AFRICAN BIM REPORT

2020

BIM.Africa

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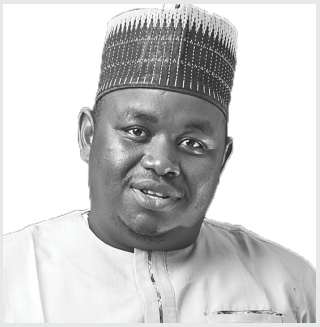

Sa'id Kori (PhD),
Chairman, Board of Directors, BIM Africa

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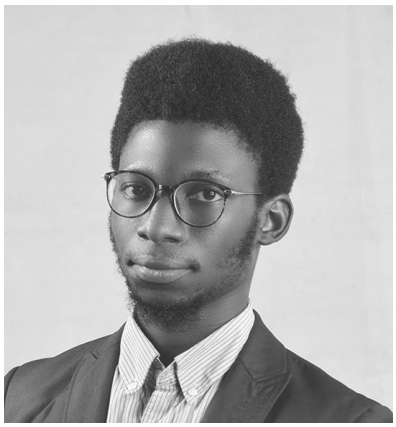
While it may seem like the adoption of Building Information Modelling (BIM) across Africa is slow-paced, the increasing advocacy efforts from various stakeholders is now resulting in a widespread drive for implementation and deployment. Coupled with the ongoing disruption by the global COVID-19 pandemic, there is now a very high degree of the utilization of digital technologies by construction professionals.

As a first of its kind across the continent, the African BIM Report was conceived to provide a continuous review of the state of implementation of BIM by the industry. The report will progressively highlight exceptional projects, industry leaders and research experts across Africa.

A pan-African survey will integrate the opinion from a wider range of professionals. As a dynamic, future-focused, and thriving community, BIM Africa is well-positioned to champion the digital transformation of the built industry across Africa. Our approach covers broad industry education, extensive research, professional development and certifications, quality networking and the formulation of locally adapted standards. Our Research and Development Committee comprises of a thriving portfolio of internationally certified and brilliant academic researchers of African descent; the coming together of bright minds to impact their motherland.

The voyage before us all is both exciting and astounding.
Iungere nobis ad incursum Afrika!



Abdullahi Saka
Committee Lead
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Introduction

Despite having the huge potential to digitize and upgrade its approach, the construction industry is known to be slow in adopting innovation when compared to other sectors like transportation, finance, and health. The situation is worse in developing countries which are often languishing on the disadvantaged side of the digital divide. With the advent of the Building Information Modelling (BIM), governments and organisations have been driving the BIM crusade in the construction industry due to the immense benefits attached to its implementation. However, developing countries are lagging in their implementation and are often underrepresented in BIM reports.

The African Continent's population is expected to be doubled by 2050 which would lead to an increase in demand on the Architecture, Engineering, and Construction (AEC) industry coupled with the current infrastructural deficit on the continent. This puts the African AEC in a strategic position towards the development of the continent, and adoption of technologies in the industry would of no doubt be of immense benefits. Albeit, the industry is bedevilled with myriads of challenges on the continent, it also offers opportunities for proffering innovation solutions.

The Research and Development Committee of the BIM Africa which comprises of industry practitioners and researchers presents the African BIM Report (ABR) 2020 which is the first of its kind on the continent. The report would be an annual publication to track and discuss the progress and opportunities of digital technologies in the African construction industry. The ABR 2020 consists of the summary of findings for African BIM Survey (ABS) 2020, project showcase and experts' opinion. The ABS was a continental-wide survey of the level of awareness and adoption of BIM across Africa; the project showcase consists of carefully selected projects across the various regions in Africa that have implemented digital technologies with details of implementation, challenges and lessons learnt; the experts' opinion consists of articles from notable authorities on the central theme of digital construction. It is hoped that this report would contribute to the growing discussion of digital construction in developing countries.

Acknowledgement

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Digital Twinning, Smart Cities & Internet of Things

A demystification and roadmap for integration in the African AEC industry

Background

The global construction industry, which has historically not been known for its eagerness to embrace innovation is in a state of flux. Today it finds itself at the receiving end of many 'innovative ideas' pushing for relevance, but not all of these are addressing the traditional challenges of productivity, profitability, quality or delivering projects on time and at an agreed cost. Certainly, there are new ideas that bring new insights and benefits, but a lot of innovations could be regarded as solutions looking for problems. Many of such solutions are petering out after hitting the 'Peak of inflated expectations' on Gartner's hype cycle. Being a heavy-spending industry which is critical to national development (and being used to stimulate stagnating economic growth) is what makes the construction industry a prime target for all manners of stakeholders. Today, it is not uncommon to find so-called experts and change-agents with zero background in construction and the built environment supposedly championing change via a process such as digital transformation (and even BIM). The African AEC industry is rapidly evolving with modernisation and development in its built assets. Still, without the necessary exposure and understanding of key concepts and technologies, some of its clients and AEC organisations may fall prey to imported quacks, who exist everywhere.

A closer look at happenings in developed countries will reveal a worrisome trend while there is always room for collaborative multi-stakeholder inputs that would improve the AEC industry. It is beyond imagination that someone without a built environment education or work experience is allowed to drive process improvement or innovation in construction, where the whole idea is to 'improve' on old practices (which a non-professional may be oblivious of). Such square-pegging of round holes could hardly happen in other industries such as Manufacturing, Banking, or Information Technology (IT). The objective of this article, therefore, is to demystify three paradigms that are ripe for exploration and exploitation by AEC professionals in Africa so they can lead the much-needed changes that would be led by professionals that are conversant with the built environment. These paradigms, which also attract substantial interests and indulgence from quasi-profession-

Digital Twinning (DT)

Concerning digital twinning (DT), it is astonishing that today, some so-called 'experts' actually refer to it as the next BIM or a superior form of BIM. Nothing could be further from the truth. By evolution, a digital twin is essentially a form of "cyber-physical system" (CPS) (see http://cyberphysicalsystems.org) which is a paradigm that existed as a separate concept for many years, owing to its existence to IoT and has been led by aerospace, mechanical and electronic industries. In short, from an academic perspective, DT is just a fancy rebranding of CPS. BIM, on the other hand has no conceptual origin or "claims" to the use of sensors, bi-directional data flow, or the kind of connectivity that is fundamental to CPS. This is not to say they are unrelated because the digital models (e.g. 3D BIM or COBie) derived from BIM can certainly benefit CPS. We could say the 6D (Facilities Management) dimension of BIM shares the same objectives as the end goal of DT. Therefore, DT cannot be the "new buzzword for BIM" as erroneously peddled around by some, rather it could/should be one of BIM's end products.

The key aspect of DT is to have a virtual model that would be linked to the physical product. A model is merely an abstraction/representation of reality, and it need not be graphic or 3D. You can have a DT purely based on a spreadsheet (e.g. COBie). You would have sensors on the physical asset to be hooked up via IoT technology to the virtual equivalent (3D model, spreadsheet, etc.). According to the Digital Twinning Maturity Spectrum (DTMS) (see Evans et al. 2019), there are many layers of sophistication of a digital twin. And, it may be necessary to start at a low level of maturity (Table 1) before gradually increasing the complexity and capability as the project (or organisational capacity) evolves.

Level	Model Sophistication	Physical Twin	Data Acquisition from Physical Twin	Machine Learning (Operator Preferences	Machine Learning (System/Environment)
1 Pre-Digital Twin	Virtual system model with emphasis on technology/technical-risk mitigation	does not exist	Not applicable	No	No
2 Pre-Digital Twin	Virtual system model of the physical twin	exists	performance, health status, maintenace; batch updates	No	No
3 Adaptive Digital Twin	Virtual system model of the physical twin with adaptive UI	exists	performance, health status, maintenace; real-time updates	Yes	No
1 Intelligent Digital Twin	Virtual system model of the physical twin with adaptive UI and reinforcement learning	exists	performance, health status, maintenace; environment; both batch/rea-time updates	Yes	Yes

In the aerospace industry, for instance, they would have a DT of a jet engine using a spreadsheet representation (model). There'd be no need for the analysts to actually "see" the engine blades represented in 3D and rotating at 25,000 rpm because real-time sensors would collect various kinds of data and present them in a time-series format using a spreadsheet/line graph. This is what is needed for decision making. For the AEC industry, although DT has links with Facilities Management (FM) and Smart Buildings, this does not mean that it was 'intended' as a direct or immediate replacement for either – although DT could certainly be the future platform for FM. Consider for instance, that FM is an entire career/profession while DT is a technology-driven process. You cannot replace a profession with a tool. Hence, for anyone to remotely suggest that DT is the 'next' or 'superior' version of BIM is not only annoying and grossly misleading, it bothers on professional quackery.

The UK has been a global leader in DT, going as far as instituting a national framework for digital twinning via Centre for Digital Built Britain (CDBB). This is done with aspirations to "digitally twin" every built asset in Britain, using a strategy is based on the "Gemini Principle" (Fig. 1). Such an ambitious drive for a concept that is largely theoretical to-date is what attracts the opportunists and quasi-professionals who pollute the genuine debate, drive and desire by AEC professionals to improve their processes. African AEC professionals would do well to identify such persons and steer clear of them. The AEC industry's traditional apathy towards change and improvements is hurting its march towards genuine solutions to real problems. We cannot afford for DT to end up being a solution looking for a problem. Practical case studies of successful DT in the built environment are few and far between, unfortunately.

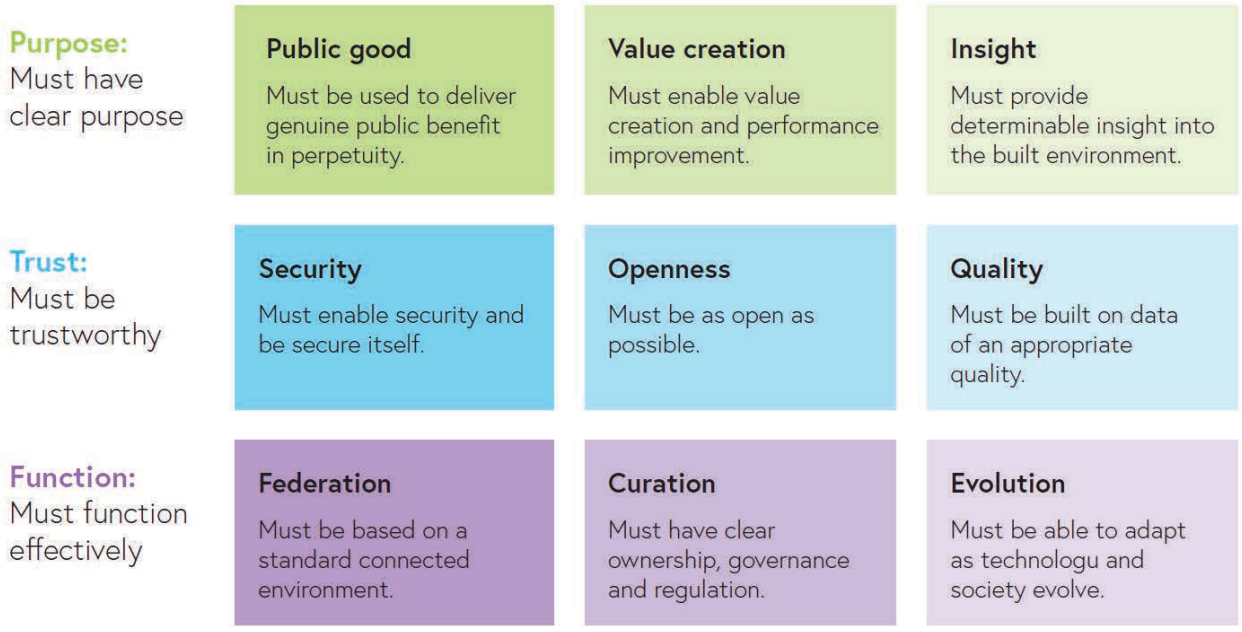


Figure 1: The Gemini principles behind UK's digital twinning approach (source: CDBB, 2018)

The AEC industry's traditional apathy towards change and improvements is hurting its march towards genuine solutions to real problems.

Smart Cities

There are many sectors of a typical urban settlement that can benefit from being a smart city from the built environment perspective.

Smart cities are being developed out of necessity and opportunity. In terms of necessity, the massive urbanisation occurring means 54% of people worldwide live in cities today, and by 2050 the population of urban residents would be 66%. This combination (population growth + urbanisation) will add another 2.5 billion people to cities by 2050. Of the top 25 fastest growing cities in the world, 10 of them are in Africa, including Bamako (6th); Lagos (7th); Dar es Salaam (9th); and Kampala (13th) among others. So the impetus to deliver sustainable, advanced and liveable cities is great for African AEC professionals.

Consequently, such professionals need to contribute their quota if we are to achieve the environmental, social, and economic sustainability required for managing the finite resources available. As far as opportunity is concerned, we have the technology (and zeal) to live better, healthier lives by improving our quality of life (QOL) and quality of place (QOP) as well as reducing negative impacts of our development on the environment, e.g. climate change. It is on the back of such necessities and opportunities that the Smart City concept emerged and is defined as a process of "utilising technologies and connected data sensors to enhance and become powerful in terms of infrastructure and city operations. This includes monitoring and managing public assets, transportation systems, citizens, power plants, water supplies, information systems, civil bodies, and other community services". Another definition is offered in the publicly available specification (PAS) on smart cities, i.e. PAS 180: 2014 Smart Cities: "the effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens" (BSI, 2014).

There are many sectors of a typical urban settlement that can benefit from being a smart city from the built environment perspective. For instance, with Smart Buildings and Infrastructure, we would have smart toilets that can be integrated into our health monitoring system (e.g. automatically detecting sugar levels in our urine and sending the data to our doctors). Other aspects would include: building energy management systems; automated building security; automated structural integrity monitoring; smart water reticulation systems, and so on. Smart Transportation and Security can help solve traffic gridlock and congestion, which robs residents of cities like Lagos of productive hours. With Smart Waste Management, a city can manage its waste from inception to disposal. This requires a proper system of collection, transportation, and disposal or recycling and monitoring of waste and with IoT technologies. Having Smart Healthcare means we could have telecare (remote healthcare, e.g. with smart toilets) in our homes and places of work. Disease monitoring would be easy due to ubiquitous sensors placed in strategic locations. Some London boroughs have launched "smart benches". These benches do not only provide free WIFI and phone charging ports but also have sensors to capture air and noise pollution data in real-time while giving people the opportunity to have a sit down (rest, chat, etc.). These smart benches are also solar-powered (Fig. 2).

Smart Transportation and Security can help solve traffic gridlock and congestion, which robs residents of ***cities like Lagos of productive hours.***

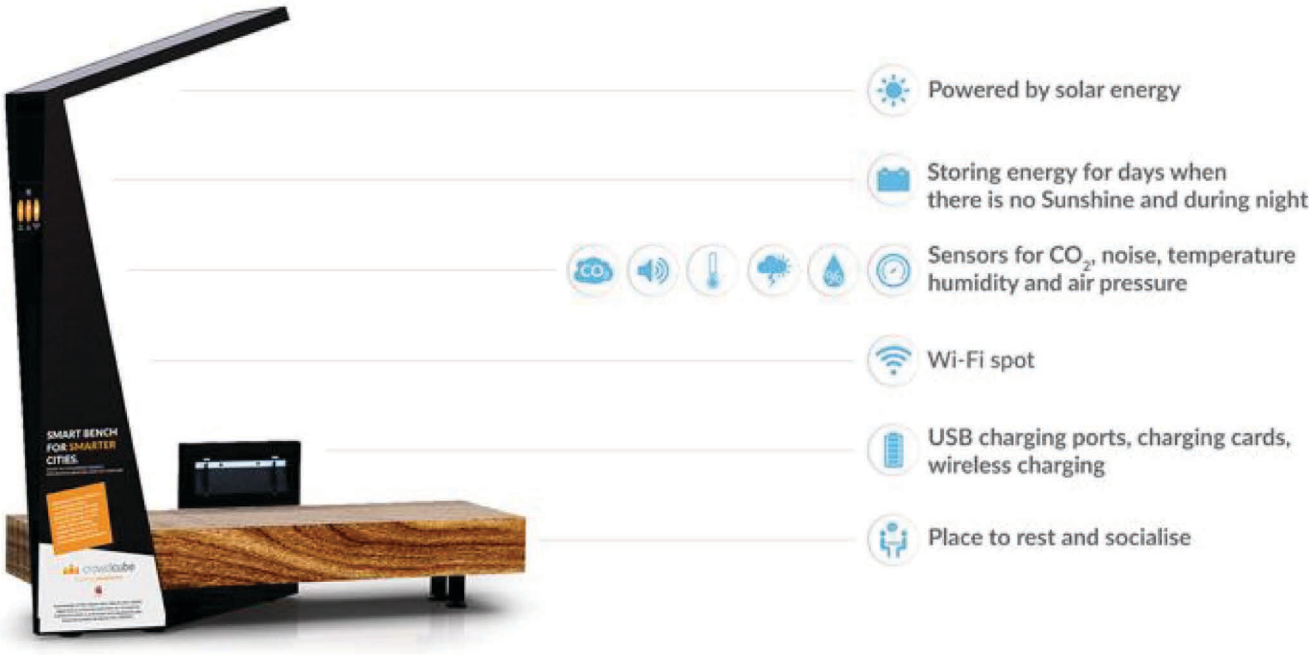


Figure 2: A typical smart bench found in many parts of London.

Traditional planning and architecture cannot deliver the paradigm of smart cities because they have failed to address the contemporary issues mentioned above adequately. Nevertheless, there are other emergent challenges and concerns for smart cities such as:

Data privacy- individuals have right to be concerned about how their data is collected, stored, analysed and exploited; Cyber-Security - through espionage, ransomware, etc. is a real threat and whole cities and departments have fallen prey to this; Profiteering and consumerism - The average lifetime of smart technologies (e.g. smartphones) is rather short and so do we need to keep replacing hardware because it is old?; Inter-municipal collaboration - Data sharing by various departments (transport, utilities, housing, security, etc.) is necessary to avoid 'silo approach' to Smart City; Enabling policies and legislation – is required so that it will put people (and not profits) first; Readiness of existing infrastructure - Both IT and physical infrastructure need to be smart-ready; Cost of implementation - Who will pay for it and what is the return on investment (ROI) or benefit from being obtained by society?

Data privacy - individuals have right to be concerned about how their data is collected, stored, analysed and exploited;

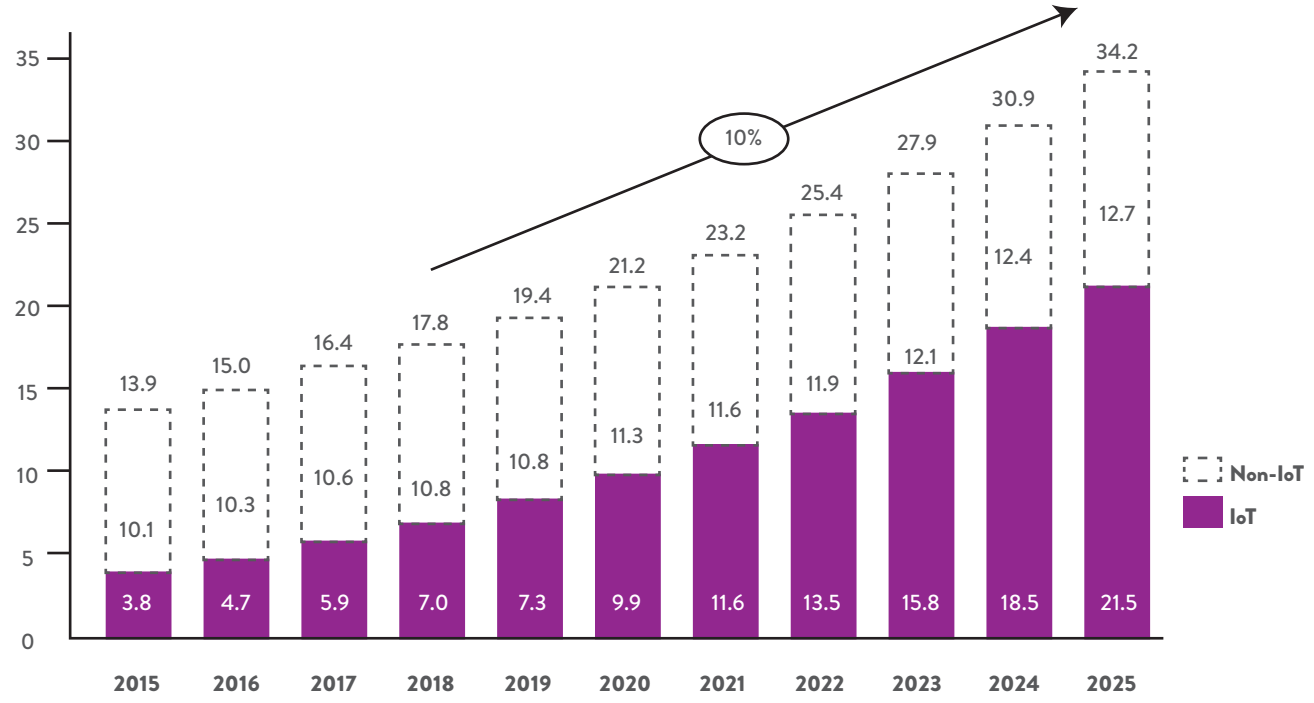
Internet-of-Things (IoT) and smart objects

Finally, it is pertinent (as can be deduced from above) that Internet-of-Things (IoT) is a fundamental and pre-requisites technology to the concepts mentioned above (digital twin and smart cities). In fact, unlike the other two concepts, IoT is probably the more open/generic one, because its applicability transcends the built environment at building or city levels. We have been able to connect objects through the internet since the 1980s, but it was at the dawn of the millennium (1999) that the term 'Internet of Things' was conceived by Kevin Ashton, a British technology pioneer. This was at a time when his contemporaries were using the phrase 'smart packaging,' for the same idea to refer to the concept of computers being able to 'know about things by collecting data without help from humans'. The development of IoT was assisted by the possibility of having Internet Protocol (IP) address, which is a unique number allocated to each device participating in a network. Generally, there are two IP address standards: IP Version 4 (IPv4) and IP Version 6 (IPv6) – with the growth of the latter helping to boost IoT adoption globally. An IPv6 address for a device comprises of eight groups of (hexadecimal) digits separated by colons, e.g. 2007:0db8:0000:0000:0000:0000:3124:5337.

