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RISK FACTORS TOWARDS PUBLIC-PRIVATE PARTNERSHIPS (PPP) PROJECTS IMPLEMENTING BUILDING INFORMATION MODELLING (BIM) IN THE UNITED KINGDOM (UK): A LESSON LEARNT FOR MALAYSIA

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Abstract

Public Private Partnership (PPP) projects involve stakeholders engaged in various contract structures in a lengthy contract duration. Such situations expose the projects to risks related to collaborative working and information integration. Building Information Modelling (BIM) is seen as a mechanism to improve the collaboration and integration in the PPP projects. However, BIM also exposes its users to additional risk when the barriers in sharing information are reduced. Therefore, the aim of this paper is to investigate the BIM risk factors that have significant impact towards PPP projects implementing BIM. Since the United Kingdom (UK) is considered advanced in practising PPP and BIM, this study investigates the UK industry players' views on what they considered as significant BIM factors in PPP projects. Consequently, the study has identified six (6) most significant BIM risk factors through questionnaire and experts' interviews. The findings provide a lesson learnt for Malaysia to consider the BIM risks in implementing BIM in PPP projects.

***Keywords**:* Building Information Modelling, Public Private Partnership, Risk Factors, Construction Procurement

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INTRODUCTION

Public Private Partnership (PPP) is a strategic approach for a government to provide public infrastructure and services to the public users by using private sector resources and expertise. PPP is either it uses private finance to reduce the financial burden of the government, or both the public and private entities sharing the financial investment in the PPP project with the aim to deliver better products or services to the users, thus providing more value for money (Hodge and Greve, 2007; Khanom, 2010). The concept of PPP was introduced in the United Kingdom (UK) since 1970s (Gamble, 1988) however in Malaysia, PPP scheme started since 1980s through privatisation followed by Private Finance Initiative (PFI) in later years (Abdul Rashid, 2007). Through PPP, Malaysia has able to procure projects such as Teaching Hospital for IIUM Kuantan, Second Penang Bridge, West-Coast Highway and Damansara-Ulu Kelang Expressway (DUKE). In addition, 24 government projects worth RM5.2 billion under Budget 2019 are to be procured via PPP whilst another RM50 million allocated in Budget 2020 to stimulate PPP in the construction industry (BNM, 2019a, 2019b).

Even though PPP is a great alternative for the government to benefit public users, the facts that PPP normally entails with lengthy contract duration involving a myriad of parties and affecting the interest of public users have exposed PPP to many risks (Li, Akintoye, Edwards, and Hardcastle, 2005; Ismail & Harris, 2014). The emergence of Building Information Modelling (BIM) in the construction industry is an immense phenomenon that can potentially assist the industry players to mitigate risks in PPP projects (Lehtinen, 2012; Ganah & John, 2013; Ren & Li, 2017). BIM has the capability in facilitating information sharing and data integration in three-dimensional (3D) data-rich digital platform while offering for a more collaborative and integrative working environment that well-suites to the nature of PPP. Notwithstanding such potentials, the risks associated with BIM are also myriad and inevitable. Thus, based on the UK's experience which considered among the pioneers and advanced in implementing PPP and BIM, the present study is conducted to investigate the significant BIM risk factors that can potentially impact PPP projects. The outcome of the study is considered relevant as a lesson for Malaysia in taking measures to ensure the success of PPP projects implementing BIM.

RESEARCH BACKGROUND

For almost thirty years, Private Finance Initiative (PFI) has become the most Public Private Partnership (PPP) variant that being used in the United Kingdom (UK), which is later in 2012 has been reformed to Private Finance 2 (PF2) to make it 'less private' as alternative to the original PFI. Despite the evolution, both PFI and PF2 remain as a collaborative contracting method for the public and private entities to work together in delivering public infrastructure and services.

The characteristics of PPP include 'bundling' contract, which is the combination of the design, construction, finance, operation and maintenance of the facility contracted out to a private consortium. It involves complex contractual structures, myriad of parties with different roles and interest that need to sustain for 20 to 40 years contract duration (Eaton & Akbiyikli, 2009; Athias & Saussier, 2010). Figure 1 shows the typical contractual structures in PPP projects.

