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Macro-BIM adoption study: establishing Nigeria's BIM maturity.

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Macro-BIM Adoption Study: Establishing Nigeria's BIM Maturity

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Abstract. Construction Industry in Nigeria has since required a disruptive technology to change its construction business and improve its capabilities and productivity. As an on-going research (PhD work) to developing a strategy for an effective Building Information Modelling (BIM) adoption in Nigeria, a macro-BIM adoption study was carried out to establish BIM maturity within the Nigerian construction market. Online questionnaire was used as tool for data collection from the professional stakeholders in the industry. In the process to formulate a National BIM Roadmap, five conceptual macro-BIM maturity models were utilized. The models' findings act as a guide in developing a national BIM adoption policy. The five applied models helped classify the macro maturity components and the key policies' deliverables that must be addressed within both the initiation and consultation phases of proposing the Nigerian BIM roadmap. The results established positive progress in awareness and adoption level compared to the 2017 survey. Recommendations are made based on the study findings as to advance into policy development.

Keywords: Building Information Modelling · macro-BIM · Adoption · Nigeria · Construction Industry

1 Introduction

BIM is gradually becoming a norm in the built asset procurement, but its adoption around the world varies significantly. Effort by government is playing a significant role in facilitating BIM adoption around the world. For example, UK, USA, Finland, Russia, Denmark, Singapore etc are some case study countries where government involvement played a significant role on BIM adoption [1][2]. Moreover, more countries are keying into this strategy, to mention but a few, such as Canada, Germany, Japan, Ireland, Qatar and Spain. Some of these countries used the developed macro-BIM adoption models to streamline or develop BIM adoption roadmap and guidance for the development of their BIM adoption policy, and such countries include Ireland and Brazil [2][3]. Other countries which are currently utilizing the macro-BIM adoption models include Spain, Canada, Russia, Brazil, Hong Kong etc.

BIM may be referred to as disruptive technological process that is changing the way construction work is being procured. The Nigerian construction sector is known to be a fragmented industry where professionals have monopolized construction information [4] and work more like a group than a team. BIM is not well established in the Nigerian construction market, but the level of awareness is rapidly progressing. The industry needs this disruptive process (BIM) to improve its productivity and capabilities through integrating the stakeholders' working process. To achieve this, BIM maturity must be established. This piece of work aims at determining the BIM maturity of the Nigerian construction market with the use of the BIM established adoption (macro) models.

2 Background of the Study

In 2015, Succar and Kassem developed five new conceptual constructs for assessing BIM adoption at macro (country) level. The developed models were subsequently refined as conceptual tools, developed additional assessment metrics to assist researchers and policy makers to analyze and improve or develop BIM diffusion policies within a market [5]. The developed macro-BIM adoption models include: Macro-Diffusion Responsibilities model; Macro-Diffusion Dynamics model; Diffusion Area model; Policy Actions model; and Macro-Maturity Components model.

Thus, the Nigerian macro-BIM adoption study aims to assist the policy makers in developing and or assessing the macro BIM diffusion policies, strategies and plans within the Nigerian construction market. Sequel to the completion of the assessment, the study aimed to achieve deliverables at Initiation Phase of Policy Development and specifically the development of a seed BIM policy framework and engagement with stakeholders. Finally, assessment and planning of diffusion roles are generated through mapping the macro player groups and the macro maturity components.

Having the macro BIM maturity models as one of the most cited and used maturity models [6][5] and already applied in several countries like Peru, Russia, Ireland, Egypt, Spain, Hong Kong and Brazil (BIMexcellence); ultimately, the macro maturity model is considered as the most viable method to assess BIM adoption at macro scale.

As part of a process to develop a strategy for effective BIM adoption in the Nigerian construction market, the market maturity should be assessed ahead of policy development or adoption guide. There are several maturity models ranging from assessment of the derived benefits of BIM utilization [7] to the capability of National BIM Standards model that deals with BIM tools and maturity levels [8] and BIM proficiency matrix by Indiana University [9] etc. In spite of their derived benefits within their individual settings, the models do not offer full understanding of how BIM diffuses at macro level or comprehensive macro-BIM adoption [10].