Today, there are around 10 billion IoT (connected) devices, and by 2025, this number would increase to about 22 billion (Fig. 2). This would have enormous implications on our homes and cities, and many built environment professionals should be interested in this development.

Total number of active device connnections worldwide

Number of global Connections (installed based) in Bn



Note: Non-Iot Includes all mobile phines, tablets, PCs, laptop, and fixed line phones. IoT includes all consumer and B2B devices connected - see IoT break-down for further details

Source:IoT Analytics Research 2018

Figure 3: Projected growth of IoT enabled devices from 2015 to 2025 (Source: IoT Analytics)

With the rise of IPv6 standards, it means your door or window could have its IP address (assuming it has embedded technology) which would allow it to connect wireless through the internet. So that your home can be smart, e.g. allowing you to open or close a window from your mobile phone while in a different country altogether. Any object (electrical appliances, building components, vehicles, people, animals, etc.) can in principle be IoT-enabled as long it has an IP address enabling it to connect to other objects in the network. When such objects have IoT capability, they can be regarded as 'smart' objects, although there is more to smartness.

So what then makes technology smart? The four criteria can be used to determine if a technology is smart which are: (1) Wireless communication: The technology must have the ability to allow a device to send and receive communication wirelessly; (2) Internet of Things (IoT): the technology must enable such wireless connection to occur with other devices whether locally or globally; (3) Artificial Intelligence (AI): the technology must enable or support data to be collected and analysed using AI due to sheer volume/speed of the data generated; (4) Solve a problem: the technology must eventually be solving a problem or an issue that we would not otherwise be able to solve efficiently, effectively or easily.

Summary: Exploiting Digital Twinning, Smart Cities and IoT for the AEC industry in Africa

In the context of developing countries (and Africa in particular), DT offers benefits for clients, and professionals as well as utility organisations, even though it is still an embryonic concept. Going forward, clients would have a real-time platform (model, tool or spreadsheet) that gives an up-to-date status on the performance of their facilities. The professionals involved in the design, construction and operation phases would have inputs, if not direct use of such platforms, e.g. FMs. Utility companies would benefit by having a handle into the energy consumption of buildings since DT could be a virtual smart meter. Smart Cities are also an important concept that rapidly urbanising settlements in Africa can exploit to upgrade and redevelop into sustainable and advanced cities with an improved standard of living for all. This represents a vast opportunity for AEC professionals in Africa and their global partners. The political will required to implement digital twins and smart cities must be matched by the intellectual capacity, which means our universities and polytechnics need to rethink if their present curriculum is future proof. Are we training professionals who can cope with 21st century needs and smart technologies?

It may be overwhelming or uncomfortable for some to consider how technology has pervaded our buildings and cities, sometimes turning them into sophisticated artefacts that people of a previous generation may not recognise. But we must remember that one of the defining characteristics of human beings is that we are creatures of habitats. We are one of few species that design our 'homes' and places of work. We typically spend up to 90% of our time in an indoor environment of some sort and so it is unsurprising that we pamper our buildings with technology. We have always done this, and it is just that nowadays, such technology is digital. This realisation echoes one of my favourite architects of all time (Ludwig Mies van der Rohe) who said: "Technology is rooted in the past, it dominates the present and trends into the future…and wherever it (technology) reaches its real fulfilment, it transcends into architecture". He said this in 1950, but truer words were never spoken!

"Technology is rooted in the past, it dominates the present and trends into the future…and wherever it (technology) reaches its real fulfilment, it transcends into architecture".

Further reading:

BSI (2014) British Standards Institute, "PAS 180 Smart city terminology," 2014. Available at: http://www.bsigroup.com/smart-cities/Smart-Cities-Standards-and-Publication/PAS-180-smart-cities-terminology/ (accessed 12 May 2020).

Madni, A. M., Madni, C. C., & Lucero, S. D. (2019). Leveraging digital twin technology in model-based systems engineering. Systems, 7(1), 7.

Evans, S., Savian, C., Burns, A. and Cooper, C. (2019) Digital twins for the built environment: An introduction to the opportunities, benefits, challenges and risks, The Institution of Engineering and Technology. Available online at www.theiet.org/media/4686/digital-twins-for-the-built-environment-iet-atkins.pdf (accessed 12 May 2020).

Digital Success: AECOM Delivers Capitec Bank Headquarters in Stellenbosch

by: Wesley Ferguson

AECOM Imagine it. Delivered.

Credit: AECOM/Terry February

The end of 2019 saw the completion of the latest project for Capitec Bank. AECOM in collaboration with dhk Architects and interior designers, Collaboration delivered this striking new building in Stellenbosch. AECOM provided Structural, Mechanical, Civil, Wet Services, Fire and Electrical Engineering services. The role of digital tools and established workflows proved key to the successful delivery of the project.

Introduction

Blending into the Stellenbosch landscape, the new 21 500 m², three-storey head office for Capitec Bank in Technopark, Stellenbosch is striking to behold. Changes in the way that projects are delivered are happening rapidly. Digital transfor mation remains key as the collaborative benefits continue to be realised. With COVID-19 shaking the construction industry to its core, the 'new normal' demands rapid adoption of new digital tools. Early adoption and commitment to digital transformation has made the transition almost seamless for AECOM, with the successful delivery of this project proving what is possible.

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AECOM Project Practice Area Lead – Structures

Craig Howie
Digital Project Delivery Lead, Buildings and Places, Africa

Wesley Ferguson
Project BIM Coordination Manager. Discipline BIM Lead – Structures Buildings and Places, Africa

AECOM development strategy and Digital strategy development

Although there have been certain pockets of digital excellence scattered throughout the AECOM Africa business for many years, it has been the commitment to digital transformation over the last 5 years that have seen the most progress and benefit to the business. The hire of a dedicated Digital Lead and team has been a major catalyst for change at AECOM. Craig Howie has been leading the team for Building and Places and notes the progressive path that large scale change takes as well as the expanding influence of digital to all aspects of project delivery: "It is worth mentioning that digital transformation is still a relatively new industry catchphrase, in the early days it was really more about the practical evolution of moving from a 2D CAD to a more automated 3D BIM way of working, and was very design focused for us. Now our digital transformation is a lot broader than just 2D to 3D and it is growing every day." As a premier infrastructure company, AECOM offers multidisciplinary services: Architecture, Structural, Mechanical, Civil, Wet Services, Fire, Electrical, PCC and PM. Due to the varied nature of these teams, integrating digital tools and workflows in a synchronized manner is no mean feat. Certain teams, due to their internal culture, adopt and adapt faster than others. The structural engineering team in Cape Town is a prime example of early adopters. Although sometimes first to get bloodied with harder, real world lessons learnt, it helps to push all other connected teams forward. Large, complex commercial projects provide opportunities to flex the proverbial muscle of established tools and workflows that get used daily, and guide the way for further development and refinement.

Capitec Project Digital Delivery Strategy

Defining Standards and Policies

Coordinating multidisciplinary projects with numerous teams and subconsultants involved is always going to have its challenges, particularly in the digital space where skill levels vary wildly. Setting the correct policies and procedures in place early on is vital. To the uninitiated, these may seem onerous in the beginning and can prove to be a hard sell. With careful consideration to simplifying the information and a dedication to training, however, the benefits are realised throughout the duration of the project. The early adopting of a well-defined, logical BIM execution plan cannot be stressed enough. With BIM processes and cloud hosted work-sharing at the core of the design and delivery philosophy, AECOM led the way in onboarding and coordinating design services. Extensive training was provided to get all stakeholders on the same page and collaborating.

Common Data Environments

As the beating heart of a digitally delivered BIM project, the right CDE (Common data environment) is essential. It's important to emphasise that the gold standard for digital project delivery is one continuous, unbroken set of data from project inception through to as-built client handover. The best CDE's put this at the core of the platform's design philosophy and build the UX (user experience) to support this objective. Other key considerations for choosing a data environment for the project was the ability to build company specific, ISO19650 best-practices and the ability to tightly integrate with most of the software used to design and coordinate the deliverables.

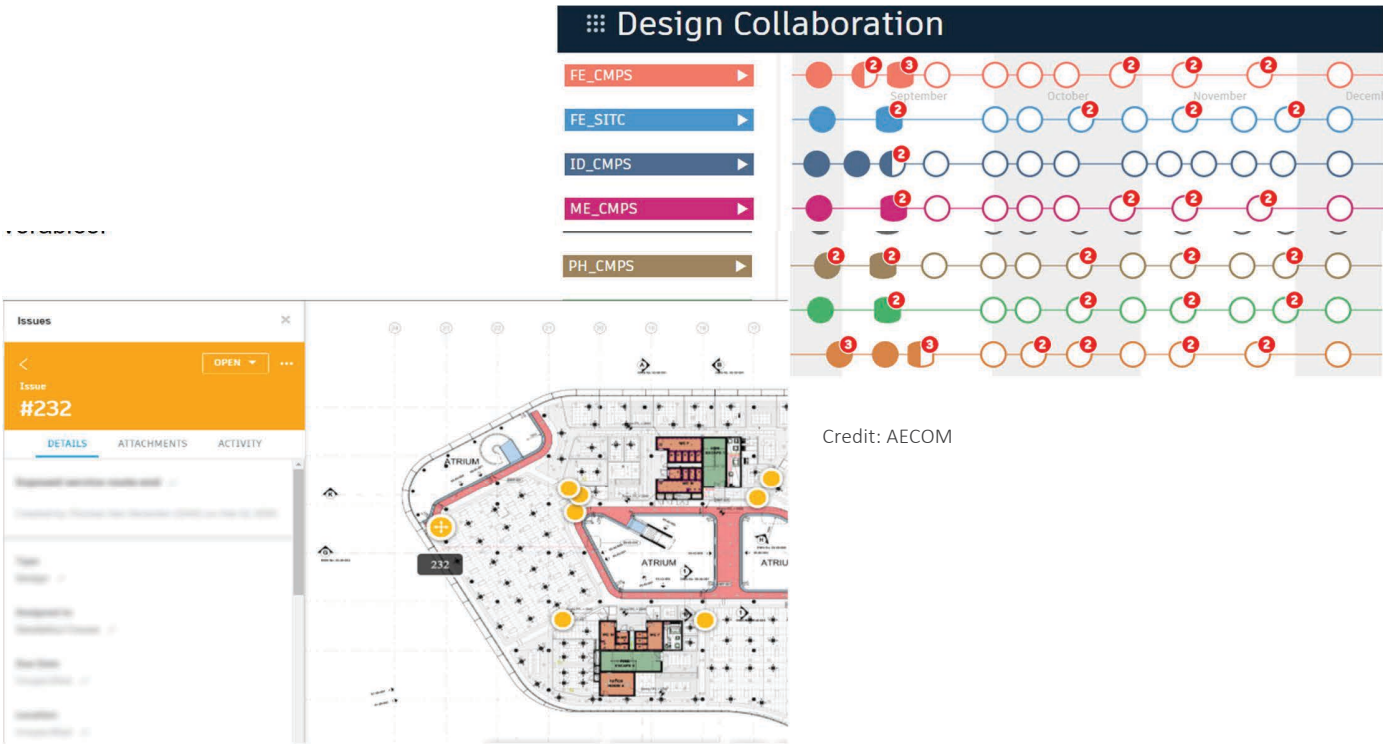
The Autodesk BIM 360 platform was chosen as the common data environment for the project. Besides the abovementioned requirements, it was the collaboration features that proved indispensable, especially considering that teams were dispersed across the country. Any member of the team could flag an issue they noted on any file or model at any time during the project. These issues were addressed to specific users to action, leading to improved accountability and opened the door to better communication around a visual cue. One of the primary features of the BIM 360 platform is effective version control. Gone are the days of prefixing of suffixing dates to files in an attempt to keep track of the most current information. The ability to track and compare versions of any file or model, in the context of a simplified folder structure, proved a significant asset.

The dynamics of the project team and complexity and quantity of the model geometry created, tested the cloud hosted working environment and its implementation. There were many insights gained by both AECOM and Autodesk which have guided the refinement of workflows and the further development of features within the BIM 360 ecosystem. Many of these enhancements are now fully incorporated and ship with the BIM 360 product today.

Design Delivery and Coordination

Autodesk Revit was used for design work by all disciplines from architecture through to electrical. Design coordination was handled with the use of Autodesk Navisworks and BIM 360 Glue. From a structural perspective, the project illustrated what was indeed possible. With barely a straight line in sight and a commitment to comprehensive BIM delivery using the latest tools, the challenges provided by this project were not insignificant by any stretch of the imagination. There has been a strong focus on delivering all steelwork and concrete reinforcement complete with 3D detailing, quantity take-offs and bending schedules over the past few years. The early development paid impressive dividends with roughly 4000 tonnes of steel reinforcing being detailed and scheduled in record time. A testament to this all-encompassing commitment, was the ability of the systems and procedures to be rapidly adapted in order to accommodate new or additional requirements as dictated by the uniqueness of the project. The importance of clear standards that get adopted by all teams in all offices cannot be overstated. This becomes especially evident when project timelines are compressed, deviating from the original. The ability to recruit additional resources from any of our offices and know that they can deliver to the correct standard is invaluable. As Schalk Marais reiterates: “With the compressed timelines imposed on this project, one thing is certain, without the digital delivery process, timeous delivery would not have been possible.”

One of the more progressive shifts in delivery methodology was seen on the Civil engineering side. Close to 90% of all geometry and design outputs were produced in Revit, although analysis and bulk earthworks remained in the Civil3D domain. This project proved to be a springboard for a new way of designing and delivering building civil projects within AECOM. There is now increased use of Revit and Dynamo scripting for translating designs between Civil3D and Revit to produce native, data rich geometry.



Credit: AECOM

Credit: AECOM

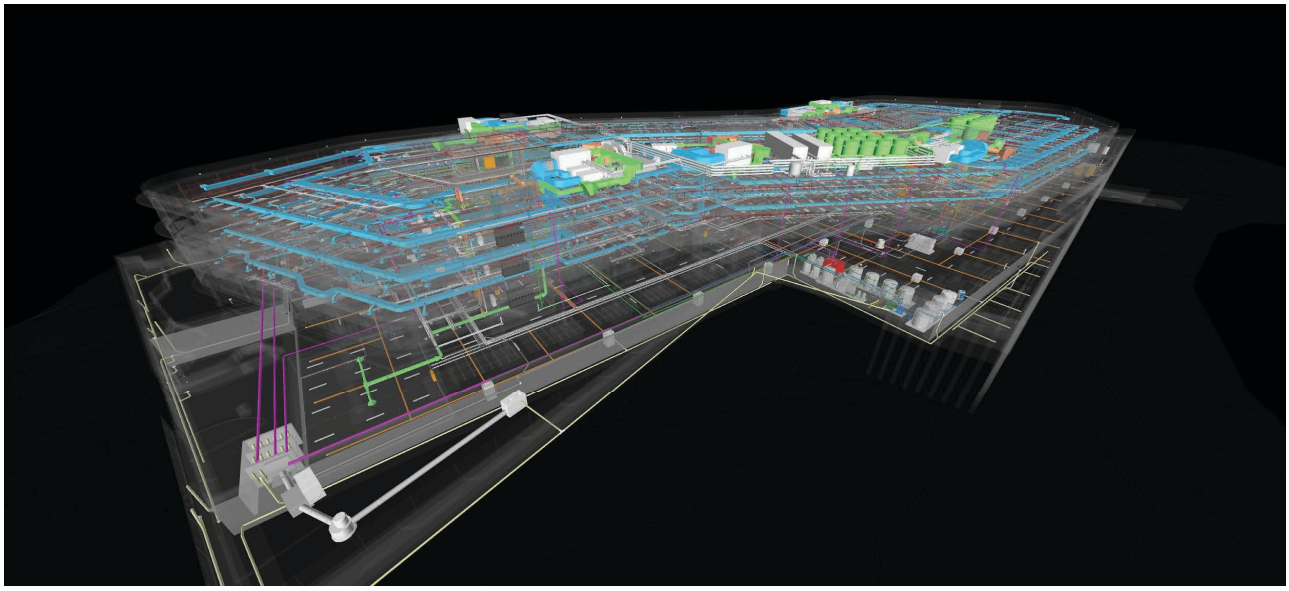
Model Coordination One of the primary design constraints, from a services perspective, was the severely restricted ceiling void spaces. Coordinating services with architecture and structure required near constant design review. Navisworks was used extensively to clash and coordinate the routing of services throughout the building. Of great benefit was having the Navisworks coordination model effectively 'plugged in' to the live data stream of authored models on the BIM 360 platform. This again speaks to the importance of a tightly integrated CDE. The ability to schedule and automate the publishing of data from all teams was invaluable and eliminated human error. With version control a key element of the BIM 360 file management, it was easy to visually compare changes between the data drops.

As good as all the coordination and tools are, care needs to be taken that it is not seen as a replacement for sound, coordinated engineering design principles. Engineering design and coordination need to go hand in hand. There can be a tendency for design leads to think that clash free results are the be-all and end-all of successful delivery. Model coordination is but a tool to be used to deliver a complete, coordinated design.

Digital Construction and Coordination Moving from design to construction is where the rubber meets the road in terms of project delivery. This also unfortunately proves to be the point at which the connected collection of data is at the greatest risk of breaking. Two of the fundamental elements that are lagging is contractor willingness to use and adopt 3D data driven environments, and fabricator readiness to take over design intent models to continue onsite coordination with shop detailing. "One of the primary drivers was to get the contractor to adopt 3D modelling more. Some contractors are keen to learn, while others are still dead-set on printed drawings," comments Schalk Marais, PrEng, Practice Area Lead – Structures.

With 3D design technology being nothing new, it could be expected that there would be seamless workflows and information exchange between design teams and contractors. With an industry largely still focused on dated, traditional approaches, however, this is far from being the case. "As soon as you get to grips with a 3D model, it is easier to interpret things and figure out what is likely to cause a bottleneck". These are benefits most professionals do not get if they simply work off drawings or even a schedule. A visual connection is critical," stresses Marais. At a very base level, having contractors switch from paper based to digital drawings opens a world of opportunities. As a contractor, being confident that you are always seeing the latest revision without having to be concerned about which revision of which drawing is in whose hands, should be enough of an incentive. Field issues, RFI's and checklists can then be directly connected to drawing and model data, 'live', onsite. This significantly closes the loop between project management, design and construction teams. Everybody wins, and we are a few tablets and an internet connection away.

Credit: AECOM


Credit: AECOM

Credit: AECOM/Terry February

Conclusion

In hindsight it is worth considering the way that the Capitec project was delivered considering the current COVID-19 situation. With pure efficiency of project delivery in mind, and the frequency at which coordination meetings needed to take place, the digital tools allowed diverse, distributed teams to collaborate in real time. With online video conferencing hosting up to 30 attendees, navigating the virtual model and working together to resolve design and model issues. This ultimately proved to demonstrate a readiness for the 'new normal' that we now experience.

