A Building Information Modelling Framework for Enhanced Public Participation in Customised Mass Housing Projects in Africa

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Abstract

Government's response has witnessed phenomenal increase in mass housing infrastructures in a deliberate attempt to provide accommodation to the citizenry. Attainment of liveability standards and other personal tastes are a growing source of concern to many housing facility users, mass housing projects' (MHP) stakeholders, and researchers alike. This study identifies the public participatory methods used in MHP; examines the challenges of identified public participatory approaches in MHP; assesses the prospects of Building Information Modelling (BIM) or Information Communication Technology (ICT) participatory framework for customised MHP; proposes an integrated BIM/ICT public participatory framework for customised MHP. The study methodology involved a critical review and exposition of relevant related literature, and concludes that Nigeria and other African nations adopt mass housing programmes that do not reflect the specific needs of end users. The study recommends the use of 'citizen control' in order to share the responsibilities of decision making; to take advantage of the compatibility of BIM/ICT for an interface that ensures user participation; and finally, a wide adoption of the study's BIM/ICT framework in order to reap the benefits of public participation in customised MHP that meets users' requirements.

Keywords: BIM, ICT, Housing Infrastructure, Mass Housing, Public Participation.

Introduction

Housing is central in the growth of emerging cities in order to fill the gap created by increasing urban housing deficit. The last six decades has been marked with a growing concern of government for intervention in the procurement of urban housing (Wakely, 2014). In a bid to curtail the current huge deficit in the stock of available houses, the three tiers of government in Nigeria -local, state, and federal- have adopted mass housing schemes as a method of solving the problems (Folaranmi, 2012a). The Centre for Affordable Housing Finance in Africa (CAHF, 2016) declares that housing deficit in Nigeria is estimated at 17 million dwelling units, with at least 1 million units needed annually to bridge the gap. Although government's efforts towards provision of mass housing for low-income earners in Nigeria has been considered somewhat adequate, it has however been viewed as unsatisfactory (Mohit and Iyanda, 2016). Jambol *et al.* (2013) reported that this is because the government has consistently used a top-down approach in the design and implementation of mass housing schemes which has failed to engage the relevant stakeholders (the end-users, inclusive of land owners and private institutions) in the decision-making process. Ilesanmi (2010) posits that the public housing as a product of direct state intervention in housing shortages has elicited quite a great deal of criticism worldwide. Jusan and Sulaiman (2005) states that although completed houses assumedly meet building and planning regulations, there is often failure of the design in meeting expectations of users from different backgrounds. Zarewa (2019) argues that for the successful delivery of large infrastructure projects, such projects largely depend on the effective involvement of all stakeholders who have shared interests in such projects. This is because of the need to capture various stakeholders' needs and expectations within the framework of a project delivery process. Bashari *et al.* (2019) assessed how residents in Jigawa State, Nigeria perceived the delivery of mass low-income housing of the state. The study showed the critical need for consumers or end-users to be involved right from the onset in the delivery of such housing.

Additionally, an earlier study by Olayiwola *et al.* (2005) on the problems and challenges plaguing the delivery of public housing in Nigeria highlighted the inability of the houses provided to meet the requirements of occupants, citing the provision of one-bedroom houses for the low-income group with an average family size of six (6) persons. In another development, Ilesanmi (2010) study of five low-income and three medium income housing estates in Lagos, Nigeria -aside from assessing the physical

characteristics of the public buildings- fundamentally examined the extent to which the houses satisfy the needs of the residents. In all cases, the occupants' desired liveability conditions are barely met thereby hindering the satisfaction derived from such housing. Ultimately, this goes to infer that housing provisioning for the public has failed due to limited inquiry and analysis of housing requirements from the occupant's point of view. In this direction, the concept of Post-Occupancy Evaluation (POE) has attracted the attention of several scholars and many definitions of this phenomenon have consequently been made. The numerous POE studies severally aim at determining whether or not design decisions made by the architects are delivering the performances required by building users. Therefore, the context of Mass Housing Projects (MHP) needs to consider a bottom-up approach where consumers' inputs, opinions and interest are sought in order to meet end user requirements from concept planning to public housing delivery. Similar to the case of Nigeria, housing policies in other African countries like, Ghana, Uganda, Cameroon, Swaziland, Johannesburg, and many more have not had the desired effectiveness and impact either, hence the need for people or community engagement in MHP (Shelter Afrique, 2010).

