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The Potential of BIM Models as Legal Construction Documents for Sustainable Growth in the Kenyan Construction Industry.

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Abstract—Building Information Modeling (BIM) has transformed the global construction industry in terms of generation, sharing and integration of design data. This has created a requirement for new protocols, activities and definitions. In Britain, the BIM overlay to the Royal Institute of British Architects (RIBA) Outline Plan of Work provides straightforward guidance on the activities needed at each RIBA work stage to successfully design and manage construction projects in a BIM environment. In the United States, two different contract addenda (E202 Building Information Modeling Exhibit and Consensus Document 301 BIM addendum) allow the contracting parties to decide whether or not BIM is to become part of the contract. The Kenyan construction industry has been using the traditional two-dimensional environments to define construction contracts. This paper suggests that as it happened with the introduction of Computer Aided Design (CAD), a tipping point will soon be reached where BIM will gain widespread local acceptance as a transformative technology and working philosophy at all scales of practice. However, with the incremental changes in projects delivery, particular concerns regarding the legal and contractual implications of BIM arise. Firstly, whether BIM will alter the traditional allocation of responsibilities for all project stakeholders. Secondly, whether standard forms of building contracts should be altered to account for the use of BIM. To assess these concerns, a survey was conducted within Nairobi with a sample of 24 industry experts from firms that have used BIM in at least one project. The data collection methods were semi-structured face-to-face interviews. Analysis of the data was done using content analysis. The findings show that consultants are adopting the use of BIM technology for projects delivery. This paper concludes that there are strategic benefits of developing BIM expertise in Kenya and that a BIM addendum, to be attached

to standard forms of contracts needs to be prepared to facilitate working at various BIM maturity levels for a sustainable growth in the Kenyan construction industry.
***Keywords*—BIM, Contractual Arrangements, BIM Maturity Levels, Collaboration, BIM addendum.**

1. INTRODUCTION

THE Kenyan construction industry contributed 7.4 percent of GDP in the year 2016 (KNBS, 2016).

The sector is worth about 8 trillion Kenyan shillings (80 Billion USD) per annum.

There's unrelenting pressure on the industry to increase productivity, quality and value and there is broad consensus, spread across the industry and its stakeholders, that construction under-performs in terms of its capacity to deliver value and that there has been a lack of investment in construction efficiency and growth opportunities (Ofori, 2000) . Additionally, poor and inconsistent procurement practices, in both public and private sectors, lead to wastage of resources and inefficiency. This is compounded by high levels of corruption, low levels of standardization and fragmentation of the industry. These challenges arise because the construction process is usually complex and involves many processes and parties, information is usually exchanged through the use of sketches, texts, emails, images, documents and drawings which can result in miscommunication and could hinder productivity in a construction project.

Over the past three decades, technology has contributed immensely to the development of various nations. There's need to manage information properly and the utilization of Building Information Modeling (BIM) will aid in meeting this objective. BIM appears to be one of the most promising recent developments in digital engineering in the construction industry. According to Talebi et al. (2014), Studies have revealed the benefits and challenges of BIM adoption in construction projects. A global survey by McGraw Hill (2014), found that 75% of highly BIM engaged consultants and contractors perceive that BIM has the ability to capture most detailed comprehensive information of a building project while 41% of contractors perceive that the reduction of design errors using clash detection as the top ranking benefit of BIM adoption. 21-23% of consultants and contractors value efficiency in quantity take-off and cost estimating (reduced construction cost) while 19% of consultants and contractors value 4D models to support construction analysis, planning and visualization for the onsite project team reducing the overall project duration. This illustrates that there are productivity gains through BIM adoption on construction projects in Kenya.

Even though the driving forces for digital engineering and building information modeling for construction are revealing globally, national level standardization and policy initiatives vary significantly in different countries (Smith, 2014). Countries like the USA, the UK, Singapore and Finland are leading in BIM policy regulations and adoption, while in countries like Kenya, policy initiatives and adoption are still slow, there's also little documented evidence of construction players implementing BIM in their projects. This is because, especially in developing countries, the majority of construction industry players see BIM as a disruptive technology that causes problems in the traditional construction process by transforming it into a new process (Eastman, Teicholz, & Sacks, 2011). However, knowledge and innovation have played a crucial role in development throughout human history and therefore developing nations like Kenya should treat their future in technology with some urgency.