This study is carried out mainly to assist the researcher in the development of a working strategy for an effective BIM adoption. Therefore, assessment of current market specific on BIM diffusion policies becomes necessary, and the developed macro-BIM maturity models by [11] or framework is thus adopted. The adopted framework consists of five conceptual models as illustrated in Succar & Kassem [11].

The precedence set by these models in their application of establishing BIM adoption at macro level ensured that the adopted framework is appropriate to achieve the researchers' objectives.

3 Nigerian Macro Maturity Model

Structured questionnaire was used as tool for data collection [6] hosted online using google forms. In addition, snowball method was adopted in targeting the survey respondents due to low level of BIM awareness and maturity in the country [12]. A few number of BIM experts volunteered to participate in the survey and subsequently more participants were recorded through them (initial respondents) – snowball. Thirty Seven (37) valid responses were recorded and analyzed quantitatively (see table 1). This study was “market” specific; and the target was establishing the level of BIM “diffusion and adoption” in Nigeria.

Table 1. Profile of respondents (*field survey, 2018.*)

Variable	Characteristics	Freq.	Percentage (%)	Total
Location of practice	North-Central	18	48.6	37
	North-East	2	5.4	
	North-West	8	21.6	
	South-East	2	5.4	
	South-South	3	8.1	
	South-West	4	10.8	
Years practice	< 5 years	12	32.4	37
	5 - 10 years	13	35.1	
	11 - 15 years	5	13.5	
	> 15 years	7	18.9	
Number of employees	< 10 personnel (Micro)	21	56.8	37
	10 - 50 personnel (Small)	12	32.4	
	50 - 200 personnel (Medium)	3	8.1	
	> 200 personnel (Large)	1	2.7	
Profession	Architecture	14	37.8	37
	Building Engineering	1	2.7	
	Civil/Structural Engineering	14	37.8	
	Construction Management	0	0.0	
	Electrical Engineering	0	0.0	
	Mechanical Engineering	1	2.7	
	Quantity Surveying	6	16.2	
	Other	1	2.7	
Specialization	Contractor/Construction	8	21.6	37
	Designer or Consultant	27	73.0	
	Client	1	2.7	
	Development Authority	1	2.7	
Level of BIM utilisation	Modelling only - BIM stage 1	20	54.1	37
	Limited to Collaboration - BIM stage 2	12	32.4	
	Up to Integration - BIM stage 3	5	13.5	

There are two dominant BIM maturity classifications or capability stages; these are the Succar [13] descriptive BIM capability stages 1, 2 and 3 and the Bew-Richards' BIM maturity levels 0, 1, 2 and 3. The Succar's three-stage capabilities evaluate maturity from the first point of adoption (*POA*) just after the readiness ramp as BIM stage 1 (*modelling* only), to BIM stage 2 (limited to *collaboration*) and BIM stage 3 (up to *integration*). On the other hand, Bew-Richards' UK BIM maturity is prescribed based on levels, BIM level 0, BIM level 1, BIM level 2 and BIM level 3. The level 0 is an unmanaged CAD, predominantly two dimensional CAD system (2D) with paper or electronic paper as dominant information exchange mechanism [14]. Moreover, the level 0 appears to be of the same description of *POA* or pre-BIM in Succar [15], while the BIM level 1, 2 and 3 may be seen to be parallel to or matching with the Succar-Kassem's capability stages 1, 2 and 3 respectively. Going by a wide consideration of BIM capability stages in most of BIM studies, Succar-Kassem's maturity stages is specifically adopted for this section of work as it were in the Macro-BIM adoption conceptual models [11].