Public participation is therefore imperative in the processes of housing provision (UN-Habitat, 2007) in order to customise housing to meet their target needs (Folaranmi, 2012c). Nour (2011) described public participation for housing and the management of urban services as a process where people as consumers and producers of housing and urban services, and as citizens, influence the course and quality of housing and related services available to them. User participation is vital in mass housing personalization or customisation as the home environment is reflective of man's physical and psychological needs which are ever changing (Jusan and Sulaiman, 2005). The role citizens play in defining the advancement or improvement in public housing delivery is critical. While the conventional public participatory approaches are salutary, they however, lack the desired cutting-edge qualities for an impactful and effective public participation (Moobela and Mahdjoubi, 2010). They fail to ensure genuine end-user participation thereby, depriving the public of the opportunity to make their ideas known at conceptual design stages (Innes and Booher, 2004). In most cases there is no interchange of information between the multiple sides of communicating parties as interest groups or vocal persons often hijack the overall process (Petts and Leach, 2000). This indicates that there is hardly any room for dialogue between the corresponding parties.

Statement of the Problem

Housing provision through mass housing schemes needs to consider a new approach of public participation towards customisation to meet the desires of the eventual residents (Duarte, 2005; Niemeijer and Vries, 2007). Mass housing customisation is a relatively new concept especially in the construction industry which requires the participation of customers in design (Khalili-Araghi and Kolarevic, 2016). By operationalizing the concept of mass housing customisation, the hopes of residents will be better reflected. In order to meet up with the desired requirements of the end-users to ensure customisation, it is beneficial to consider and learn from past projects through POE. The studies by Zubairu (2002); Zubairu and Olagunju (2012); Zubairu and Ayuba (2012); Adedayo and Zubairu (2013); Anunobi and Zubairu (2015); Adedayo and Zubairu (2016); on POE -albeit not targeted towards MHP- emphasised the need for end-users involvement in the design decision making process of some facilities (informal housing, hotels, schools, factories) within Minna, Niger State, Nigeria. The studies revealed vital information on design requirements that are often ignored that could lead to better user satisfaction. POE establishes the fact that if users of public housing are engaged in the initial design stage, better and more user-friendly designs will be produced that are geared towards meeting the desired liveability conditions of occupants (Zubairu, 2006). This means that learning from the failure of past MHP, future projects can shift towards mass customisation so as to adequately meet with the needs of end-users. In doing so, the paradigm shift in the realisation of mass housing schemes can adopt an innovative approach in such project delivery. Essentially, the design team should be enlarged to accommodate end-users for a holistic experience and salutary results.

Justification of Study

Building Information Modelling (BIM) alongside associated Information and Communications Technology (ICT) presents novel shift in the way buildings are realised. Through BIM, project

participants can efficiently collaborate in real-time thereby facilitating communications from the idea/conception stages down to schematic design, and through to completion/handover (Khalili-Araghi and Kolarevic, 2016). Studies abound on customisation in developed countries involving public participation for mass housing (Duarte, 2005; Niemeijer and Vries, 2007; Shin et al. (2008); Benros and Duarte, 2009). However, these studies were more focused on computer programming rather than BIM. The studies of Yenerim *et al.* (2011); Yenerim and Clayton (2013; 2016) used BIM to ensure that residents of US low-income communities are engaged in housing design decision making. However, the studies were limited to self-help housing rather than customised mass housing (CMH), and without relevant ICT techniques to engage the residents. While the aforementioned studies reflect the importance of public participation in housing in developed countries, related studies in mass customisation of housing in developing countries and specifically Africa is lacking. Hence, this research seeks to explore the potential of BIM and related ICT capabilities in adopting a bottom-up approach towards effective public participation in customised MHP in Nigeria and other nations of Africa. While this research focuses on the Nigerian perspective, it is envisaged that the model prescribed in this study can also find its relevance in the wider African continent and other developing economies.

Research Objectives
1.   To identify the public participatory methods used in MHP.
2.   To examine the challenges of identified public participatory approaches in MHP.
3.   To examine the prospects of BIM/ICT based participatory framework for customised MHP.
4.   To propose an integrated BIM/ICT based public participatory framework for customised MHP.

