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A Preliminary Review on Transaction Cost Components Within the BIM Adopted Procurements

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ABSTRACT

The Malaysian construction industry although it plays a crucial function in stimulating the economy, is lagging behind other economic sectors. This is due to its unique characteristics such as fragmentation and slow technology adoption. These very characteristics make the industry susceptible to construction disputes. Construction disputes were found to incur high transaction costs (TCs), affect the parties involved, and subsequently increase overall project costs. Because TCs measure the costs that incur from transaction activities, they can be used to better understand the benefits within each transaction. Additionally, TCs are the best mechanism for analysing the 'unseen' costs of construction procurement. Previous studies on the traditional, design-and-build, and public private partnership (PPP) procurement methods have demonstrated TCs affect the organizational dynamics of construction and selection of procurement. The emerging Building Information Modeling (BIM) technology is said to be beneficial in addressing the problems associated with disputes and overall project costs. Consequently, many projects embark on BIM adoption in procurement. Hence, this preliminary study seeks to identify the TCs of BIM-adopted procurement by employing a structured literature review to determine the components and activities within the BIM procurement within the BIM implementation. The initial framework for the components of TCs of BIM procurement was drafted by referring to RIBA Plan of Work with BIM overlay. The components are categorised into pre-contract and post-contract components. These components can serve as the basis for developing a framework that can serve as a guideline for construction players involved in managing the TCs of BIM procurement.

Keywords: Transaction costs, Building Information Modeling (BIM), Procurement, Construction industry

1. Introduction

Construction industry plays a vital role in the economy because it acts as an investment industry (Mustapa, 2014) from which the outputs are used by other sectors as economics factors of productions (Ive & Gruneberg, 2000; Ofori, 1990). Although its contribution to the GDP is considered relatively small (3–5% annually) (Kpamma et al., 2017), the special character of the industry has made it a sector necessary for shaping the economy (Mustapa, 2014; CRC Construction Innovation, 2007; Gofhamodimo, 1999). One of the special characteristics of the construction industry is its transient nature (Mustapa, 2014) in that the "organisations" running the industry are "temporary" and will be disbanded at the end of a construction period (Kpamma et al., 2017). For this reason, there is a need to determine contractual obligations between parties in order to safeguards individual interests. Contractual obligations can be established and clarified at an early stage prior to signing a contract, and the contract documents in turn

would serve as evidence of the agreement. A contract document then becomes an essential piece of information that acts as the binding obligation formed between two or more parties in a construction project. It serves as a document that conveys legal and technical information and ideas to the various construction parties involved in a project (Gofhamodimo, 1999).

1.1 High Transaction Costs due to Disputes in Traditional Procurement

Traditional procurement nevertheless has been the most dominant form of contract used in the Malaysian construction industry from 2015 to 2017 (Kpamma et al., 2017). The trend could probably be due to familiarities among construction players as well as the method being a tried-and-tested approach within the construction industry (CRC Construction Innovation, 2007). However, the traditional procurement method has been noted with several drawbacks, such as the separation between design and construction phase (Mohd Nawi, Baluch, & Bahauddin, 2014), the obligations held by many parties (Masterman, 1992), and the adversarial relationships among construction parties (McDermott, 1999). The separation between the design and engineering phase is seen to be the root cause to many of the problems in construction projects (Mohd Nawi et al., 2014). Apart from being inefficient during the construction stage, the traditional procurement is also known to cause project complexity and disrupt project scheduling. Other unfavourable outcome noted from the use of the conventional method are the high number of design changes, high number of redo-works, costs increase, and construction delay, which subsequently lead to construction disputes (Thobakgale, Aigbavboa, & Thwala, 2014; Li, Arditi, & Wang, 2014; Kong & Gray, 2006).

Construction disputes not only affects a project's scheduling and performance but also leads to increase in construction costs (Thobakgale et al., 2014). In fact, disputes and litigation inflict high transaction costs in construction projects (Li et al., 2014). In Asia, it was reported that the value of disputes reached RM 261 million (Arcadis, 2016). This can imply that disputes cause high transaction costs in the Asian construction industry, including the Malaysia's. This view is supported by M. Rajeh (2014) who studied the relationship between transaction costs and traditional procurement. The findings highlight the higher transaction costs incurring in traditional procurement compared to the outcome from the use of other procurement types, such as design and build. It can be deduced that the traditional procurement method could lead to high transaction costs following disputes, and therefore, other procurement methods should be considered in ensuring successful project completion.

