BUILDING INFORMATION MODELLING

Assessment of the Readiness of the Nigerian Construction Industry for the Full Implementation of BIM

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Abstract

Building Information Modelling (BIM) is now a routine requirement on public projects in several advanced economies, yet its use in Nigeria remains largely confined to design. This study assessed how ready the Nigerian construction industry is for full, lifecycle-wide implementation of BIM, looking at people, technology, process and institutional support. A structured questionnaire on a five-point Likert scale was administered to construction professionals and to students of construction-related programs at the University of Ibadan, Obafemi Awolowo University and the University of Lagos; 138 of 250 questionnaires were returned (55.2%). Construct validity was confirmed by principal component analysis (all loadings ≥ 0.63) and reliability by Cronbach's alpha (0.784–0.902). Data were analysed with descriptive statistics, two-way analysis of variance, Pearson correlation and multiple regression. Mean familiarity with BIM was moderate (3.28 on a five-point scale); 55.1% of respondents had received formal training, and 15.2% could use no BIM-related software. Use was concentrated at the design stage (81% of reported uses), with cost estimation at 14%, scheduling at 4% and sustainability analysis at 1%. High license cost (35.7% of cited challenges), inadequate training (24.7%) and poor internet service (10.4%) were the dominant barriers. Respondent category had a small but significant effect on familiarity ($p = 0.036$, partial $\eta^2 = 0.052$), whereas academic level did not. Support for indigenous BIM software development ($\beta = 0.498$, $p < 0.001$) and concern over software cost ($\beta = 0.228$, $p = 0.010$) were significant predictors of support for lifecycle-wide adoption; internet connectivity was not ($p = 0.719$). The industry is aware of BIM but not yet ready for full implementation. Affordable or locally developed software, structured training and a government implementation mandate are the most direct routes to readiness.

Keywords: building information modelling; construction industry; indigenous software; Nigeria; technology readiness

1 Introduction

The construction industry drives the physical development of any economy, yet in Nigeria, as in many developing countries, it is beset by cost overruns, delayed delivery, rework and quality deficiencies. Many of these problems trace back to fragmented information flow between the professionals who design, cost, build and maintain a facility. Building Information Modelling (BIM) addresses this directly. Unlike conventional computer-aided design (CAD), which produces geometric drawings, BIM builds a shared, object-based digital model that carries information through the whole project life-cycle [1], [2].

The value of BIM grows with each dimension that is implemented. Beyond three-dimensional (3D) modelling and clash detection, 4D links the model to the construction program, 5D to quantity take-off and cost control [3], [4], 6D to sustainability and energy analysis [5], and 7D to facility and asset management [6]. Full implementation therefore means using BIM from conception to operation, not merely for visualization at the design stage.

Adoption is uneven across countries. The United Kingdom has required BIM Level 2 on centrally procured public projects since 2016, and Finland, Singapore and the United States have pursued national roadmaps and procurement mandates; even within Europe, however, regulatory approaches vary widely [7]. In developing countries, high implementation cost, weak technological infrastructure, scarce skills and the absence of enabling policy are the barriers most often reported [8], and a meta-analysis of a decade of adoption studies found that economic level and national culture shape how BIM is taken up [9].

In Nigeria, previous studies report growing awareness but limited use. BIM has been found to be used mainly at the design stage and rarely during construction or facility management [10]; insufficient awareness, a shortage of skilled personnel and high software prices are recurring barriers [11]–[13]; and a lack of skilled BIM personnel has been identified as a core constraint [14]. Most architectural firms still rely on 2D CAD despite knowing about BIM [15], and a recent survey found that two-thirds of professionals were aware of BIM but not yet using it [16].

Two gaps remain. First, most studies measure awareness or list barriers; fewer ask whether the industry, including the professionals now in training, is ready to use BIM across the whole lifecycle. Second, the roles of internet connectivity and of locally developed (indigenous) BIM software, both pressing questions in the Nigerian context, have received little empirical attention. This study therefore assessed the readiness of the Nigerian construction industry for the full implementation of BIM. Its objectives were to: (i) establish the level of BIM familiarity, training and software competence among professionals and students; (ii) determine the extent to which BIM is used across project stages; (iii) identify the main barriers to adoption; and (iv) examine how software cost, internet connectivity and indigenous software development relate to support for lifecycle-wide adoption, and derive strategies for implementation.

2 Literature review

2.1 BIM readiness and its dimensions

Readiness is the capacity of an industry to adopt and sustain a technology, as distinct from awareness of it. In this study, readiness is assessed on four dimensions: people (knowledge, skills and training), technology (software, hardware and digital infrastructure), process (the extent to which BIM is used across project stages) and institutions (policy, standards and professional support). An industry may be aware of BIM and still lack readiness on one or more of these dimensions.

