential legal issues towards Malaysian professional designers in Building Information Modelling and (2) to propose preliminary legal framework clauses with reference to Building Information Modelling into current local standard form of contracts between clients and consultants. International standards such as Consensus Doc 301, BIM Particular Conditions, CIC BIM Protocol and AIA Document E203 are compared on their contract provisions on BIM legal aspects defined in the literature. A survey questionnaire was adopted to collect data on the potential BIM legal variables and BIM-related legal clauses using selective sampling method. Local form of contracts namely Architects Rules 20210, BEM Form 1999 and Form CSA 2014 were compared on the current contract provisions and in-depth analytic discussions were carried out to develop the potential legal clauses with reference to BIM into these local contracts as an addendum. The proposed contractual framework intends to provide a preliminary guideline to the Malaysian construction industry in the contract drafting of legal contracts, especially to contracts between clients and consultants.

2. Literature Review

The implementation of BIM technology requires collaboration among project participants with, encouraging multi-disciplinary integration and data sharing of project model. However, the efficacy of BIM implementation could be difficult if existing legal contractual provisions are unable to practically support BIM functionalities [30]. The legal framework should define the legal obligations and liabilities of the professional designers to avoid any possible disputes among model owners [28]. Aside from that, procurement and contracting system could be easier to be factilitated with a legal BIM framework that specifies the all possible legal risks regarding the usage of BIM-associated model data and information [1] to avoid any legal disputes among project participants due to lack of clarity in legal obligations and liabilities of professional designers [11]. The possible legal risks are as below:

2.1 Model Ownership and Intellectual Property Rights

The collaborative nature of BIM raises legal challenges towards professional designers in model ownership and intellectual property rights due to the joint works from multi-disciplinary parties [7]. The risk impact of intellectual property in BIM collaboration is significant to professional designers [11] and this leads to the following question: Who owns the ownership of the model or the intellectual property? The federated BIM model is an integrated model created by cocreators (architects and engineers) and there will be problems since each contributor is the owner of their own part's creation. In general, each contributors shall entitled to the ownership of their respective contributions and to provide other contributors non-exclusive license to use the model only for the purpose of the project itself in accordance with international guidelines such as Consensus Doc 301 [3,14,19]. The license provided to the project owner is suggested to be limited to the use in operation, maintenance and marketing purposes only and additional licenses shall be purchased from the model owner for future use in other projects by the owner [9]. In situation where architect is the principal designer, the architect shall retain the ownership of the design model but to provide the owner and contractors with licensed uses on the model [3]. On the other hand, there will be certain conditions where the project owner wants to own the BIM model as the model is created for them as contract documents. Ownership may be vested in the project owner (typically for institutional or public owners such as local government), however the designers that created the digital model shall be entitled a license to use the digital model for project purposes if they would like to reuse their model elements on later projects in future [3]. In the case of data information sharing among contributors, this will give path for legal disputes regarding the reuse of model by others via patented information, trade secrets or copyrighted information [24]. Intellectual property rights or copyright infringement could possibly happen if any proprietary and confidential data information is reproduced or reused by others without license or agreement with the model owner [2]. Hence, any use of the digital model under granted licenses from the model owner shall be used only within their scope of works until project completion and the licensed party is not allowed to disclose any digital data to third party to avoid copyright infringement issues [12].

2.2 Roles and Responsibilities of Project Team

The roles and responsibilities of professional designers underwent changes following the introduction of BIM to the construction industry. For instances, the transformation of roles of drafter or draughtsman to BIM modeller [23]. There is no doubt that the BIM model will be replacing the manual method of 2D drafting with computer-aided design (CAD) programme where drawings can

be easily produced from the integrated model [17]. The collaborative working environment of BIM highlights the needs of addressing the roles of the leading designers and the assignment of designers in charge of design quality checking as well as designer that is responsible in carrying out clash detection among multi-disciplinary co-models [35]. The allocation of these obigations among designers ensures the avoidance of legal risks incurred during BIM model integration among project participants [5]. A new position as BIM manager should be introduced into BIM-enabled project to undertake the role of coordination and management of the BIM model data, ensuring an effective and efficient collaboration process among professional designers [6,14,23]. The introduction of BIM manager helps to facilitate BIM coordination and warrant the quality of the joint works by each contributors in such a way that legal disputes and miscommunication could be avoided.