In terms of digital delivery, there has been a greater adoption across the entire industry. "Everybody has been forced to work remotely and to adopt digital tools. This has served to advance the industry in that an average engineer is now required to be multi-skilled. Engineers with programming skills, for example, are much sought after as they can keep up with the developments in software that are essential to automate everyday tasks and improve efficiencies" notes Howie.

5/5

The private sector is realizing substantial benefits from implementing BIM and AEC technologies. With the immediate focus on reactivating the industry post the COVID19 lockdown, the public sector can take a page from this book. There could not be a better time for governments and the construction industry to re-evaluate the status quo and commit to changes that can so positively impact a countries economy.

Artificial Intelligence and Digital Construction for Nigeria's Sustainable Development

Prof Lukumon O. Oyedele

Assistant Vice-Chancellor,
Digital Innovation and Enterprise,
University of the West of England,
Bristol, United Kingdom.

This article looks at how AI and digital construction can be leveraged to address these challenges, especially concerning the Architecture, Engineering and Construction (AEC) Industry.

Background

The world, and indeed Africa (including Nigeria) is witnessing a watershed moment, with the COVID-19.

The COVID-19 was first reported in Wuhan City of China as of December 2019 and has since then spread rapidly across the globe with devastating impacts on people's lives and nation's economies. Experts have predicted that digital technologies, especially Artificial Intelligence (AI), and Digital Construction will be among the main influencers of economic recovery and growth. Leading AI economies in America and Europe are expected to capture between 20% to 25% of the net economic benefits of digital technologies by the year 2030 (Mckinsey, 2017) while developing economies such as Nigeria can only anticipate between 10% to 15% of the benefits of AI and the digital economy. At the moment, Nigeria struggles on all fronts in terms of meeting and fulfilling the UN Sustainable Development Goals (SDG), which it signed up to in 2015. With various development index such poverty, hunger, healthcare, industry, innovation, education, gender equality, good job & economic growth looking unimpressive for Nigeria, this article looks at how AI & digital construction can be leveraged to address these challenges especially in relation to the Architecture, Engineering and Construction (AEC) Industry. The write-up dissects the UN-SDGs, by examining Nigeria's current performance, whilst proposing strategies for improvement, using real-life use-cases across the globe with the aim of having practical implications for policies in Nigeria.

Creating Wealth through Digital Technologies

The population of Nigeria is over 200 million and many parts of the country are urbanising and expanding rapidly, with the huge pressure of existing infrastructure (i.e. road, hospitals, schools and so on). Nigeria is burdened with constrained finance and resource scarcity, which has stopped it from achieving many of the 17 UN SDGs. The Built Environment is usually affected by the SDGs especially in the economy (jobs, industry, infrastructure, circular economy etc.), society (poverty, health, education, energy etc.), and environment (climate change, air quality etc.). The purpose of adopting digital technologies in Nigeria should be from the perspectives of creating wealth and diversifying the economy. According to Mckinsey (2019), AI will deliver up to $13 trillion in world economic activity by 2030. The UK's £4.7 billion Industrial Strategy Challenge Fund (ISCF) is an example of the government's initiatives to raise earning power and diversify the economy through digital technologies.

The AEC industry in Nigeria is poorly organised, unpredictable and highly bureaucratic. The average income, job security and benefits of employed trades and professionals in the industry is neither commensurate with the earnings of their counterparts in other nations nor sufficient to create economic wealth. The AEC Industry and the Built Environment is not mature enough to provide the necessary Quality of Life (QoL), security and safety for the citizens. Hence, it is important to innovate new ways to create wealth, enhance productivity and ensure the public good. Digital technologies including AI and digital construction are intelligent ways of using data to improve productivity, enhance privacy and trust, enable evidence-based decision making, and implement real-time automated information systems.

Deriving Value from Data Processing

The essence of adopting AI and digital construction is to create value through automated and real-time data processing, analytics and diagnostics. Economic value can also be derived from scenario modelling, early intervention, prediction and automated processes. With existing disruptive models such as radical personalisation, massive data integration and orthogonal data sets, AEC companies can leverage data to stay ahead of the competition by adopting digital technologies. A simple description of digital technology is any data-enabling technology which creates value and improves the digital economy. An example of some value-adding digital technologies is presented in Figure 1, with the average data traffic in one minute. Most readers must be aware of many of these technologies and the value that is being derived from each of them. Hence, the AEC industry must look inward, create values and improve efficiency through the creative use of data in the Built Environment.

Figure 1: Data traffic of Web Technologies in 60 seconds (Source: Go-Globe.com)

As expected, the construction industry has been left behind in the adoption of emerging technologies for business processes. Aside from lagging behind in global productivity growth as compared to other sectors of the economy, the construction industry is still burdened with inefficiency-related issues like high wastages, low profitability, unnecessary complexity and so on. There is no better time to improve AEC processes and operations with the automated and intelligent use of data to create value in the Built Environment, especially with the current Covid-19 pandemic.

Advancing AEC and the Built Environment with Digital Technologies

There are numerous emerging technologies that are gradually gaining attention in Built Environment research. Common emerging digital technologies include Augmented Reality and Virtual Reality, Blockchain, Computer Vision, Digital Twin, Edge, Fog and Cloud Computing, Robotics, Internet of Things and Quantum Technology. The Big Data Enterprise and Artificial Intelligence Lab (Big-DEAL) have delivered multiple real-life projects such as (a) Supply chain collaborative BIM system for minimising construction waste in design; (b) Deconstruction and Recovery Information modelling (DRIM), and; (c) Integrated and Mobile-BIM system for optimised construction (read more).

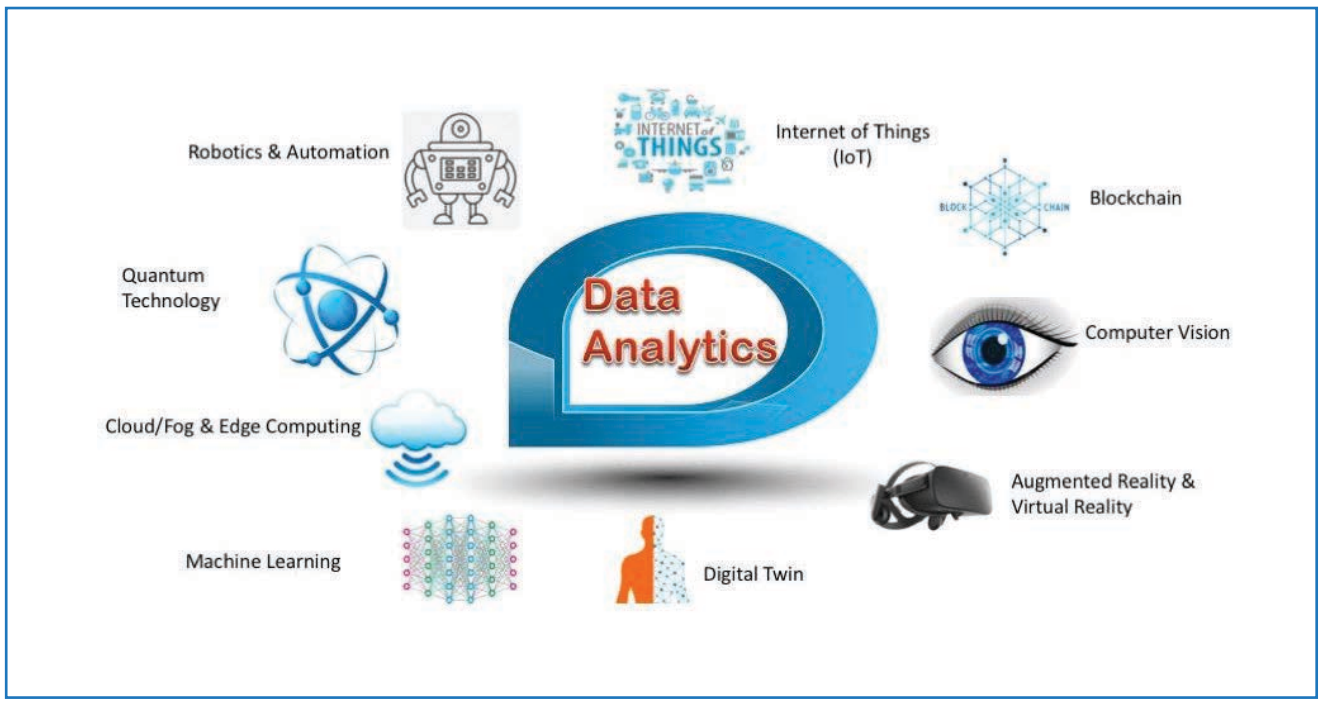


Figure 2: Data Enabling Technologies for Powering the Digital Economy.

Big-DEAL is also carrying out ground-breaking researches to tackle construction inefficiencies using the various emerging digital technologies. Our current projects include: (a) Holistic Digital Solution (HDS) for secure and affordable Building Management Systems (BMS); (b) IoT-enabled Real-time Energy Analytics Platform (I-REAP) for commercial buildings; (c) Real-time Emission Visualisation (REVIS) for eco-friendly travel behaviours; (d) IoT-enabled Platform for Rail Asset Monitoring and Predictive Maintenance (I-RAMP). To also tackle the challenge of low construction productivity, we are integrating Conversational-AI and Augmented Reality (AR) with BIM for faster and collaborative on-site construction assemblage (read more). The AEC and Built Environment is in dire need of digital innovation to fast-track the industry's growth and improve profitability for its businesses.

Concluding Remarks

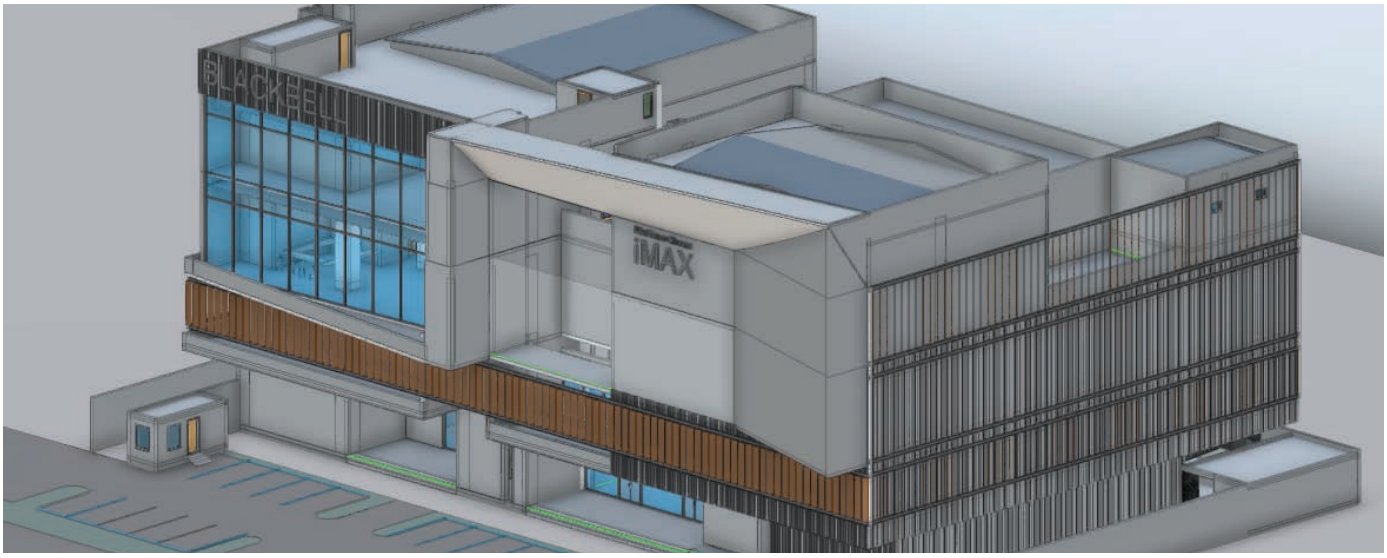
Achieving UN SDGs through AEC industry requires a need to create an ethical platform for the responsible adoption and delivery of AI and digital systems for the Built Environment. The moral scope of the social and ethical impacts of innovations must be evaluated to ensure ethical permissibility. The design processes of AI systems must transparent to ensure public trust and accountability. With an appropriate AI policy and implementation guide, innovators will have the opportunity to be more intentional about solving the AEC problems in Nigeria. The population of Nigeria is massive and young, and Nigerians are very brilliant and innovative. There is no limit for Nigerians if given the necessary enabling environment to be creative.

There are enormous problems to be solved in all parts of Nigeria's Built Environment such as healthcare, smart cities, commercial building, critical national infrastructures, waste management, logistics optimisation, circular economy, efficient housing and quality living. The application of AI, BIM and Digital Construction is inevitable if the AEC industry and the Built Environment in Nigeria will meet up with modern-day challenges and will survive through the uncertain climate induced by COVID-19.

Professor Lukumon Oyedele – is currently the Assistant Vice-Chancellor for Digital Innovation and Enterprise at the University of the West of England, Bristol, United Kingdom. Amongst other record-breaking achievements, Prof. Oyedele is the first Black Minority Ethnic to occupy such position (Assistant Vice-Chancellor) in the history of the UK Higher Education. He has pioneered and founded many trailblazing Research and Development (R&D) establishments including Bristol Research and Innovation Centre (BERIC) and Big Data Enterprise and Artificial Intelligence Laboratory (Big-DEAL); in addition to winning over £13.8million in R&D Grants. He is renowned and widely respected as one of the leading academics in UK Construction Innovation. As part of his excellent scholarship, Professor Oyedele was recently recognised as one of the three Leaders in Construction Innovation with an award of £1.8million R&D grant by the UKRI & EPSRC. He seats on the Editorial Board of several World Leading International Journals and has been in the scientific committee of many international conferences since 2005. He is a visiting Professor in several top Universities including Australia, Brunel and China.

AN MEP CONTRACTOR'S APPROACH TO BIM IMPLEMENTATION

Blaze's BIM Project Support to Mar and Mor Integrated Services Limited



Blackbell Shopping Mall, Ikota, Lagos State, Nigeria

Client: A. A. Holdings
Architects/Structural Engineers: Baron Architecture
Project Manager: Falomo Properties Limited
MEP Consultants: Building Services Design Consultants Limited
MEP Contractors: Mar and Mor Integrated Services Limited

INTRODUCTION

Background

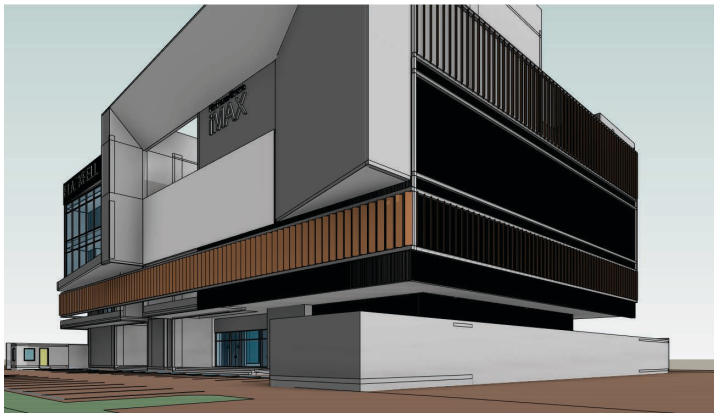
Blaze is an IT Integrations and BIM Consultancy outfit based in Nigeria, with the mandate to help Architecture, Engineering, Construction, and Operations (AECO) Firms work smart. Mar and Mar Engineering Services Limited is a building services (contracting) company that is passionate about customer satisfaction, best practices, and standards compliance- a technology/local partner to Siemens Building Technologies. In a bid to transition to a BIM-based delivery and workflow, MAR&MOR used the Blackbell Shopping Mall as a pilot project, while Blaze offered a BIM Project Support to achieve the objective. The Project is currently still at the detailed design stage.

ABOUT THE PROJECT

The Team Setup

The Blackbell project is a proposed Shopping Mall, owned by A. A. Holdings, to be located at Ikota, Lagos State, Nigeria. The Project sits on a total of 2692.654SQM with a built area of 52.95%- including the main building and other ancillary facilities.
Some of the main stakeholders on the project are Falomo Properties Limited (Project Managers), Baron Architecture (Architects and Structural Engineers), Building Services Design Consultants Limited (MEP Consultants), and Mar and Mor Integrated Services Limited (MEP Contractors).

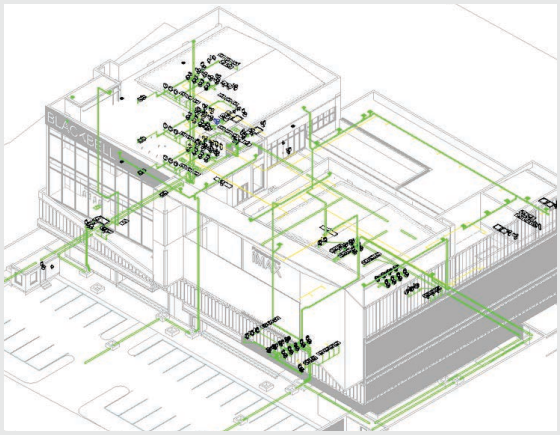
The above-named stakeholders have offices in Lagos, Nigeria - with no contractual agreement to work through a Common Source of Information (CDE). Hence, they all have independent design files, which they manually share as design progresses.



A Level 2 BIM Implementation

The Primary consultants on the project (Architectural, Structural and MEP) all did their designs in Autodesk Revit. However, the MEP Contractor MAR&MOR- typically work via a CAD-based approach. Thus, MAR&MOR saw this project as the right project to transition to a BIM-based workflow using a very practical approach. That was how Blaze came into the scene- to assist in the transition process. The primary aims for the pilot after an initial (psuedo) BIM Execution Plan between Blaze and MAR&MOR- include:

1. Create Shop Drawings directly from the Consultants BIM Model- in Revit
2. Use the BIM Model as the basis for quantification-using accurate schedules in Revit.
3. Identify and resolve all clashes in the Model before going to the site- using Autodesk Navisworks Manage.



<Space Schedule>

C	D	E	
Room: Name	Room: Number	Space Lighting Key	Require
PHARMACY	124	(none)	
ATM	116	(none)	
BAKERY	105	(none)	
BLACKBELL RESTAURANT	103	(none)	
COLD ROOM	108	(none)	
ENTRANCE PORCH	102	(none)	
ENTRANCE PORCH	101	(none)	
FEMALE TOILET	123	(none)	
FEMALE TOILET	120	(none)	
GENERATOR HOUSE	001	(none)	
KITCHEN	107	Kitchen	500 lx
LIFT	114	(none)	
ENTRANCE LOBBY	111	(none)	
TOILET LOBBY	121	(none)	
TOILET LOBBY	118	(none)	
BAKERY	105	(none)	
MALE TOILET	122	(none)	
MALE TOILET	119	(none)	
PANEL ROOM	002	(none)	
COLD ROOM	108	(none)	
STAIRCASE TYPE 1	112	(none)	
STAIRCASE TYPE 4	110	(none)	
STORE	109	(none)	
SUPER MARKET	117	Supermarket	750 lx
TECHNICAL ROOM	113	(none)	
			1250 lx
FEMALE CHANGING	204	(none)	
LOBBY	201	(none)	
MALE CHANGING	203	(none)	
LOBBY	201	(none)	
			0 lx
BISTRO	302	(none)	
EMERGENCY LOBBY	327	(none)	
MALE TOILET	311	(none)	
FEMALE TOILET	318	(none)	
JANITOR ROOM	325	(none)	
		(none)	
KITCHEN	310	(none)	
LOBBY	303	(none)	
LOBBY	321	(none)	
MADAM'S OFFICE	304	(none)	
MAIN FOYER	316	(none)	
KITCHEN	310	(none)	
MALE TOILET	317	(none)	

Infrastructure needs

The Execution Planning process explored ways to work around the existing constraints- manually shared files- to achieve the identified BIM Uses. A primary focus was to identify the needed Hardware, Software, and Modeling Content Standards.

As a result, MAR&MOR had to acquire new set of workstations and also procure licenses for Autodesk AEC Collection and BIM 360 (as a Common Data Environment).

On the part of Blaze, we needed to federate the BIM Models from the consultants, and use their existing families, parameters and standards as a starting point to generate the Modeling Content Standards, Shared Parameter File, File Naming Convention, Folder Structure, etc.

CONFIGURATION OF WORKING ANALYTICAL VIEWS - FOR MECHANICAL, ELECTRICAL, AND PLUMBING DISCIPLINES

For the actual delivery process, Blaze is charged with the BIM Model Updates and Engineering, while MAR&MOR designers are charged with reviewing the exported CAD files and converting them to (schematic) shop drawings.

Both teams worked together at MAR&MOR Lagos office for real-time knowledge exchange - using BIM 360 Design as the primary information/document exchange platform.

The initial co-working process spaned a period of six weeks, while subsequent communications were done remotely through BIM 360.