2.2 Barriers to BIM adoption in Nigeria

Nigerian studies converge on a multidimensional set of barriers. Olanrewaju et al. [10] identified technological and business limitations, insufficient training and financial constraints. Bamgbose et al. [12] surveyed 182 professionals in small and medium-sized enterprises and grouped barriers into software functionality and compatibility, implementation risk, and lack of BIM resources. Oladiran and Ameh [13] highlighted the absence of enforced policy, weak support from professional

institutions and low client demand, and Amade et al. [14] placed the lack of skilled personnel at the root of the barrier hierarchy. In modular construction, Awodele et al. [17] reported similar inhibitors. Beyond design, 7D BIM supports infrastructure asset management by making relevant information available during operation and maintenance [18], a stage at which use in Nigeria is reported to be very low [10].

Two Nigeria-specific factors receive little attention in these studies. Unreliable internet service affects cloud-based collaboration, which is central to multi-disciplinary BIM workflows. Software licenses are priced in foreign currency, which raises the question of whether locally developed, Naira-priced applications could widen access. This study tests both.

2.3 Hypotheses

Three hypotheses were formulated on support for lifecycle-wide BIM adoption and implementation:

- **H1:** Software cost has a significant effect on BIM adoption and implementation.
- **H2:** Internet connectivity has a significant effect on BIM adoption and implementation.
- **H3:** Indigenous BIM software development has a significant effect on BIM adoption and implementation.

In addition, the study tested whether familiarity with BIM differs by respondent category (professional or student) and by academic level.

3 Methodology

3.1 Research design and population

A quantitative cross-sectional survey was adopted. The population comprised practicing construction professionals (architects, builders, civil engineers, land surveyors, project managers and quantity surveyors) and students of construction-related programs, who represent the industry's future workforce. Students were drawn from the University of Ibadan, Obafemi Awolowo University and the University of Lagos in south-western Nigeria. A sampling frame of 200 per professional group across five groups was used, and 25% of each (250 respondents) was targeted. Of the 250 questionnaires administered, 138 valid responses were returned, a response rate of 55.2%.

3.2 Research instrument

The questionnaire, administered online, had eight sections: demographic information (A); BIM awareness and experience, covering familiarity, formal training, software proficiency and uses (B); high software cost (C); poor network and internet connectivity (D); the extent of BIM adoption and implementation throughout the project lifecycle (E); interoperability and indigenous BIM software development (F); general perception of BIM (G); and open-ended questions on challenges, strategies and recommendations (H). Sections C–G used a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), and familiarity with BIM was rated on a five-point scale.

3.3 Data analysis

Data were analysed with the Statistical Package for the Social Sciences (SPSS). Construct validity was examined by principal component analysis and internal consistency by Cronbach's alpha. Frequencies and percentages summarised the demographic and multiple-response items. A two-way analysis of

variance (ANOVA) tested the effects of respondent category and academic level on familiarity with BIM, with Bonferroni-adjusted pairwise comparisons and a Tukey HSD post-hoc test. Pearson correlation and multiple linear regression examined the relationships between software cost, internet connectivity, indigenous software development and BIM adoption and implementation (the Section E construct). Significance was set at $p \leq 0.05$.

4 Results and discussion

4.1 Profile of respondents

Students made up 52.2% of the sample and practicing professionals 47.8%; 89.1% were male. Quantity surveying (23.2%), civil engineering (18.8%) and architecture (18.1%) were the largest disciplines, giving a spread across the main design, cost and construction professions. Of the respondents, 43.5% were affiliated with the University of Ibadan, 32.6% with Obafemi Awolowo University and 23.9% with the University of Lagos.

4.2 Validity and reliability

Principal component analysis extracted five components (Table 2). All retained items loaded at 0.63 or above on their intended component, above the recommended threshold of 0.6 [19], and item F1 was not retained. Cronbach's alpha ranged from 0.784 to 0.902, indicating good to excellent internal consistency [20]. The software-cost items split into two components: the burden of cost (C1–C3) and the expected effect of affordability and support (C4–C6).

4.3 Familiarity, training and software competence

Mean familiarity with BIM was 3.28 (SD 1.21) on a five-point scale: 3.56 (SD 1.07) for professionals and 2.94 (SD 1.26) for students. Formal BIM training had been received by 55.1% of respondents, leaving 44.9% without any. Table 3 shows the software respondents could use. AutoCAD dominated (73.2% of respondents), followed by Revit (35.5%) and PlanSwift (21.0%); Tekla Structures was used by only 2.2%, and 15.2% could use none of the listed applications. AutoCAD is a CAD tool rather than an object-based BIM authoring platform, so the high familiarity reported partly reflects CAD skills. Competence in true BIM platforms (Revit, ArchiCAD, Tekla, Civil 3D) is considerably lower, which signals a skills gap on the people dimension of readiness.

4.4 Use of BIM across project stages

Design accounted for 81% of reported uses, cost estimation for 14%, scheduling for 4% and sustainability analysis for 1%; no respondent reported using BIM for energy, health and safety, waste management or facility management. BIM in Nigeria therefore operates largely at the 3D level. This agrees with earlier findings that use declines sharply after design [10], [15], and it is the clearest evidence that the process dimension of readiness is weak: the information-rich dimensions that deliver most of BIM's value over the lifecycle [3]–[6] are almost unused.