2.3 Interoperability Issues

The BIM collaborative working environment among project participants involves integration of joint works from different contributors and in certain occasions, heterogenous softwares may be used in the same project for modelling [22]. BIM has been the tool for exchanging information between project participants in the project and the design software becomes the medium for information transfer among them [36]. Interoperability during format exchanging of the digital model from different programmes is the greatest challenge and need for the BIM industry since not all project participants own the same BIM software [31]. The exchanged data may include project information such as material quantities, project schedule and costing, structural design and geometric features of the model. Losses to the project owner is unavoidable in terms of cost and time if the interoperability specifications are not well addressed throughout the whole project life cycle [18]. Hence, interoperable file formats such as Industry Foundation Classes (IFC) is always used to support as tool for importing and exporting of digital data from different softwares [36]. Besides that, software incompatibility may lead to information loss during data exchanging as well. In short, technical interoperability problems such as software compatibility, data exchange and file formats are the key issues to be solved during the project planning stage [7] and these specifications shall be attached into contract documents in accordance with BIM exection plan (BEP) to avoid legal disputes from project participants on interoperability issues [12].

2.4 Risk Allocation

Professional designers are imposed to risks when all parties are involved in a joint design of an integrated model during data exchange and information transfer. Flaw or incompatibility of software may impose legal disputes among designers when the model contributor does not review and identify the errors of the model from BIM software [25]. Risk allocation shall be made to all project participants in terms who is responsible in the maintaining and checking the BIM model? The risks coud be transferred away from other designers if an audit system is proposed into the BIM system with assigned party as the maintenance manager of the model in assuring the quality and accuracy of the integrated joint model [24]. On the other hand, the data exchange via external storage systems may impose risks to professional designers such as data loss, data infringement or corrupted data. Therefore, the implementation of secured cloud space or local server among project participants helps to minimize the risk of any data security breach and to provide protection to the BIM data [1]. Aside from data security perspective, the model contributor shall transfer all risks regarding the duty of care away from other project participants. The standard duty of care of the designers shall be following the governing contract or common law [16]. All model contributors are responsible to

provide professional services with appropriate judgement and decision to prevent losses to the project's client [7]. Therefore, model contributor shall limit the use of the digital data in any modification or alteration to safeguard the professional designer's standard duty of care and any errors or inconsistencies of data shall be reported to all project participants to avoid any legal claims or disuptes resulted from the errorneous data [12].

2.5 Professional Indemnities

Professional designers are obligated to provide their professional services including data sharing related to the project to other parties. In case of third party negligence, professional designers shall be indemnified against all claims when there is misuse of digital model by third party. Consensus Doc 301 recommnded that each contributor shall agree to indemnify, defend and hold other project participants harmless against negligence of third parties in cases such as infringement towards designer's contribution [16]. Addition to that, model contributors are not liable towards any unauthorized uses of the model [10] but they are still obligated to carry out due diligence for the information provided to other parties with professional integrity. Moreover, the professional indemnification provision helps to safeguard the risks of professional designs especially to the architects where most of the time architects are at most risks when delegating design obligations on any defective design claims [32].

2.6 Payment and Compensation

BIM implementation is considered as an additional effort in model creation that may benefit to the project owner in future for maintenance. Hence, in the designer's perspective of view, BIM shall be recognised as an effort which deserves additional payment to the professional designers who implemented it. The cost for BIM model development could be addressed in the legal agreement including the rewards if any throughout the whole project [14]. However, some authors argued that project owner may not agree and will not accept additional payment to BIM services as the BIM adoption is considered as a process or method to increase the productivity and efficiency of the designers [10].

2.7 Comparison of Legal Aspects among International BIM Standards

Content analysis is carried out by in-depth review of four international guidelines on the potential legal aspects from the literature, namely: Consensus Doc 301, BIM Particular Conditions, CIC BIM Protocol and AIA Document E203. In general, Consensus Doc 301 provides a more comprehensive legal provisions on all potential legal aspects from the literature than other three standards except for the aspects of payment where all current international guidelines do not provide any legal provisions on payment to professional designers. Table 1 summarizes the legal provisions according to the potential legal aspects defined in the literature.