Theoretical Framework

The Concept of Mass Housing Projects (MHP)
The term "mass housing" simply means to mass-produce a house. MHP means to build the same model/design many times in order for it to be useful to many people as possible. Ahadzie (2007) declares that mass housing was imbibed into the construction industry from the manufacturing sector to describe mass production techniques of housing development. Adebayo (2012) defined mass housing as the provision of large number of housing units for a selected or prospective group of people or in some cases, the general public. MHP is also viewed as the design and construction of standardised multiple domestic housing units, usually in the same or several geographical locations, executed within the same project scheme and under the same management and contract (Kwofie *et al.* 2014). The concept of MHP was brought into existence by the continuously increasing global population and constant transformation (Tabet *et al.* 2016). This has led to the consequential increase in demand for housing to adequately respond to the needs of the masses. Mass housing, as the name suggests, is intended for the masses. According to Oxley (2000), mass housing was driven in Western European housing policies due to housing shortages after the Second World War. The origin of mass housing can be traced to 1860s where the earliest social housing was said to have been established. The first England local authority housing was built between 1863 and 1869 (HPD, 2006). The reasons for mass housing vary amongst countries though the aim is often in response to housing shortages. Several authors aver that housing problems are often caused by rapid increase in population, urbanization, and in some cases natural disaster (Tabet *et al.* 2016; Tian et al., 2015; Kwofie *et al.* 2014; Onder, 2007;). As such, population increase in urban cities without adequate provision for housing units is responsible for the housing shortages.

In the Nigerian context, the adoption of the colonial masters' method of housing led to the formation of what is referred to as the Government Reserved Areas (GRAs), which catered for the upper-class in the society. The improvement in the economic capability of the middle- and low-income class saw the government providing staff quarters for them also (Adebayo, 2012). Mass housing in recent times has constituted a major concern for urban dwellers, especially with the population explosion, and massive rural-urban drift in Nigeria. This typically resulted in increased population densities, and scarcity of urban housing which as a counteractive measure, the government resorted to mass and social housing to deal with the challenges.

Housing Personalization

Personalization approach to mass housing allows users to be involved in the design or improvement of their living environment for achieving sustainable development UN (1992). Personalization as a concept of self-provision housing which is about building quality homes within the standards set by the households themselves (Jusan and Sulaiman, 2005) which also has excellent cost saving potentials (Duncan and Rowe, 1993). Personalization as a sustainable housing approach enables users to have affordable quality houses and which often relates to the structural modification of houses involving house extension, renovation, transformation and remodelling (Jusan and Sulaiman, 2005). The practice of personalization is prevalent in India, Egypt, Bangladesh, Ghana, Zimbabwe, and Malaysia (Tipple, 2000) and this allows users to realise their aspirations in the built environment (Rapoport, 1982). There is a significant value gap between a house designer and a house user, with the user's values considered more important (Rapoport, 1982; 2000).
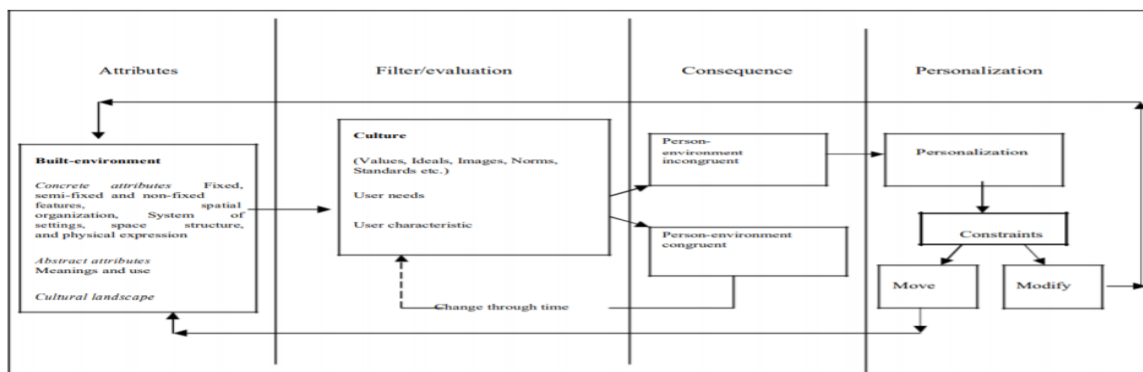

Figure 1: Theoretical model for personalization in built environment
Source: Jusan and Sulaiman (2005)

The formal sector of Ghana's housing delivery is dominated by players in the public sector (Table 1). The activities of the sector contribute about 10% of total dwelling units with focus on middle and high-income households (UN-Habitat, 2011). Ghana's formal sector public actors are led by Ministry of Water Resources, Works and Housing (MWRWH) and its Directorate of Housing provides policy design in the housing sector. A key challenge in Ghana's housing provisioning is the division between public policy and the key players - more specifically households and informal institutions. This is because Ghana's public policies and regulations on housing do not take into account the capacities and needs of households within the present context of increasing land scarcity, rising cost of housing provisioning, and the escalating prices of building materials among several others.

