# Chapter 5
# BIM for Construction Education in Nigeria


**Theophilus Olowa, Emlyn Witt, and Irene Lill**

**Abstract** Introducing advanced information technologies (AITs) such as a BIM-enabled learning environment (BLE) into architectural, engineering, construction, and facility management (AEC/FM) education might be an indirect but effective means of eradicating poverty and ensuring upward socioeconomic mobility for people all over the world, as the UN rightly recognizes in their mandate. In this study, we focus on a data collection tool to investigate the current state of the art of BIM for construction education among academics in an emerging economy (Nigeria). In the same framework, we strive to understand their perspectives, the benefits of BIM for construction education, and its perceived limitations. This preliminary study will assist us to later identify and compare structural features in these contexts to those in Europe and then assess the outcomes and repercussions of the proposed BLE in a developing economy like Nigeria. Using qualitative survey research design and analyzing with the aid of NVivo, nine themes emerged from the preliminary findings, viz., advantages, beyond present area, BIM in teaching, BIM in BIM-enabled learning, constraints, general views about BIM in Nigeria, stakeholder attitudes, and teaching method. These suggest that the designed data collection tool is sufficient in eliciting information from the population that is associated with BIM-enabled learning among academics in emerging economies which would help in meeting the fourth goal (Quality Education) of the UN's Sustainable Development Goal (SDG) plan.

**Keywords** Building Information Modeling (BIM) · BIM-enabled learning · BIM education · Virtual learning environment · AEC-FM

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## 5.1 Introduction

As part of its aim as a member of the Global Education Coalition, the United Nations (United Nations, n.d.) is assisting countries "…in mobilizing resources and implementing innovative and context-appropriate solutions to provide education…" globally. This, they stated, is in line with the fourth goal of their 2030 agenda for Sustainable Development Goals (SDGs). While 2030 is only a few years away, the agenda has been negatively disrupted by COVID-19 as most schools were shut down for an extended period. Digitalization is not only disrupting the construction industry but also revolutionizing the way that knowledge in architectural, engineering, construction, and facility management (AEC/FM) disciplines is conceived, developed, delivered, and reconstructed between academics and students. This offers an opportunity to prevent (or at least limit) the negative impact that may arise in the future from similar disasters. Building Information Modeling (BIM) is pivotal in this revolution. Digitalization has permeated human existence to the extent that it defines generations, based on how influenced and digitally exposed people are to it. For example, we have Gen X, Y, and Z that are all defined according to peoples' affinity to digitalization. The change in knowledge creation, construction, reconstruction, and the desire to contribute to sustainable development by seeking equitable solutions and universal access to education is also attracting researchers' attention to consider an effective means of how these new bodies of knowledge are stored, communicated, shared, transmitted, and evaluated. In response to these challenges, the development of a BIM-enabled learning environment (BLE) is an initiative in its developmental stage to augment competency-based teaching and learning in a common but location independent, open, accessible, self-paced, and collaborative environment by leveraging advanced information technologies.

The structures of the proposed BLE have been delineated into three domains (BIM, collaborative, and VLE functions) and interpreted using Adaptive Structuration Theory (AST) in our earlier work (Olowa et al., 2022). However, the identification, isolation, formulation, and validation of the existing different structural features and spirit under these domains are based on data collected from only three European countries, viz., Italy, Finland, and Estonia. The geographical context from which the structural features and spirit are formulated imposes a limitation of whether a globally relevant set of structural features and spirit have been captured. Therefore, the aim of this study is to find out if there are other context-specific structural features and spirit that are missing in the validated three domains especially from the perspective of developing economies.

In this study, we focus on the data collection tool by using the Will, Skill, Tool (WST) model among academics for exploring the general state of the art of BIM for construction education in developing economies. We try to understand their views on stakeholders' attitudes, advantages of BIM for construction education, and perceived constraints in the same context. Afterward, we intend to delineate and compare the identified structural features in this context to the European context and eventually use Adaptive Structuration Theory (AST) to evaluate the outcomes and consequences of the proposed BLE in an emerging economy like Nigeria.