1.2 Transaction Cost Economics (TCE): Better Understanding in Making Economic Exchange

Transaction cost economics or analysis allows construction parties to have better understanding of the reasons of conflicts and disputes that occur during an economic exchange, for instance, contract incompleteness due to bounded rationality and uncertainty, as well as opportunistic behaviour (Yates, 1999). Transaction costs are the costs incurred from transaction activities within the construction industry (Li et al., 2014). It involves the searching and information costs; bargaining and decision costs; and policing and enforcements costs (Williamson, 1985). For instance, the activity to identify and evaluate potential contractors for the construction project is considered an activity during the tendering stage (Sinclair, 2012), which incur costs as it involves the cost of searching for information.

Transaction costs analysis is said to be useful for studying the benefits of making economic exchange as well as for studying the impacts of an organisation with high performance ambiguity at both pre and post contract works (Boudreau, Watson, Chen, Greiner, & Sclavos, 2007; Rajeh, Tookey & Rotimi, 2015). Transaction costs incurred from disputes is categorised into both direct and also indirect costs (Yates, 1999). Direct costs include the costs for lawyers in settling the disputes, consultants' claims, time management, and delays in projects completion (Bruin, 2015). Indirect costs include the costs caused by deterioration of the relationships among working partners, effects of mistrust among parties, and insufficient teamwork (Yates, 1999).

1.3 Potential of Building Information Modeling (BIM) to Lower Transaction Costs By Reducing Disputes

Building information modeling (BIM) was introduced in response to the technological change within the construction industry. BIM is said to be able to minimise the costs related to supply chain by offering a sharable asset information platform for the coordination of design and construction (EC Harris, 2013). In addition, BIM should benefit the industry in several ways, particularly by (i) achieving the idea of sustainability and efficiency (Khalfan, 2015); (ii) discouraging legal disputes as well as costly litigation (Mosey et al., 2016); (iii) improving the roles played by supply chains; (iv) facilitating the construction firms in achieving competitiveness, qualities, and efficiency, profitability; and (v) providing collaborative and innovative work nature (Khalfan, 2015). Furthermore, projects adopting the BIM method would benefit from cost reduction, enhancement of control, and time savings (Bryde, Broquetas, & Volm, 2012).

By allowing digital viewing, testing, designing, constructing, and deconstructing at the early stage of a project's lifecycle, BIM can facilitate the projection of a construction process before the actual construction, which will normally involve large amount of labour, material, and equipment (Khoshnava & Ahankoob, 2006). Hence, adoption of BIM allows the identification of problems beforehand and also allows the construction team to resolve the problems before the commencement of the construction. Such a benefit was demonstrated in a project in America where 257 constructability issues and 7,213 conflicts were identified through the BIM reviewing process at the early stage prior to construction. On the other hand, only 6 constructability issues and 1 conflict were identified from the use of the traditional method (Khoshnava & Ahankoob, 2006). These findings clearly imply the difference between the traditional and BIM models in reviewing and searching for conflicts at the early phase. It can be concluded, therefore, that the BIM model could prevent disputes among construction players (Khoshnava & Ahankoob, 2006).

BIM adoption has been applied in several procurement types, including public private partnership (PPP), and has been witnessed its efficiency and effectiveness in improving project outcome by means of increasing the project value (Ganah & John, 2013), to list a few. The transaction costs incurring with the use of other procurement types have been studied as well, such as those of design-build projects (M. A. Rajeh, Tookey, & Rotimi, 2013), and PPP projects (Thomassen, Vassbø, Solheim-Kile, & Lohne, 2016; De Schepper, Haezendonck, & Dooms, 2015). A study on the transaction costs of PPP projects allows identification of variables that can have severe impacts on the transaction costs in PPP, which in turn, can inform the suitable solutions for designing higher efficiency in PPP governance (Ho & Tsui, 2009). In addition, studying the transaction costs involve in PPP projects can facilitate the understanding of the competitive setting of PPP market, thus enabling the findings to inform measures for safeguarding the benefits of the project. Some of the measures are to lower the transaction costs and to make improvement and increase value to the private sector's investment (De Schepper et al., 2015).