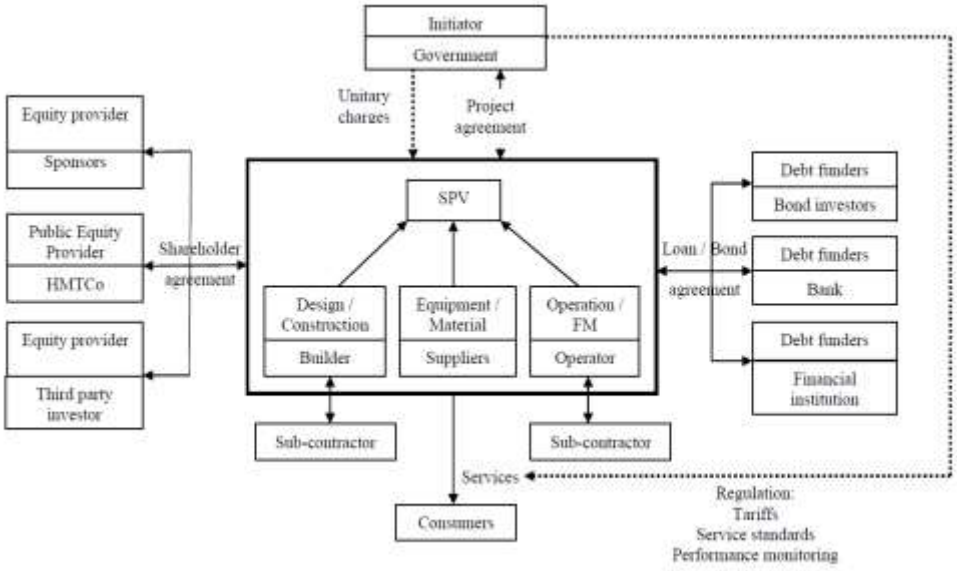

Figure 1: Typical contractual structures in PPP project
Source: Sundaraj (2012)

The complexity of PPP structures leading to the exposure of risks mostly related to the collaborative arrangement, unpredictable future changes and demands; and the expectations on the ability to deliver the project and services with value for money. Therefore, procuring public infrastructure and services via PPP is not always successful (Soomro & Zhang, 2015). Despite the fame of PPP, critics and issues surrounding PPP also being voiced, mostly regarding the real fact of value of money which PPP is supposed to offer (Pollock et al,, 2007; Shaoul, 2009); public accountability issue related to public expenditure and changes in risk allocations (Price & Pollock, 2008; Asenova & Beck, 2009); and profiteering by the shareholders (Chinyio & Gamesan, 2009).

Therefore, some scholars encourage the use of BIM in PPP projects to mitigate the risks (Laishram, 2013; Quinn, 2014; Ren & Li, 2017). BIM is defined as "a modelling technology and associated set of processes to produce, communicate, analyse and use of digital information models throughout construction project life-

cycle" (CIDB, 2016, p.3). Even though it is not expected to completely overcome the uncertainty and complexity of the PPP projects, BIM may encourage the parties to closely collaborate and integrate as well as facilitate possible changes that might happen during the course of the project life span. Impact on future costs and other possible constraints can also be projected which can improve the financial viability. Furthermore, BIM can potentially aid in forecasting and appraising value for money, hence excessive profiteering by the shareholders can be avoided.

St Helens and Knowsley Hospital Project delivered three months ahead of the original schedule is one example of a PFI-BIM project that confirmed the benefits of BIM in PPP projects. Although the adjacent hospitals' buildings need to stay operational throughout the construction period, coordination through BIM enabled off-site construction to be carried out with waste reduction, 60–70% time savings to find documents and 75–80% savings in design coordination (BuildingSMART, 2010). Another PFI-BIM project, £1 billion Barts and Royal London Hospitals Project, also experienced 10% cost reduction via design coordination, construction monitoring and planning (Harty, Throssell, Jeffrey & Stagg, 2010). Notwithstanding such potentials, the risks associated with BIM is inevitable, where 24 risk factors were identified as presented in Table 1.

