ASSESSMENT OF FINANCIAL RISK FACTORS IN ADOPTION OF BUILDING INFORMATION MODELLING FOR CONSTRUCTION PROJECTS IN ABUJA

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ABSTRACT

Building Information Modelling (BIM) is a reliable information data base in form of a 3D digital prototype graphics that represents in details the total life cycle of a facility. Literature revealed that the process of implementing new technology involves numerous challenges, and the performance of new technology can be weakened by unidentified risk factors during implementation. This study assessed the financial risks in adoption of BIM for construction projects in Abuja. Literature reviewed revealed 8 benefits and 8 financial risk factors of BIM respectively. This forms the basis for adopting a structured questionnaire that was administered using simple random sampling to a sample frame of 81 professionals at building design firms in Abuja. The three most important benefits of BIM were identified as 'Visualization', 'Estimating is improved through the ability to model project options before and during Construction' and 'The quality level of the finished projects is improved as the quality of data in BIM models is maintained by its users. It is therefore recommended that identified risks some of which include high cost of software and high cost of hardware upgrade should be fully understood by consultants, contractors and all BIM practitioners in the construction industry. It is also recommended that a systematic analysis of financial status and capability to identify the changes needed to facilitate BIM implementation in the construction industry should be undertaken.

Keywords: Adoption, Benefit, Building Information Modelling, Construction Industry, Financial risk.

INTRODUCTION

Building Information Modelling (BIM) is one of the most promising developments in Architecture, Engineering, and Construction (AEC). With BIM technology, one or more accurate virtual models of a building are constructed digitally. It supports design through its phases, allowing better analysis and control than manual processes. Building Information Modelling (BIM) is also a powerful set of design management's tool that has been highlighted by the AEC. BIM has significant advantages over the entire building lifecycle, particularly design but also construction and facility management. BIM is emerging as a new powerful technology. Firstly, it has all the functions of 3D CAD. Whereas 3D CAD modelling was merely collections of points, lines, 2D shapes and 3D volumes, in the BIM concept, such geometric entities can also have symbolic or abstract "meaning", as well as quantitative or qualitative data (Yan and Damian, 2008).

Enhanced usage of electronic design and construction processes holds promises for saving time and money, reducing claims and increasing the quality of performance, especially on complex projects. one must consider and recognize however the individual risks associated with this new process (Stanley, 2014).

Cost and Finance play a very vital role in any construction project, therefore, proper understanding of the financial risks' factors affecting BIM adoption is necessary to ensure that

BIM is efficiently adopted. This research is aimed at assessing the financial risks in adoption of BIM for construction projects in Abuja by identifying and examining the risk factors as this was not done by previous researchers.

REVIEW OF LITERATURE

Building Information Modelling (BIM)

Abubakar *et al*. (2014) stated that Building Information Modelling (BIM) is one of such innovative processes that promise to bring about the continuous improvement and desired change in the construction industry and revolutionise the processes of its operation to achieve better collaboration between project parties and ensure successful project delivery. BIM stimulates the construction activities in a virtual environment. With BIM technology, an accurate virtual model of a building known as Building Information Model is digitally constructed and used to support the design, procurement, fabrication and physical site construction activities required to realize the structure are all developed. The model is also used for the maintenance and facility management of the building after completion.

BIM extends its use to incorporate a 4th dimension (4D) - time and a 5th dimension (5D) - cost, which specifically concerns the quantification, modification and extraction of data contained within the model in order to become the primary source of information for Quantity Surveying (QS) services (Stanley, 2014).

BIM has been defined as the digital representation of the physical and functional characteristics of a facility, which serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward (Building Smart, 2010). According to (Thuraijah and Goucher 2013) Building Information Modelling (BIM) represents the formation of digital models for use during the planning, design, construction and operation stages of a facility 's life.

BIM Application

BIM entails a seven-dimensional process. The 3D modelling process extends to scheduling and sequencing (4D), cost estimating (5D), sustainable design also termed Green Design (6D) and facility management (7D)" (Hassan and Yolles, 2009). Fansworth *et al*. (2014) identified thirty-two different applications of BIM use for commercial construction, and those most commonly used included clash detection, 3-D modelling, team collaboration, constructability issues of design, and sales. Communication, scheduling, coordination, visualization, and clash detection were identified as the top advantages of using BIM. Regarding the effects of using BIM, companies reported a positive impact on profitability, time of construction, and marketing.