One of the first engineering steps that was taken by Blaze team on the federated BIM Model was to create working views. These are mostly schedules serving the purpose of analyzing towards the required design objectives. These include:

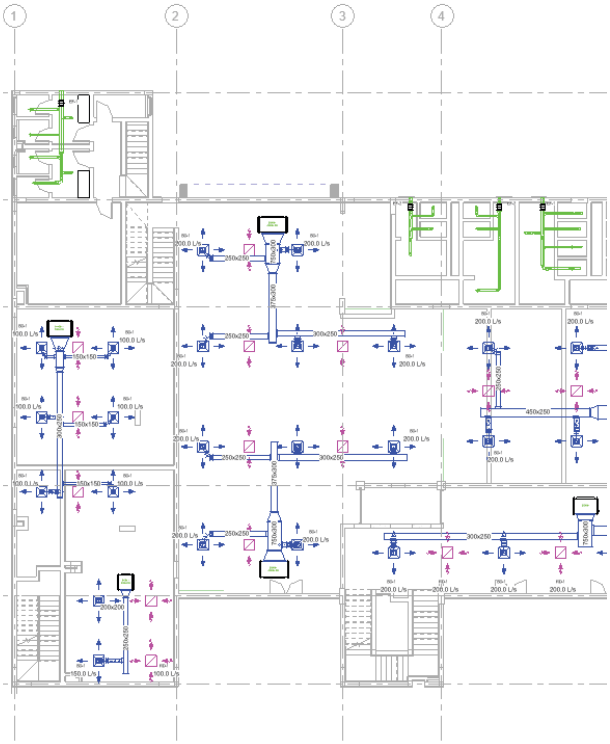
- Configuring the MEP Settings in Revit.
- Generating Space Schedules tracking such information as the Heating and Cooling Loads, Required Lighting Levels for the spaces.
- Embedded Schedules showing the quantities of devices, fixtures, and equipment for every space in the facility.

RESULTS AND OUTCOMES

Documentation

Currently (June 2020), the project is still at detailed design stage. The Architectural and Structural Designs are linked into the MEP Model received from the main consultants. The federated model serves as the basis for all project documentation. As updates are being received from the consultants, the linked files are replaced with ('reload from') the updated models. The contracting firm- MAR&MOR- is also looking at the other tools that came with the AEC Collection, that are tailored towards the MEP Disciplines. These include Autodesk ESTmep, CADmep, and CAMduct. These tools will assist in the bidding, detailing, and also the fabrication of their future projects. Despite the Covid-19 pandemic, MAR&MOR is still able to access the design files remotely through Autodesk BIM 360.

The pilot project has served as a practical demonstration of a BIM-based delivery workflow for MAR&MOR. This is just the beginning of the BIM Journey for them.



For this project, the quantities of the Mechanical, Electrical, and Plumbing fixtures, devices, equipment, fittings, etc. will be extracted from Autodesk Revit- through the 'Schedules and Quantities' feature. This goes beyond just quantifying various components, but will also include the tracking engineering accuracy and behavior of the various systems and spaces. Through Revit, they can easily generate (customized) Panel Schedules, Heating and Cooling Load Reports, other engineering reports, etc. This is the real benefit of the "I" dimension of BIM for them- coming from a federated BIM Model.

Clash Detections

Another direct benefit of this BIM-based workflow for MAR&MOR is identifying clashes within the federated model. They can visualize the relationship of their elements with the Architectural and Structural elements- even with other MEP elements. For the Clash detections and resolutions, the preferred tool for them is Autodesk Navisworks Manage.

In the end, the final model will serve as a template for them in their subsequent projects. The Parameters, Families and Components, MEP Settings, Working Views, etc. will all be saved into a template file for their future projects.

ABOUT MAR&MOR

Gboyega Amao - Managing Partner

- *Mar and Mar Engineering Services Limited is a building services (contracting) company that is passionate about customer satisfaction, best practices and standards compliance - a technology/local partner to Siemens Building Technologies.*
- *We design procure, Install and maintain Heating, Ventilation and Air Conditioning (HVAC) systems, water treatment, Fire Fighting and water supply systems as well as Power Supply, Electrical Network and Communication systems to meet industrial, commercial or residential requirements. We also provide quality general plumbing services.*

LESSONS LEARNED - MAR&MOR

For this project, the quantities of the Mechanical, Electrical, and Plumbing fixtures, devices, equipment, fittings, etc. will be extracted from Autodesk Revit- through the 'Schedules and Quantities' feature. This goes beyond just quantifying various components, but will also include the tracking engineering accuracy and behavior of the various systems and spaces. Through Revit, they can easily generate (customized) Panel Schedules, Heating and Cooling Load Reports, other engineering reports, etc. This is the real benefit of the "I" dimension of BIM for them- coming from a federated BIM Model.

TRANSITION TO A BIM-BASED WORKFLOW IS A JOURNEY, AND WE ARE GLAD TO HAVE TAKEN THE FIRST STEP

BIM Survey: Summary of Findings

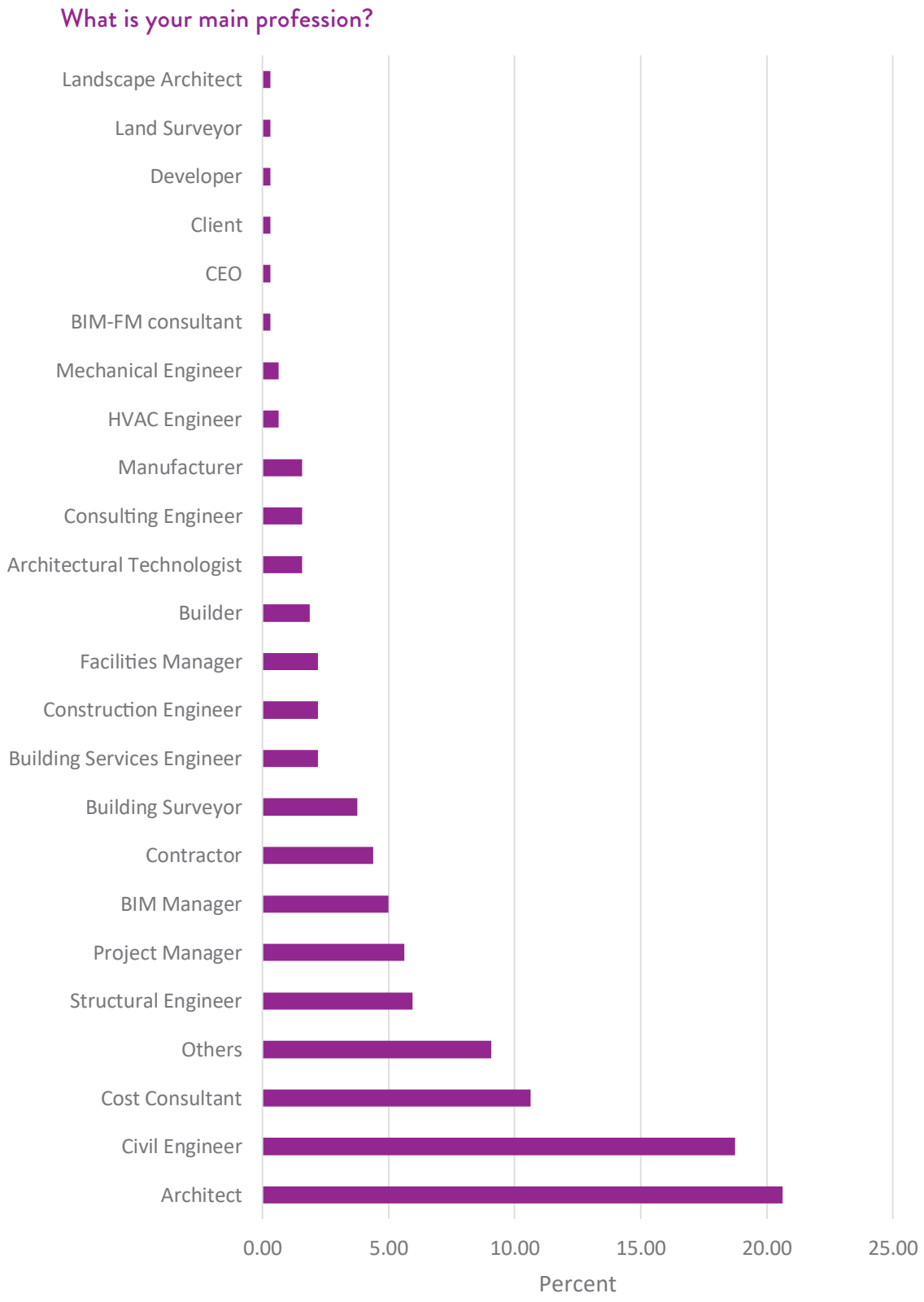
Research & Development Committee

The BIM Africa Research Committee embarked on the first continental-wide BIM Survey in Africa (African BIM Survey: ABS) after a pilot survey between November 2019 and May 2020. The UK National BIM Survey Form was adapted to suit the African context – with permission from the NBS. The ABS was made available in English and French Language to cater for the various regions in Africa.
In the course of the survey, the COVID 19 pandemic outbreak occurred, and this might have influenced the turn out rate of the respondents. About 500 entries were recorded across the various regions in Africa before the closure of the survey. This number of entries might seem low because of the area of study, however, being the first of its kind in Africa it is hoped that subsequent ABS would garner more respondents as lessons learnt during this survey will be of utmost importance and a regional data collection approach would be adopted as against the single central data collection.
We thank all the respondents for taking their time in completing the survey. It is hoped that this ABS 2020 would push the frontier of knowledge forward and contribute towards digitizing the African Built Environment.

About your Organisation - Including yourself, approximately how many people are employed in your organisation?

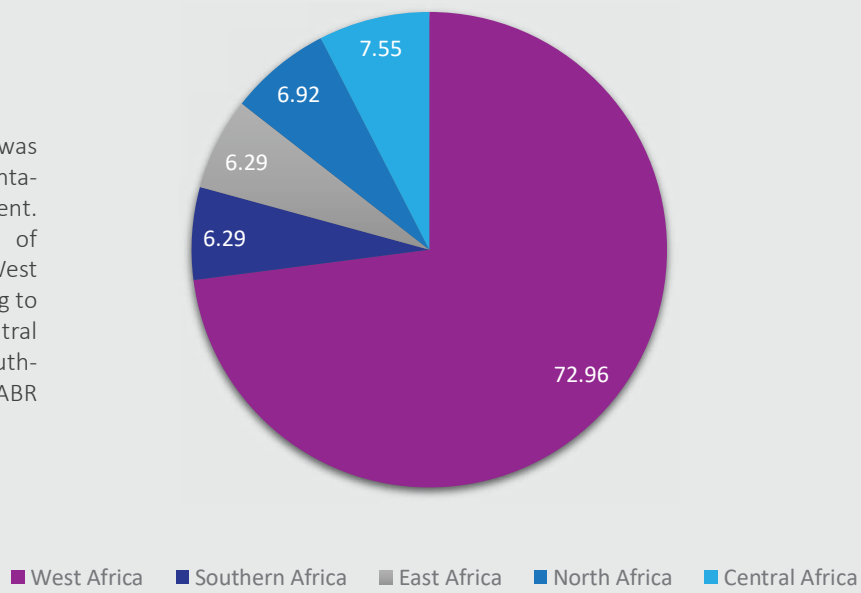
The survey kicked off by identifying the number of employees to provide a broad understanding of the size of the organisations. A range of business sizes were represented, however, organizations with 3-5 and 6-15 employees had large percentage of the respondents with more than 30% and about 25% representation respectively. Whereas, a combined representation of about 20% of the respondents are from firms with over 100 employees. This might be related to the fact that the SMEs are the backbone in the construction industry and often represent about 80-90% of firms in the industry.

Furthermore, the size of organizations was complimented by a wide range of professions. According to the chart below, Architects, Civil Engineers and Cost Consultants (Quantity Surveyors) provided the largest representation of respondents. However, the variety of professional profiles spanning across the built environment were also represented to ensure inclusive participation.



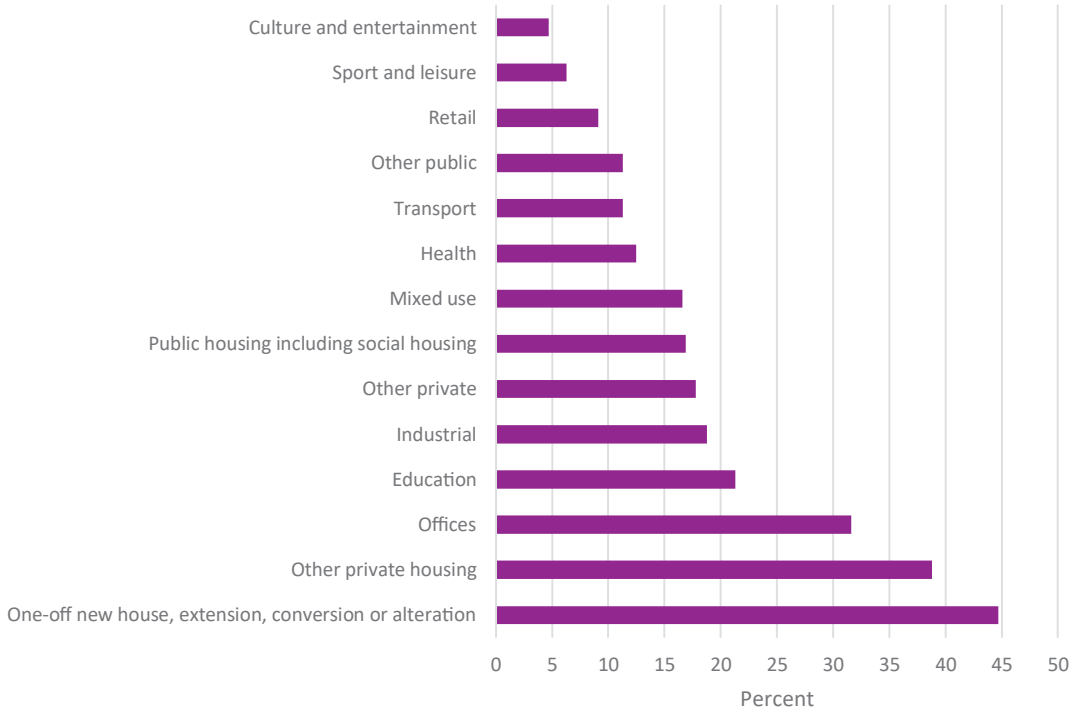
Location

As a Pan-African survey, it was important to ensure representation across the continent. Although a large proportion of the respondents were from West Africa, it was equally refreshing to find respondents from the Central African, North African, and Southern African region in this first ABR edition.



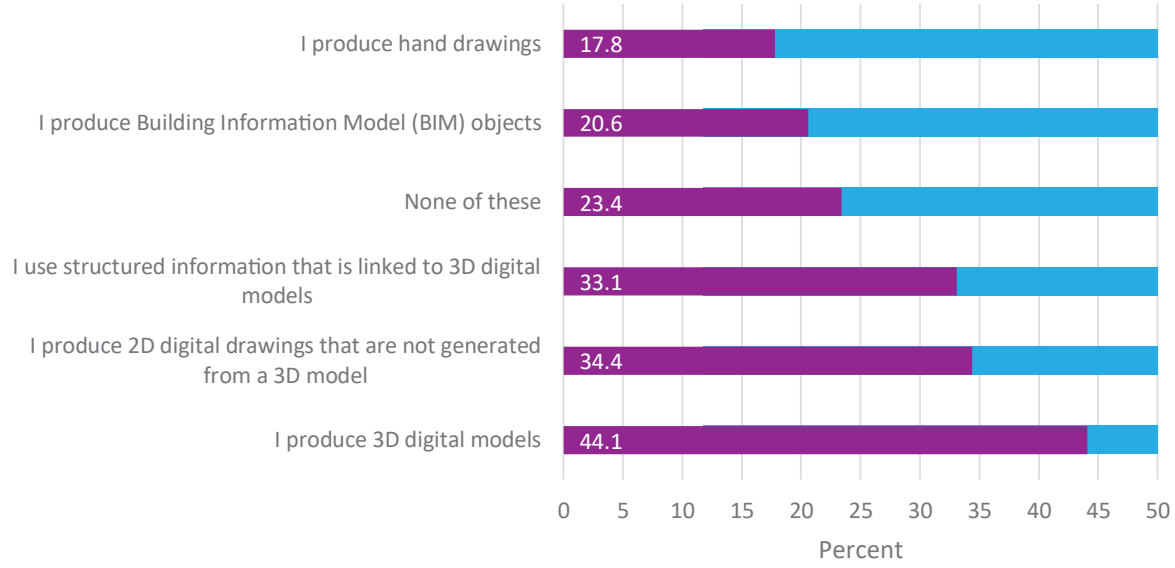
Considering that the Construction Industry serves a wide variety of sectors across the African economy, we decided to enquire on the nature of projects our respondents have been involved in. Most of the respondents are involved in One-off new house, extension, conversion or alteration projects, other private housing and office projects. However, the chart below also indicates projects within Educational, Industrial, Health, Transport and Public housing among other important sectors as well.

In the last twelve months, which of the following project types have you been involved in? (Please tick all that apply)



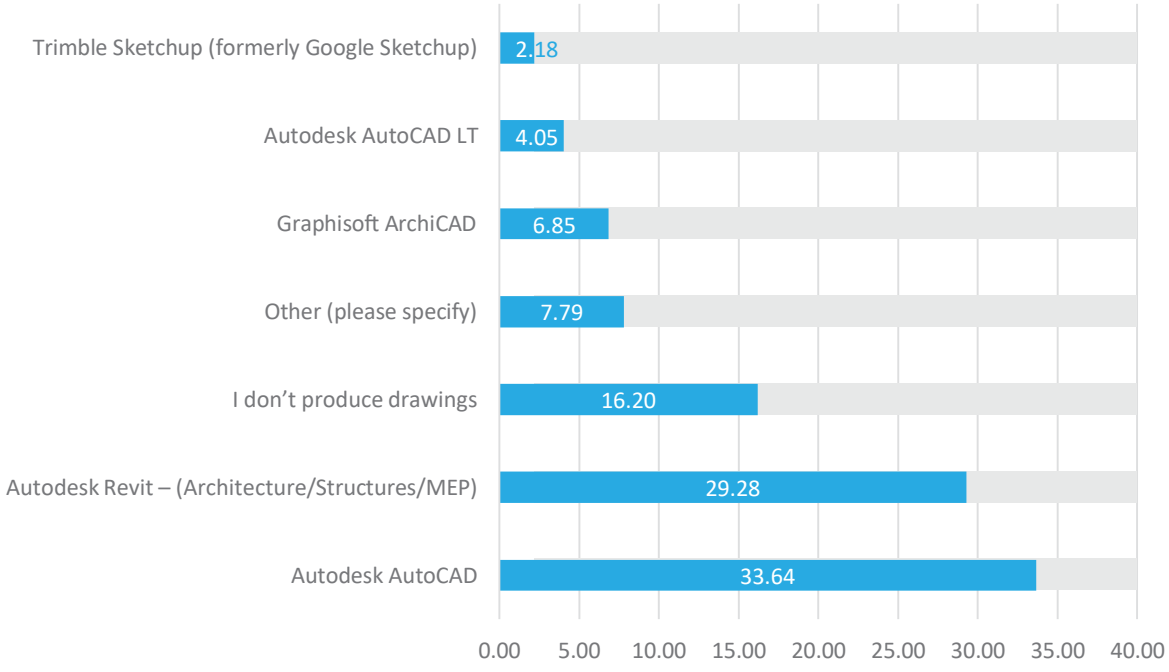
The survey provided us with critical insight on the working practice in the African construction industry. It was interesting to realize that over 40 percent of the respondents produce 3D digital models. Also, about 34 percent indicated they produce 2D digital drawing that are not generated from 3D models. This shows that there is a strong uptake of digital design tools for Architecture, Engineering and Construction in Africa which is further highlighted by the low production of hand drawings. However, the chart indicates a gradual trend towards the utilization of intelligent and rich information modelling with about 33 percent and 20 percent of representation respectively.