Table 1: BIM risk factors

Risk Level	Risk Subgroup	Risk Factors	Authors					
			A	B	C	D	E	F
Macro	Social	Resistance to change					✓	
		Lack of available skilled personnel			✓		✓	
	Legal	Existing legal system poorly equipped to regulate multiparty, collaborative relationship		✓				
	Political	Change of BIM policies	✓					
	Technological	Lack of BIM standards and guidelines			✓		✓	
Meso	Contractual	Liability issues	✓				✓	✓
		Ownership of information / model	✓			✓	✓	
		Status of BIM model	✓				✓	
		Unclear position, duty, responsibility, and liability of Information Manager	✓			✓	✓	✓
		Lack of guidelines for contractual agreements	✓				✓	
		Intellectual property rights						✓
		Unclear allocation of risks				✓	✓	
		Privity of contract and third-party reliance				✓	✓	✓
		Integrity of BIM model				✓		✓
		Data security					✓	✓
	Financial	High initial cost to implement	✓		✓		✓	
		Time consuming to be proficient	✓				✓	
Micro	Process	Increase short-term workload			✓			
		Lack of collaborative work processes					✓	
		Inadequate top management commitment			✓			
	Technical	Defective integration between software tools/ Interoperability not guaranteed	✓		✓		✓	
		Errors in the model	✓	✓			✓	
		Little knowledge and experience	✓		✓			
		Model management difficulties	✓		✓			

References:

A = Talebi (2014)
B = Ness (2011)
C = Chien, Wu, and Huang (2014)
D = Simonian and Korman (2010)
E = Azhar et al. (2012)
F = Boyes (2014

RESEARCH METHODOLOGY

Survey research with structured questionnaire and semi-structured validation were carried out to investigate the BIM risks factors that have significant impact on PPP projects based on "significance" 5-Likert scale. Due to the absence of database on the number PPP projects implementing BIM in the UK, convenient sampling of organisations and persons involved in PPP and BIM projects and research was employed, where 700 questionnaires were distributed to 128 organisations and 60 academicians. A total of 88 valid questionnaires were used representing 12.57% response rate. The low response rate is anticipated as BIM is considered new in the construction industry. This is also due to some of the companies have a policy of prohibiting participation in any surveys or questionnaires received from external sources. The respondents were divided in three categories as shown in Table 2.

Table 2: The categories of the respondents

Categories of the Respondents	Frequency	Percentage
Involve in PPP projects only	10	11.4
Involve in PPP and BIM projects	44	51.1
Involve in BIM projects only	34	37.5
Total	88	100.0

The data collected were analysed using the Statistical Package for Social Sciences (SPSS) V23 to calculate the mean score and mean score ranking to obtain the relative significance of each factor for PPP projects implementing BIM. The differences in the opinion among the three groups of respondents were then investigated via Kruskal-Wallis H test and subsequently followed by Mann-Whitney U test for pairwise testing.

RESEARCH FINDINGS AND DISCUSSION

Demographic data of the respondents

Despite the low response rate, the number was considered appropriate for the study since 70% of the questionnaires were answered by a very experienced and knowledgeable group with more than 10 years of experience in the construction industry. Figure 2 presents the demographic data of the respondents.