The structure of this paper is as follows: the next paragraph briefly examines the relevant literature followed by the methodology and results sections, respectively. Conclusions are drawn at the end of the paper.

### *5.1.1 Literature Review*

BIM education for both graduates and construction professionals has not progressed nor advanced as quickly as in the industry deployment of BIM (Casey, 2008; Forgues & Becerik-Gerber, 2013), and this presents a challenge for the education of architectural, engineering, construction, and facility management (AEC/FM) students (Ambrose, 2012). Firstly, graduates and construction professionals must be BIM natives to meet the immediate industry needs and challenges if they are to successfully carry out their professional tasks especially as global industry players. Many higher education institutions (HEIs) and faculty or practitioner researchers around the world are already standing up to this challenge, whether in bits and pieces or in major chunks, by altering existing curriculums at topical level within a course or carrying out a total overhaul and redesign of academic programs (Gerber et al., 2015; Olowa et al., 2019). Secondly, education tends to also miss out on new opportunities arising from BIM which have the potential to enhance AEC/FM education and benefit the industry in return (Olowa et al., 2020). These include opportunities for improving the integration of curricula within and between construction-related disciplines using real project data and creating learning environments that more closely correspond to industry realities.

Previous studies in advanced economies have adduced different reasons for the slow reflection of BIM in AEC/FM education generally. For example, Puolitaival and Forsythe (2016), Gier (2008), Klotz et al. (2009), Wong et al. (2011), Becerik-Gerber et al. (2011), Clevenger et al. (2012), Codinhoto et al. (2013), Forsythe et al. (2013), and Underwood and Ayoade (2015) argue that unavailability of appropriate teaching and learning resources for BIM; difficulty in finding the balance between theory and practice, technology and process, and traditional and emerging Construction Project Management (CPM) methods; and facilitating staff's professional development as the major challenges facing BIM in construction education. Despite these challenges, some of the authors (e.g., Puolitaival & Forsythe, 2016) opined that theoretical educational resources are available, easy, and straightforward to locate. Notwithstanding the availability of these educational resources, they maintained that having actual building models is a challenge in terms of preparing and optimizing usage of the model for high-quality educational purposes. These challenges and benefits are largely from studies carried out in the developed economies.

In the emerging economies context which Nigeria represents, there is a growing corpus of study that attempts to probe into the challenges/barriers and benefits of BIM in the sense of the construction industry in general (e.g., Amuda-Yusuf et al., 2017) and in quantity surveying profession specifically (e.g., Babatunde et al., 2018;

Babatunde & Ekundayo, 2019). Babatunde and Ekundayo (2019) identified 17 major barriers to the incorporation of BIM into quantity surveying undergraduate curriculums as follows:

- The lack of IT infrastructure or poor internet connectivity
- Intensive resource requirement of executing BIM protocols
- The inability of government to lead/direct BIM implementation
- High cost associated with staff/lecturer training or retraining
- Unavailability of staff with BIM expertise to take BIM courses
- The frequent need for BIM software upgrading
- The nonexistence of accreditation standards and requirements to guide the implementation of BIM
- Inadequate/erratic power supply
- The lack of collaboration with industry expert
- BIM is problematic for people with weak general IT skills
- Resistance to change
- Difficulty in introducing BIM in an already well-established curriculum
- Need for industry involvement, i.e., the need to engage expert industry practitioners in the development and delivery of a BIM curriculum
- The lack of university management support
- The lack of ICT literacy of staff or technical expertise
- Problem with integrating different areas of the curriculum to realize the multidisciplinary aspect of BIM
- BIM demands new teaching methods
- The lack of BIM-specific materials and textbooks, as well as other educational resources for students

Furthermore, the study also identified 12 BIM drivers and 14 BIM benefits of incorporating BIM into undergraduate quantity surveying curriculums using quantitative approach.

While previous research on BIM in HEIs identified barriers, drivers, and benefits based on a mono-discipline quantitative data from students and faculties (Babatunde et al., 2018; Babatunde & Ekundayo, 2019), this study explores the general state of the art of BIM education by considering it from a multidisciplinary perspective among the AEC-FM faculties using a qualitative approach to have a deep insight into the contextual advantage, stakeholders' attitudes, and constraints of BIM-enabled education in Nigerian HEIs.