3.1 Model A: Diffusion Areas model

Diffusion area model explains how BIM field types (process, policy and technology) relate with the BIM capability stages (integration, collaboration and modelling) to produce nine diffusion areas where BIM diffusion occurs; thus, such areas can be analysed and planned. Findings here demonstrated irregular distribution of rates (see fig. 1). Nigeria and Ireland are reasonably mature in applying technology for modelling purpose with a little move at applying technology for collaboration as well as processes at modelling stage. There is very low level of inter-organisational collaboration and no model workflow at both fields not to talk of integration. On the other hand, there has been no policy or mandate by government [16].

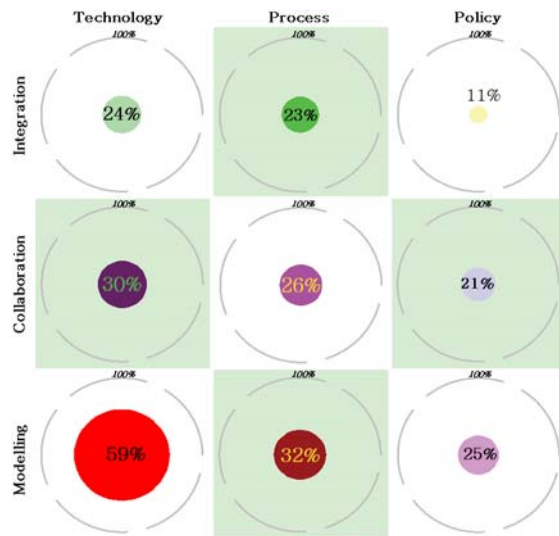


Fig. 1. Diffusion Areas model for Nigeria

It is therefore established that by 2018, the diffusion levels of staged capability milestones in the Nigerian construction market are as follows:

- 25% diffusion rate of modelling capabilities,
- 21% diffusion rate of collaboration capabilities and
- 11% diffusion rate of integration capabilities.

3.2 Model B: Macro-Maturity Components model

There are eight complementary components within the Macro Maturity Components model used in measuring and establishing maturity of BIM at country level. The developed and refined components by Kassem [5] are as follows: Champions and drivers; Measurements and benchmarks; Noteworthy publications; Objectives, stages and milestones; Learning and education; Standardised parts and deliverables; Regulatory frameworks and Technology infrastructure.

Fig. 2 below illustrates Nigerian maturity components that is, Nigeria's current maturity within each component. These components were assessed with BIM Maturity Index (BIMMI), which has different maturity levels (from the outer to the inner circle) as follows: ad-hoc – low maturity; defined – medium-low maturity; managed – medium maturity; integrated – medium-high maturity; and optimised – high maturity.

The components converge as they mature from *a* to *e* corresponding to *ad-hoc* to *optimised* or *low maturity* to *high maturity*. These components and their maturity index set a very clear description of all the eight components within a market. The closer these components are (converging), the mature they are. Assessments are made holistically based on granularly matrix as to compare relative maturity of one component over the other as prescribed in [11 table 11]. Successively, each component is evaluated using component-specific metrics as described in [11 table 3–10 pp.70-72].

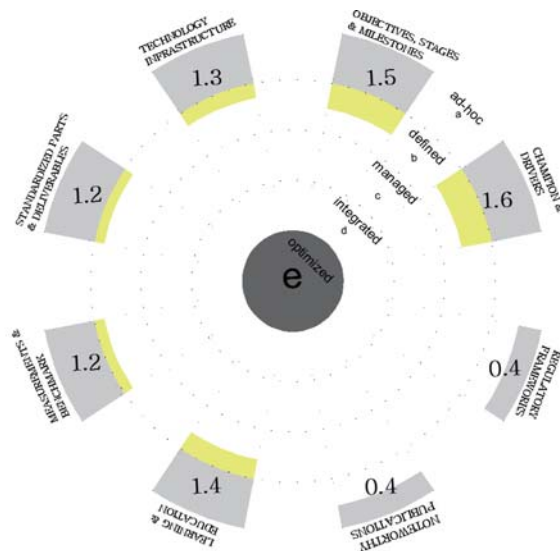


Fig. 2. Macro-Maturity Components model for Nigeria

Nigerian construction market appears with a dominant ‘*medium-low*’ maturity. Champions & drivers leading with 2.6 (between medium-low and medium maturity) on a Likert scale of 5 corresponding to maturity levels of *a*, *b*, *c*, *d* and *e* as prescribed above. These indicated that the components tangle between ‘*defined*’ and ‘*managed*’ levels (*b* and *c*), as such all the components needed a push. The evaluation suggests an early adopter with individuals as champions promoting the new concept.