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Table 1
Comparison of Legal Aspects among International Guidelines

Potential Legal Challenges	Consensus Doc 301	BIM Particular Conditions	CIC BIM Protocol	AIA Document E203
Ownership and Intellectual property rights	Model Contributor retains ownership on its own contribution.	Contributor is the owner of all	Any rights of proprietary works	Transmitting party of digital data ows the copuright

	Contributors to grant owner and other contributors limited, non-exclusive licenses for model use in the project only Model contributor owns the rights in their own contribution in the joint model	copyrights in its own contributions. Model author does not convey any ownership right to other parties Each contributor grants other parties with limited and non-exclusive license for the model use in the project only	are remain vested in the contributor. License granted to other parties should not include the right to modify and reproduce without main author's written consent Contributors shall grant the owner a non-exclusive license to use the proprietary work under permitted purpose	Transmitting party does not convey ownership right of digital data Receiving party shall keep the digital data as confidential and shall not disclose to third parties other than owner, consultants and contractors.
Unclear roles and responsibilities	Design obligations of professional shall not be relieved in this addendum including responsibility for its contributions under governing contract BIM execution plan (BEP) shall be developed and enclosed as exhibit to the addendum	Design obligations of professional shall not be relieved in this addendum including responsibility for its contributions under governing contract	Project Owner shall arrange protocol with designer's obligations including Information Particular and Responsibility Matrix	Architect shall prepare and distribute to the other project participants digital data protocols for review, revision and approval Architect shall manage and maintain the centralized electronic document management system
Interoperability	To include protocol in management of model uses and deliverables in BEP Owner to designate BIM manager to undertake overall responsibility for the use, implementation and creation of BIM for the project that includes obligations as per indicated in clause 3.2.	BEP to be developed in accordance with BIM guideline BS EN ISO 19650	Project team member gives no warranty that software is compatible with that of any other project team member(s) or the employer	Architect shall be obligated in the preparation of digital data protocols, modelling protocols and modelling management protocols
BIM data security	BIM manager to undertake the obligations to develop system access controls for authorized	Nil	Built Asset Security Manager to be employed by the owner to undertake security	Nil

	contributors to access model data BIM manager to maintain and provide security to the digital model		management of the digital data	
Risk Allocation	Each contributor shall be responsible for their own contributions Standard of care applicable to a Contributor's contributions in model data shall be governed by Contributor's governing contract or common law No Contributors shall be responsible for costs, expenses, liabilities or damages that may result from use of its model by other contributors beyond the uses. Project Participants may rely upon the accuracy of information in the design models.	Each contributor is intended to be shared with subsequent model authors throughout the project Model users and may rely on the accuracy of a model element by main author. Standard of care applicable to each party regarding any contribution shall be in accordance with the Principal Agreement Each contributor shall minimize the risk of claims and liability arising from the use of model and it shall not relieve any party of liability for any of its contribution	The project team member shall have no liability to the employer arising out of any modification or amendment, copying use of material by the employer or other project team member for any purpose other than the permitted purpose	Any unauthorized use of digital data is at that party's sole risk and without liability to the other party
Professional Indemnities	Each contributor agrees to defend, indemnify and hold other project participants harmless for claims and causes of action by third parties relating to infringement of expression by that contributor's contribution.	Each party agrees to indemnify and hold such other parties harmless against claims of third parties relating to infringement of expression contained in that party's contribution.	Nil	Nil
Payment	Nil	Nil	Nil	Nil

3. Methodology

BIM has not been widely adopted by local consultants in Malaysia and it is not mandated by the Malaysian government to enforce on the implementation of BIM in AEC industry. Hence, quantitative analysis is suitable to study the wide spectrum of response on the potential legal challenges in Malaysian AEC industry. Selective sampling was applied in the survey questionnaire method by targeting professional designers such as architects, engineers, surveyors and BIM consultants as respondents since BIM is not fully matured yet in Malaysian AEC sector. The survey questionnaires were distributed to a selective target of group of professional designers in Google Form format via email and Whatsapp application.

The survey questionnaire was divided into three sections: Section A to request the information of respondents including profession roles and number of projects involved in BIM-enabled projects. Since working experience in terms of years is not the critical factor in reflecting the actual experience of BIM adoption for professional designers due to the immaturity level of BIM in Malaysia AEC industry, therefore the study recognised the respondent's experience level using BIM by high level experienced (> 5 BIM projects), medium-level experienced (between 2 to 5 BIM projects) and low-level experienced (1 BIM project). In CIDB Technical Report Publication No.208, a majority of 38.9% respondents have zero to five years experience and only less than 10% of the respondents having more than 5 years experience in BIM. Therefore, assumptions need to be made to the justification of level of experiences of respondents where the normal distributed number of designers have BIM experience between 1 to 5 years. Hence, it is logical to assume a designer as high-level experienced if the designer has more than 5 BIM projects within 5 years period.