Table 1: Key Actors in Ghana's Housing Sector

Key Housing Sector Actors				
Traditional	Public	Private	NGO	International
Chiefs	MWRWH	GREDA	Habitat for Humanity	Cities Alliance
Queen mothers	MLGRD	GHACEM	People's Dialogue	UN-Habitat
Family heads	MLNR	Universal Banks	COHRE	World Bank
Clan heads	NDPC	Mortgage companies	Housing the Masses	GIZ
Land priests	ECG	NBFIs	Amnesty International	
Individual households	GWCL CWSA	Building/architectural firms/consultants	GFUP	
Artisans/small-scale contractors (carpenters, masons, electricians, plumbers, steel bender, etc.)	DUR Lands Commission MMDAs TCPD EPA	Steel/roofing manufacturing companies		
Land/housing agents	State Housing Company Ltd			

Source: Adopted from Ghana Statistical Service, 2014

Issues of Public Participation in Africa's MHP

Widely regarded as an approach towards sustainable development, public participation presents a promising edge towards ensuring improved living conditions for the residents of mass housing schemes. Andre et al. (2006) defines public participation as the engagement of persons or groups that are positively or negatively affected by, or interested in a proposed project, program, plan or policy that is subject to a decision-making process. Moseti (2010) argues that the precept of public participation holds on the fact that people affected by any resolution, have the right or entitlement to be involved in the decision-making process. This basically means that authorities or policy makers will have to set aside a collaborative platform where the government and the general public or civil society will contribute in the decision-making process of any development. By so doing, the public is empowered through such platform to directly influence decisions that are otherwise determined by a centralised system of authority thus nurturing justice and equity. Some key benefits germane to public participation according to UN-Habitat (2007) include: sense of tolerance and cooperation among ethnic groups; sense of ownership among stakeholders; increased abilities for citizens to negotiate and manage projects; recognition of the needs of the civil society and better targeting of decisions to satisfy such needs; and increased cost efficiency and effectiveness of projects based on societal requirements. While the aforementioned benefits (of public participation) are hugely acknowledged in literature, methods adopted for public participation can prove challenging even for mass housing provision thus exposing their weakness towards such development.

Existing Participatory Approaches and their Weaknesses

There is no doubt that public participation has an immense role to play in MHP but the fundamental question here, as a matter of fact is "how can the limiting factors of the existing approaches be tackled for effective public engagement towards customised mass housing schemes (CMHS)?" An extensive awareness of the limitations of the various approaches will wholly uncover strategies that can be adopted to bridge the gap between existing participatory approaches and the realization of CMHS. Dibra (2010) identified public hearings, participatory budget processes, and referendums as some of the major participatory mechanisms in practice. This is backed by Moseti (2010) who indicated that some key participatory tools include: study circles; citizen advisory boards; government contract committees; public hearings; and public watchdog groups. Innes and Booher (2000; 2004) argued that key participatory techniques mostly adopted (in the context of the US) include: public hearings; written public comments (on proposed projects); and citizen-based commissions. Public hearings appear to be the most commonly used system of participation where information, views, and any objections are expressed in a formal meeting between citizens and government authorities with the aim of influencing the authorities for, or against a particular subject of discussion (Dibra, 2010). However, while there are benefits associated to it, its drawback is that it does not allow for the interchange (of information) between the public and the authorities as it is typically a one-way communication process where the opinions of the public are merely channelled to policy makers. This makes it non-binding in the sense that opinions expressed do not compel to act accordingly (Innes and Booher, 2000). This is indicative of the fact that there is hardly any room for debate between the communicating groups. These are also tantamount to written public comments. Referenda alongside public hearings, is another technique of involving the public in any decision-making process. Referenda allow for people to vote in favour of, or against a proposal for establishing a new plan or strategy for a subject under consideration.

BIM for Enhanced Collaboration in MHP

BIM is widely acknowledged as a technology that will curtail the inefficiencies associated with the construction industry. It allows for the digital creation of a virtual building model which contains rich information needed for design, procurement, fabrication, and construction activities required to realise the building (Eastman *et al.*, 2008). Such information is then stored for use in the building's operation and maintenance phases, and eventual deconstruction. Furthermore, it ensures efficient and effective collaboration between all stakeholders (owners, architects, contractors, engineers, and consultants) having a shared interest in the success of a project. This means that as

the model is being developed, these stakeholders can constantly refine and adjust project decisions based on the preferences of the owner to ensure accuracy before the project is realised (Carmona and Irwin, 2007). However, while BIM has been hugely successful with regards to housing development in developing countries, its application in developing countries is very much limited (Nuramo and Haupt, 2016), more so in the context of mass housing development. The limitations of the traditional participatory techniques mean that there is the need to adopt innovative methods for collaborating with communities to develop their housing projects (Baldauf *et al.*, 2013). Marzouk and Metawie (2014) argue that BIM can be used for the selection of optimum housing alternatives for sustainable development. Drawing from the merits of BIM in terms of its collaborative platform as a result of its technological prowess, there is a huge potential that it can promote efficient and effective public participation when compared to the traditional participatory techniques. Arguably, BIM has potentials that ensure real time collaboration between societies and the relevant authorities to curb the problems of substandard housing. Given the scope of this study is further related to the development of CMHS using BIM in the African context, this research sought to explore other related BIM research studies in Africa.