Because disputes are one of the notable factors that lead to high transaction costs, good understanding and anticipation of disputes at the early stage of a construction project is beneficial. Managing conflicts and disputes at this stage and providing solution to the conflicts are central in ensuring successful project completion. However, there is still a lack of research that focuses on the TCs of BIM-adopted procurement. Therefore, this research seeks to study transaction costs of the procurement with BIM adoption. This research will determine the transaction cost components in BIM procurement with the aim to provide a basic guideline for the construction players involved in BIM adoption procurement.

2. Methodology

A structured literature review was implemented to study the transaction cost economics and BIM adoption procurement to outline and identify the transaction cost components involved in BIM adoption procurement. The review process managed to derive the crucial components of transaction costs in the typical life cycle of a BIM-adopted project. Findings from the literature review were then based upon to outline a conceptual framework of the transaction costs incurred in BIM-adopted procurement, as shown in Figure 1.

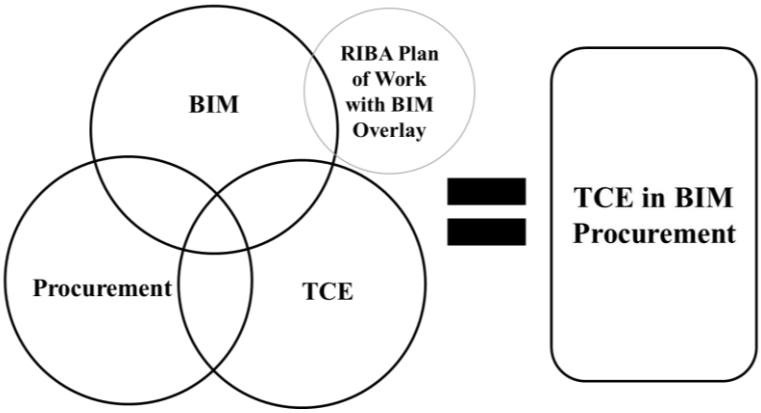

Figure 1 Proposed Conceptual framework for outlining Transaction Costs within BIM adopted procurement

As shown in Figure 1, neither one of the three elements (procurement, BIM, TCE) can be absented from the framework. As indicated in the literature on TCE, transaction costs can be categorised into pre-contract and post-contract costs which consist of (i) searching and information costs; (ii) bargaining and decision costs; and (iii) policing and enforcements costs. Each of the pre-contract and post-contract transaction costs can be further broken down into detailed stages based on the RIBA plan of work, such as the appraisal stage and design brief. For each of the stages, the activities related to transaction costs were identified to determine the transaction costs involved. The components of BIM in relation to procurement were identified and outlined as a basis for identifying the transaction costs incurred. The expected outcome will help shape the conceptual framework for this study.

3. Main Results

3.1 Transaction Costs Framework for Different Procurement Methods

Table 1 shows the framework of transaction costs incurring at different stages of the traditional procurement and BIM adoption procurement.

Table 1 Transaction Costs Framework in Traditional and BIM Adoption Procurement

Stages		Types of Transaction Costs in Different Procurement	
		Traditional Procurement	**BIM Adoption Procurement**
Pre-Contract	*Appraisal, Design Brief, etc.*	• Searching and Information Costs	• Searching and Information Costs, Bargaining and Decision Costs
Contract	*Tender Action*	• Bargaining and Decision Costs	
Post-Contract	*Construction, etc.*	• Policing and Enforcement Costs	• Policing and Enforcement Costs

As shown in Table 1, the pre-contract stage in the traditional procurement involves searching and information costs while the contract stage involves bargaining and decision costs (Chang & Ive, 2000). Whereas in BIM-adopted procurement, it is anticipated that both searching and information costs, and bargaining and decision costs, are involved since pre-contract and contract stage, due to BIM's collaborative practice.