Section B comprises a total of of seven legal aspects with eighteen potential legal variables to be agreed upon by respondents as potential legal challenges that are facing by the professional designers in the industry. The potential legal variables were extracted and summarised from the literature. Section C is the extension of Section B with addition of potential legal clauses proposed as suggested in the literature and international standards to be agreed upon by respondents on the appropriateness of these clauses to be considered into current local standard form of contracts as BIM addendum. 5-point Likert scale is used in the survey questionnaire for Section B and Section C (on a scale of 1-5 from strongly disagree to strongly agree) and the appropriateness of the proposed legal clauses to be included in local contracts were calculated by averaging the mean from both dependent variables at Section B and Section C. The means from the questionnaire were then analysed and categorized into three simple categories as per recommended by Chong *et al*., [14]:

Agree = 3.5 < mean value ≤ 5
Undecided = 2.5 ≤ mean value ≤ 3.5
Disagree = 1 ≤ mean value < 2.5

The mean $\bar{x}$ is calculated as follows:

$$\bar{x} = (\sum_{i=1}^{n} x_i)/n$$

Where: x = score from Likert scale
n = total number of data samples

Table 2 summarizes the potential legal variables and proposed legal clauses to be studied on its appropriateness for further consideration into local contracts as BIM addendum in future.

Table 2
Potential Legal Variables and Proposed Legal Clauses

Legal Aspects	Legal Variables		Proposed Legal Clauses	
Model Ownership and Intellectual Property Rights	LV1	Unclear model ownership	LC1	Each contributor is the copyright ownership of its own contributions.
			LC2	In the case of ownership of intellectual property transferred to the Client, the agreement should make clear if there is any "background intellectual property" which the contributor will retain ownership.
			LC3	Copyright ownership will be vested in the government, government organization or international body for government projects as stipulated in Malaysia Copyright Act 1987.
	LV2	Unclear right of access for key stakeholders	LC4	No contributor possesses rights in a model greater than those of its own contribution to that model or to a joint work on a model.
			LC5	Model contributor does not convey any ownership rights to other parties unless otherwise granted in a separate license from the contributor to use, modify and transmit the model limited to the scope of the project.
	LV3	Copyright infringement	LC6	Each contributor grants the owner and other contributors limited, non-exclusive license to reproduce, distribute, display or make derivative works only related to the project itself.
			LC7	Additional Copyright License to be used by Owner in using the models developed for purposes other than this project should be governed by the Governing Contract between Owner and Design Professional.
			LC8	The receiving party shall keep the data or model strictly confidential and shall not disclose it to any third parties except its employees, consultants and contractors.
Unclear roles and responsibilities of designers	LV4	Unclear scope of works of professional desginers	LC9	Any design obligations of the design professional shall not be relieved under its governing contract, including for its contributions to comply with applicable codes, regulations or laws.
	LV5	Unclear roles and responsibilities of professional designers	LC10	Roles and responsibilities of each contributor to be determined by BIM manager at the early stage of contract upon agreement from all parties and clearly addressed in the BEP as a supporting document in the governing contract.
	LV6	The need of new roles and responsibilities of BIM manager	LC11	Project Owner to designate BIM manager to undertake overall responsibility for the use, implementation and creation of BIM for the project.
Interoperability	LV7	Information loss due to software incompatibility	LC12	BIM Manager to determine the hardware and software including file sharing platforms and applications including version in the BEP upon agreement among all parties.
			LC13	BIM Manager to determine the format of the digital model to be shared among all contributors using open data formats such as IFC, xlsx and PDF in BEP upon agreement among all parties.
	LV8	Difference in Level of Detail (LOD)	LC14	BIM Manager to determine the model precision requirements such as the use of level of development, granularity, and level of detail measurement tools by phase and milestones.