Related BIM/ICT Based Researches in Africa
BIM has gained ground and is continuing to become a major force in the western world. This is indicative of the numerous researches conducted on BIM in developed nations which surpasses that done in developing nations and more specifically, Africa. The study by Jung and Lee (2015) to uncover the status of BIM adoption in six continents revealed that North America is the most advanced. Europe and Australia ranked the next most advanced ahead of Asia, while the Middle East and Africa ranked the lowest as BIM adoption there is still in its infancy. While this is arguably the case, research about BIM in Africa has picked up and is slowly advancing. Smallwood *et al.* (2012); Froise and Shakantu (2014) evaluated the extent to which BIM is in practice in South Africa based on the views and practices of architects and general contractors. Abanda *et al.* (2014) investigated the BIM implementation practice alongside major barriers hindering its uptake in Cameroon. Abanda *et al.* (2014) examined the embodied energy and CO_2 impacts of mud-brick and cement-block building materials for houses in Cameroon using BIM. Abubakar *et al.* (2014) investigated the level of awareness, drivers and barriers to the adoption of BIM in the Nigerian construction industry. Nuramo and Haupt (2016) investigated the role of BIM in sustainable infrastructure design and delivery, coupled with the readiness of Architecture, Engineering and Construction students to implement BIM into practice in Ethiopia. Albeit not specific to Africa, Abanda and Tah (2014) examined the availability and potential of open source BIM software systems for developing countries with limited resources. Kori and Kiviniemi (2015) investigated the prospects of the digital technology market presented by BIM and the readiness of architectural firms to adopt such technology in Nigeria.

The numerous amounts of aforementioned literature indicate the auspicious delve into research about BIM in Africa. However, while this is a welcome approach, research is quite scarce revealing how BIM can be used to support community members' involvement in developing their communities. This is a debatable issue considering the availability and level of ICT use in Africa. Steyn *et al.* (2013) investigated how ICT can be used to drive community participation to solve business related problems. Although the research was not BIM specific, it outlines the vital role of ICT in identifying, and taking the necessary measures to solve community problems by community members. A study conducted by Marzouk and Metawie (2014) proposed a framework for developing low income housing in Egypt by integrating BIM and Generic Algorithms (GA) to ensure sustainable construction. The research uncovered optimum construction materials and techniques that will minimise construction cost and duration while achieving maximum Leadership in Energy and Environmental Design (LEED) points for low-income housing projects. Notwithstanding, the study did not consider the involvement of community members. With the availability of ICT and BIM, it is argued that ICT can complement BIM towards developing communities by engaging the community members to fill the gap created by previous studies for more holistic results.

The Prospects of ICT Based Participatory Approaches

In the past few decades, there has been a rapid use of ICT most especially in developing countries (Chinn and Fairlie, 2006). This is often a necessary tool for the sharing of experiences, coordination, and organisation of activities and events. In line with this, an active participatory environment that uses ICT boosts effective engagement of public in decision-making (Garau, 2013). An assessment of the various participatory approaches studied by Rowe and Frewer (2000); Petts and Leach (2000) against the ladder of participation proposed by Arstein (1969) provides an insight into the various levels that each participatory approach falls into. By examination, most of the approaches from the study of Petts and Leach (2000) are rather one-way involving both traditional, and a number of innovative approaches. Approaches such as advertising, and local/national newspapers strictly inform the public on decisions only in order to raise awareness without any room for true participation. This indicates that they are of rungs 1 and 2. Public hearings and other innovative approaches like focus groups/forums, open house on internet website, and deliberative polls allow the public to give their opinions. However, these approaches are merely for information gathering where the public is seen as a research tool without having any power to influence decision making. Such indication places these approaches in rungs 3-5. Further up the ladder are more innovative approaches that allow for true participation. According to the US Environmental Protection Agency (2016), Citizens' juries involve a randomly selected set of individuals (representing the citizens) who are briefed in detail on the background and current thinking related to a proposed project. It quite involves the ordinary citizens, aiming to empower them for healthy decision making. However, not all interest may be represented and taken into cognisance (Petts and Leach, 2000). Consensus conference is another approach similar to citizens' juries aiming to empower citizens in some way. Community advisory committees involve small groups selected to proffer the views of the community they represent (Rowe and Frewer, 2000). Altogether, these approaches tend to steer towards true participation, but still lack full engagement of the citizens, and as such do not guarantee full satisfaction of the public's interests. If anything, they ensure genuine partnership at rung 6 in figure 2. Planning for Real (PFR), Public Participation Geographic Information System (PPGIS), multimedia, and visioning on the internet tend to be the approaches that push towards genuine participation.

