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EVALUATING BUILDING INFORMATION MODELLING (BIM) ADOPTION REQUIREMENTS FOR SMALL AND MEDUIM CONSTRUCTION FIRMS IN KATSINA METROPOLIS

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ABSTRACT

Building information modelling is an agent of digital revolution and game changer that is shaping the direction of construction sector in this modern and ever-changing world. This study aimed at evaluating BIM adopting requirements for Small and medium construction firms in Katsina metropolis. The study employed quantitative approach and data for the study was gathered using a structured questionnaire. The target respondents for the study were architects, quantity surveyors, builders and civil engineers working in small and medium sized construction firms. The study distributed ninety questionnaires (90) using convenience sampling and recorded a return rate of 67.77%. according to the respondents, the most important requirements for BIM adoption include; policy for BIM (RII 0.854), requirement for BIM adoption, specifying level of adoption (RII 0.785). The study recommends that; necessary changes be made to the existing government policies on construction and its procurement so as to reflect BIM, necessary infrastructure be provided so as to ease the adoption of BIM, BIM education be included in our educational curriculum so as facilitate its awareness and adoption.

Keywords: *Building Information Modelling (BIM), Requirements, SME, Construction*

INTRODUCTION

The construction industry in which small and medium construction firms operate is one of the oldest industries organized by mankind to execute projects Inuwa (2014). The industry plays a vital role in the economy and activities of the industry are vital to the achievement of socio-economic development goals of a country through the provision of infrastructure, housing and employment (Olugbenga & Oluseye, 2014; Anaman & Ose, 2007). The industry has been under serious critique for its inability to provide value for money, sustainable infrastructure, improve productivity and to bridge the fragmented nature of its delivery system ((Mihindu & Arayici, 2008; Khalfan & Anumba, 2000; Chen, 2016). Porwal and Hewage (2013) identified other reasons why the industry is lagging behind other industries, and reported that the work pattern of the Architectural, Engineering and Construction firms (AEC) makes information sharing and reuse difficult; most information during the project life cycle is not reusable, while poor information management leads to unnecessary duplication of data, project delay and budget overruns.

Building Information Modelling (BIM) is the present face of construction industry innovation, a set of technologies, processes and policies, affecting industry's deliverables, relationships and roles. (Succar & Kassem, 2015). This made the UK government to mandate the industry professionals to start to facilitate the wider adoption of BIM on projects, particularly the public projects (BIS, 2011). Blackwell (2012) warns that Small and Medium Enterprises (SMEs) could lose contracts in both the domestic and international markets if they remain slow in grasping and adopting Building Information Modelling (BIM) as a transformative technology and process. Losing out on business results in the SMEs feeling less competitive and innovative in comparison with their competitors (Harris, 2013). This trend may continue if SMEs do not pay attention to investing in new technology and reforming their organisations in order to meet with the requirements of the emerging industry.

Building Information Modelling (BIM)

The idea of Building Information Modelling (BIM) was mentioned by Eastman et al. (1974) as a 'Building Description System', and the term 'Building Modelling' was first mentioned by Robert Aish in 1986 including 3D modelling, real-time construction simulation (Aish, 1986 in Chen 2016). 'Building Information Model' was firstly used by Nederveen in 1992 (Nederveen, 1992). The term Building Information Modelling appeared later and was mentioned (Tolman,1999).

BIM was referred to as digitalised representation of building and its attributes, a new concept for data, personnel, process and information management (Arayici, Coates, Koskela, Kagioglou, Usher & O'reilly, 2009) during the entire building lifecycle of AEC industry (Eastman, Teicholz, Sacks & Liston, 2011; Porwal & Hewage, 2013). It promotes a new relationship and collaboration paradigm among stakeholders. It is also an advanced modelling and simulation concept to improve sustainable design, customer satisfaction and commercial value (Love, Hill, Standing & Simpson, 2013). In addition, the concept promotes integration, where multiple types of information embedded in the same digital database could benefit and facilitate collaboration among all stakeholders e.g. designer, contractor, facility manager, etc. (Rezgui, Beach & Rana, 2013). More specifically, BIM integrates the following new functionalities into traditional construction process: project feasibility study, 3D design/drawings, atypical shape design, time line management, costing analysis, clash detection, sustainability analysis, constructability, facility management and engineering analysis etc. (Ding, Akinci, & Zhou, 2014; Lee, Yu, & Jeong 2015)