	LV9	Lack of auditing procedures	LC15	Design review, audit and analysis including quality control, lean coordination and resolution requirements and building systems performance analysis such as structural, MEP, fire protection, etc. to be identified in BEP and managed by BIM Manager.
	LV10	Lack of strategic plan for collaboration	LC16	BIM Manager to prepare Building Information Modelling Execution Plan (BEP) which includes the preparation of deliverables, requirements and BIM-related processes procedures for every party to be agreed upon project initiation phase.
BIM data security	LV11	BIM Data Security Breach	LC17	BIM Manager to develop system access controls for authorized model contributors to avoid any unauthorized access of BIM data.
			LC18	BIM Manager to establish and maintain encryption and access security measures.
			LC19	BIM Manager is responsible to document and report any incident regarding to the BIM Model, including but not limited to an incident originating outside the Model that results in the Model data loss, corruption or unauthorized access and take action to protect the BIM model.
			LC20	QR code for drawings and documents to prevent any infringement or copyright issues.
	LV12	Professional liability on errorneous BIM data	LC21	Each model contributor shall use its best efforts to minimize the risk of claims and liability arising from that contributor's use of BIM Model where such efforts shall include promptly reporting to affected contributors on any errors, inconsistencies or omissions the Contributor discovers in its Models or other Project Models. This shall not relieve any party of liability for any of its contribution.
	LV13	Professional liabilitie on loss of data/unauthorised uses	LC22	Each model contributor shall be responsible for the contributions it makes to a model or the data that is developed as a result of that contributor's access to a model. Each contributor in the affiliated contract waives claims against the other project contributors for consequential damages arising out of or relating to the use of the BIM Model.
			LC23	No contributors involved in creating BIM Model shall be responsible for costs, expenses, liabilities or damages which may result from the use of its Model beyond the uses of stated in the BEP.
Risk Allocation	LV14	Standard duty of care	LC24	The standard of care applicable to a Contributor's contributions to BIM model shall be governed by a contributor's primary agreement or if no such standard is stated, then pursuant to common law.
	LV15	Right to rely on model	LC25	All contributors may rely upon any design models that are included as contract documents in BEP.
Professional Indemnities	LV16	Unclear coverage of professional indemnities	LC26	Each Contributor agrees to defend, indemnify, and hold the other project parties harmless against claims and or demands relating to infringement or alleged infringement of expression contained in that party's contribution.
	LV17	Lack of professional services insurance coverage	LC27	Contributors shall procure and maintain insurance coverage on professional liability insurance for BIM manager, professional designers and technology / cyber liability insurance for all contributors.

Payment	LV18	Additional payment to BIM services	LC28a	BIM contributions should be paid to all contributors including BIM manager as additional service fees by the Client.
			LC28b	Client should not pay for the additional service fees to all contributors including BIM manager as the BIM model is only the approach from the professional designers in design and coordination of a project.

4. Results and Discussion

A total of approximate 60 potential respondents were identified and invited to complete the survey questionnaire and 31 valid questionnaires were collected. 31 valid survey questionnaires were received from the respondents and the sample size of more than 30 respondents is sufficient to approach the normal distribution sampling size for the mean score analysis of the survey questionnaire based on central limit theorem [34]. Majority of the respondents are architects and engineers with 39.4% and 36.4% respectively, followed by BIM consultants with 12.1% and surveyors with 9.1%. In the perspective of experience level in BIM projects, a majority of 42.4% of the respondents experienced 2-5 BIM-related projects, followed by 36.4% of them with only one BIM-enabled project and 21.2% of the respondents who are experienced in more than 5 BIM-related projects. It is worth noting that most of the respondents only possess medium-level or low level experience in BIM. Hence, data validation shall be made to test the accuracy and reliability of the data results. The results shall be interpreted in such a way to determine the relation between these two independent variables against dependent variables in this study.

Two separate reliability tests were carried out to determine the intercorrelation of the 18 dependent variables (potential legal variables) and 29 dependent variables (appropriateness of proposed legal clauses as contract provisions in local contracts) based on Cronbach's alpha test. Cronbach's alpha test determines the internal consistencies among the variables (both legal variables and legal clauses) [13] and the results showed intercorrelation value of 0.821 and 0.946 for both dependent variables which are higher than the threshold value of 0.7. The dependent variables are justified to be acceptable in terms of internal consistencies and hence the results from Likert Scale is reliable. Kolmogorov-Smirnov and Shapiro-Wilk analyses were carried out as normality tests to determine whether the samples are normally distribute or not. As the result, both tests showed significance values below 0.05 for all dependent variables, indicating that the samples are not normally distributed and hence non-parametric tests shall be carried out to determine the relationship between the dependent variables.

Table 3 shows the analysis results for all analyses carried out to the samples. Both dependent variables were analysed by calculating the mean and standard deviation and the variables were categorized into the predefined categories (Agree, undecided or Disagree). Spearman correlation tests were conducted on both dependent variables to determine the relationship and correlation between the two dependent variables. It can be concluded that there is a monotonic relationship between the legal variables and the proposed legal clauses if the p-value in the test is smaller than 0.05 and the Spearman Rho's correlation indicates the strength of association between the variables. The result showed that only 15 out of 29 legal clauses are having monotonic relationship and the rest to be non-monotonic relationship with the potential legal variables in terms of agreement score by the respondents from Likert Scale. The monotonic relationship between both variables shows that the agreement score by respondents on the potential legal variables increases when the agreement score on potential legal clauses as contract provisions is either increases or decreases.