PFR is a nationally recognised community planning process drawn from the assessment of a 3D model of a proposed community plan. This involves a partnership between the community and the local agencies (PFR, 2012). Usually, the plan is modelled manually so that the public can see and touch it as they put forward their views and opinions. PPGIS is a web-based version of PFR involving a virtual version of a community plan which is launched on the web together with the physical model during an organised local event (Kingston et al., 2000). Through both means, the public raise their opinions which are taken into consideration for the final decision on any proposed plan, hence satisfying the rungs of delegated power and total citizen control for true participation in figure 2. Multimedia which allows for virtual simulation of a proposed project is another participatory approach as studied by Moobela and Mahdjoubi (2010). The study demonstrated using a case study of Barton Hill redevelopment in Bristol, UK that multimedia is a viable approach that can substitute futile traditional approaches by engaging the public. In this regard, such approach satisfies rungs 7-8.

Figure 2: Assessment of Participatory Approaches Against the Ladder of Participation
Source: Authors (2020) adapted from Arnstein (1969)

From an assessment of the model in figure 2, it is evident that ICT based approaches allows for a genuine participation in customized mass housing provisioning. Sabie *et al.* (2016) argue that ICT is pertinent to housing development in the context of scarce resources as it allows for better provision of amenities. BIM which signifies a paradigm shift from the traditional construction approaches presents a technological approach for development supported by ICT. Using BIM coupled with the strengths presented by ICT, communities can be empowered towards deciding, alongside relevant authorities, on the appropriate practices relevant for developing their housing. While this presents a novel approach for housing development, very little research has been directed towards CMH development using BIM.

Related BIM Studies for Customised Housing Developments

Ever since BIM became a much talked about topic in the Architecture, Engineering, and Construction (AEC) industry, it has been successfully implemented in numerous projects of which it proved quite advantageous. But the bottom line is that it has been used for large and complex projects. While this is commendable, little is known about its ability towards customers' or public participation for the delivery of mass housing. In recent times, there is beginning to be some consensus about BIM use for the delivery of CMH. Park and Kim (2014) examined the potential of BIM towards ensuring sound decision-making for housing refurbishment projects. The study indicated the significance of customers' preferences with regards tochoice of material use in refurbishment elements under the guidance of construction professionals. However, the study was directed towards ensuring energy efficiency in already existing self-help housing by refurbishment and not the realisation of mass housing schemes from inception. Parn *et al.* (2015) argue that BIM presents better opportunities through which CMH can be achieved. Hence, sound customer engagement will ensure that their views and concerns are well incorporated in customised housing delivery. However, the study did not expound on practical processes through which BIM can be used alongside other ICT systems for the delivery of CMH. Rather it focused on how BIM can facilitate customer experience by understanding BIM processes and/or information in the delivery of housing at a holistic level. Andujar-Montoya *et al.* (2015) proposed a theoretical model for mass customisation of buildings through integrating users into the process. The study focuses on users' engagement throughout the construction/execution phase of traditional construction project with particular emphases on integral management of works/tasks towards achieving project goals and objectives. The study of Badaulf *et al.* (2013) proposed a method for modelling the requirements of public housing clients with the support of BIM. Conversely, it did not directly engage the users as only the technical expertise of construction professionals was considered in enhancing the modelling of such requirements using BIM. Yenerim *et al.* (2011) argues that by facilitating a participatory approach (amongst city/county officials, service providers, architects, planners, engineers, and residents), the housing and living conditions of residents can be improved. However, based on the lack of comprehensive information on design patterns, materials, construction, and parameters of individual housing, no meaningful collaboration can be achieved. Drawing form this, Yenerim *et al.* (2011) developed a database of individual case study houses through the analysis of their forms, orientation, materials, and energy systems using BIM, and proposed that such database would allow for the estimations of energy use, replacement cost, and value for low-income communities. Furthermore, Yenerim and Clayton (2013) proposed a conceptual framework for delivering sustainable cost-effective architecture and construction knowledge from experts to residents of Texas colonias. The study argues that best practices for sustainable cost-effective building design and construction from professionals' views, together with preferences and patterns of construction, compatible with the lifestyle of residents can be incorporated into BIM. This can then be used to produce a toolkit for designing sustainable homes for the residents of Texas colonias by relevant professionals. Building on Yenerim and Clayton (2013), Yenerim and Clayton (2016) developed a Colonias BIM toolkit (CBT) consisting of exclusive library of building components and materials used in their case study. They demonstrated how the CBT can be used to model homes to ascertain utility demands, and concluded that this can be helpful towards determining policy decisions related to design and construction.