Moreover, ranking regulatory framework lowest is an indication that government lacks policy consideration in this regard; and pending when regulatory requirement is considered, most of these components will not advance.

3.3 Model C: Macro-Diffusion Dynamics model

The macro-diffusion dynamic model was adopted [11 pp.72 fig.7] primarily to assess the adoption trend within a market and compare with the directional pressures to how diffusion unfolds within a specific market. This model comprises three diffusion dynamics namely: Bottom-Up; Middle-Out and Top-Down [11]. Moreover, this model sets four directional pressure mechanisms who are laid over the three diffusion dynamics; these include Downwards, Horizontal Downwards, Upwards Horizontal and Upwards Horizontal pressures.

The study reveals Nigeria’s diffusion dynamic as predominantly bottom-up, by ‘*majority*’ response [11]; this result indicated smaller organisations are those pushing the adoption in the industry but not the bigger firms or the government. However, the bigger organisations seem to be picking up as the result suggests their suit.

The bottom-up diffusion dynamic assured the transmission by small organisations in an upward horizontal pressure mechanism with industry bodies, larger and other small organisations as pressure recipients and potential adopters. With current lack of policy in place [16] and unwillingness from most of the bigger companies to embrace the BIM concept, the bottom-up diffusion dynamic would possibly continue.

3.4 Model D: Policy Actions model

The policy action model (fig. 3) has nine policy actions generated from mapping the three implementation approaches (passive, active and assertive) and the three implementation activities (communicate, engage and monitor) [11]. Succar [11] developed this model as an assessment tool to generate activities/task, which are used in comparing policy actions across many countries for a structured policy intervention in achieving a market-wide BIM adoption.

The Nigerian policy action pattern recorded a full *active* with a partial *assertive* at engagement stage (see fig. 3). This suggests government intervention at both engagement and monitoring stages. Moreover, incentivise and enforce (fig. 3) are mostly prescribed by government/regulations. Therefore, the practitioners desired active government involvement approach.

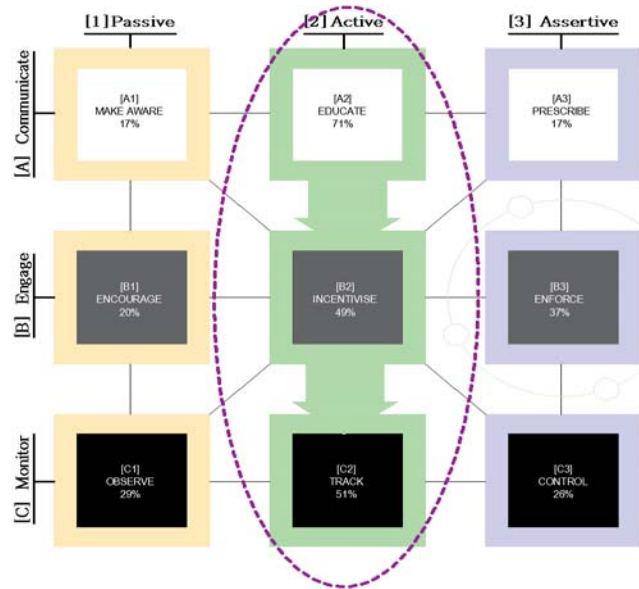


Fig. 3. Policy Actions model of Nigeria

The evident result of diffusion of innovation within smaller organizations (bottom-up) has considerable influence in the behaviour of the bigger organizations or higher end of the supply chain [17].