In Kenya, BIM is facing huge challenges from the construction industry players because they are reluctant to change the traditional process and this is closely related to human and organizational

culture. According to Arayici et al. (2011), these challenges include managing resistance to change from the construction stakeholders, making them understand the BIM benefits compared to traditional 2D drafting, managing education and training in BIM and explaining new roles and responsibilities of different stakeholders in BIM. There are also technical challenges related to use of BIM in developing countries like Kenya. Abubakar et al.(2014), summarize them as upgrading technology, interoperability, compatibility and complexity.
This study conducts a comprehensive review on the BIM implementation strategies and status in Kenya coupled with international and national strategies, regulations and policy initiatives globally and makes conclusions and recommendations to facilitate working at various BIM maturity levels in the Kenyan construction industry for a more efficient working environment.

2. BIM - BUILDING INFORMATION MODELLING ADOPTION

BIM, WHAT IS IT?

From the foregoing and considering the practical implications of BIM on the current working processes, it is vital to consider its definition.
BIM is the acronym for 'Building Information Modeling' which is commonly defined using the Construction Project Information Committee (CPIC) definition as the digital representation of physical and functional characteristics of a facility creating a shared knowledge resource for information about it forming a reliable basis for decisions during its life cycle, from earliest conception to demolition (RIBA, 2012). Therefore, BIM is an electronic process which manages the planning and designing of buildings.
The most logical way to understand BIM is to refer to the widely used BIM maturity diagram prepared by Mervyn Richards and Mark Brew in 2008, as illustrated in the figure below.

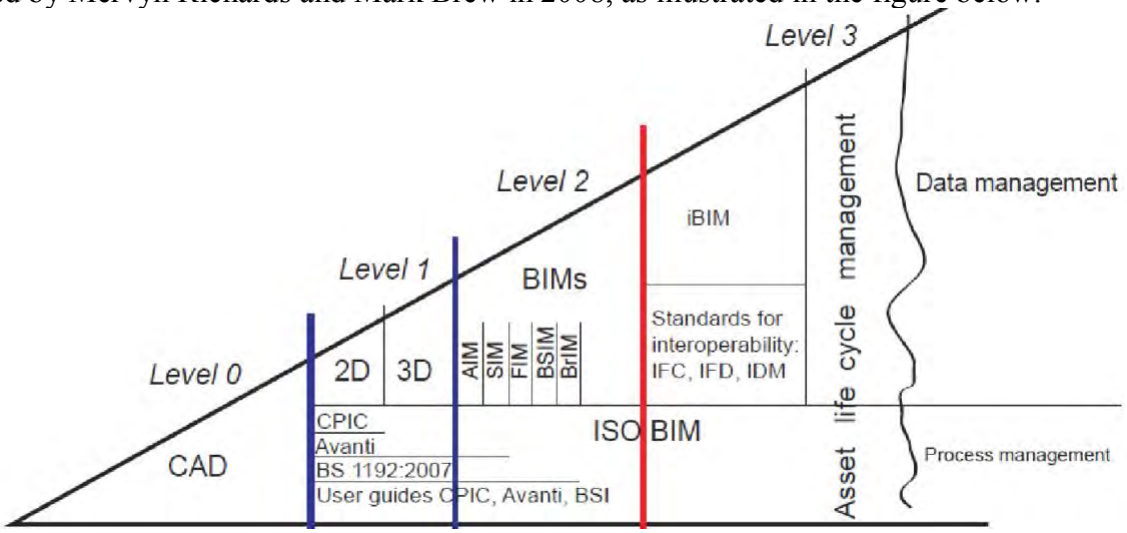

Fig 2. BIM Maturity Diagram (Source: Brew and Richards, 2008).

According to Richards and Brew (2008), the level of BIM adoption can be differentiated based on the maturity levels.
BIM level 0 is usually defined by 2D environments with unmanaged CAD coordination, most formats are papers and electronic e.g. .dwg and .pdf files. These formats are treated as the main data exchange mechanisms. Majority of design practices in Kenya are currently using this process. From the diagram, it's important to note that there's no process or data management at this stage.