Case study examples exist where BIM is being used for mass housing. An example is the development of a component-based system for single and multi-storey homes construction in India by Kieran Timberlake associates. The development takes into account affordable cost, efficient construction, mass-customisable materials, resource conservation, thermal comfort, water recycling, and owner

involvement factors (AECbytes, 2016). Also, BIM has been important for the conceptualization and proposal of the Honeycomb Village which will serve as a mass housing option for people living in slums like the Dharavi in India. Rather than having to use mainstream construction materials, the use of local materials and components will be used. A prototype of the project with a few units has since been completed (AECbytes, 2016). The potential of BIM is not yet fully uncovered in the construction industry when compared to other industries, however there is a strong conviction that its capabilities will become more pronounced in due course (Raji and Gomez, 2012). In line with this, this study seeks to propose a framework that is capable of adapting BIM, facilitated by ICT, into communities in Nigeria and Africa at large as a means of delivering CMHS.

Methodology
This research is a qualitative study involving an exploratory research undertaken towards revealing or uncovering observations and findings, whereby such findings allow for the emergence of a theoretical framework. Naoum (2013) asserted that with a qualitative research, a theory emerges which can be put further to test in subsequent studies. Neuman (2006) argues that qualitative studies create concepts, stressing the development of theoretical emergence whereas quantitative studies tend to test theories previously developed. Since this study is purely a desktop study, it started with a thorough literature review of peer-reviewed sources by way of extensive examination of scientific journal databases to understand the domain of existing public participatory approaches alongside their limitations. Upon understanding their limitations with regards to MHP, studies such as Moobela and Mahdjoubi (2010); Twitchen and Adams (2011) argue that technology can serve to improve upon such bottlenecks presented by the conventional participatory approaches. In line with this, further review of literature was conducted to uncover means through which BIM can prove auspicious towards realising CMH. By aligning the core elements of BIM with its associated ICT capabilities, a framework was developed using the Business Process Modelling and Notation (BPMN) to demonstrate how genuine public participation can be achieved in CMH delivery using BIM. BPMN aims at illustrating components that form an inclusive model which serve to present the manner in which a service and/or product can be provided by ensuring effective automation in a schematised form (Aldin and Cesare, 2009). Hence, it offers a conceptual model of how operations are to be performed with relevant activities and/or events in a control flow logic (Fan et al., 2016). The tool adopted for this is the Bizagi open source process modelling software. This software checks developed models by way of validation so as to guarantee that such a model is free from any error.

Underlying Philosophy
BIM is more than just a suite of software. It is a tool that aligns technology with people, process, and management.

The People
Communities in Africa consist of community development groups or associations which are even more prominent in rural areas. These groups seek to improve themselves through self-help efforts which are organised on a wider scale exceeding the boundaries of villages to local governments, states, and national levels (Okwakpam, 2010). Such groups embark on development projects like construction of roads, markets, health centres, maternity homes, schools, bridges, water supply projects, civic centres, and even electricity projects. Some examples of associations in Nigeria include: All Farmers association of Nigeria, Forolagba community Development Association, Ogunbiyi Community Development association, and the plethora of cooperative societies. Rural Development Centre (RUDEC) is an example of a well-established voluntary association in Cameroon. Some smaller groups are Adashe groups in northern Nigeria, Nago in Ivory Coast, and Jojuma in Togo, where these groups meet weekly or monthly to make small contributory savings scheme which can serve as a source of borrowing in the case of emergencies (Premium Times, 2014). In the context of this study, in order to meet the housing conditions of the public, such associations or groups can participate profoundly in the development process of their housing. This way, they can deliberate with their community or association/group leaders on acceptable building design taking into consideration patterns of construction and their lifestyle without compromising best practices for construction. Additionally, this is facilitated with the expert input of professionals.