Which of the following statements apply to you personally? (please all that apply)



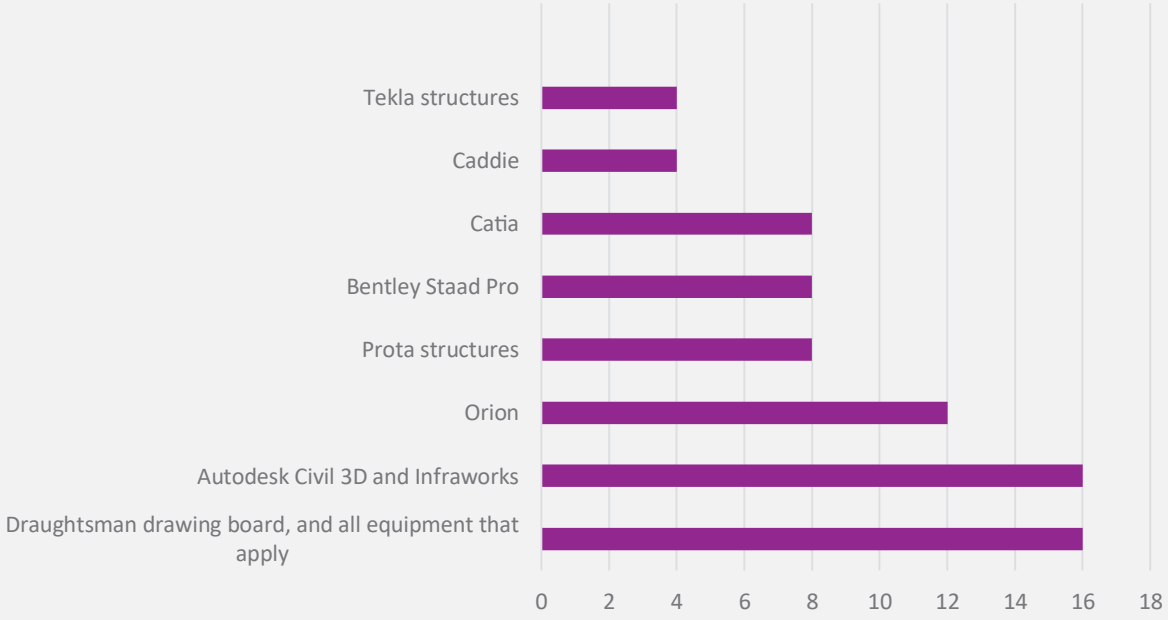
Which of the following statements apply to you personally? (please all that apply)

To further buttress our findings of the utilization of digital design tools, our respondents identified Autodesk AutoCAD and Revit as their most preferred software applications. The chart also reinforces- as previously highlighted- the closely balanced representation between production of 2D digital drawings via AutoCAD, the production of 3D digital models and utilization of structured information via Revit. This also highlights the low use of other proprietary applications such as ArchiCAD and SketchUp.



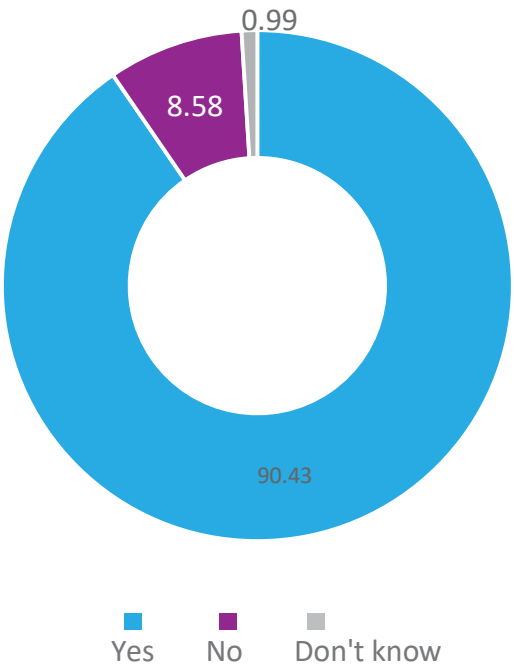
The study also found that there is a gradual uptake of tools for civil/infrastructure design such as Autodesk Civil 3D and Infraworks. There is also some utilization of tools for engineering analysis and design such as Orion, Prota and Staad Pro among others. However, this showcases a very low adoption of tools for Civil/Infrastructure design compared to Building design.

Others



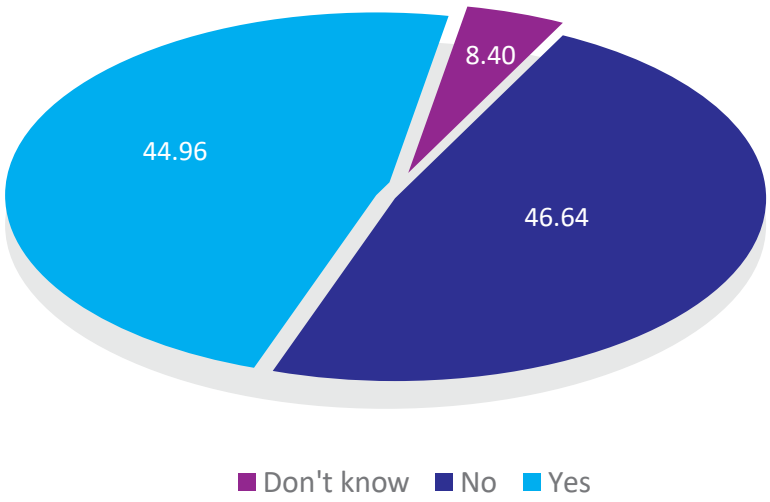
Before taking this survey, had you ever heard of BIM (Building Information Modelling)?

In order to measure the level of awareness in Africa, we asked our respondents if they ever heard about BIM prior to participating in this survey. Interestingly, about 90 percent of the respondents indicated they were aware of BIM. This shows the growing interest among industry stakeholders as well as an increased in coordinated awareness drive across the continent.



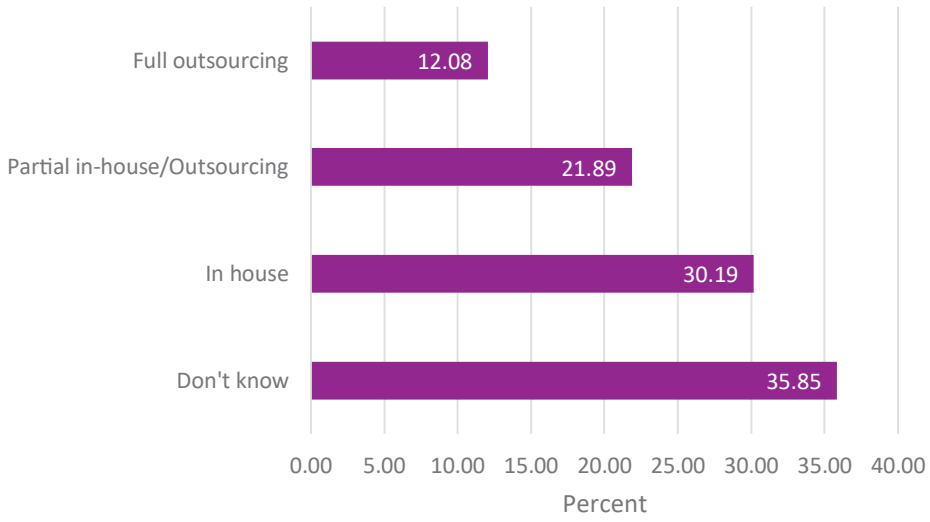
Furthermore, to provide an overview of the level of implementation of BIM, the study indicates that only 45 percent have adopted BIM for projects in their organisations. This indicates that the high level of awareness does not translate into level of utilization within AEC firms.

Within your organisation, have you adopted BIM for projects you have been involved with?



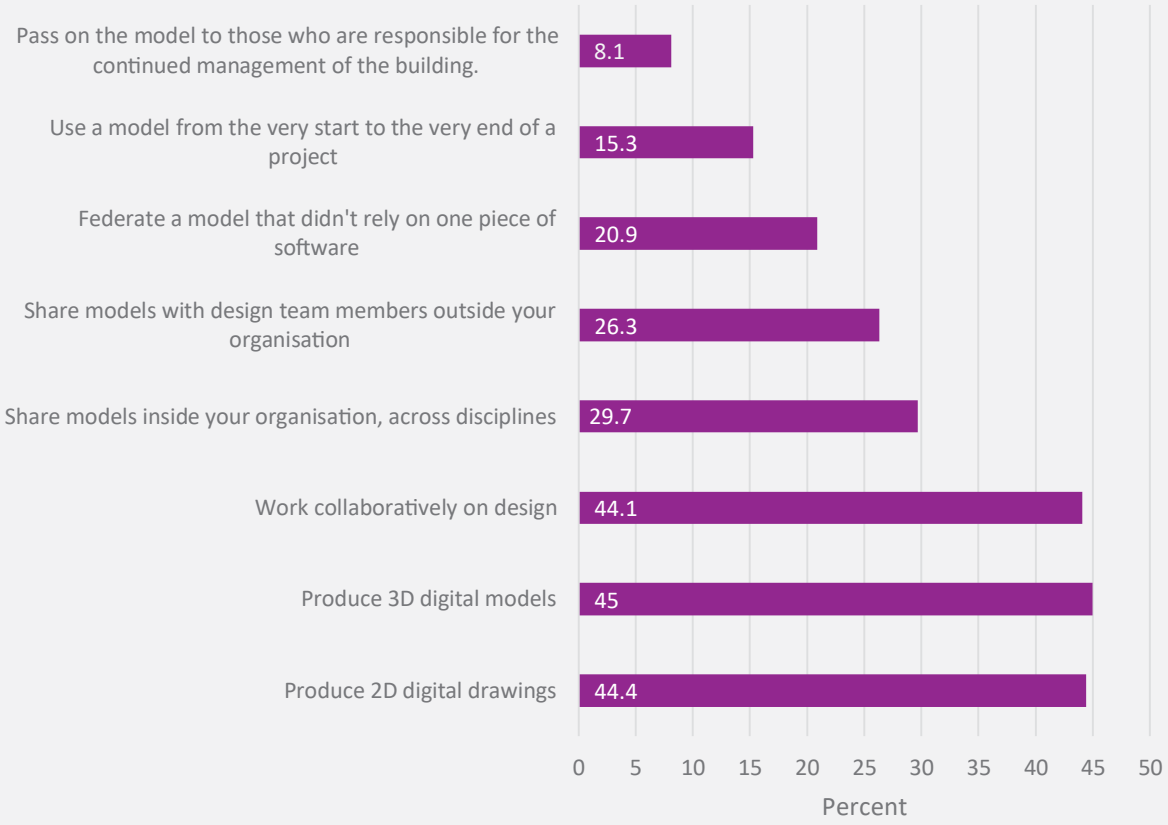
Among the respondents who mentioned that BIM has been adopted within their organizations, only about 30 percent have had full implementation of BIM for their projects. Whereas about 21 percent and 12 percent of firms have partially or fully outsourced BIM for their projects. This highlights the need for in-house BIM upskilling within organizations to meet up with the growing enthusiasm for BIM knowledge in Africa.

How does your firm implement BIM?



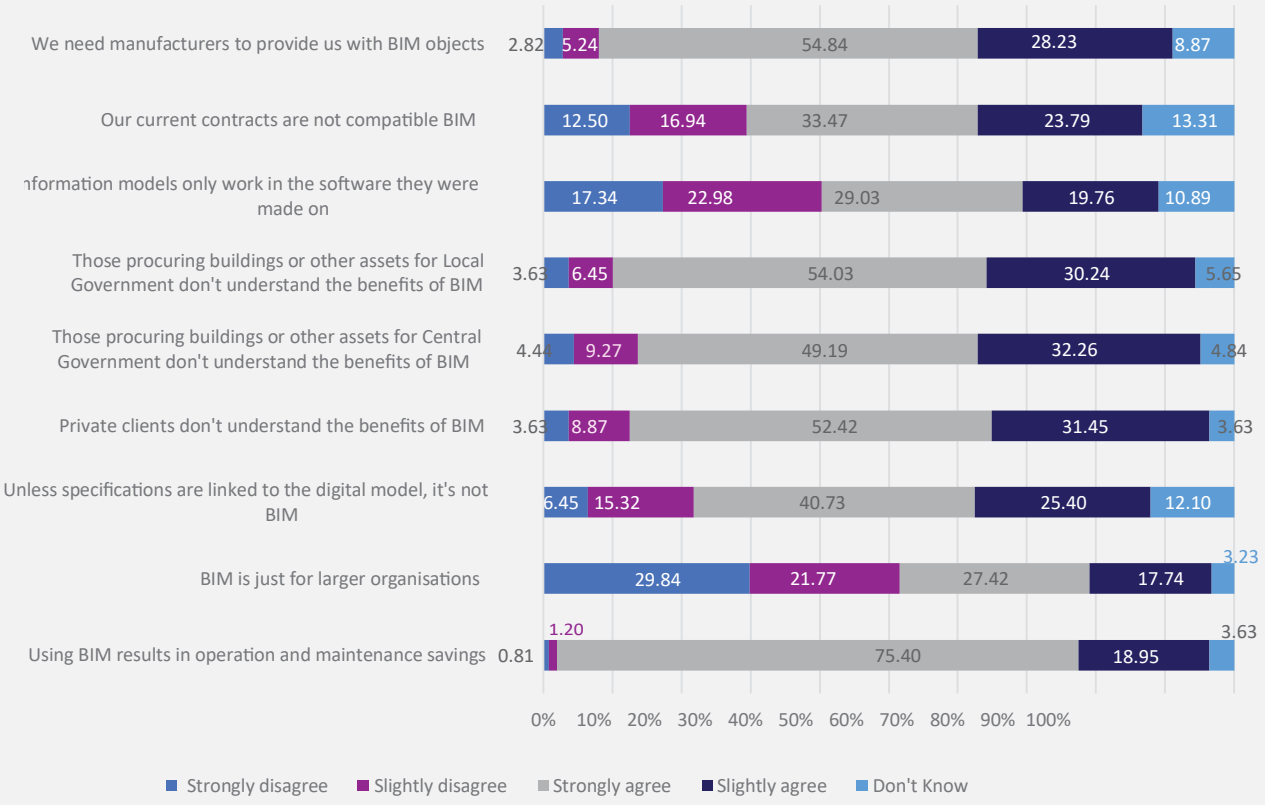
The study provides a hint on the project workflows of individual respondents within the past year. It shows that although there is a balanced level of production of 2D digital drawings and 3D digital models among the respondents, only 15 percent have used a model from start till the end of a project. Also, about 45 percent of the respondents have worked collaboratively in design. However, less than 30 percent have shared models with team members within and outside the organization. This highlights the continued utilization of "Lonely" BIM methods in place of "Collaborative" BIM methodology. This further highlights the continued exchange of 2D digital drawings in dwg or pdf formats for project delivery among team members.
Interestingly, there is a gradual uptake of utilizing federated models for multidisciplinary coordination via Open-BIM methods. However, the inability to fully utilize information-rich digital models from design, through construction, and handover for facility operations shows that the construction industry in Africa is yet to fully realize the benefits of BIM for project delivery.

Thinking about the projects you were involved in over the last 12 months, did you ever... (Please tick all that apply)



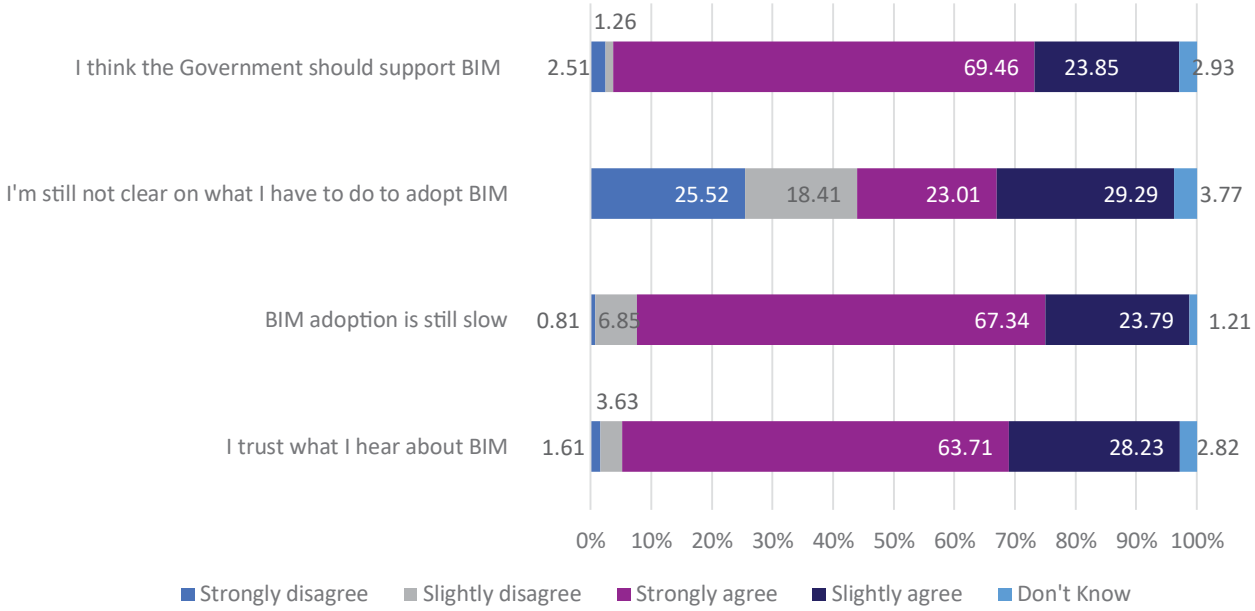
We also asked our respondents to agree or disagree with the following statements about BIM. It was encouraging to find that a majority (over 70 percent) strongly agree that using BIM results in operation and maintenance savings. This connects with the overall clamour for clients within the public and private sectors to fully understand and embrace BIM in project procurement as they stand to gain the most out of the benefits that BIM offers in the lifecycle of built assets. Furthermore, 40 percent strongly agree that BIM is not complete unless specifications are linked to the digital model. In order to achieve this, about 55 percent strongly recommended the need for proprietary BIM objects from product manufacturers instead of generic BIM objects.

How strongly do you agree or disagree with the following statements about BIM?



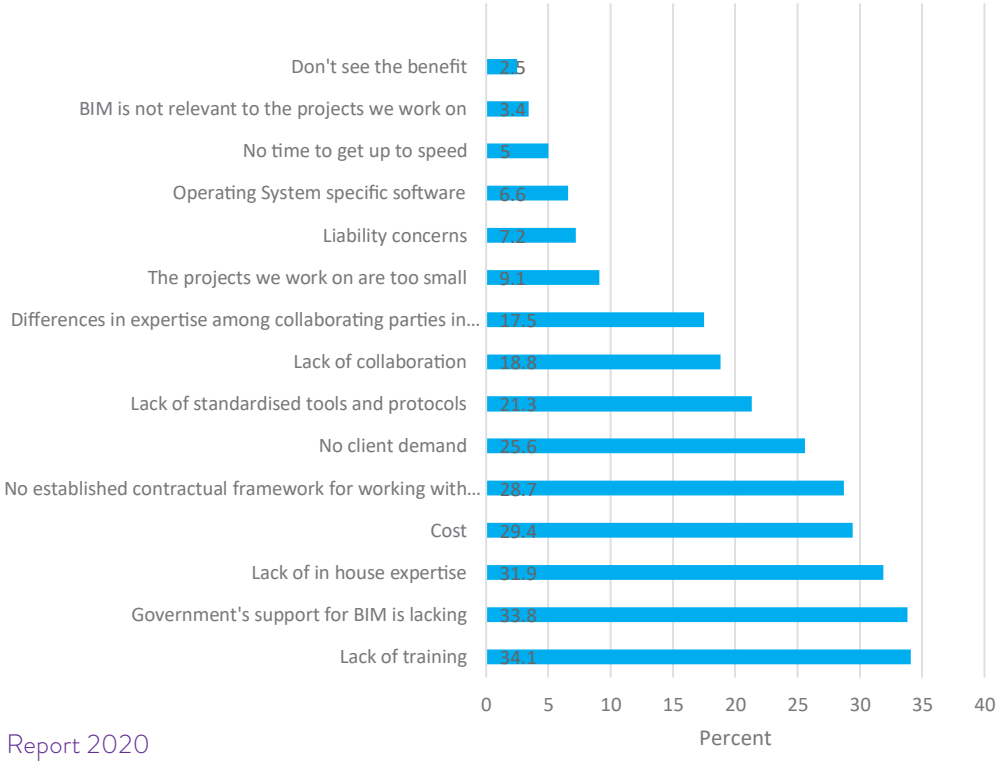
In addition, about 70 percent strongly agree that the adoption of BIM across the African continent is slow, while clamouring for Government intervention to speed up the process. However, it was equally refreshing and encouraging to find that over 90 percent of our respondent trust what the hear about BIM. This indicates a very high prospect for BIM adoption across the continent which is an opportunity that needs to be seized at the moment.

How strongly do you agree or disagree with the following statements about BIM?