A total of 15 out of 18 potential legal variables are agreed as potential BIM legal challenges in Malaysian AEC industry by the respondents with respect to professional designer's legal obligations. The potential legal variables which are ranked as strongly agree (more than 4 points) are copyright infringement (LV3: 4.16) and professional liability on errorneous BIM data (LV12:4.03). On the other hand, 3 legal variables are less agreeable and remain undecided by the respondents as the potential legal variables (less than 3.5 points) namely: unclear right of access for key stakeholders (LV2: 3.48); unclear roles and responsibilities of professional designers (LV4:3.45) and unclear scope of works of professional designers (LV5:3.39). In the subsequent section, a total of 28 out of 29 proposed legal clauses are agreed upon on the appropriateness to be considered as BIM contract provisions. Among all legal clauses, 6 legal clauses are ranked as highly agreed on its appropriateness as below:

- (LC2:4.1) - In the case of ownership of intellectual property transferred to the Client, the agreement should make clear if there is any "background intellectual property" which the contributor will retain ownership of (e.g., information model objects)
- (LC8:4.03) – Any confidential data or model transferred from the contributor to other parties, the receiving part shall keep the data or model strictly confidential and shall not disclose it to any third parties except its employees, consultants and contractors.
- (LC16:4.03) – BIM Manager to prepare Building Information Modelling Execution Plan (BEP) which includes the preparation of deliverables, requirements and BIM-related processes procedures for every party to be agreed upon project initiation phase.
- (LC22:4.06) – Each model contributor shall be responsible for the contributions it makes to a model or the data that is developed as a result of that contributor's access to a model. Each contributor in the affiliated contract waives claims against the other project contributors for consequential damages arising out of or relating to the use of the BIM Model.
- (LC25:4.1) – All contributors may rely upon any design models that are included as contract documents in BEP.
- (LC28a:4.06) – BIM contributions should be paid to all contributors including BIM manager as additional service fees by the Client.

Kruskal Wallis test was also conducted to determine the relationship between independent variables and dependent variables in this study. There is a need to study and understand the significance of the groups in independent variables on the dependent variables (agreement score on potential legal variables and proposed legal clauses). The test results showed significance p-values above 0.05 and this indicate that regardless the professional role of respondents and the experience level, the agreement scores by the respondents for both potential legal variables and proposed legal clauses are consistent.

Discussion and Preliminary Legal Framework For BIM Addendum

As a result from this study, most of the legal variables were recognised as the potential legal challenges that exist in Malaysian AEC industry. Besides the legal aspects from unclear roles and obligations of professional designers which remains undecided, other legal aspects such as model ownership, interoperability, data security, risk allocation, professional indemnities and payment provisions are the main categories that should be focused on during drafting of BIM addendum. Roles and responsibilities of professional designers could be less worrying during BIM implementation due to the standard duty of care of professional designers that is governed by the principal agreement. Professional designers are obligated to only provide services under his knowledge. Hence, during BIM

implementation, the scope and responsibilities of professional designers do not differ much compared to conventional projects. However, the contractual provisions shall still be included into local contracts to avoid any legal disputes in future.

Majority of the agreed legal clauses could be reuse or rephrased into drafting as an exhibit for BIM addendum into local standard contracts. The main concerns from professional designers views are the ownership issues, interoperability, data security and risks allocation. These legal aspects may lead to legal disputes if left unsolved. Therefore, these legal aspects are at higher ranks in terms of score as potential legal challenges in AEC industry with respect to professional designer's legal obligations. On the other hand, it is noteworthy that additional payment may not be the main consideration for professional designers in BIM implementation. However, majority of the respondents still agree that additional payment shall be given to designers who committed effort in adopting BIM. The obligations and liabilities of a professional designers shall not be neglected on its importance in BIM implementation comparing to payment.

Ownerships of the model is undoubtly another point worth to be brought into discussion on its legal provisions. This study showed that the copyright and model ownership shall be vested in the model contributor itself and any use of the model for the project purpose by other parties shall be granted a limited but non-exclusive license by the model author. Although the project owner owns the project, designers still are entitled to own their creation. However, the model ownership shall be vested in the government for public sector projects as stipulated in Malaysia Copyright Act 1987.

The proposed contractual framework on legal provisions for BIM addendum into local current contracts is presented in Figure 1. The potential legal variables can be defined as the subtheme of the BIM addendum. This legal framework clearly indicates the proposed legal clauses in each legal provisions agreed in this study. The framework is critical in the enforcement of BIM implementation in Malaysian AEC industry where professional designes are safeguarded in terms of their obligations and liabilities against any potential legal issues. In-depth analysis of current local standard form of contracts such as Architects Act 1967, BEM Form 1999 and Form CSA 2014 were carried out. However, there is no BIM legal provisions to address the obligations of professional designers. The proposed legal framework intends to assist in the drafting of the Malaysian BIM addendum which is suitable to include in all local standard form of contract as additional contract documents.