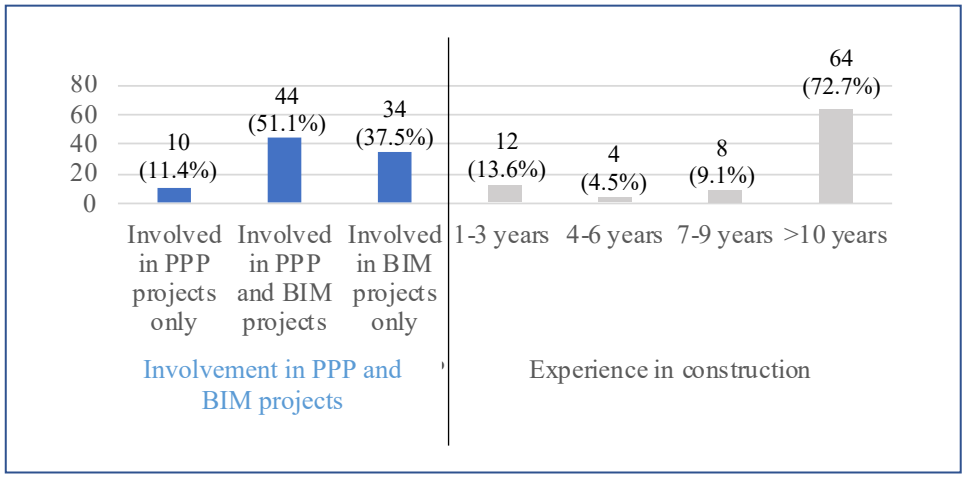

Figure 2: Demographic data of the respondents

Results and Discussion

Table 3 shows the mean ranking based on the opinions of the respondents on the significance of BIM risk factors on PPP projects. Risk factors with mean values over 4.00 are regarded as the most significant risk factors and in this case, there are two most significant risk factors, which are *"lack of available skilled personnel"* and *"resistance to change"*. On the other hand, risk factors which scored mean values of less than 3.50 are considered as moderate risk factors. Subsequently, the data were analysed using Kruskal-Wallis H test to evaluate the differences of opinions among the three categories of respondents. The categories were coded with 1, 2 and 3 respectively.

Table 3: Respondents' opinions on the significance of BIM risk factors on PPP projects

No	BIM risk factors	PPP projects only		PPP + BIM projects		BIM projects only		Overall	
		Mean	**Rank**	**Mean**	**Rank**	**Mean**	**Rank**	**Mean**	**Rank**
1	Lack of available skilled personnel	4.20	2	4.20	1	4.18	2	4.20	1
	Resistance to change								
2	Little knowledge and experience	3.60	4	4.11	2	4.30	1	4.13	2
3	Lack of collaborative work processes	3.50	9	4.02	4	4.00	8	3.95	3
4	Integrity of BIM model	4.40	1	3.89	7	3.88	11	3.94	4
	Defective integration between								
5	software tools	3.80	3	3.91	6	4.03	6	3.94	5
6	Inadequate top management commitment	3.00	18	4.02	3	3.88	12	3.85	6
7	Ownership of BIM model	3.40	11	4.02	5	3.76	18	3.85	7
	High initial cost to implement								
8	Lack of BIM standards and guideli	3.00	19	3.70	10	4.06	4	3.76	8
9	Liability issues	3.20	14	3.73	9	3.91	9	3.74	9
10	Data security	3.60	6	3.52	17	4.00	7	3.71	10
	Existing legal system not equipped								
11	support BIM	2.60	24	3.57	12	4.18	3	3.69	11
12	Lack of guidelines for	3.40	10	3.57	14	3.88	10	3.67	12
13	contractual agreement	3.60	5	3.55	15	3.79	16	3.64	13
	Model management difficulties								
14	Time consuming to be proficient	3.40	12	3.55	16	3.85	14	3.64	14
15	Status of BIM model	3.00	17	3.73	8	3.67	19	3.62	15
16	Unclear position, duty, responsibilit	3.20	15	3.34	20	4.00	5	3.60	16
	and liability of Information Ma								
17	Unclear allocation of risks	3.60	8	3.36	19	3.85	13	3.57	17
18	Errors in the model	2.80	23	3.59	11	3.67	21	3.53	18
	Increase short term work-load								
	Change of BIM policies								
19	Privity of contract and thir	3.00	21	3.57	13	3.52	23	3.48	19
20	party reliance	3.60	7	3.50	18	3.42	24	3.48	20
21	Intellectual property rights	3.20	13	3.20	21	3.82	15	3.44	21
22		3.00	16	3.18	22	3.79	17	3.39	22
23		2.80	22	3.16	23	3.55	22	3.26	23
24		3.00	20	3.00	24	3.67	20	3.25	24

As seen in Table 4, Kruskal-Wallis H test revealed that six risk factors showed significant values of less than 0.05. The low significance values indicate that the opinions of the three groups of respondents regarding the significance of BIM risks towards PPP projects vary significantly. The data were then underwent Mann-Whitney U test in order to test pairwise differences of opinions among the three groups. The values which are statistically significant are marked in bold;

(Asymptotic Significance is less than 0.015. This provides that the opinions between the groups of respondents when being compared vary significantly.