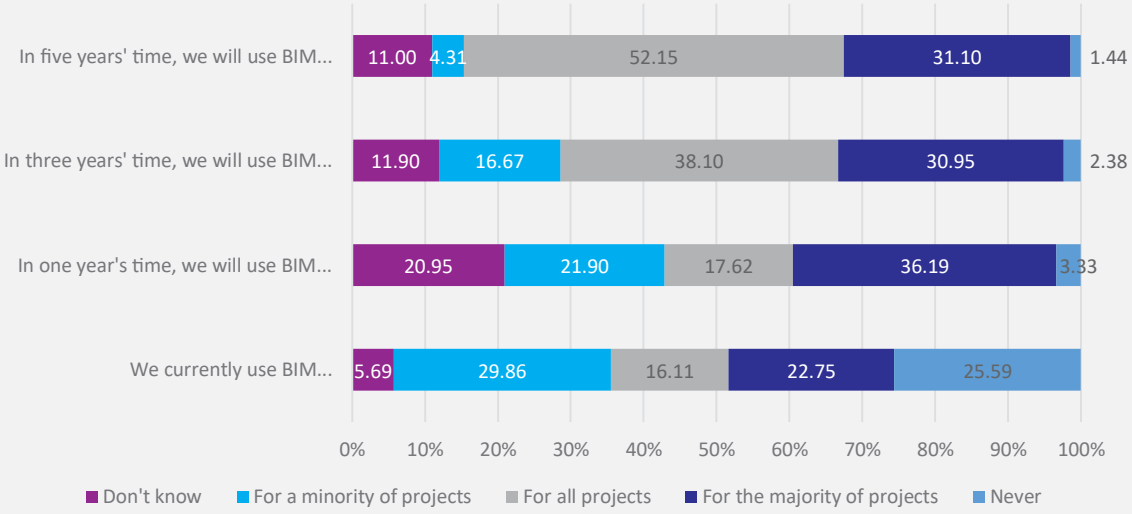
As with every novel technology or methodology, certain setbacks and trade-offs should be expected. However, it was important to seek the opinion of our respondents regarding this matter to help identify the most critical barriers and thus, help to steer the course towards a sustainable BIM adoption strategy. Among the 15 established challenges to BIM adoption, a majority identified the lack of training; lack of government support; lack of in-house expertise; lack of a legal framework; and cost- as the most critical barriers to BIM usage in Africa. As such, it is vital that stakeholders begin to address these issues strategically to enable a continental-wide adoption of BIM in the construction industry.

What do you think are the main barriers to using BIM?



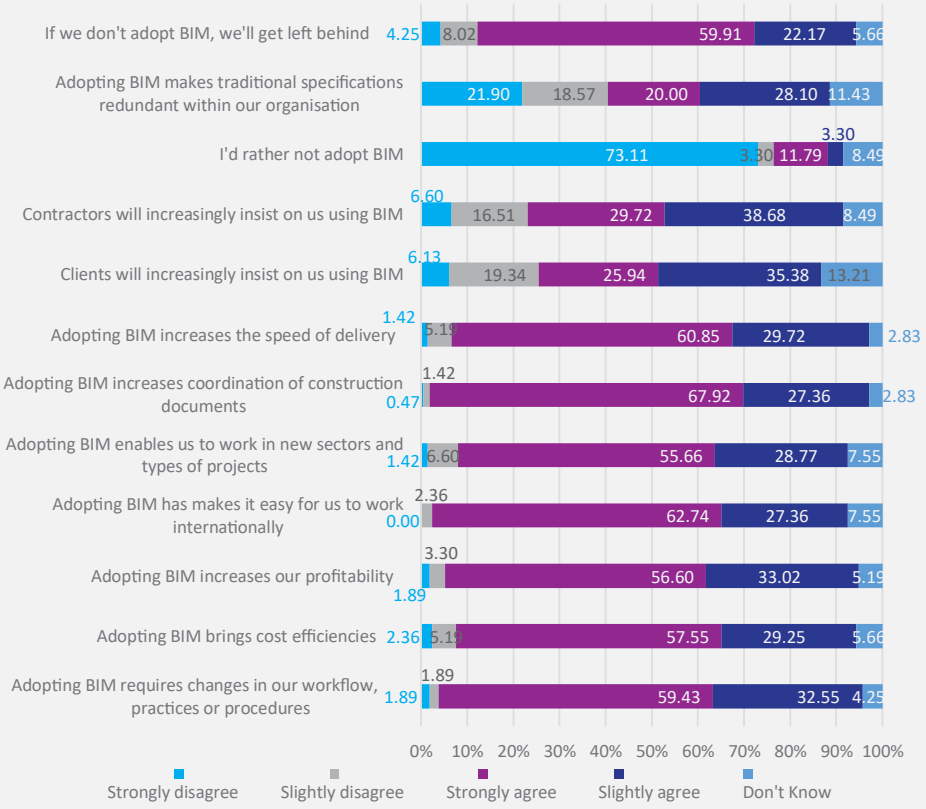
Looking into the future, we decided to seek some insights on the changing trends that are shaping the construction industry in Africa.
To begin with, we asked our respondents about the ambition regarding the use of BIM within their organisations. As it stands, about 16 percent and 30 percent of respondents currently utilize BIM for all and majority of projects respectively. However, we expect to see a strong uptake of BIM in the nearest future, with a broad adoption of about 53 percent in one year, 70 percent in three years, and 83 percent in five years respectively. However, this will be dependent on the need to address the aforementioned barriers.

How would you describe your organisation's future use of BIM?



Furthermore, our respondents were able to identify the most motivating factors driving BIM adoption within their organizations. A majority strongly agreed that adopting BIM will increase the speed of project delivery and profitability, improve the coordination of construction documents, and make participating in international projects much easier among others.

From your experience or understanding of using BIM, how strongly do you agree or disagree with the following statements?



It was also fascinating to find that the fear of being left behind is a major motivation for our respondents. This indicates the increasing realisation of the impacts of digital transformation sweeping across the global construction sector as result of the fourth industrial revolution. Apparently, the construction industry in Africa will need to adopt fast or be left behind in a globally connected world. Nonetheless, the high level of enthusiasm indicates that Africa is willing to step up to the challenge and become a key player in the construction sector.

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Conceptual Building Information Modelling Framework for Sustainable Housing Upgrading in Informal Settlements

This study aims to introduce and critically appraise a new approach to building local community capacities through the use of BIM and mobile technologies in the design and delivery of sustainable housing and settlement upgrading.

The success of low-income housing projects in the global South, including settlement upgrading, requires the participation of all stakeholders, including residents. However, traditional participatory methods are limited in involving the wider community. This tends to be dominated by specific community interest groups and therefore often fail to enable genuine coproduction and bottom-up decisions making. Significant technical constraints here relate to tools for broader collaborative practices and information sharing. Emerging Building Information Modelling (BIM) and related mobile devices can overcome such limitations by facilitating deeper participation of residents and other community stakeholders in housing and community upgrading. The technologies can significantly enhance residents' capacities to easily participate in the design and execution of upgrading and housing projects. BIM systems can be linked to mobile devices through freely available mobile apps and cloud-based systems that now have increasing penetration among all income groups, including informal communities. Accordingly, residents' requirements can be captured through their direct input into the project BIM system and merged with existing housing data to gain an in-depth understanding of design optimisations and their implications for housing and occupants. This will also enable virtual assessment of design options by residents and other stakeholders that allows their informed participation in the decision-making process. This study aims to introduce and critically appraise a new approach to building local community capacities through the use of BIM and mobile technologies in the design and delivery of sustainable housing and settlement upgrading. This will include demonstrating how BIM can be used to collect, analyse and model housing performance data; managing development and upgrading projects' information. And how residents and other stakeholders can participate constructively in the lifecycle of sustainable housing and upgrading delivery using emerging mobile/cloud BIM.

Background

Sub-Saharan Africa is home to some of the largest slums in the world with an estimate of over 55% of the urban population living in areas classified as slums and informal settlements (Adegun, 2018). The slums are characterised by deplorable living conditions such as lack of services, easy susceptibility to health hazards and chronic poverty. Thus, many governments and international organisations are now implementing strategies to upgrade slum communities (Danso-Wiredu and Midheme, 2017). Many failed upgrading projects are now too common, especially in developing countries. Furthermore, this is exacerbated by the fact that the participation in the design, monitoring and evaluation of slump upgrading projects of all stakeholders, including residents or slum dwellers are often limited. The roles of slum dwellers are usually limited to providing information to officials and designers of projects. In essence, there is a failure of interactive and in-depth participation for informed decision-making. This is not just due to a lack of political will, the fact remains that active citizen participation, particularly in informal communities, is quite a challenge. This is manifested in many ways including different and sometimes conflicting interests within communities, the domination of the process by vested interests or sections of the community, lack of a common language (understanding) and protocol of information exchange, costs of travelling to workshop/meeting venues if outside the community and cultural perceptions. Furthermore, both 'one-way' and 'interactive' participatory methods are limited in capturing 'real-time' information over the project lifecycle especially given that informal community members may change their requirements many times during the project lifecycle.

According to UNCHS (2001), effective slum upgrading requires the active involvement of the target beneficiaries. Emerging ICT provides the opportunity to involve citizens in the design, monitoring and evaluation of slum upgrading projects. Building Information Modelling (BIM) can be easily used to foster the participation of dwellers, manage and process huge data associated with slum upgrading projects due to their complex nature.

Many failed upgrading projects are now too common, especially in developing countries.

Emerging ICT provides the opportunity to involve citizens in the design, monitoring and evaluation of slum upgrading projects.

BIM for Community Participation in Slum Upgrading Projects

The participation of slum dwellers in upgrading projects of their communities has long been recommended by various government and international development agencies. However, despite efforts by donor agencies, many upgrading projects are still underperforming far below expectations. As argued by Njeru and Kimutai (2018), in Kenya, many slum upgrading projects have failed to meet their objectives despite strong recommendations for dwellers' participation from their government. Active participation requires the involvement of dwellers in the different phases of the project lifecycle. The participation includes undertaking or being actively involved in the activities of the slum upgrading projects and also exchanging information about the projects with the ultimate goal of making informed decisions about progress and outcomes. However, studies that discuss the involvement of dwellers in the different phases are limited. Most studies often talk about citizen involvement without explicitly stating their roles in each phase. Although limited in the number of phases, one of the most elaborate studies was conducted by Kihiu (2017) which only focused on 3 phases: citizens participation in project design, capacity building, and the utilisation of local resources concerning the sustainability of the projects.

Despite efforts by donor agencies, many upgrading projects are still underperforming far below expectations.

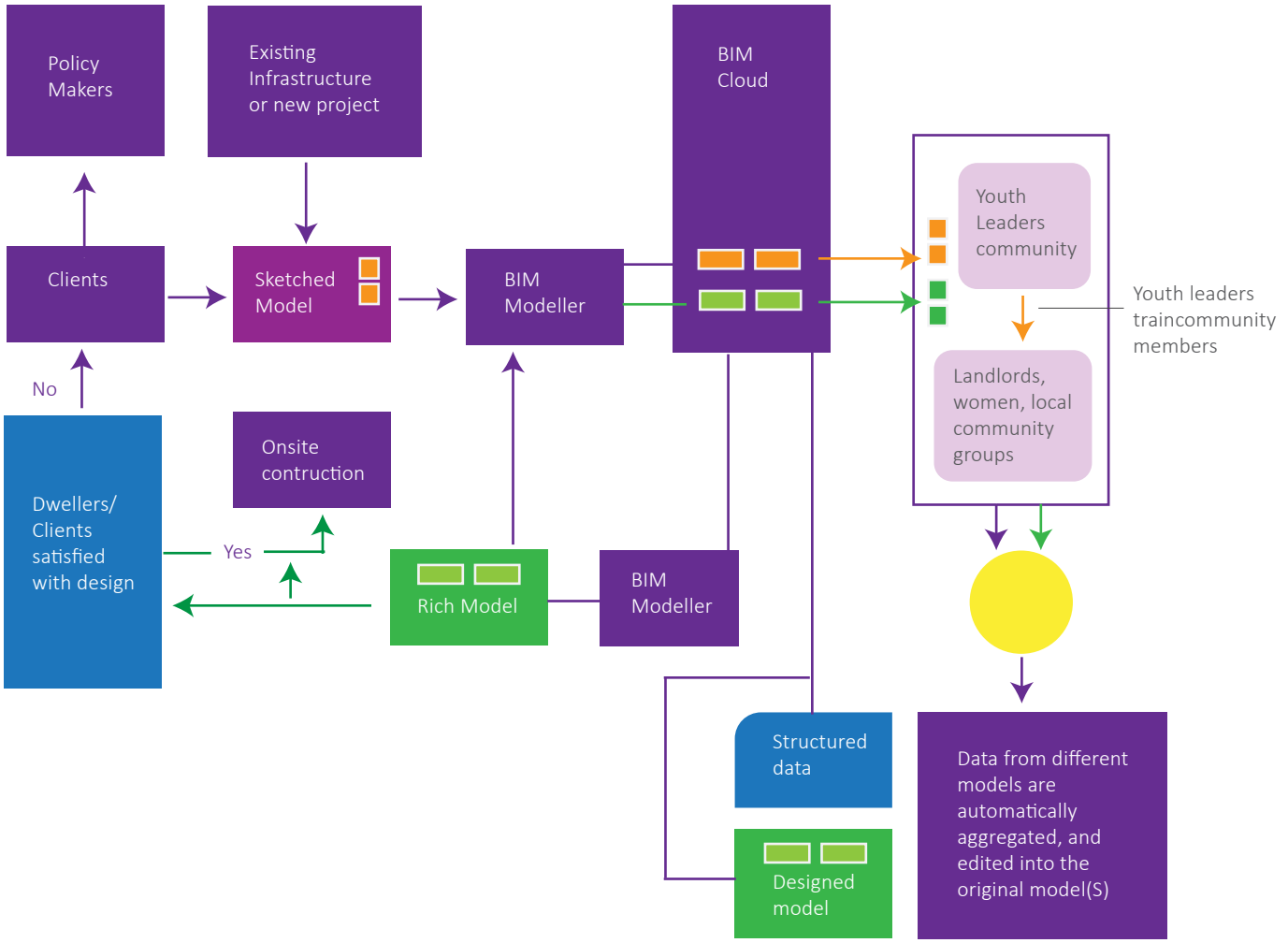
Furthermore, the techniques used for the involvement of dwellers have proven to be ineffective and inefficient. The conventional techniques can be classified into three categories: traditional (public hearings/meetings, surveys, interviews and questionnaires, national/local newspapers, advertising, referenda); innovative (workshops, focus groups/forums, open house on an internet webpage/website, planning for real); and ICT (e-Collaborate, e-Empower, e-Informing, e-Consulting, e-Participate, e-petitioning, e-voting, e-polling, podcasts, wikis, blogs, surveys).

The traditional and innovative approaches are limited in fostering participation because it requires physical attendance of dwellers and/or representatives during participatory meetings. Dwellers find this difficult, time consuming and find it had to sacrifice their various money income-generating activities for participating in meetings. Furthermore, given the current pandemic (COVID-19), the other participatory methods may be ineffective, especialy if physically distancing is to be respected.

While the ICT methods improve on the weaknesses of the other methods, it does not contain geometrical data necessary for visualisation and understanding of upgrading projects. Furthermore, existing methods are effective in exchanging information real-time, anytime and anywhere. Emerging BIM is excellent in fostering real-time collaboration and managing geometrical and non-geometrical data for effective exchange amongst stakeholders, including dwellers. However, research of BIM applied to slum upgrading is rare. This study provides a framework that can be used in fostering the participation of stakeholders, especially low-income dwellers, during the upgrading of slums.

Active participation requires the involvement of dwellers in the different phases of the project lifecycle.

Proposed framework



NB: App solution only for the design phase, but same can be done with the construction

- Model has rich structured information
- Perormance Indicators in units easily understandable by non-experts
- Data analysis is more rapid and effcient

Early and detailed design phase tasks

Construction phase tasks

The cycle commences with a sketched model for existing or new upgrading project informed by client requirements. After this stage, the sketch is transformed into a rich model by a BIM modeller, which is then presented to slum dwellers who can easily understand the model due to the visual power of BIM software systems. If the slum dwellers disapprove the rich model, it is then returned to the clients for refinements, if not, it is handed over to the contractor(s) for development on site. The agreed model is now uploaded to the cloud; typically a Common Data Environment (CDE) and accesses shared with community groups. The accessibility is provided via mobile apps through which community members can be providing real-time feedback about the progress of the upgrading projects from the comfort of their homes. Their feedback can aid in monitoring and evaluation of the project and ensure their views are taken into account during the entire project lifecycle.

Conclusion

The voices of slum dwellers are crucial in the delivery of slum upgrading projects, especially in the era of COVID-19. With the high internet penetration in Africa, professionals can build on this and involved dwellers in the entire project lifecycle and benefit from their experiences anytime from anywhere. The framework presented provides an opportunity for the commencement of an exploratory study in the field of mobile BIM in the delivery of slum upgrading projects. Building on past researches (e.g., Abanda and Tah (2014) and Abanda et al. (2015)), existing CDEs and other BIM systems will be explored for the implementation of this framework as part of future studies. Further research will also look into the possibility of developing tailored and suitable BIM software for slum upgrading in Africa.

References

Abanda H. & Tah J.H. M. (2014) Free and open source Building Information Modelling for developing countries. In: The ICT for Africa 2014 Conference, October 1-4, 2014 Yaoundé, Cameroon

Abanda F.H., Vidalakis C., Oti A.H. & Tah J.H.M. (2015) A critical analysis of Building Information Modelling systems used in construction projects. Advances in Engineering Software, 90 : 183-201.

Adegun, O. (2018). African Cities Must Address Social and Economic Issues When Upgrading Slums. The Conversation. Retrieved, February, 2019, from https://theconversation.com/african-cities-must-ad dress-social-and-economic-issues-when-upgrad ng-slums-97471

Danso-Wiredu, E.Y. & Midheme, E. (2017). Slum Upgrading in Developing Countries: Lessons from Ghana and Kenya. Ghana Journal of Geography, 9(1), 88–108.

Kihiu, S.N. (2017). Influence of Community Participation on Sustainability of Housing Projects: The Case of Kibera Housing Project Funded by United Nations Human Settlements Programme in Nairobi County, Kenya. A Research Project Report Submitted in Partial Fulfilment of the Requirements for the Award of the Degree of the Master of Arts in Project Planning and Management of the University of Nairobi.

Njeru, D. K. & Kimutai, G. (2018). Participatory Project Management and Success of Slum Upgrading Projects in Korogocho Informal Settlements Nairobi City County, Kenya. International Academic Journal of Information Sciences and Project Management, 3(1), 74-92

UNCHS (2001). Implementing the Habitat Agenda: The 1996–2001 Experience. UNCHS (Habitat), Nairobi.

The Big 5 Construct Nigeria is now recognized as the largest Building & Construction event in Nigeria – with over 130 exhibitors from 21 countries. The 2021 edition is now expected to bring together over 8,500 construction professionals to network, build contacts and also plays host to a series of local & international speakers from the across the world. The 2019 launch edition has surpassed all expectations – receiving the support from key stakeholders of Nigeria including Nigeria Institute of Architects, Nigeria Society of Engineers, Nigerian Institute of Town Planners, Project Management Institute of Nigeria, Interior Designers Association of Nigeria, Surveyors Council of Nigeria, just to name a few.

Now back in for its 2nd year and scheduled for **8 – 10 June 2021**, new development plans in Nigeria is creating huge demand for international suppliers to bring their products and technologies into the Landmark Centre, Lagos. Organised by dmg events, the event will feature hundreds of construction products and innovative solutions. Alongside the international and domestic exhibitors, the event offers free-to-attend CPD workshops and seminars to update attendees on the latest industry innovations, best practices and practical ideas. Other features include specialized zones that enable visitors to rapidly find the products they are looking for, live demonstrations and plenty of opportunities to network with industry peers.

Website: www.thebig5constructnigeria.com

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EXCERPT OF THE ROADMAP FOR THE ADOPTION AND IMPLEMENTATION OF BIM TECHNOLOGY IN THE ARCHITECTURAL, ENGINEERING AND CONSTRUCTION (AEC) INDUSTRY

By The Ethopian Construction Project Management Institute (ECPMI)

1.0 Introduction

The existing construction project management system in Ethiopia is largely reliant upon two-dimensional drawings (plans, elevations, sections, etc.) and is characterized by inadequate interoperability arising from "the highly fragmented nature of the industry, the continued paper-based business practices, a lack of standardization, and inconsistent technology adoption among stakeholders" leading to a huge loss of resources and failing to bring about the required transparency and integration among various stakeholders. In addition, the existing project management is inefficient in cost estimation, visualization and related works in construction sector among others.