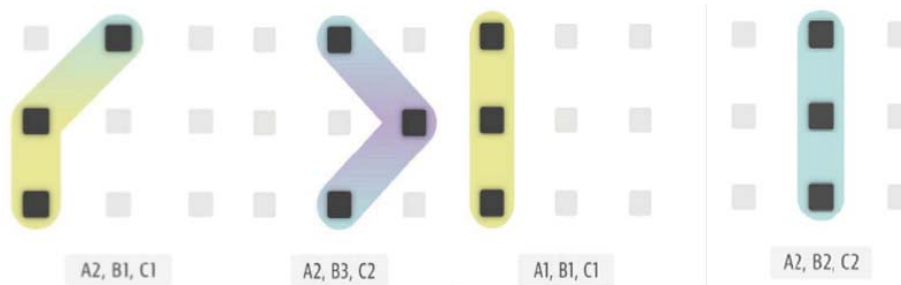


Fig. 4. Policy Actions models of USA, UK Australia and Nigeria respectively

There are series of policy action model patterns at various country specifics that go along vertical stripe, alternating within passive, active and assertive action along the three implementation activities. For example, fig. 4 above presents different sets of policy action models of USA (A2, B1, C1), UK (A2, B3, C2), Australia (A1, B1, C1) and Nigeria (A2, B2, C2).

3.5 Model E: Macro-Diffusion Responsibilities model

The established BIM field types have their respective capability sets (that differ base on BIM stage) as group of players within construction industry and across the

BIM field types [13]. This goes into the analyses of BIM diffusion through the players' (stakeholders) roles in the industry as a network of actors [11]. The nine player groups are: technology advocates, communities of practice, policy makers, individual practitioners, construction organisations, educational institutions, technology developers, industry associations and technology service providers (fig. 5). Any of the player groups is either belongs to one of the three BIM fields type (Policy, Process & Technology) or intersection of any two; more to that, any player group has a number of player types as well.

The survey result reveals that at present, the educational institutions and individual practitioners are the most influential players in the Nigerian construction market. In the same vein, construction organisations & professional associations were acknowledged as key process players. However, policy makers and communities of practice were lowest players within this market. Fig. 5 demonstrates the results of the model.

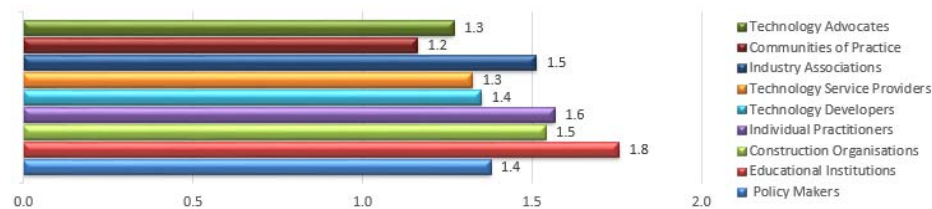


Fig. 5. Nigerian Macro-Diffusion Responsibilities model

4 Development of BIM Policy Plans and Templates

The above models as equally explained in [10] have assisted in deeper understanding of BIM maturity in the Nigerian construction market and equally revealed grey areas where attention is needed. Succar and Kassem demonstrated how these models are utilised to provide basis for the BIM roadmap development at national level.

The policy plan is developed through three phases (Initiation, Consultation and Execution). However, due to a limitation to this study, only the first two (initiation and consultation) phases were dealt with for now.

4.1 Initiation Phase

The initiation phase is determined to institute “*task group*” (as a proposal) and the seed BIM Framework that will act as guidance to the National Framework. The following are set as applications of the three models (B, C and D) at initiation stage: model B is used in assessing BIM maturity or worldwide efforts, model C is used to identify the market specific diffusion dynamic and model D is used to establish a policy approach to be taken by policy makers.