## 5.2 Methodology

This study is a preliminary phase of an exploratory sequential mixed methods (Creswell, 2013) approach to explore the level of BIM for construction education among academics in higher education institutions (HEIs) in Nigeria with a focus on the development of a data collection tool. The anticipated solution being proposed

toward promoting dispersed and self-paced learning in a BIM-enabled environment would be principally beneficial to educators especially those in HEIs, i.e., academics. As such, academics were recruited to participate in this preliminary study.

### *5.2.1 Site*

Interviews were carried out among professors in the faculty of environmental sciences at the university of Ilorin (UNILORIN) using purposive sampling technique. This was done to overcome part of the limitations of an earlier study carried out within the European Union by finding additional evidence from a different social context and making a comparison. Although the University of Ilorin itself was founded in 1976, the faculty of environmental sciences was not established until 2013 starting with five departments, namely, architecture, estate management, quantity surveying, surveying and geo-informatics, and urban and regional planning departments. The number of departments is still what it used to be as at the time of this study. The staff structure is such that most faculty members are either experienced professionals from the industry or other academic institutions with very few inexperienced junior academics. There are only two departments that currently run master's programs at present, namely, departments of architecture and urban and regional planning. This institution was chosen for this preliminary study because of its reputation as a stable (i.e., not given to unexpected closures due to strikes, etc.) academic institution in the country.

### *5.2.2 Theoretical Model*

The Will, Skill, Tool (WST) framework is used as a general framework to give meaning to the experiences of academics participating in this study. The WST model has been extensively used in both quantitative and qualitative studies as either an indicator or predictor of teachers' readiness to integrate technology into their teaching (Agyei & Voogt, 2011). Sasota et al. (2021) argue that WST model is versatile in explaining the integration of technology in teaching practice by academics. There are three important components in the model, namely will, skill, and tool. Will is described as the desire to use technology, skill as the ability to acquire the requisite knowledge and use the desired technology, while tool is the availability and accessibility of the technology. The will and skill are internal factors considered to be within the control of academics to some extent. The tool, however, is regarded as external factor because the technology (i.e., hardware and software) is expected to be provided by the employer. The model showing the connection between these attributes required for integrating technology in teaching practice is shown in Fig. 5.1.

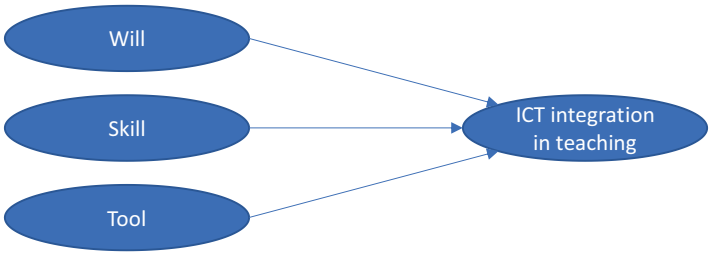


**Fig. 5.1** WST model of ICT integration in teaching. (Based on Velazquez, 2007)

### *5.2.3 Instrument*

A semi-structured interview was used as a tool to explore the academics' experiences and teaching practices in construction education because it allows the respondents to describe their experiences in a broad way (Krahn & Putnam, 2003) yet channels the conversation toward issues of research interest. This tool's flexibility and openness allowed customizing questions to the specific circumstances and discursive meanings of participants (Hildebrand & Markovic, 2007). The main questions asked were as follows:

1. What are your general views about BIM in Nigeria, stakeholder attitudes, advantages, constraints?
2. Please describe your teaching practice with respect to subject(s) and target audience.
3. Do you currently use BIM in delivering your teaching/training?

If yes:

   (a) How do you use BIM in the delivery? (e.g., for visualizations, project data, communication, etc.)

if no:

   (b) Could you use BIM to help deliver your teaching/training and for what? (e.g., for visualizations, project data, communication, etc.)