The Ethiopian Construction Project Management Institute (ECPMI) intends to introduce the benefits of Building Information Modeling (BIM) to the construction industry of the country. BIM is an enabler of Integrated Project Delivery (IPD) allowing the lateral and longitudinal integration of disciplines, industry participants and construction phases (design, fabrication, assembly and delivery). The realization of a construction industry where IDPs prevails is one of the strategic goals set out in the Federal Democratic Republic of Ethiopia (FDRE) Construction Industry Development Policy (CIDP). The policy document has also laid down the need to enhance construction productivity by way of utilizing appropriate technologies acquired in most economical way through consistent and speedy imitation from foreign countries.

To this intent and cognizant of the potential benefits associated with BIM technology, Growth and Transformation Plan (GTP) II has spelt out the need to pilot and appraise the applicability of BIM to the Ethiopian construction industry. Few organizations and companies in Ethiopia have begun to delve into BIM topics in the past few years and widen the application of information technology in the construction industry. Despite this, it can be said that BIM is at its infancy stage in Ethiopia. While individual stakeholders are preparing for, or have prepared to use BIM, they wish to see a more organized and systematic approach that drives the industry-wide adoption of BIM in Ethiopia through the concerted efforts of the construction industry. It is not arguable to say that stakeholders generally agree that the construction industry is expecting an industry-wide catalyst to boost the use of BIM and for an industry leader to blueprint, drive, accelerate and engage its implementation.

In view of a growing trend for using BIM in construction projects, the ECPMI has undertaken the task to define the Roadmap for BIM Implementation in Ethiopian Construction Industry (ECI) of which further development and maturation are expected to be spearheaded by the Ethiopian Construction Industry Council. This document is an excerpt of the roadmap for the BIM Africa Report 2020.

1.1 Objectives of the Road Map

The purpose of the roadmap is to define a high-level plan of action to drive the industry-wide adoption of BIM in Ethiopia through the concerted efforts of the construction industry in a more organized and systematic approach. It is believed that the roadmap is highly instrumental and vital to realizing the targets set in Ethiopian CIDP among other objectives.

1.2 Scope of the Roadmap

The road map attempts to address the introduction of IPD as an alternative construction project delivery method in addition to the BIM adoption and implementation agenda.

1.3 Roadmap Preparation Process and its Outputs

The roadmap has utilized a planning and analysis tool driven by “technology push” to map out what can be done with the existing stock of BIM Technology and how it can be adopted and implemented in ECI. Hence, the planning approach is built on what BIM technology can enable ECI to fulfill its vision and the level of BIM maturity level needed to get there.

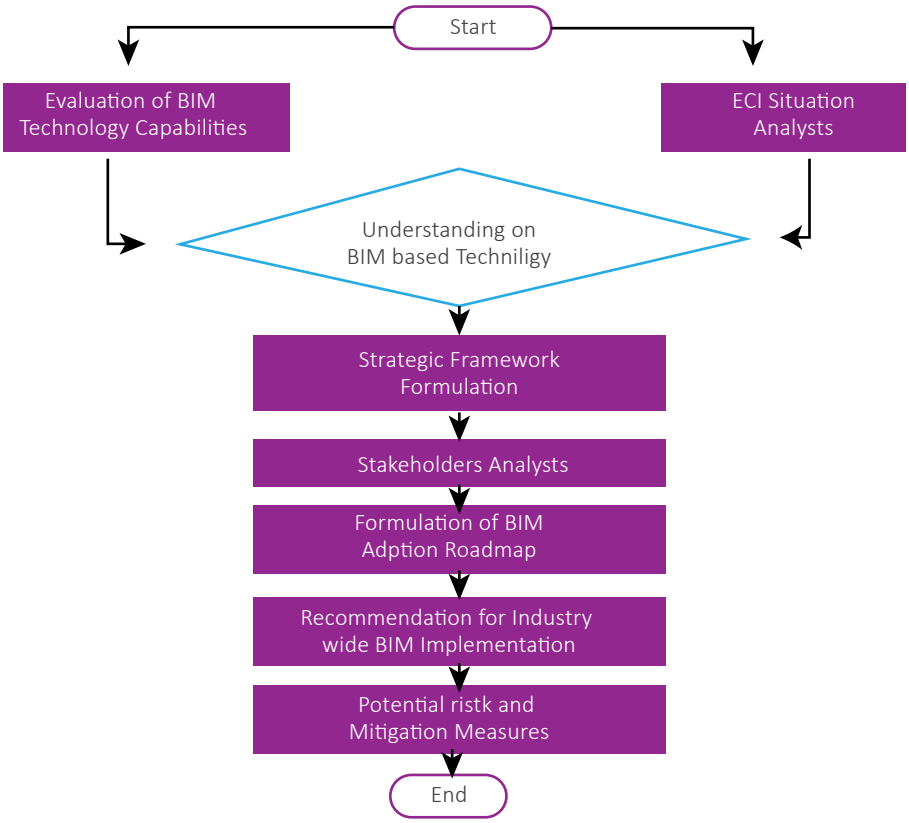

Figure 1: The overall roadmap preparation process for BIM adoption and implementation in ECI

2. ETHIOPIAN CONSTRUCTION INDUSTRY

2.1 Review of BIM Adoption in Ethiopian Construction Industry

Few organizations and companies in Ethiopia have begun to delve into BIM topics in the past few years and widen the application of information technology in the construction industry. Despite this, it can be said that BIM is at its infancy stage in Ethiopia. As mandated body to fulfill the target set in GTP II to pilot and appraise the applicability of BIM to the Ethiopian Construction Industry; ECPMI has so far undertaken the following major activities during the 2010 and 2011 Ethiopian Fiscal Year: acquisition of genuine server based BIM software package with three years' maintenance subscription license and training manuals, acquisition of 20 BIM compatible desktop computers, training and certification of 18 trainees with the application of BIM technology, additional practices on BIM technology to sharpen trainees' capabilities, piloting on two projects, developing a BIM Road map for BIM adoption, and delivery of first round BIM Training to twenty (20) trainees drawn from universities, professional associations, public clients and regulatory bodies.

The piloting of BIM on two projects made it possible to identify the major problems in the original design packages such as: over and under estimation of quantities, missed items (as per the standard method of measurement), clash detections and mismatches among various design documents, non-constructible design elements, insufficient design documents, and improved visualization, design review and documentations.

In the course of developing the road mapping exercise, two plenary sessions were organized in February and March 2019 with themes focusing on why the ECI needs to switch to BIM? And how BIM can be adopted and implemented in ECI? More than 400 participants representing relevant government institutions, higher learning institutions, professional associations and post graduate students researching on BIM have contributed essential inputs. BIM practitioners from Germany and locals also shared their insights and vision in the future application of BIM. While appreciating its immense potentials in enhancing the performance of ECI; the successful seminars were over-subscribed which reflected the industry's interest in BIM with the challenges set out by the participants such as: intended government's support package to incentivize private sector investment on BIM, the awareness creation effort, incentive BIM promoters, legal framework for BIM implementation, who will be held accountable should the technology fails to bring about the expected, is environment conducive for BIM adoption and implementation established? How financially feasible is the technology?

It is expected that there will be productivity gains of BIM implementation in the design and execution of large and complex construction projects.

Instead of limiting its scope to building sector, the strategic framework shall address the whole sectors of the construction industry. While emphasizing its potential in prompting transparency, the technology adoption shall consider the local context and prohibitive cost associated with infrastructure for BIM adoption and implementation. The government shall supply the consultants and contractors with BIM packages. BIM shall be first implemented in Public projects and later in private projects. The BIM roadmap shall be championed by ECPMI while other institutes work in collaboration with CIC for inclusion in the curriculum as a chapter, module, program at under-and post-graduate levels, How to make BIM accessible to higher learning institutions?, Why BIM? And how to explore other similar digital information technologies? BIM shall not be taken as a cure-for-all but there is a need to change work culture. Moreover the successful implementation of the roadmap shall be backed by pertinent studies preferably, to make BIM mandatory by project cost instead of storey number.

In general, the aforementioned concerns are categorically summarized into the following sets of challenges: (a) Challenge 1: Lack of demand for BIM, Existing Culture and Mindset (b) Challenge 2: Awareness creation and capacity building (c) Challenge 3: Legal framework (d) Challenge 4: Collaboration and integration of efforts (e) Challenge 5: Investment and incentives

2.2 BIM related Ethiopian Standards

The Ethiopian Standard Agency (ESA) has released the following three BIM related standards in 2018:-

i) ES ISO 12911:2018. First edition (20-11-2018). Framework for Building Information Modeling (BIM) guidance (Identical with ISO/TS 12911:2012) ICS:91.010.01. Published by Ethiopian Standards Agency (ESA/ISO)

ii) ES ISO 29481-1:2018. First edition (20-11-2018). Building Information Models- Information Delivery Manual- Part 1: Methodology and format. (Identical with ISO 29481-1:2016). ICS:91.010.01. Published by Ethiopian Standards Agency (ESA/ISO)

iii) ES ISO 29481-2:2018. First edition (20-11-2018). Building information models- Information delivery manual- Part 2: Interaction framework (Identical with ISO 29481-2:2012). ICS:91.010.01 Published by Ethiopian Standards Agency (ESA/ISO)C

2.3 Drivers and capability gaps in ECI

Some of the drivers for BIM adoption in the Ethiopian Construction Industry are:-

1) To annul the customary cost overrun, time overrun and substandard quality of products associated with construction projects

2) To strengthen the integration and collaboration among industry stakeholders at all levels.

3) To pay attention to the early stages of project cycle including risk identification and management.

4) To introduce modern project delivery systems and promoting supportive behavior across the supply chain.

5) To enhance the project management maturity level.

6) To treat project in its entirety as a single system.

7) Uplift productivity by project management, risk management, consistency and quality of output,

8) Enhance capability of construction in terms of innovation and value-added.

In a nutshell, it is expected that there will be productivity gains of BIM implementation in the design and execution of large and complex construction projects. ECI looks ahead to achieve significant financial and time savings by avoiding the project planning issues that would otherwise only be detected at the construction phase, reducing the number of audits and time needed using sections of the tender documents as models. Furthermore, the adoption of BIM is already a global trend. ECI must keep up with the fast pace of the global adoption of BIM so as to bring its Architecture, Engineering and Construction (AEC) to competitive level in the region and in the world at large. Ethiopia's AEC companies would need BIM skills to compete for jobs/projects outside the local market in the foreseeable future. It is reported that the BIM technology will be one of the standard norm in the future of construction management process in many nations. Considering the globalization issue and world trade organization impact, stepping towards familiarizing the industry with such new technology would be vital for ensuring the competitiveness of local companies by enhancing their capacity.

3.1 Policy Framework

The broader objective of the road map is to ensure a construction industry where IPDs prevails through adoption and implementation of BIM technology in a phased, scaled and targeted approaches. The mission/targets set out in the FDRE Construction Industry Development Policy (CIDP) and GTP II describes the roadmap as envisioned for a competitive construction industry at continental and international level by 2025. The policy document sets out eleven strategic goals of which its fulfillment would ensure the realization of the vision. The following two among the strategic goals, have direct relevance to the adoption and implementation of BIM in ECI:-

a) Indigenous construction industry stakeholders with increased local construction market share, and export standard products and services through building their implementation capacity and ensuring their competitiveness in project delivery time, cost and quality performances; and

b) Enhanced construction delivery capacity and competiveness through promoting integration and collaboration among industry players, and strengthening continental and international partnerships.

The strategic directions of the construction industry during the period of GTP II and beyond include among others: enhancing transparency and accountability in the industry, enhancing management of construction projects and technology transfer, strengthening competitiveness of the construction industry, and creating enabling environment for those actors and professionals of the sector are the other strategic directions which will be given due emphasis during the period of GTP II.

In line with these strategic directions, GTP II under the National Construction Project Management Capacity Building and Technology Transfer Program, has set out to bring about significant change in construction performance by ensuring the application of sample construction projects implementation tools (like kaizen, integrated project work management and information system). During the GTP II period, building modeling will be implemented as one of the reform tools in the construction industry.

3.2 Vision

The vision ECPMI as proposed is to see BIM as an industry standard for the implementation of building projects worth more than 250 million ETB by 2025 and to see an AEC Industry with "Typical Practice Level" on BIM/Virtual Design and Construction (VDC) score rating system by 2025.

4.1 Themes for stakeholder identification

Six key themes are identified with a cross-section of representatives from the ECI as relevant to the development of a roadmap for BIM uptake and implementation: Lead agent role, Client role, Mandates, Pilot Projects, Metrics, and Standards.

4.1.1 Lead Agent Role

The ability of information technology to transform organizations and entire industries is widely accepted where the context is characterized by change. The relationship between new technology and the institutional environment is important because implementation of new standards and processes may require changes to agreements which can in turn affect the economic performance of the industry. While collaborative decision making and stakeholder engagement is generally necessary to achieve such transformation, it is also important to have a steering agent responsible for developing overall guidelines and frameworks for operation of an industry sector. This also requires a common communication platform for performance and productivity improvements and measures associated with technology uptake.

4.1.2 Client Role

The key clients for the delivery of physical and economic infrastructures are instrumental in playing the leadership role in BIM adoption and implementation, so long as they recognize the importance of their roles in facilitating greater productivity through the use of data associated with BIM/VDC.

4.1.3 Mandates

BIM mandates by many government entities demonstrate how enlightened owners can set specific targets to empower design and construction companies to leverage on BIM technologies to meet and exceed those goals thereby, driving BIM into the broader project ecosystem in the process. Research showed that although a mandate by the central government can promote the accelerated uptake of new technologies, there are other ways in which public clients can take a leadership role. Some studies also show that there seems to be little demand for a formal mandate without a period of testing and piloting the use of BIM/VDC. It was however acknowledged that a mandate from a single government agency could lead the industry as a whole towards a higher uptake of BIM/VDC and the realization of significant benefits from more integrated systems.

BIM mandates by many government entities demonstrate how enlightened owners can set specific targets to empower design and construction companies to leverage on BIM technologies to meet and exceed those goals

4.1.4 Pilot Projects

Pilot projects can be used to validate and demonstrate the readiness of outputs. Exemplar projects can help increase acceptance and accelerate the uptake of well-designed collaborative BIM processes. It is to be highlighted that pilot projects are an important factor in increasing acceptance of new technologies and ways of working. They help to understand implementation issues and can be used as learning tools by disseminating the outcomes and learned lessons.

4.1.5 Metrics

Although BIM and more integrated models promise many benefits, there are very few metrics available that can objectively measure and quantify the productivity improvement and other intangible benefits. Without such metrics, teams and organizations are unable to consistently measure their own successes and/or failures. Performance metrics enable teams and organizations to assess their own competencies in using BIM and to potentially benchmark their progress against that of other practitioners. Furthermore, robust sets of BIM metrics lay the foundations for formal certification systems which could be used by those procuring construction projects to pre-select BIM service providers. The lack of agreed and readily available metrics for assessing the benefits of BIM/VDC implementation is largely acknowledged and is commonly mentioned as an issue to make the business case for BIM/VDC. Publicly available information of this kind is an important element in demonstrating the medium to long-term benefits of adopting digital modeling. While firms do establish and report on internal Key Performance Indicators (KPI) to monitor time-savings, return on investment and error reduction, there is no national or global standard for the gathering and reporting of such data to enable policy settings and drivers to be set in place.

4.1.6 Standards

Good standards provide clear requirements that set minimum conformity specifications and strike the right balance between too many and too few varieties. This works in the best interests of both the product supplier and the consumer. They enable trade, improve safety, facilitate efficient use of resources, reduce time, improve quality, permit compatibility and aid integration. The availability of national standards avoid duplication across the industry and allow the use of libraries that would in turn reduce the cost burden of adoption and make the transition more accessible to small and medium-sized enterprises.

4.2 Identified stakeholders with their roles

The mandates of stakeholders that are believed to have potential roles in the adoption and implementation of BIM Technology in the ECI are outlined below:

4.2.1 The Ethiopian Construction Industry Council

The Ethiopian Construction Industry Council established with the objective to deliberate and provide direction to policy makers on modernizations in the industry and provide solutions on the challenges facing the construction industry in the overall national development (Council of Ministers regulations No. 419/2017).

The Construction Industry Council (CIC) will be the leader of this road map for the wider adaptations of BIM technology in the Ethiopian Construction Industry leading the industry for the IPD system. The council will set BIM Technology as criteria for the design approval, procurement, construction and building use permit in the future of the construction industry. The CIC gives technical advice on the adoption of BIM technology, distributes tasks for the stake holders and evaluate the performance and adoption of the technology and on taking remedial actions. As a statutory platform for communication and collaboration among construction industry stakeholders, the CIC shall take the initiative to spearhead the adoption of BIM and keep Ethiopian construction stakeholders abreast of international standards and developments.

4.2.2 Public clients

Public clients play the leadership role in BIM adoption and implementation through taking the lead so as to create market demand

4.2.3 Minister of Innovation and Technology

Ensures that there is adequate fund to build up BIM capability and sustain those activities, develop and improve the national productive capacity and competitiveness through efficient application of innovation using BIM technology.

4.2.4 Ministry of Urban Development and Construction

Allocation of sufficient fund for incentivizing the BIM adopters and supporting investment on BIM technologies, facilitate the adoption and implementation of BIM technology in the construction industry. In collaboration with Ministry of Finance, work on ways of changing of procurement practice.

Good standards provide clear requirements that set minimum conformity specifications and strike the right balance between too many and too few varieties.

4.2.5 Ministry of Science and Higher Education

Formulate strategies to enable higher education addresses the developmental needs of the country and how BIM technology will be part of their curriculum strategies that are compatible with domestic and international developments and work collaboratively on the development of BIM guide, manuals and checklist.

4.2.6 Ethiopian Construction Project management Institute

Provides necessary manpower and finance for the required tasks, spreads the use of BIM and work closely with all stake holders, initiates the development of standard and guideline for the adoption of BIM in the country, organizes seminars and workshop on BIM technology and international practices, provides training for selected professionals and showing the way for the dissemination of the technology etc.

4.2.7 Universities and training institutes

Add BIM courses to their under-and post-graduate curriculums, implement a fast-track training programme for in-service professionals and management staff to understand integration from a management perspective instead of a technical perspective, provide on-the-job training which provides professionals and technicians with practical experience using BIM.

4.2.8 Professional Associations

Work collaboratively for the implementation and adoption of BIM technology in the construction industry, create awareness about BIM technology for their members, participate on further development of BIM road map and work towards the success of the road map, work collaboratively for the development of BIM guidelines, manuals and checklist.

5.1 Recommendations for the industry

Specific recommendations for the industry are:

(i) Develop a national strategy for the adoption of integrated project environment in Ethiopia which will require the leadership and coordination of a lead agent to engage with other lead industry associations and disseminate information.

(ii) Leverage on the fact that main construction clients are regional, states and federal government agencies. As such, these organizations are in a unique position to influence the uptake of new technologies and processes.

(iii) Use pilot projects, monitored and evaluated to build a knowledge base especially in terms of productivity benefits and processes associated with the uptake of BIM and IPD.

(iv) Build consensus on standard performance indicators and metrics to prove the business value of BIM and IPD in terms of project, business and industry-wide productivity gains.

(v) Develop national standards to provide a framework for a nationally consistent approach for uptake that reduces macro-economic burden of adoption and increases productivity. The scope should include, but not be limited to architectural, structural, civil engineering, and MEP BIM models in stages of conceptual, preliminary design, detailed design, construction and as-built.

(vi) Planning: Invest in shared BIM standards to harmonize BIM implementation across a spectrum of design, construction, and operation disciplines. Establish performance measures and target goals.

(vii) Adoption: (1) Establish BIM and VDC education program at all levels from executive to apprenticeship, to keep decision-makers informed of latest value propositions and strategies leveraging BIM and build skill sets of the Architects, Engineers, Contractors, Owners and Operators (AECOO community) who design, deliver, and manage the built environment. (2) Incentivize beneficial use of BIM in public and private projects through education grants, bonuses, and/or benefit sharing agreements.

(viii) Technology: implement all categories of BIM processes from visualization to automation, throughout the AECOO community, and in all stages of project life cycle from conceptualization to operation and recycling.

(ix) Performance: Develop meaningful corporate, industry, and national targets for project and built environment performance, track how BIM contributes to realization of these goals

5.2 Roadmap for Strategic BIM Implementation

To successfully implement BIM, attention must be paid to two key areas: the BIM data model and BIM working process. Taking into account value, benefit, issue and concern, the following recommendations have been developed to help to guide the successful staged implementation of BIM in Ethiopia. A timeline and Suggested Action Parties are intentionally not included in this version of the roadmap as it can only be proposed after industry-wide acceptance and understanding of BIM have been achieved.