The first part of the Initiation phase is the establishment of a task group; this includes the development of goals for the group and their corresponding objectives. There is currently no organisation taking similar responsibility in Nigeria. This research has been working to establish the BIM maturity within the Nigerian AEC industry for about 2 years. This has been attained through direct contact with Higher

Education Institutions [18]; direct contact with the construction professionals (in the last 5 months of 2018); and direct discussions with some industry stakeholders [16].

As illuminated in [5 pp.294 fig.5], the task group targets the development of a seed BIM policy framework, where this section is considered achieved quantitatively in this study. The framework development involves investigation into similar efforts around the world and identify a suitable model approach to domesticate. Finding from the application of macro maturity components model on 21 countries suggests UK's framework as the strongest [10].

BIM has well-established guidance and workflows in the UK as such, those who adopted BIM concept in Nigeria considered UK BIM protocol as a source of guidance. The respondents largely agreed that the UK model provides substantial guide once adopted. Other potential countries that are worth learning from are USA and Australia, they have potentials in technologies and terminology, and their BIM participation at the world stage and availability of noteworthy BIM publications [19] are eminent. Any remodelled framework for the study context must certify acceptability to the country and its ecosystem.

The sequential input by model C and model D are explained based on the survey findings; as such, model C (diffusion dynamics) identified the Nigerian market diffusion dynamic as predominantly bottom-up. This will subsequently influence the next input (model D – policy approach). The policy approach as presented in model D [5 pp.294] is mostly active, hence putting further pressure on the proposed BIM framework whose smaller organisations are currently leading.

Although there is no mandate in place, there is still a substantial awareness mostly at lower or individual level. The awareness in the education sector is moving very fast since the launch of BIM Africa Student Advocacy Program mostly patronised by Nigerian students of AEC related courses. This program (initiated in 2018) is serving as a medium to create awareness and training to students of higher institutions. Although, the rudimentary training can increase awareness; however, some of the critical issues that will subsequently arrive are the availability of up to date software and BIM expert for training as multi-disciplinary class [18]. The organisational BIM adoption represents discrete approaches that need profound consultations with the professional stakeholders to confirm the level of execution, successes and challenges.

Primary website development as source of valuable information for the Nigerian AEC industry is the last stage of the initiation phase. This portal/website also serves as a medium for awareness, guidance and source of Noteworthy BIM Publications (NBPs). AEC related professional regulatory bodies and National Information Technology Development Agency (NITDA) are the key players in this aspect.

4.2 Consultation Phase

The consultation phase is explained as a stage where seed BIM framework is finally refined and transformed into a roadmap. The roadmap has a set of responsibilities that are assigned to selected stakeholders for action [5 pp.295 fig.6]. Model E is then deployed with performance indicators and timeframes. The initial stage involves identifying (from the survey undertaken) experienced stakeholders and conducting face-to-face interviews as a replacement to the round-table discussions and workshops

[10]. As a result, this process aids in capturing of challenges and recommendation of the stakeholders as well as identifying champions at implementation stage.

The diffusion responsibility model helped in identifying sectors and areas where the Nigerian construction industry is lacking the needed attention as priorities are also considered; adequate resources are to be provided all through as a recommendation. A roadmap is therefore designed with crucial dates and milestones labelled and connected to policy deliverables through a Macro Roadmap Template generated in 2017 as explained by Kassem [5 pp.296 fig.8].

5 Conclusions

The findings of this study provided the Nigerian construction industry's stand with regard to current BIM adoption and significant information where the country is lacking that has to be addressed in order to advance in macro adoption. As such, these include the following: the low diffusion level of 11% and low maturity components (especially in regulatory framework and NBPs) as suggested from the 'bottom-up' dynamic due to lack of regulations. Moreover, the active policy approach is also suggested as the government participation became paramount. This piece of work also demonstrated briefly how the findings could be used further to develop a roadmap for an effective BIM adoption in Nigeria. A proposed roadmap will reflect these findings and some other challenges that are not mentioned here through a series of recommendations based on other results from subsequent collected data. However, the execution phase remains out of this research scope and will require substantial resources to ensure its realization.

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