4. Beyond your present area(s) of teaching/training, how do you think BIM could be used in BIM-enabled learning?

### *5.2.4 Analysis*

The analysis of the interview was carried out using thematic analysis. It seemed logical to use thematic analysis, as its qualitative nature provides a method particularly suitable for understanding subjective meanings and the process of social construction of individual narratives surrounding a particular theme. This was achieved

through content coding by using NVivo (QSR International Pty Ltd, 2020) for the substantive contents of the interview.

## 5.3 Results

This section provides the preliminary findings of the study.

### *5.3.1 Demographics*

Table 5.1 shows the breakdown of the participants' demographics.

Table 5.1 shows that there were ten faculty members interviewed from the University of Ilorin with only one of them being female while the rest were males. Breakdown of their cadres reveal that there was an associate professor, three technologists, and six lecturers (who were either in Lecturer I or II positions) that participated in this study. They represented three departments from the institution, namely, architecture, urban and regional planning, and estate management with five, one, and four participants from the departments, respectively. With respect to their highest educational qualifications, there was only one PhD degree holder, seven master's degree holders, and two first degree holders.

**Table 5.1** Demographics of participants

| Characteristic | Number of interviewees | Percentage (%) |
|---|---|---|
| Gender | | |
| Male | 9 | 90 |
| Female | 1 | 10 |
| Academic title | | |
| Associate professor | 1 | 10 |
| Technologist/instructor | 3 | 30 |
| Lecturer (I and II) | 6 | 60 |
| Length of service in present university | | |
| 5–10 years | 10 | 100 |
| Discipline | | |
| Architecture | 5 | 50 |
| Urban and regional planning | 1 | 10 |
| Estate management | 4 | 40 |
| Highest qualification | | |
| PhD | 1 | 10 |
| Masters | 7 | 70 |
| Bachelors | 2 | 20 |

### 5.3.2 Themes Emerging from the Interviews Based on WST Model

Table 5.2 shows the themes generated through content analysis, the number of coded references generated in each, and the number of participants from whose transcripts the codes were extracted.

### 5.3.3 Description of Themes Relating to Will

#### 5.3.3.1 Academics' Perception on Stakeholder Attitudes

In describing the attitudes of the stakeholders, the participants attempted to distinguish among the various stakeholders. They opined that there are some stakeholders that they believed are interested in BIM and its application, whereas there are others that are averse to and skeptical about its use. Some examples of those interested in BIM and its application as suggested by participants include the public sector and some private organizations, which are large. The use of BIM by academics and among other stakeholders is viewed as almost nonexistent.

#### 5.3.3.2 General Views of Academics About BIM

Participants viewed BIM in Nigeria as a welcome development which allows for more realistic designs and quicker design development, thereby leading to overall time saving in construction. They also opined that the advent of BIM would see a lot of job loss especially those that relate to draughts men's and job men. They also feared that BIM gives an unrestrained avenue for nonprofessionals to promote quackery in different AEC disciplines.

**Table 5.2** Emergent themes from the interviews

| Themes | Number of references | Number of interviewees |
|---|---|---|
| Will | | |
| Stakeholder attitudes | 5 | 3 |
| General views about BIM | 10 | 6 |
| BIM in teaching | 6 | 5 |
| Skill | | |
| Advantages | 6 | 4 |
| Teaching method | 10 | 6 |
| Tool | | |
| Beyond present area | 3 | 3 |
| Constraints | 18 | 8 |
| Total | 57 | 9[a] |

[a]While the total was ten, one of the interviewees' transcripts had no relevant data for this study

#### 5.3.3.3 BIM in Teaching

In response to how the interviewees reflect BIM in their teaching, the majority revealed that it does not reflect in their teaching at all while a few indicated that they only carry out BIM awareness education.

### *5.3.4 Description of Themes Relating to Skill*

#### 5.3.4.1 Advantages

The advantages ascribed to the use of BIM by the interviewees include: speed of design accuracy of design and calculation parameters; usefulness in prefabrication; saves time and gives good results; ability to design more complex structures; and ability to simulate and plan construction activities.