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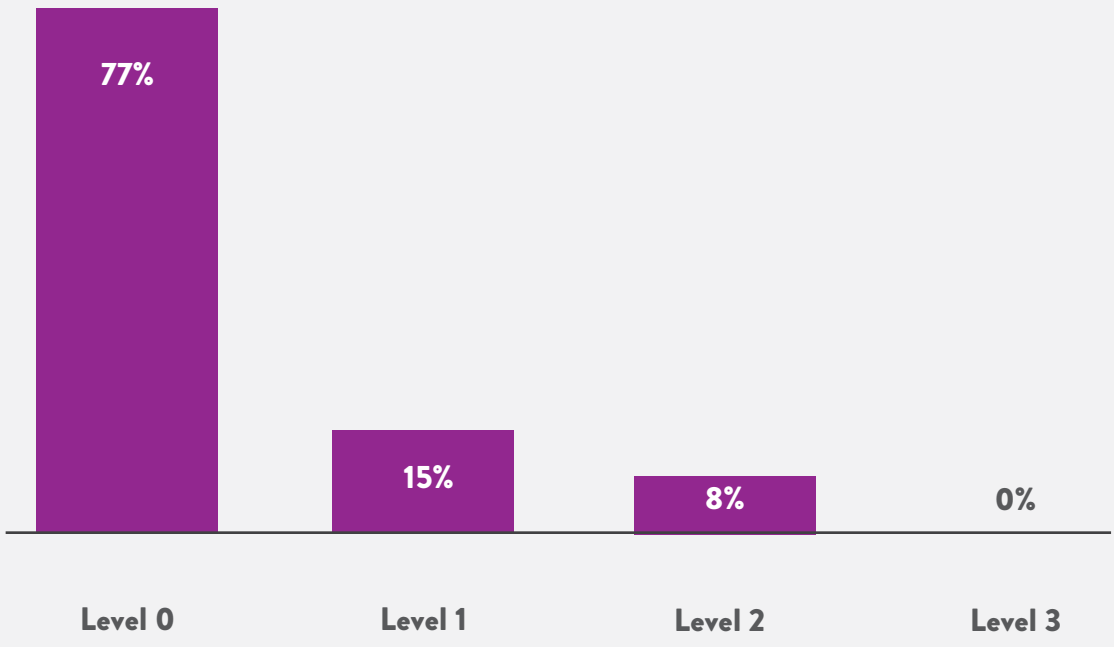
ASSESSMENT OF BUILDING INFORMATION MODELING (BIM) UTILISATION IN THE TANZANIAN CONSTRUCTION INDUSTRY: EIGHT YEARS LATER

In the last decade, the construction industry has witnessed a huge transformation in terms of the use of digital technologies, and particularly Building Information Modelling (BIM). Though internationally, BIM has gained an excellent reputation for boosting productivity in the construction industry. BIM holds undeveloped possibilities of supporting the Tanzanian construction industry. This study aimed at revealing current BIM knowledge, perception and utilisation status in the Tanzanian construction industry to create a reference for formulating strategies of a strong local industry absorptive capacity. This is necessary to facilitate a successful BIM adoption. This study is conducted eight years later, following the 2011 data that was published in 2014.

Although the baseline knowledge of BIM has slightly increased, a survey of the AEC community (Table 1 & Figure 1) indicates that the understanding of BIM by clients and competing companies is still very low, whereas BIM is perceived to offer no competitive advantage. While improved visualisation, reduced construction time, and maximisation of productivity appeared to be the most attracting factors to BIM adoption, insufficient training and lack of BIM knowledge are considered the most hindrance to its adoption. Most professionals in the industry use CAD software, only few companies indicated to have capability to deliver a project at BIM level 1 or 2. Very few of those who indicated to have BIM capability linked their experience through participating in a practical BIM project which involves the design and construction of Julius Nyerere International Airport Terminal 3, and Maji House at Ubungo, Dar es Salaam. However, the two projects also involved foreign companies, making it unclear the extent of local contribution to BIM utilisation.

Table 1: AEC industry Survey response

TYPE OF FIRM	INTERVIEW	QUESTIONNAIRE	TOTAL	RESPONDED	%RESPONSE
ARCHITECTURAL	5	30	35	34	97%
STRUCTURAL ENGINEERING	5	30	35	29	83%
QUANTITY SURVEYING	3	20	23	14	61%
CONTRACTORS	5	55	60	32	53%
TOTAL	18	135	153	109	71%



Though there is a delay of BIM adoption in Tanzania (Figure 2), better future is promised when a large percentage of the representatives of Architecture, Engineering, and Construction (AEC) community showed interests in BIM. As one step forward, Ardhi University has recently introduced the BIM course in the program of Architecture, although the teaching of the course had not started at the time of this study. While the industry craves for increased efficiency, it might take a while before the first graduates can join the industry to push for BIM utilisation. Study findings showed that the government and academic institutions are perfect organisations to promote BIM utilisation (Figure 4) as they are capable of exercising more collaborative efforts than individuals. A coordinated effort is, therefore, necessary to facilitate steady progression to adopt and implement BIM. Extensive training, execution of sample BIM projects in Tanzania and a strong adoption strategy (Figure 3) can be of great assistance towards BIM adoption.

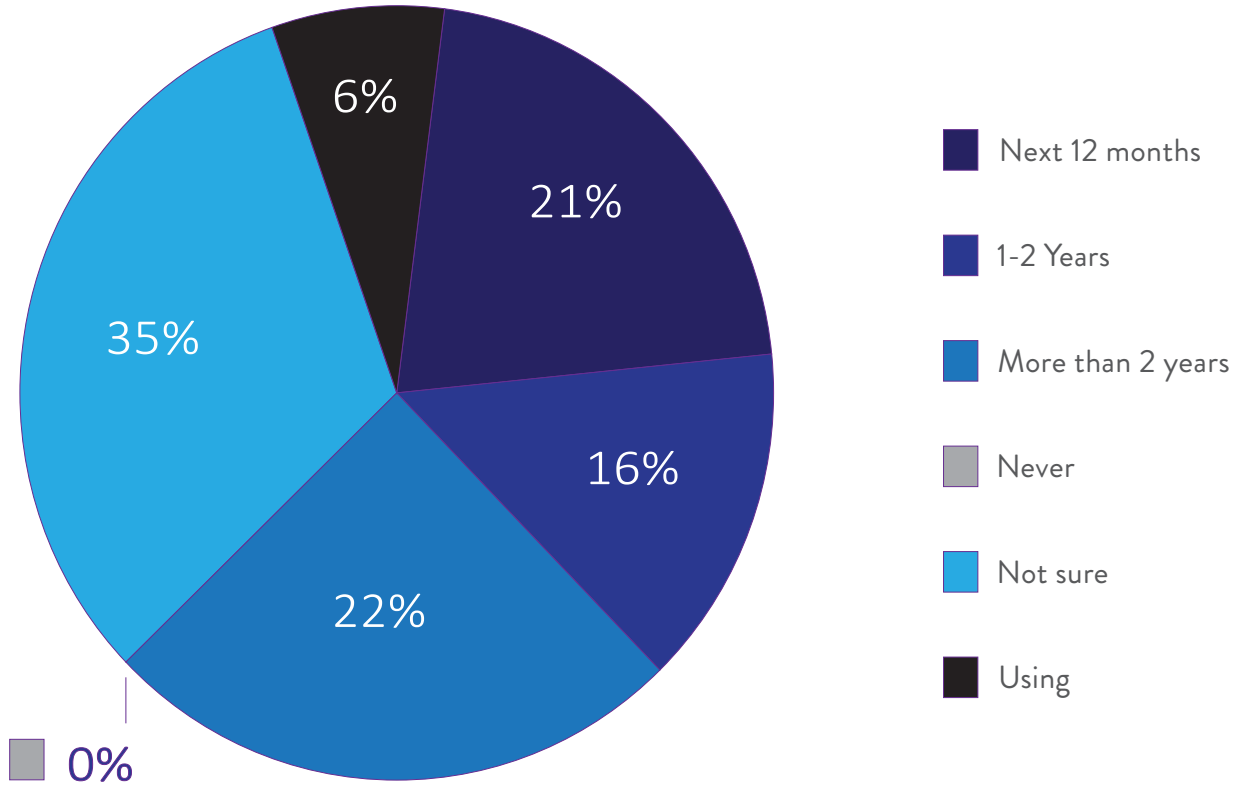


Figure 2: Prospects to adopt BIM by AEC Community

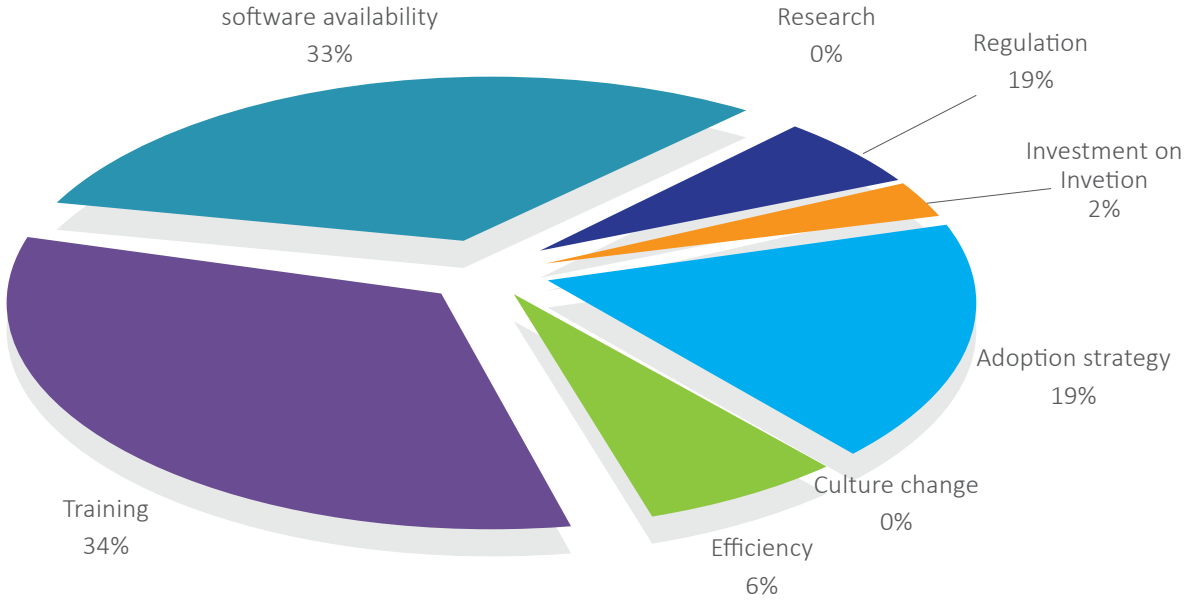


Figure 3: Factors influencing BIM adoption decision

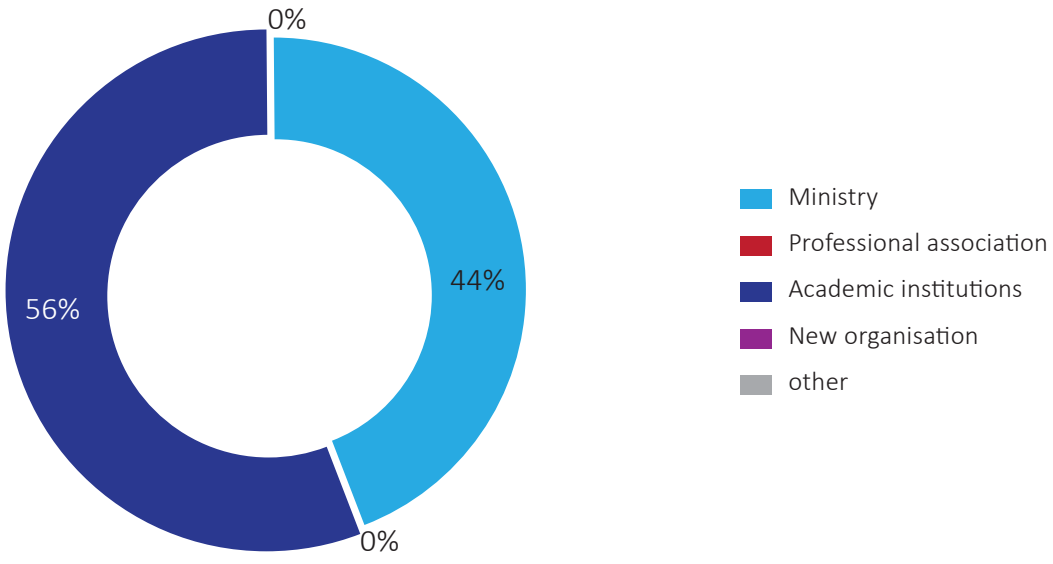


Figure 4: Respondents' choice of organisation to lead the BIM utilisation in Tanzania

Framework for BIM Implementation in the Ministry of Housing and Town Planning, Algeria

SPA BEREG / SARL MBIM

The 21st century is rife with digital revolution, changing the work process of almost all industries on the global market. Cloud platforms, mobile monitoring and electronic documentation systems became essential components of contemporary business models. BIM (Building Information Modeling) manages both graphical and construction information, allowing digital drawings, reports, design assessment, project planning, resources management, design development, construction and facilities management.

The engineering department of the Algerian Ministry of Housing and Town Planning initiated its pilot project geared towards developing a framework for BIM implementation in Algeria through a national call for tenders, launched by its subsidiary EPE / SPA BEREG (Office of Research and Engineering). Our company, MBIM had the honor of carrying out this project. The implementation methodology presented in the project specifications was based on an organizational transformation, supported from each company top executives to its employees. This methodology is based on three essential strategies working as a whole:

- **The vision:** The success of the BIM implementation rests on a concise and well defined vision supported by the management team. It will include the steps of the BIM transformation, the main elements of the transformation and the goals at each different stage.
- **Controlled leadership**: Leaders of the companies undergoing BIM transformation are responsible for leading and motivating change within the organization.
- **Integrated progressive evolution:** Change takes place through new policies and strategies, management of organizational change, standards and processes and integrated technical aids.

Mission 01: Acquisition of the software necessary for the training and the implementation of the BIM process;

N°	Activities	Software
01	BIM Management	AEC Collection multi user network
		BIM 360
02	Architecture	REVIT
03	Civil engineering	AEC Collection multi user network
04	Contractors	REVIT
		Caneco
05	Infra structures / Topo graphy	Civil 3D
06	Quantity surveying	AEC Collection multi user network

Mission 02: Employees training defined by the company in the pilot project;

N°	Activities	Training	Amount of people
01	BIM Management	BIM Manager	01
		Navisworks - Initiation	06
		Navisworks - Perfecting	06
		BIM 360 - Initiation	06
		BIM 360 - Perfecting	06
02	Architecture	REVIT Architectur e - Perfecting	06
		Lumion - Perfecting (realistic rendering)	06
03	Civil engineering	REVIT Structure concrete +wood - Initiation	06
		REVIT Structure concrete +wood - Perfecting	06
		Ro bot concrete +wood - Perfecting	06
		Advance steel - Perf ecting	06
04	Contractors	REVIT MEP - Initiation	06
		REVIT MEP - Perfecting HVAC	06
		REVIT MEP - Perfecting pluming	06
		REVIT MEP - Perfecting electricity	06
		Caneco Perfecting	06
		Fisa CAD - Perfecting	06
05	Infra structures / Topo graphy	Ci vil 3D topography + infrastructures - Initiation	06
		Civil 3D topography + infrastructures - Perfecting	06
06	Quantity surveying	Surveying – Perfecting on all the software above	11
07		Travail collaborative BIM - P erfecting on all the software above	11

Mission 03: Training certifications delivered by the organization as well as the software publishers.

Mission 04: Assistance and support in setting up the pilot project, chosen by the BEREG BIM experts.
By the end of training, the assistance and support will start on a pilot project selected by the company which consists of:
- providing assistance and support to the teams in the realization and the implementation of the pilot project in its different study phases (Sketch, Preliminary Project, Execution etc.). It should be in accordance with the deadlines included in the contract.
- guiding the employees to solve problems encountered using their own skills, knowledge acquired during this training.
- unlocking the encountered issues.
- providing help, assistance and advice for the treatment of specific real and simulated problems during the course of the pilot project;
- assisting the BIM manager of the company, in the development of BIM conventions, BIM Specifications, BIM Execution Plan, BIM graphic charter, or any document essential for the implementation of the BIM process and its management;

Mission 05: evaluation of the training and the digital model as well as formulation of recommendations by a BIM expert for the generalization of the BIM process within the EPE / SPA BEREG company.
After the training and software support for the different technical project management departments led by Mr. DELLILI Rabeh. BEREG continued its deployment starting with the BIM management plan, a key step into a successful BIM transition. It consists of the definition of the internal BIM organization structure for each department which establishes the methodology and processes for ongoing or future projects. BEREG was accompanied by Mr. Oussama HELLASSA (Expert / Trainer- MBIM) who established a roadmap. Among his actions are creation of the BIM-BEREG Standard, creation of software templates by service, creation of the library families by profession, definitions of roles and responsibilities (BIM manager / BIM coordinator / BIM modeler), establishment of exchange workflow between disciplines, organization of BEREG's server and the production process, creation of the BIM Execution Plan for different projects, creation of the Audit model & control of the models, training in BIM Management and synthesis and coordination tools.
Throughout the BIM implementation, support for change was taken into account by the technical management department with exchange and explanation meetings with the members of each department. This had a positive impact with facilitated deployment and can be renewed during projects or even when a new member joins a department.
Through training, deployment and support, BEREG has been able to equip itself to face the digital transition that the building world is going through and can now respond to national and international BIM calls for tenders. The BIM BEREG / MBIM experience is certainly one of the most complete in the field of construction in Algeria and remains an adventure that pushes BIM-Algeria forward…

PARAGON ARCHITECTS

144 Oxford Road Project: Stretching Sustainability beyond limits.

Designed by Paragon Architects for Growthpoint Properties, the 144 Oxford Road project is an urban landmark at Rosebank's Central Business District in Johannesburg, South Africa. The 36,700m2 premium-grade office development secured a 5-Star Green Star Office v1.1 Design Rating from the Green Building Council of South Africa (GBCSA). Undergoing various design iterations and architectural concepts, the edifice was initially designed to include a hotel apartment. The decision to evolve into a nine-storey multi-tenant office development was in reaction to the demand for premium-grade office space in Rosebank's business precinct, which currently exceeds the demand in neighbouring Melrose and Sandton precinct.

As a flagship project for both its architects and developers, the designers collaborated with Aurecon to provide mechanical engineering and environmentally conscious design services alongside Tiber WBHO Joint Venture as the main contractor. Other stakeholders included Origin Project Management as Project managers, Sutherland Engineers as Civil Engineers, Conscius Electrical Engineers and Claassen & Auret Consulting Engineers as Electrical Engineers, MG Building Services as Wet services engineers, RLB Pentad and Farrow Laing Quantity Surveyors as cost consultants, Specialised Fire Technology as Fire engineers, Solutions for Elevating as Lift consultant, and Ochre Office as Landscape Architects. This collaboration between various construction experts helped to achieve the delivery of the development in line with its sustainability objectives as an eco-design.

The design of the 144 Oxford Road project features two curved office towers linked by an open central atrium enhancing lighting entry into the interior spaces. This bespoke shape, wrapped in high-performance glazed façades, mirrors the bustling traffic of Oxford Road to the west of the development. The west facades are shaped towards a curved glass pinnacle which cantilevers outwards towards the road. The main façade consists of double-glazed unitised façades, incorporating a dark grey glass. The outermost facade of the northern building features a secondary offset glazed 'skin' with raking sides, a nod to the fast-paced vehicular movement on Oxford Road.

Paragon Architects implemented the deployment of Building Information Modelling (BIM) during the design and development stages of the project. Autodesk Revit was adopted as the model authoring software with each design team member designated with unique packages. The software choice helped to also accommodate collaborative inputs from other stakeholders on the project. Continuous clash detection and coordination of the federated model was executed in Autodesk Navisworks during the design before construction kickoff.

The eight-man architecture team ensured to involve a facilities manager during the design phase to provide advisory on sustainability and efficient building maintenance requirements for the project. The intrinsic sustainability elements of the project feature all-round energy-efficient lighting, vast glazing to enable sufficient natural lightning and adequate outdoor view, an energy-efficient air-conditioning system, water-saving sanitary fittings, water-efficient landscaping, and a rainwater harvesting system. Paragon architects believe that the project posed an exciting challenge to date, morphing through various design iterations to engrave an architectural statement in Rosebank, Johannesburg.

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BIM Africa Initiative is a not-for-profit and collaborative membership-based professional organization that was formed to enable and regulate the adoption and implementation of Building Information Modeling (BIM) in the Architecture, Engineering, Construction and Operations (AECO) Industry across Africa.