BIM level 1 involves managed CAD in 2D or 3D format with a collaborative tool providing a common data environment possibly using some standard data structures and formats. In Kenya, 3D software is mainly used as a conceptual tool in architecture in the early project stages and for visualization of the finished project. Globally, level 1 embraces the need for management processes to move alongside design processes, this is captured in BS 1192:2007, collaborative production of architectural, engineering and construction information - code of practice.

Level 2 BIM involves working in a managed 3D environment held in separate discipline "BIM models" and tools with attached data. Data exchange is mainly on the basis of proprietary of exchange formats. This approach may include 4D program data and 5D cost data. All key members of the design team must produce 3D information models, the models need not co-exist in a single model but each designer's model must progress in a logical manner so that it can be used by another designer.

The outputs required at each stage require greater definition, and in turn require the project manager to clarify the inputs that they require at each stage of the design in order to co-ordinate the design as it progresses. Another requirement is the replacement of the currently fragmented design team from the contractors to be replaced by integrated teams working collaboratively under new forms of procurement using new working methods (Chan, 2014). This will be a challenge for Kenya as the consultants work during the pre-construction process before bringing the contractors on board.

Level 3 BIM is a fully open process with a single project model and data integration and exchange using Industry Foundation Class (IFC) standards; the process is managed by a collaborative model server. The challenge with working with one model is the harnessing of the information in the model so that it is of great use (Teo et al., 2015). For the information to have great value, software interoperability will be required.

However, with level 3 BIM, it will be possible for early rough and ready design analysis on environmental performance minimizing iterative design time, cost models to be derived quickly from the model using new costing interfaces, health and safety aspects associated with the construction and maintenance of the building to be analyzed parallel with the design and asset management, Key Performance Indicators (KPI) and other information to be aligned with intelligent briefing, enabling information in the model to develop during design and to be used as part of soft landings approach, and to inform and improve future projects (RIBA, 2012). This will be very helpful for the Kenyan construction industry where a lot of time is spent during design, projects usually have cost over-runs, health and safety aspects are not well coordinated and environmental factors are given minimal consideration.

3. METHODS

An inductive qualitative approach was used to provide for an enhanced understanding of BIM in the Kenyan construction industry. An interpretivist research philosophy was also adopted and since there was no prior hypothesis to be tested, an exploratory study was used to inform the research. Literature review was conducted to examine the definition, concepts, application and all related issues of BIM. Exploratory interviews were conducted to collect data from the perspectives of purposefully sampled construction industry players (The Government, Clients, Project Managers, Architects, Engineers, Quantity Surveyors and Contractors) in Nairobi, Kenya. 24 semi-structured face to face interviews were conducted over a 3 month period. An interview guide was used to collect data for the fulfillment of the research objectives. Materials from pervious desk studies were used to prepare for the interviews, all interviews were approximately 1 hour in length for

each respondent. The respondents had experience in using BIM in at least one of the projects they were involved in. The data was then analyzed by the authors using the technique of context mapping.

4. FINDINGS AND DISCUSSION

The research questions of this study were whether BIM will alter the traditional allocation of responsibilities for all project stakeholders and whether standard forms of building contracts should be altered to account for the use of BIM in the Kenyan construction industry. This can be summarized as the legal implications of BIM in the Kenyan construction industry. However, to support this, other themes emerged during the interviews which are National and organizational culture, technology transfer and government recognition and support. All the factors are closely related and are major factors in ensuring the successful implementation of BIM in the Kenyan construction industry.

Organizational Culture, Technology Transfer and Government support

According to literature (Bin Zakaria et al., 2013; Bryde, Broquetas, & Volm, 2013; Masood, Kharal, & Nasir, 2014; Teo et al., 2015), there is evidence of the benefits that the Kenyan construction industry could gain by implementing BIM. However, Kenya has not realized this because BIM implementation is still low. The main reason for this is that there's little knowledge about BIM and the majority of the respondents believe that most of the consultants and contractors do not know why, how, when and what to start. This is because there is no standard of BIM implementation at the national level for them to follow. Some of the firms in Kenya are trying to be BIM champions by developing their own version of BIM implementation guidelines while some are influenced by expatriates especially when working on international construction projects and end up using the standards and guidelines of the foreign country. However, the outcome is confusion at the industry level.