BIM has been described as an accelerator for change (Bernstein, 2005) directed toward reducing industry's fragmentation (CWIC, 2004), improve its efficiency/effectiveness (Hampson & Brandon, 2004) and reduce the high costs of inadequate interoperability (NIST, 2004). Research has indicated that guidance on how small and medium AEC's practices should adopt BIM is lacking (Jung & Joo, 2010). This lack of guidance is one of the reasons why small and medium AEC's practices are disinclined to adopt BIM. There is a growing need for more knowledge on how BIM technology

and processes can be and should be adopted and what happens when BIM technologies and processes are adopted and used in the practice of construction (Coates, 2013). Blackwell (2012) warns that SMEs could lose contracts in both the domestic and international markets if they remain slow in grasping and adopting BIM as a transformative technology and process.

The study aimed at evaluating BIM adoption requirements for small and medium sized construction firms in Katsina Metroplis with a view to improving their performance.

REQUIREMENTS FOR BIM ADOPTION

Legislation/Policies on BIM

BIM when proposed to get started in the United Kingdom drew great interests as an object of analysis and reference. The first step adopted by the UK was formulation of an 'implementation policy' which was adopted by the United Kingdom on the BIM usage (IBIM, 2013). More so, Ibrahim and Abdullahi, (2016) identified Government support through provision of legislation as an important driver to BIM adoption, Autodesk (2015) equally opined legislation by Government on BIM will facilitate and guide its adoption.

Setting BIM Goals and Objectives

Chen (2016) has described that an organization striving to adopt BIM in its operations there should be some objectives as to what particular role the BIM should play in that organization. Du et al (2014) and Wang et al (2005) opined that setting organizational objectives for BIM should be made in such a way that it can he adjusted (flexible) to accommodate future use. Anumba et al (2009) also opined that one of the most important steps in the BIM planning process is to clearly define the potential value of BIM on the project and for project team members through defining the overall goals for BIM adoption.

BIM Leadership

According to Azzouz (2019), BIM leader is the person who has the technical skills, theoretical knowledge and the motivation to lead and guide

teams in setting BIM foundation or improving BIM adoption at given organization. BIM doesn't work without leadership (Barker, 2013), that is why organizations are struggling to find people who fit into this role (Price, Damian & Ahmad, 2012). There is a need for the right people with the right mix of skills to be promoting the uptake of BIM (Barker, 2013).

Forming a Dedicated Team

Price et al (2012) have identified the need to have a dedicated team to with, starting with a team; and spreading the adoption to other parts of a given industry. They further explain that the advantage of starting with a team is that, it can easily be managed rather than starting with the entire professionals with an organisation. Obstacles encountered by a small team could be avoided by an entire organisation; saving project time and cost.

Organisational Managerial Support

Melville, Kraemer,and Gurbaxani, (2004) opined that top management of every firm seeking to adopt IT systems such BIM are at the best position to either make it happen or not. They further stress that management support may include, for example, changing organisational policies and rules, changing organizational structures, changing workplace practices and changing organizational culture and others. It is only through significant organizational changes that major improvements in business value can occur (Melville et al, 2004).

Stakeholder Involvement

The perspective of key stakeholders regarding BIM usage in the AEC sector is fundamental to its adoption since they achieve direct benefit from it (Ratajczak, 2018). The involvement and collaboration between and among stake holders can increase organizational capacity in BIM adoption and project management during design and construction process (Arayici et al, 2011).

Outlining the Required Skills

Rahman and Rahimi, (2016) identified among other factors the required skills needed from participants to make its adoption a success. They raised

some valid questions about BIM skill required; what skills are correlated with BIM skills? Do people possess BIM skills? These questions together with others if not answered could impede organizations from effective BIM workforce development.