3.2 Initial Framework of BIM Transaction Cost Components

Table 2 outlines the proposed framework of the transaction cost components of BIM adoption procurement. The proposed framework outlines the stages in a construction project according to the RIBA plan of work with BIM overlay.

Table 2 Initial Framework of BIM Transaction Cost Components

BIM Procurement	Stages	Transaction Cost Component derived from Core BIM Activities *extracted from RIBA Plan of Works with BIM overlay* (Sinclair, 2012)
Pre-Contract Costs	**Appraisal, Design Brief**	• Advise client on purpose of BIM including benefits and implications. Agree level and extent of BIM including 4D (time), 5D (cost) and 6D (FM) following software assessment. Advise client on Integrated Team scope of service in totality and for each designer including requirements for specialists and appointment of a BIM Model Manager.
		• Define long-term responsibilities, including ownership of model.
		• Define BIM Inputs and Outputs and scope of post-occupancy evaluation (Soft Landings).
		• Identify scope of and commission BIM surveys and investigation reports.
	Concept	• BIM pre-start meeting.
		• Initial model sharing with Design Team for strategic analysis and options appraisal.
		• BIM data used for environmental performance and area analysis.
		• Identify key model elements (e.g. prefabricated component) and create concept level parametric objects for all major elements.
		• Enable design team access to BIM data.
		• Agree extent of performance specified work.
	Design Development, Technical Design	• Data sharing and integration for design co-ordination and detailed analysis including data links between models.
		• Integration/development of generic/bespoke design components.
		• BIM data used for environmental performance and area analysis.
		• Data sharing for design co-ordination, technical analysis and addition of specification data.
		• Export data for Planning Application.
		• 4D and/or 5D assessment
	Production Information, Tender Documentation, Tender Action	• Export data for Building Control Analysis.
		• Data sharing for conclusion of design co-ordination and detailed analysis with subcontractors.
		• Detailed modelling, integration and analysis.
		• Create production level parametric objects for all major elements (where appropriate and information exists this may be based on tier 2 supplier's information).
		• Embed specification to model.
		• Final review and sign off of model.
		• Enable access to BIM model to contractor(s).
		• Integration of subcontractor performance specified work model information into BIM model data.
		• Review construction sequencing (4D) with contractor.

Table 2 Initial Framework of BIM Transaction Cost Components (Cont')

BIM Procurement	Stages	Transaction Cost Components derived from BIM Activities (extracted from RIBA Plan of Works with BIM overlay)
Post-contract Costs	**Mobilisation, Construction to Practical Completion**	• Agree timing and scope of 'Soft Landings'.
		• Co-ordinate and release of 'End of Construction' BIM record model data.
		• Use of 4D/5D BIM data for contract administration purposes.
	Post Practical Completion, Model Maintenance & Development	• FM BIM model data issued as asset changes are made.
		• Study of parametric object information contained within BIM model data.

For example, during the pre-contract appraisal stage, activities involving advising client on purpose of BIM is considered as activities within the transaction cost analysis. This pre-contract activity requires searching and information costs, which are within the transaction cost components and BIM-adopted procurement.

4. Conclusion

It has been noted that the transaction costs within the traditional procurement is higher than those incurring in other procurement types, including the design-and-build method. Because BIM brings several advantages to the construction industry by means of the reduction in overall project costs, it would be beneficial to perform a transaction costs analysis of the BIM procurement so as to ascertain the benefits of the method to the construction industry generally and construction projects specifically. There is still lack of studies investigated the transaction costs of BIM procurement. Findings from this research, therefore, can facilitate determining the transaction costs incurring in the BIM adoption procurement and procurement types as a means to determine the benefits of the procurement to related parties.

It is expected that the types of transaction costs involved in BIM procurement are differing from those incurring in traditional procurement. BIM adoption procurement is expected to involve both costs of searching and information as well as costs of bargaining and decision during pre-contract and contract stages due to the collaborative nature of the method. The conceptual framework of the components that incur transaction costs in BIM adoption procurement is prepared by referring to core BIM activities extracted from RIBA plan of work with BIM overlay. The conceptual framework is classified into pre-contract and post-contract stages, which are further expanded into more detailed stages of transaction costs in order to better illustrate the TCs of each project stage to industrial players.

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