According to one of the respondents, the main challenge in BIM implementation is that there are no national standards or guidelines; since BIM in Kenya is still at its nascent stage, there is need for the government to urgently set up a team or committee to develop the national BIM guideline. Additionally, one of the respondents, an engineer, still doubts the effectiveness of BIM because of the limited information that has proved the effectiveness of BIM in the Kenyan context. However, another respondent, an architect stated that he has used BIM in three of his projects and some of the major benefits were the reduction of design changes and discrepancies between contract documents especially the architectural, structural and services engineering drawings/ models by detecting clashes and design conflicts early enough. Another respondent, a quantity surveyor, uses BIM for quantity take off and costing stated that the Bills of Quantities that his firm produces using BIM are more accurate and the client is able to make proper funds arrangements expecting little or no cost variations in the building costs.

According to Masood et al.(2014), the lack of highly skilled staff and BIM knowledge causes the majority of industry players to fail in realizing the benefits of BIM. One respondent, an engineer, suggested that a series of awareness programs, which could be funded by the government, should be undertaken to promote the use of BIM in construction projects.

Additionally, organizations are facing challenges from within. Resistance to change, fear of the unknown and lack of knowledge are some of the challenges. To manage these issues, one respondent stated that in his firms case, they bought a BIM software and one of the key staff members was trained on BIM, then the staff member trained his co-workers and BIM knowledge was disseminated throughout the firm, they created a new role of BIM coordinator. This shows that companies and organizations can assess their individual challenges and develop a custom BIM roadmap which can be as simple as migrating from BIM level 0, to 1, to 2 within a specific time period and strategy. The approach is different for one of the respondents, from an international architectural firm based in Kenya, he stated that their company had to act fast due to their international presence and now use BIM to add value in their profile while bidding for projects. Currently the firm is working on BIM level 2 in selected projects. However, the architect suggested that working together with a BIM expert should be mandatory for first timers as it could speed up the BIM adoption process and minimize associated risks.

From the interviews, it is evident that the readiness for the Kenyan government and local firms to adopt BIM will be heavily influenced by top management support. This is because BIM will change established work processes to a new work process that will require bold decisions. Below is a brief SWOT analysis of BIM in the Kenyan Construction Industry context.

Strengths	**Weaknesses**
• Saves time and money (Reduces waste, the team gets it right at the first time). • Improves 3D design capacity. • Simulates construction sequences. • Reduces Risks and errors. • Reduces energy use over a building's lifecycle. • Can be used by SME's.	• There's no culture of collaboration across disciplines. • The focus is on the buildings not information. • The government needs to take the lead. • Design firms and contractors need to work together. • There's no universal design standards. • There are initial hardware, software and training costs.
Opportunities	**Threats**
• Linkage with international leaders in BIM education. • Integrating with simulated training innovations. • BIM is the DNA of future construction. • Development of new skills and knowledge for the local industry. • Kenya can be a leader in BIM education and use in Africa.	• BIM will change the traditional ways of working in the local construction industry. • New types of contracts/ contract addenda will be needed. • There's limited understanding of BIM. • There are few firms working together, across disciplines. • Resistance to change.

Figure 3: BIM adoption in Kenya - SWOT analysis (Source: Authors).

The Legal implications of BIM in the Kenyan Construction Industry

The significant legal implications associated with BIM can be summarized into five categories namely; Model ownership, Intellectual property rights, Third party rights, Roles and responsibilities, and duty of care. Interview questions were drafted with the intention of investigating the industry perceptions as to how these particular legal implications should be approached in Kenya.

For model ownership, the interview results were conflicting as some of the respondents argued that the use of BIM does not change the inherent principles and ownership should lie with the designer while others argued that there's the likelihood of several model authors and this would require a complicated joint ownership or maybe the client (once it's complete), project manager or lead designer should assume ownership (during production). However, model ownership was not considered very critical for the Kenyan construction industry.

Intellectual property rights are closely linked to model ownership. This is basically the ownership of information embedded in the elements of the model. This is especially critical since even though a party may have ownership of a model, they may not necessarily hold the intellectual property rights of certain design elements in the model. The respondents did not generally consider the issue of intellectual property rights as critical for the Kenyan construction industry. One of the participants states that "Every project is unique and different. It's ridiculous for consultants to keep trying to protect their intellectual property rights". Additionally, the respondents unanimously agreed that guarding intellectual property rights conflicts with the idea of open and collaborative communication that BIM creates.