Specify Level of adoption

Ahmad et al (2012) and Jung and Joo (2010) have identified the levels of BIM adoption and that any sector seeking to adopt it should understand the level that could suit it. They however, identified Industry wide level, Organization level and project level.

Table 1: BIM adoption components

S/NO	Components of BIM adoption	Sources
1	Policy or Legislation on BIM	Ibrahim *et.al* (2014); Autodesk (2015); IBIM (2013).
2	BIM goals and objectives	Chen (2016); Du *et al*., (2014); Wang *et al*. (2005); Anumba *et al* (2009).
3	Appointment of BIM leadership	Azzouz (2019); Ahmad *et al.* (2012); Barker (2013).
4	Start with dedicated team	Ahmad *et al*. (2012).
5	Specify level of implementation	Ahmad *et al* (2012); Jung and Joo (2010).
6	Managerial support	Melville *et al*. (2004).
7	Involvement of all stakeholders	Ratajczak (2018).
8	Outline the required skills	Rahman *et al*., (2016).

Small and Medium Size Construction firms

There is no consensus among policy makers and scholars concerning the point at which a business firm is deemed to be small. Indeed, there is no universally or even nationally acceptable standard definition; except that

the scale of business needs to be defined for a specific purpose (Owualah, 1987). As in developed economies, Nigeria with the introduction of the National Policy on Micro, Small and Medium Enterprises (MSMEs) has addressed the issue of definition as to what constitutes micro, small and medium enterprises. The definition adopts a classification based on dual criteria, employment and assets (excluding land and buildings) as shown below.

Table 2: Classification of Micro, Small and Medium sized enterprises

S/N	Size Category	Employment	Assets (=N= Million) (excl. land and buildings)
1	Micro enterprises	Less than 10	Less than 5
2	Small enterprises	10 to 49	5 to less than 50
3	Medium enterprises	50 to 199	50 to less than 500

Source: SMEDAN (2013)

Business, whether small, medium or large-scale can be defined as the sum total of activities involved in the creation and distribution of goods and services for private or personal profit (Isimoya, 2005). Awe (2002), opined that up to about 90% of the business ventures operating in Nigeria as a country can be referred to as small and medium scale enterprises (SMEs). In some economies of the world, SMEs have been acclaimed to be the engineer of growth. However evidences have shown that SMEs in Nigeria still face a lot of problems affecting their performance which include lack of technological support.

Owualah (1987) and Fadahusi (1992) stated that SMEs represent 90% of the enterprises in Africa, Caribbean and Pacific (ACP) countries. They also provide 70% of employment opportunities for the citizens and promote indigenous technology. They further stated that small businesses employ 53% of the private workforce and accounted for 47% of sales and 51% of private sector gross domestic product GDP. Therefore, the SMEs predominate the economy in both developed and developing countries.

European Commission (EC) also coined the term Small and Medium Enterprises (SMEs). The SMEs sector is made up of three components:

(i) Firms with 0 to 9 employees - micro enterprises
(ii) 10 to 99 employees - small enterprises
(iii) 100 to 499 employees - medium enterprises
Alternative classification for small and medium firms by united nations industrial development organization (UNIDO, 2015) Definition for Developing Countries:
Large firms with 100 + workers
Medium firms with 20 - 99 workers
Small firm 5 - 19 workers
Micro firm <5workers

UNIDO's Definition for Industrialized Countries:
Large - firms with 500 + workers; Medium - firms with 100- 499 workers; Small - ≤99 workers. In the light of all the above definitions, this study adopts to use SMEDAN's definition for the purpose of this study.

METHODOLOGY

The study started by collecting data about the research problem and exploratory research was used. Literature review was used to gather data directly by the researcher. Literature review is the systematic identification of location, retrieval, analysis and evaluation of documents that are related to the research problem (Kothari & Garg, 2014; McNabb,2009).
This study used field survey as a tool for collection data directly from respondent. Field survey was used because is the most commonly used of all quantitative research making up to 80% (McNabb, 2009). The study area was restricted to Katsina, Katsina state; Katsina is situated in the north western part of Nigeria. Katsina State having the third highest population size in the north-western zone (NPC, 2010), it has a higher concentration of construction activities in the north-western zone The study population comprised mainly of professionals (Architects, Quantity Surveyors,

Builders & Civil Engineers) working with small and medium construction firms.