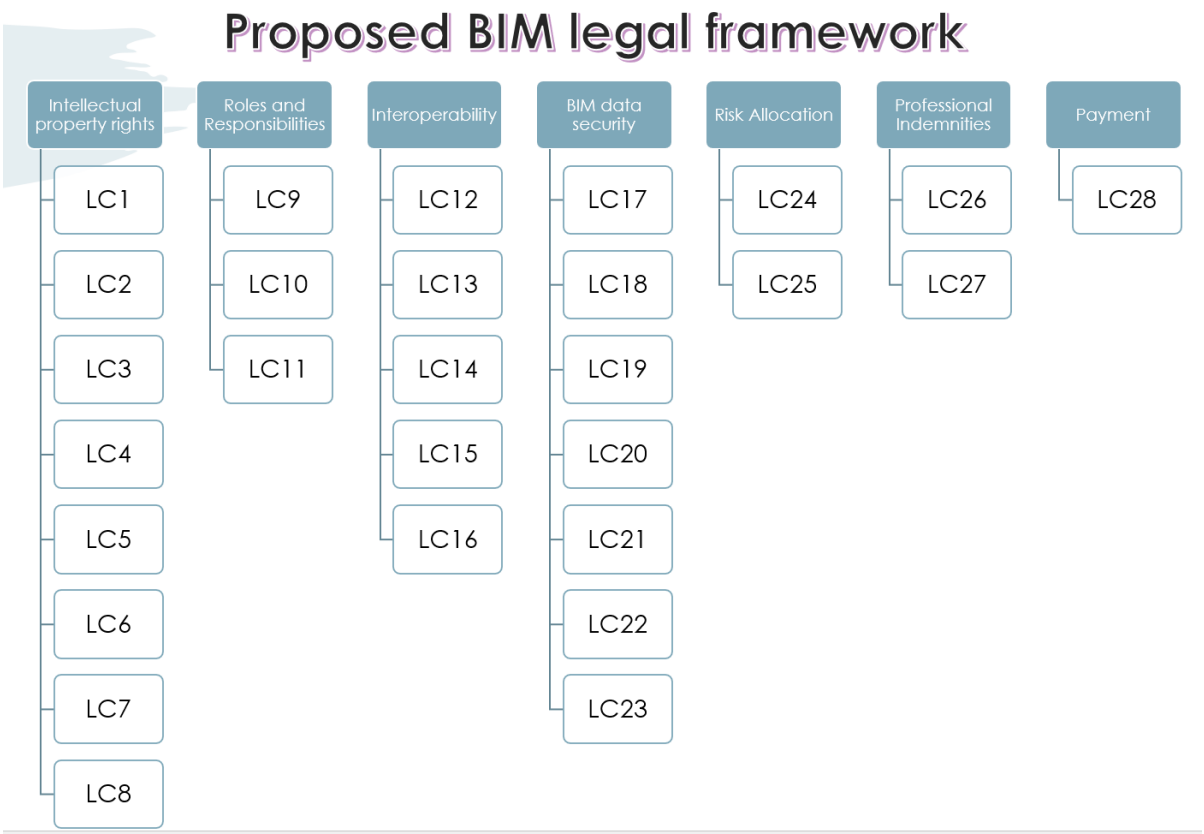


Fig. 1. Proposed BIM legal framework

Table 3
Analysis results for dependent variables

LV	Mean	SD	LC	Mean	SD	Average Mean	Spearman Rho's correlation	p value	Correlation	Decision
LV1	3.77	0.956	LC1	3.97	0.875	3.87	0.181	0.165	non monotonic	Agree
			LC2	4.1	0.746	3.935	0.308	0.046	monotonic	Agree
			LC3	3.9	0.831	3.835	0.356	0.025	monotonic	Agree
LV2	3.48	1.029	LC4	3.61	0.955	3.545	-0.026	0.445	non monotonic	Agree
			LC5	3.65	1.05	3.565	-0.049	0.397	non monotonic	Agree
LV3	4.16	0.82	LC6	3.58	1.057	3.87	0.31	0.045	monotonic	Agree
			LC7	3.97	0.983	4.065	0.553	0.001	monotonic	Agree
			LC8	4.03	0.948	4.095	0.468	0.004	monotonic	Agree
LV4	3.45	0.888	LC9	3.65	1.018	3.55	0	0.499	non monotonic	Agree
LV5	3.39	0.955	LC10	3.77	1.087	3.58	-0.032	0.433	non monotonic	Agree
LV6	3.9	0.908	LC11	3.68	1.107	3.79	0.438	0.007	monotonic	Agree
LV7	3.81	0.98	LC12	3.74	0.855	3.775	0.279	0.064	non monotonic	Agree
			LC13	3.97	0.752	3.89	-0.034	0.429	non monotonic	Agree
LV8	3.94	0.814	LC14	3.84	0.934	3.89	0.409	0.011	monotonic	Agree