#### 5.3.4.2 Teaching Method

Many of the participants said that they use "hybrid" methods in their class teaching. By this, they give notes or handouts to students and sometimes project on the wall. In addition to this traditional method of teaching, some include a method they referred to as "learning by doing" which involves giving briefs to students for development. Assessments are carried out formatively by tests, writing of term papers, and presenting in seminars. Summative assessments are carried out by writing semester exams.

### *5.3.5 Description of Themes Relating to Tool*

#### 5.3.5.1 Constraints

The major constraints to the wide spread of BIM in Nigeria that were expressed by the interviewees include procurement and renewal cost, accreditation bodies not mandating BIM knowledge or skills for students, outdated curriculums, lack of access to technological hardware (e.g., computers, internet, and electricity), lack of BIM education, less emphasis on practical knowledge, inadequate security of lives and properties in the country, staff training and empowerment, and lack of time.

#### 5.3.5.2 Possible Areas Beyond Present Use

It seemed difficult for most of the interviewees to suggest how BIM could be used in other areas beyond their present teaching practice as most of them already revealed that they do not interact with BIM in their practice. However, one area that

was suggested is in 3D house printing, where BIM would be the backbone on which the operations take place. The other area was in virtual learning, where BIM would enhance the ability of students to learn remotely given the ongoing experience of the COVID-19 pandemic.

## 5.4 Conclusions

COVID-19 has underscored the importance of having an effective way to engage learners in distributed learning globally if a meaningful achievement is to be made toward providing sustainable education for all by 2030. Introducing advanced information technologies (AITs) like the BIM-enabled learning environment (BLE) into AEC/FM education might be a veritable means to achieving this. This in turn will serve the 2030 agenda of the United Nation's SDG to eliminate poverty and guarantee upward socioeconomic mobility of peoples around the globe. This is because the BLE will promote location-free, competency-based, common, open, compatible, convenient, and accessible platform for AEC/FM disciplines at graduate level and offer opportunity for both self and continuous professional development toward sustainable human development and growth. To achieve this goal, a fully robust BLE must first be developed and made operational.

This study is a preliminary exploration of academics in AEC/FM disciplines to understand the state of the art of BIM education in Nigeria, their views about stakeholders' attitudes, opportunities, and constraints. Nine themes emerged from the preliminary findings and were grouped using the WST model, viz., advantages, beyond present area, BIM in teaching, BIM in BIM-enabled learning, constraints, general views about BIM in Nigeria, stakeholder attitudes, and teaching method. With these responses and the analyzed results, it is now possible to proceed in eliciting information from a much larger and country-wide population sample. This will enable the identification of structural features (structures and spirit) associated with BIM-enabled learning among academics in emerging economies. This would contribute to meeting the 4th goal (Quality Education) in the UN's SDG plan.

In response to how the interviewees reflect BIM in their teaching, the majority revealed that it does not reflect in their teaching at all while a few indicated that they only carry out BIM awareness education. This condition could be ascribed to several reasons associated with will, skill, and tool. In many cases, it is important to be aware of a technology and what it can do before the concepts of will and skill (or skill and will) can take effect. It also seemed difficult for most of the interviewees to suggest how BIM could be used in other areas beyond their present teaching practice as most of them already revealed that they do not interact with BIM in their practice. These realities among the academics underscore the need for an avant-garde platform such as BLE that will promote teaching and learning of BIM-enabled education in construction economics and organization. This will empower and provide both academics and learners who might not have BIM authoring experience nor BIM teaching and learning resources (e.g., modules) to have access to BIM-enabled education with just their browser and the internet.

The WST model suggests that it is possible to achieve a high level of technological integration into teaching by enhancing the will and skill of the academics and providing an enabling environment for the will and skill to be demonstrated. It is when this happens that the academics in emerging economies may constructively offer suggestions for improving the BLE to ensure its robustness and dependability for global use irrespective of the developmental context.

There are limitations in this study some of which will be addressed in future research. An important one is about the number of participants sampled in this study. In future, the study will consider a greater number of academics from a number of higher education institutions and representative of a more diverse range of AEC/FM disciplines.

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