4.5 Barriers to BIM adoption

Respondents cited 154 challenges in all. High license cost was the most frequent (35.7%), followed by little or no BIM training (24.7%) and lack of internet service (10.4%). Resistance to change (7.8%), unfavourable government policy (4.5%) and poor power supply (2.6%) followed; thirteen further challenges, each cited one to three times, included computer illiteracy, poor digital infrastructure, the

cost of high-end computers and a lack of knowledge of BIM's benefits. Cost and skills together account for 60% of all citations, consistent with earlier Nigerian studies [11]–[14] and with evidence from developing countries more broadly [8]. Because licenses are priced in foreign currencies, cost is a particular burden for Nigerian users.

4.6 Strategies for adoption and indigenous software

Continuous professional training was the most cited route to wider adoption (27.4%), followed by government assistance and the inclusion of BIM in university curricula (16.0% each), and the involvement of professional bodies (8.5%). On the development of indigenous BIM software, government assistance dominated (35.1%), followed by cost subsidies and cooperation among professional bodies (13.8% each), support for developers and training programs (12.8% each). The responses point to a shared view that readiness cannot be achieved by individual firms alone; it needs coordinated action by government, professional bodies and universities.

4.7 Effect of respondent category and academic level on familiarity

The two-way ANOVA showed a statistically significant main effect of respondent category on familiarity with BIM ($F(2, 124) = 3.41$, $p = 0.036$), although the effect was small (partial $\eta^2 = 0.052$). Academic level had no significant effect ($F(6, 124) = 0.49$, $p = 0.813$), and neither did the interaction between category and level ($p = 0.527$). With the Bonferroni adjustment, no pairwise difference between categories reached significance; the largest, between professionals and students (mean difference 0.81), had $p = 0.077$, and the Tukey HSD test placed all academic levels in a single homogeneous subset. Familiarity therefore rises modestly with professional practice but not with progression through university, which suggests that current curricula do little to build BIM competence. This supports the respondents' call for BIM to be embedded in construction-related programs.

4.8 Relationships between software cost, connectivity, indigenous software and adoption

All four constructs were positively and significantly correlated ($p < 0.01$). Indigenous software development showed the strongest correlation with BIM adoption and implementation ($r = 0.653$), followed by software cost ($r = 0.557$) and internet connectivity ($r = 0.356$).

In the multiple regression, indigenous software development was the strongest predictor of support for lifecycle-wide adoption ($\beta = 0.498$, $p < 0.001$), followed by software cost ($\beta = 0.228$, $p = 0.010$). Internet connectivity was not significant once the other two were controlled for ($\beta = 0.027$, $p = 0.719$). H1 and H3 were therefore supported and H2 was not.

The positive coefficient for software cost should be read with the scale in mind. Its items record agreement that license costs are a barrier and that affordable or subsidized software would raise adoption. Respondents who saw cost as the binding constraint were also the strongest supporters of lifecycle-wide BIM, which suggests that price, rather than reluctance, is holding back many willing adopters. Indigenous software development captures the same aspiration from another angle: locally produced, Naira-priced applications that reduce dependence on imported licenses. The non-significant effect of internet connectivity, despite its positive bivariate correlation, indicates that its influence is largely shared with the cost and software constructs, with which it is correlated ($r = 0.419$–0.528). Connectivity matters, but it is not an independent driver of support for adoption in this sample.

4.9 Readiness profile

Findings show that the industry is aware of BIM and favourably disposed towards it, but readiness for full implementation is limited on every dimension, and most of all in process and institutional support.

5 Conclusion

This study assessed the readiness of the Nigerian construction industry for the full implementation of BIM using responses from 138 professionals and students. Awareness of BIM is widespread, but readiness for lifecycle-wide implementation is low. Familiarity is moderate, nearly half of respondents have had no formal training, and practical competence lies mostly in CAD rather than in object-based BIM platforms. BIM is used almost exclusively for design, with scheduling, cost, sustainability and facility management barely represented. High license cost and inadequate training are the dominant barriers. Support for indigenous software development and concern over software cost are the strongest predictors of support for lifecycle-wide adoption, whereas internet connectivity has no independent effect.

Four recommendations follow. First, government should lead implementation through a phased BIM mandate on public projects, supported by national standards, as advanced economies have done [7]. Second, license costs should be reduced through educational licensing, subsidies or national agreements with vendors, and research and development of indigenous, Naira-priced BIM software should be funded, with professional bodies coordinating developers and end users. Third, universities should embed BIM, including 4D and 5D applications, throughout construction-related curricula rather than leaving it to elective or self-directed learning. Fourth, professional bodies should make structured BIM training part of continuing professional development.

The study has limitations. The sample was drawn from south-western Nigeria and was dominated by male respondents and students, and adoption was measured through perceptions rather than observed project practice. Future work should survey firms across all geopolitical zones and measure BIM use on live projects against cost and time performance.

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