Benefits of BIM

The productivity and economic benefits of Building Information Modelling (BIM) to the global building industry are widely acknowledged and increasingly well understood. Further, the technology to implement BIM is readily available and rapidly maturing (Pittman *et al*., 2007).

The benefits of BIM are obvious in its ability to capture, organize, integrate, maintain and grow the wide amount of knowledge, data and information required to conceive, plan, design, construct, operate, maintain, adapt, renovate and, finally, beneficially deconstruct a building at the end of its life cycle.

Eastman *et al.* (2012) found that the team experience level was very important in maximizing benefits from BIM, and with little experience, it is possible to see negative results from its implementation.

Generally, the major benefits of BIM can be highlighted as: 'Visualization', 'Collaboration', 'The quality level of the finished projects is improved as the quality of data in BIM models is maintained by its users', 'Project conceptualization is made easier', '5D offers more efficient take-offs during the Budget Estimate Stage', 'Earlier risk identification e.g. potential clash detection is improved, at an earlier stage than with traditional approaches', 'Improve Energy Efficiency and Sustainability', 'Estimating is improved through the ability to model project options before and during Construction'.

Risks of Adopting BIM

BIM brings with is many it many advantages for the digital design of buildings. Yet with BIM comes issues and risks that a design professional must consider. Enhanced usage of electronic design and construction processes holds promises for saving time and money, reducing claims and increasing the quality of performance, especially on complex projects. one must consider and recognize however the individual risks associated with this new process (Stanley, 2014).

Bello (2016) assessed risk factors impacting on adoption of BIM at organizational level and identified 30 risk factors in relation to technical, financial, management and legal aspects of BIM. Previous research identified a list of financial and cost issues which form the financial risks of adopting Building Information Modelling.

The risk factors affecting BIM can be grouped into Technical risks, Management risks, Environmental Risks, Financial Risks, and Legal Risks.

Financial risks affecting BIM adoption

Table 1 shows a summary of the financial risk factors affecting BIM adoption as identified in the literature review.

Table 1: Summary of financial risks.

S/N	Factors	Sources
1	High Cost of Integrated software/Models	Abubakar, 2014
2	High cost in terms of time and training	Chengshuang *et al.*, (2015)
3	High cost of implementation process	Thomson & Miner, (2010); Azhar, (2011); Ganah & John, (2014)
4	Cost of required software upgrade	Giel & Issa, 2011:2013; Rezgui *et al.*, (2013); Eadie *et al.*, (2013); Porwal & Hewage, (2013)
5	Cost of hardware upgrade	Abubakar *et al.*, (2014)
6	Increase in short term cost	Kuo-Feng *et al.*, (2014)
7	Transition and behavioural costs	Kuo-Feng *et al.*, (2014)
8	Additional Expenditure	Kuo-Feng *et al.*, (2014)
9	No proof of financial benefits	Khosrawshashi *et al.*, (2012)

RESEARCH METHODS

The target population of this research is the Nigerian Building Design firms. Since not all the design firms could be studied, a sample of the population was focused on. The study identified Architectural, Engineering, Building and Quantity Surveying consultancy firms as those responsible for design of buildings in Nigeria. Considering a sample frame of 420 design firms in Abuja. Using Yamane's formula, a sample size of 81 design firms was determined and used in the study.

The primary data was obtained through survey, using a structured questionnaire designed into three major sections (Sections A and B and C). Section A was used to obtain information regarding the profiles of the respondents and their companies. Section B concentrated on the benefits of adopting BIM on a 5-point Likert scale where; 5 = very important, 4 = Important, 3 = Moderately Important, 2 = Slightly Important, 1 = Not Important at all. Section C of the questionnaire, on the financial risk factors based on a 5-point Likert scale, where 1 indicates "very rare", 2 indicate "rare", 3 indicates "occasionally", 4 indicates "frequently" and 5 indicates "very frequently". The respondents were also requested to rate the effect of financial risks on the adoption of BIM based on a 5-point Likert scale, where 1 indicates "lowest effect", 2 indicate 'low effect", 3 indicate "moderate effect", 4 indicate "high effect" and 5 indicate "highest effect"

Data Analysis

Statistical analyses were undertaken using the Statistical Package for Social Sciences (SPSS), Version 21 for Windows. The ranking of financial risk factors was based on arithmetic mean value scores.