Table 4: Difference of opinion of the respondents on the significance of the BIM risk factors on PPP projects

Risks factors	Kruskal-Wallis H	Mann-Whitney U (at sig. 0.015)		
	Sig.	Respondents' category		
		1&2	1&3	2&3
Defective integration between software tools	0.037	**0.011**	0.037	0.511
Liability issues	0.000	0.053	**0.001**	**0.001**
Time consuming to be proficient	0.004	0.962	**0.002**	**0.001**
Increase short term work-load	0.029	0.560	0.218	**0.008**
Change of BIM policies	0.005	0.849	0.046	**0.002**
Intellectual property rights issue	0.014	0.782	0.601	**0.002**

Based on the responses received from the survey, eighteen (18) BIM risk factors considered to have significant impact to PPP projects were identified (overall mean score above 3.50). Since respondents' opinions vary significantly, validation with six industry experts was undertaken as shown in Table 4.

Table 4: Experts' background

Experts	Designation	Work background	Years of experience	Experience in PPP projects	Experience in BIM projects
IV-1	Director	Construction Lawyer	21 years	12 years as legal advisor	5 years in research on BIM
IV-2	Chief Executive; Professor	Construction Lawyer; Academician	26 years	25 years as legal advisor	6 years in research on BIM
IV-3	Director	Construction Lawyer	30 years	15 years as legal advisor	4 years as legal advisor
IV-4	Senior Lecturer	Construction Lawyer; Academician	11 years	2 years as legal advisor	5 years in research on BIM
IV-5	SPV and Investment Manager	Quantity Surveyor, Project Manager	22 years	15 years	5 years use BIM in design and data
IV-6	Quantity Surveyor	Quantity Surveyor, Developer	17 years	17 years	7 years

Two of the BIM risks factors, which are *'lack of available skilled personnel'* and *'resistance to change'* are social-related risk due to unfamiliarity with the new norms of working with collaborative and integrative BIM (Arayici, Egbu, & Coates, 2012; Lindblad & Vass, 2015). These are also the reasons of technical competency-related risks which are *'little knowledge and experience'*; and *'model management difficulties',* listed as significant BIM risks to PPP projects. Khosrowshahi & Arayici (2012) claimed that BIM implementation not only requires learning new software applications, but also learning how to reinvent the workflow, how to train staff and assign responsibilities, and the skill in modelling the projects. In the context of PPP, the risks are more severe because the data management has to be sustained for 20-40 years. Two more risks factors which are *'lack of guidelines for contractual agreements'* and *'liability issues'* are related to legal and contractual matters; thus, contractual risks related to collaborative and integrated working (Winfield, 2015, King's College Centre of Construction Law and Dispute Resolution, 2016) need to be addressed in order to eliminate the constraint that hinders having successful PPP projects implementing BIM.

CONCLUSION

PPP and BIM are well-promoted worldwide, and both can be integrated to boost the industry, however studies that integrate these two are very limited. The findings of the present study suggest that despite the massive benefits that BIM can offer to PPP projects, additional risks associated with BIM cannot be underrated. Risks related to technical competencies, social and legal are the most significant risks that can impact PPP projects, thus need to be addressed brilliantly to ensure success. Besides of adding to the limited knowledge in this field, the findings are considered as a lesson learnt for the Malaysian construction industry to consider developing relational-collaborative contractual instruments that can seamlessly integrate parties in PPP projects and acts as risks mitigating strategy in PPP projects implementing BIM.

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