Privity of contracts dictates third party rights, this is where a third party cannot enforce conditions of a contract between the primary parties to that contract. According to Ashcraft (2008), with multiple contributors to a BIM model, the legal obligations of the various parties involved with a project will become blurred. One of the respondents in the study was concerned that information contained in a model may end up being used by third parties for purposes that it was not originally intended for. However, this concern conflicts with the principle of BIM that a model should enable the unrestricted flow of information in order to extract maximum value for all parties. Most of the respondents were of the view that third parties should be able to rely on the model, as long as the users were authorized from the outset of the project. Defining the authorized users of a model will somehow address the issue of privity of contract as it would identify the intended benefit conferred to the third party and thus the English law of contract and the Law of contract act 2012 will still be applicable (Kenyan law of contract act CAP 23).

On the issue of duty of care, there were conflicting views as to what impact BIM will have on the duty of care of architects and engineers. However, according to Ashcraft (2008), BIM will cause an increase in the level of duty of care due to the enhanced clash-detection that BIM enables but increased clash - detection will give rise to an increased use of risk transfer methods such as indemnification agreements to decrease professional liability (Yarmohammadi & Ashuri, 2015).

On the issue of roles and responsibilities, all of the participants were of the view that there won't be a change in the job that every team member does in a project, BIM will only help them do it better.

The Implementation of BIM in Kenyan Standards Contracts

One of the anticipated challenges to implementing BIM in Kenya is the fact that most, if not all, of the standard forms of contracts completely ignore BIM and therefore, perhaps most importantly, how can they enhance rather than limit the benefits to be gained through the use of BIM.

Any discussion on BIM integration in each form of Kenyan Standards of Contracts is beyond the scope of this paper. This paper does not address specific legal issues that may arise from the use of BIM, it only suggests a contracting approach. The best contracting approach would be by the use of a new document dealing with BIM (a BIM Addendum).

The BIM addendum should incorporate the best practices in the use of BIM techniques and technology. The document should be fair and balanced for it to be acceptable to all parties involved in a project utilizing BIM. It should further address all the issues raised in this study. Therefore, rather than attempt to draft a BIM - specific standard form of agreement between the client and the consultants or between the owner and the main contractor, it would be more effective to attach a BIM addendum into the standard forms of agreements. The proposed attachment would modify the terms of the standard form of agreement to which it will be attached and will address all BIM - related issues that are beyond the scope of the standard form of agreement.
The main goal will be to create a document that will enable contracting parties to easily and effectively introduce virtual design and construction or building information modeling into the Kenyan construction industry while still retaining the standard form documents.

5. CONCLUSIONS

Global trends have indicated an increase in BIM implementation and this is set to continue accelerating into the future. Government initiatives in Singapore, United Kingdom, United States, Finland, Norway, Denmark among other countries are helping all construction industry stakeholders realize the benefits of this technology. Such developments should encourage BIM implementation on a wider scale as developing countries like Kenya might be left behind if they don't keep pace with the trendsetters in the BIM field.
The transition from the traditional approach to BIM in the Kenyan construction industry will not be an easy process. It will need decision making and change management strategies which will be guided by top management in the government and private sector. The government will be very instrumental during the transition period from previous traditional workflows to BIM workflows, convincing professionals about the potential of BIM, developing education and learning strategies and understanding new roles.
Firms and practices should also understand that when implementing BIM, there will be initial costs. To reduce the risks associated with BIM, the management at the firm level will have to phase BIM implementation gradually moving from BIM level 0, to BIM level 1, 2 and 3 eventually.
Since current BIM implementation in Kenya lies between BIM level 0 and BIM level 1, recognition and support from the government will improve the productivity of the construction industry and implementing BIM in public construction projects should lead the way.
The construction industry is following the globalization of the economy as international barriers are increasingly being removed. Therefore, competition for projects will not be local with companies with little or no BIM capabilities but will be international with companies with developed BIM capabilities and expertise at the bidding table. The strategic benefits of developing BIM expertise in Kenya will only be realized if the government and the private sector work together creating a push and pull situation.

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