Sample size for this study were 90 professionals in the SMEs determined using convenience Sampling. Convenience sampling is a type of non-random sampling where members of the target population meet certain practical criteria, such as easy accessibility, geographical proximity and availability at a given time (Donyei, 2007).

Table 3: Alpha Score and grades for pilot and field data

Questionnaire Variables	Number of items	Pilot Alpha Score	Field Data Alpha Score	Grading
Requirement for BIM adoption	8	0.53	0.82	Excellent

The data was analysed using Relative Importance index (R.I.I) which is given by Fagbenle *et al.,* 2004.

$$RII = \sum W/(AxN)$$

Where:

W = Weightage given to each factor by the respondents.

A = Highest weight (i.e 5).

N = Number in the sample.

Results and Discussions

Table 4: Questionnaire Response Rate

Number administered	Number Returned	Number Valid for Analysis
90	61	55

Table 2 shows te questionnaires were distributed to small and medium sized construction firms in the study area which yielded a return rate of 67.77% while the response was 61.11%. This is adequate based on the assertion of Moser and Kalton (1971) that the result of a survey can be considered significant if the response rate is not lower than 30-40%.

The response rate for this type of survey is higher than other studies carried out in similar area in the construction industry. For example, Kori and Kiviniemi (2015) recorded a response rate of 40%; Abubakar, *et al* (2014) recorded 49% response rate; Pena (2011) recorded a response rate of 50%.

BIM adoption Requirements

Table 5: Importance Index of BIM adoption Requirement

Requirements for BIM adoption	Importance index	Percentage
Provision of Legislation and policies on BIM	0.854	85.4
Defining BIM goals and objectives	0.741	74.1
Start with a team	0.701	70.1
Appoint BIM leadership	0.705	70.5
Needed Managerial support	0.709	70.9
Specify level of implementation	0.785	78.5
Involve all stakeholders	0.778	77.8
Outline the required skills	0.752	75.2

Table 15 shows the importance of BIM adoption requirements. The study revealed that the requirements identified are important with an aggregate index of 0.75 as indicated in table 15. Respondent rated some of the requirements as very important to the adoption BIM, and they are; Provision of Legislation and policies on BIM with an index of 0.854, specifying level of adoption with an index of 0.785, and stakeholder involvement with an index of 0.778.

Data analysis and questionnaire responses reveals that all the requirement identified were significant for adopting BIM as depicted by an average index of (0.747). Respondent shown a great level of agreement with the requirements identified.

This finding conformed with Chen (2016) sighting hierarchy model for requirements of BIM adoption identified involvement of all stakeholders, managerial support and appointment of BIM leadership as crucial to any

organizational based BIM adoption. This study is also in line with Hosseini *et al*. (2016) where they identified provision of legislation on BIM, defining BIM objectives, team work and specifying the level of implementation as important component to BIM adoption.

Previous studies cited above mostly focus on diffusion (industry wide requirement) but did not segregate between large, medium and small sized construction firms because they could have different level of preparedness for the technology. However, this study only focused on small and medium construction firms.

Summary, Conclusion and Recommendations

The requirement identified were agreed upon by the respondent as necessary for BIM adoption by SMEs in Katsina metropolis. The noticeable requirement includes; provision of legislation on BIM and specifying level of adoption.

In the view of these, the study concluded that if SMEs performance is to improve, barriers identified must be addressed and that the requirement identified must be in place for small and medium construction firms to adopt BIM. It is by so doing that benefits assessed can be achieved.

The necessary infrastructure including stable power supply, effective internet services, be provided so as to ease the adoption of BIM. Also the cost of acquisition and training be subsidised by the Government.

That BIM education be included our educational curriculum so as facilitate its awareness and adoption.

This study made a positive contribution to knowledge by providing a strong base (foundation) upon which BIM adoption for small and medium construction firms can be achieved. No study precedes this one to explore areas that need attention of SMEs to enable them improve performance.

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