RESULTS AND DISCUSSIONS

Characteristics of Surveyed Respondents and their Firms

Out of the 81 questionnaires administered, 62 were returned which amounted to a response rate of 77%. 65% of the respondents were male while 35% were female. 90% of the respondents had their tertiary education while 5% had their basic education and 5% had their secondary education. 37% of the respondents were Architects, 11% were Engineers and 52% were Quantity Surveyors. 21% of the respondents worked for small firms, 65% worked for medium sized firms and 14% worked for large firms.

Benefits of Adopting BIM

The results obtained from the research as shown in Table 2 shows that the most important benefits of BIM are Visualization, Estimating is improved through the ability to model project options before and during construction, quality level of the finished projects is improved, Project conceptualization is made easier. This is consistent with the study carried out by (Umezinwa, 2017). The least important benefits are 5D offers more efficient take-offs during the Budget Estimate Stage and also Earlier risk identification.

Table 2: Benefits of Adopting BIM

S/N	Benefits of Adopting BIM	MIS	Rank
1	Visualization	3.93	1
2	Estimating is improved through the ability to model project options before and during Construction.	3.70	2
3	The quality level of the finished projects is improved as the quality of data in BIM models is maintained by its users.	3.67	3
4	Project conceptualization is made easier	3.56	4
5	Improve Energy Efficiency and Sustainability	3.51	5
6	Collaboration	3.47	6
7	5D offers more efficient take-offs during the Budget Estimate Stage	3.35	7
8	Earlier risk identification e.g. potential clash detection is improved, at an earlier stage than with traditional approaches	3.05	8

Source: Researcher's Analysis, 2018

Financial Risk Factors in Adoption of BIM in Construction Project

Table 3 shows that the most important risks are High cost of Integrated Software, Cost of required software upgrade, Cost of hardware upgrade, High cost in terms of time and training and High cost of implementation process. This is in Line with the research carried out by (Bryde *et al.*, 2013) where he stated that most of the challenges of adopting BIM are focused on software or hardware issues. The three least occurring financial risks are additional expenditure, transitional and behavioural cost, no proof of financial benefits having means 3.35, 3.07 and 2.67 respectively.

Table 3: Frequency of BIM Financial risks.

S/N	Financial Risk Factors	MIS	Rank
1	High Cost of Integrated software/ models	3.86	1
2	Cost of required software upgrade	3.84	2
3	Cost of hardware upgrade	3.81	3
4	High cost in terms of time and training	3.58	4
5	High cost of implementation process	3.53	5
6	Increase in short term cost	3.47	6
7	Additional Expenditure	3.35	7
8	Transition and behavioural costs	3.07	8
9	No proof of financial benefits	2.67	9

Source: Researcher's Analysis, 2018

CONCLUSIONS AND RECOMMENDATIONS

This research highlighted the various financial risks that affect the adoption of Building Information Modelling. The study identified that the most important benefits of BIM are Visualization, Estimating is improved through the ability to model project options before and during construction, quality level of the finished projects is improved, Project conceptualization is made easier. The study also concluded through ranking that the most important financial risks are High cost of Integrated Software, Cost of required software upgrade, Cost of hardware upgrade, High cost in terms of time and training and High cost of implementation process.

This study identified a number of Financial risks which is consistent with previous research. In order to facilitate proper adoption of Building Information Modelling: Identified risks should be fully understood by consultants, contractors and all BIM practitioners in the construction industry. Also, a systematic analysis of financial status and capability to identify the changes needed to facilitate BIM implementation in the construction industry should be undertaken.

RECOMMENDATION FOR FURTHER STUDIES

The scope of this study covered the identification of financial risks, the frequency of occurrence and effect of these financial risks. Once risk factors are identified and their effects are assessed, the next step is to develop risk response strategy.

Due to time constraint, this research was not able to do that. Thus, it is recommended that other research in this area should develop such risk response strategies.

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