LV9	3.97	0.948	LC15	3.81	0.873	3.89	0.48	0.003	monotonic	Agree
LV10	3.71	0.824	LC16	4.03	0.836	3.87	0.306	0.047	monotonic	Agree
LV11	3.68	0.871	LC17	3.94	0.772	3.81	0.259	0.08	non monotonic	Agree
			LC18	3.81	0.91	3.745	0.144	0.219	non monotonic	Agree
			LC19	3.97	0.948	3.825	0.202	0.138	non monotonic	Agree
			LC20	3.58	1.119	3.63	-0.178	0.169	non monotonic	Agree
LV12	4.03	1.016	LC21	3.81	0.98	3.92	0.553	0.001	monotonic	Agree
LV13	3.97	0.983	LC22	4.06	0.929	4.015	0.482	0.003	monotonic	Agree
			LC23	3.55	1.15	3.76	0.49	0.003	monotonic	Agree
LV14	3.84	0.82	LC24	3.81	0.749	3.825	0.389	0.015	monotonic	Agree
LV15	3.81	0.833	LC25	4.1	0.908	3.955	0.541	0.001	monotonic	Agree
LV16	3.87	0.806	LC26	3.68	1.045	3.775	0.138	0.23	non monotonic	Agree
LV17	3.74	0.965	LC27	3.58	1.148	3.66	0.03	0.437	non monotonic	Agree
LV18	3.77	1.283	LC28a	4.06	0.929	3.915	0.287	0.059	non monotonic	Agree
			LC28b	2.58	1.361	3.175	-0.388	0.015	monotonic	Disagree

5. Conclusions

This research aims to investigate the impact of BIM modeling technology towards Malaysian construction industry in terms of legal obligations on professional designers. It had been reported by CIDB that one of the major reasons that hinders the growth of BIM implementation is lack of legal contracts between client and consultants that include the BIM-related provisions with respect to the professional designers. Hence, this study is designed to determine the possible BIM legal challenges that are faced by the professional designers in terms of legal obligations. Current local contracts between client and consultant such as Architects Act 1967, BEM Form 1999 and Form CSA2014 are adopted in this study, and it is well noting here that the current local contracts are not able to address the issues from BIM legal challenges faced by the designers.

A total of 18 BIM legal variables are identified from the literature to be considered as BIM legal challenges and they are categorized into seven main categories which are model ownership and intellectual property rights, unclear roles and responsibilities of designers, interoperability issues, BIM data security issues, risk allocation, professional indemnities and payment. From the survey conducted in this study, respondents are agreed upon on most of the possible legal challenges from the literature. Fifteen out of eighteen BIM legal variables are identified as possible legal variables to be considered for professional designers during BIM implementation. As overall, the respondents are slightly disagreeing to BIM legal variables such as unclear scope of work, and responsibilities of professional designers in BIM-enabled project and this could be due to the nature of the scope of works and responsibilities of designers to be in accordance with the governing contract agreement between client and consultant.

The identification of BIM legal variables further strengthens the need of BIM legal clauses to address the BIM legal variables with respect to legal obligations of professional designers. Hence, a total of 28 legal clauses are agreed upon by the respondents to be included as BIM addendum for

local contracts agreement between client and consultant in addressing to the legal obligations of professional designers. These BIM legal clauses proposed are the contractual framework of legal provisions for BIM-contracts to be considered in the future by the Malaysian construction industry and may increase the level of confidence for professional designers in widely adopting the BIM as design tool in future.

Recommendations for Future Research

This research provides an overall concept of the BIM legal provisions and to be propose a preliminary BIM legal framework to the Malaysian AEC industry. Therefore, further research need to be carried out to study in a more detailed approach in proposing the BIM legal provisions into local contracts. Recommendations for future research are suggested as below:

1. To consider qualitative research method in determining the BIM legal provisions from BIM specialists such as in-depth interviews.
2. To consider other research parameters that might be assisting the study such as previous court cases evidence related to BIM experienced in other countries as research material.

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