The Technology
The strong ability of BIM, coupled with mainstream ICT technology such as the internet, and mobile phones penetration in Africa will be central towards the aim of this study. While BIM constitute the design and construction management tools/software systems that will aid in achieving the desired housing design for CMHS, a platform on which residents/communities can participate and put forth their opinions will be required. This is where mobile computing comes in. According to Rebolj and Menzel (2004), the concept of mobile computing consists of computers, networks, and mobile applications. Computers consist of tablet PCs, pocket computers, palmtops, and wearable computers which can be used indoors, or outdoors. Networks basically consist of wireless wide, local, and personal area networks not forgetting satellite networks too which can support the connection and communication of mobile computers. Mobile applications on the other hand can support user's processes enabling them to work together collaboratively in a mobile computing environment (Chen and Kamara, 2008). Using mobile computing, leaders of community groups will be able to share and communicate the views and opinions from group members through BIM cloud applications from which project team members can access to incorporate into designs.

The Process
The process constitutes the entire system of how the people involved will use the available technology effectively in the required manner to achieve the ultimate aim of improving their living conditions. While some or most of the members in such community development groups can be ignorant or lacking in the knowledge of best construction practices, they can be enlightened by construction professionals on proper housing developmental methods or techniques. The leaders of such groups, who in most cases are well-educated and informed, can be taught how to use BIM mobile applications. Through meetings, the group members can communicate and share opinions on suitable designs through "words of mouth" which can then be passed on to the BIM professionals using mobile applications by their leaders. The professionals on the other hand, can then be able to review those opinions, advice on the acceptable practice, and then incorporate satisfactory and acceptable techniques of design into BIM models. Through such means, a database of housing components and/or requirements will be available in a BIM system which can facilitate the development of CMHS in present and future cases.

Process Conceptual Diagrams
Figure 3 below illustrates the conceptual map of the process. It demonstrates the participatory approach that can be enhanced by BIM and ICT. Although, figure 3 represents the conceptual map, a detailed process model in fig. 4 below provides an elaborate framework of procedures encompassing both community participation via ICT, and the BIM process. The argument here is that by aligning BIM and the prowess of ICT, residents can participate and collaborate effectively with construction experts, albeit through their leaders to decide on design issues. Such approach will drive towards the delivery of CMHS which will prove beneficial towards sound living conditions in their respective communities.

Discussion of Findings
The findings of this study are fourfold. Table 2 briefly describes how the research objectives were achieved. Having achieved the set objectives, the following findings are discussed. Firstly, common participatory approaches used for citizens' engagement were identified and it was understood that most of the approaches were social science based that tend to lack the power of genuine participation. For example, common traditional participatory approaches like public hearings, focus groups, and opinion polls are merely one-way interactive processes where citizens' opinions do not necessarily affect policy making decisions. Hence, such processes can prove abortive in CMHS delivery since public opinions on housing requirements need to be satisfied. Secondly, while there are a number of innovative participatory approaches that tend to drive towards true participation albeit some limitations, it was realised that ICT based approaches can prove effective in bridging the gap between healthy public participation and decision-making process. This is seen as established in fig. 2. In line with this, the technological finesse of BIM (as an efficient collaborative tool), taking into consideration the three main BIM paradigms of people, process, and technology were used to establish how BIM can align with ICT in Customised MHP. Lastly, the critical discourse due to the findings uncovered led to the

development of a process model for BIM/ICT-based process model for CMHS delivery. It is envisaged that such a framework can enhance the achievement of CMHS through genuine public engagement.

Table 2: How the research objectives were achieved

| S/No.	Objectives	Achievement of objectives
1	To identify the public participatory methods used in mass housing projects (MHP).	This was achieved through an in-depth literature review where the study started off with the appreciation of public participation in the general context. Subsequently, thorough assessments of the existing participatory approaches were discussed.
2	To examine the challenges of identified public participatory approaches in MHP.	This was achieved through an extensive assessment of peer-reviewed literature similar to objective 1. The challenges with existing public participatory approaches were illustrated in Fig. 2.
3	To assess the prospects of BIM/ICT based participatory framework for customised MHP.	The findings arising from critical exposition of literature on objectives 1 and 2 corroborate that BIM and ICT techniques are compatible, and can successfully be interfaced for use in ensuring user participation in the delivery of CMHS. This was established through the numerous studies considered for this research.
4	To propose an integrated BIM/ICT based public participatory framework for customised MHP.	Arising from the prospects of objective 3 as stated above, the integration of BIM and the relative capabilities of ICT were employed in developing a framework for public participation in the delivery of CMHS. This was established in fig.3, which was integral in achieving a schematised model in fig. 4.
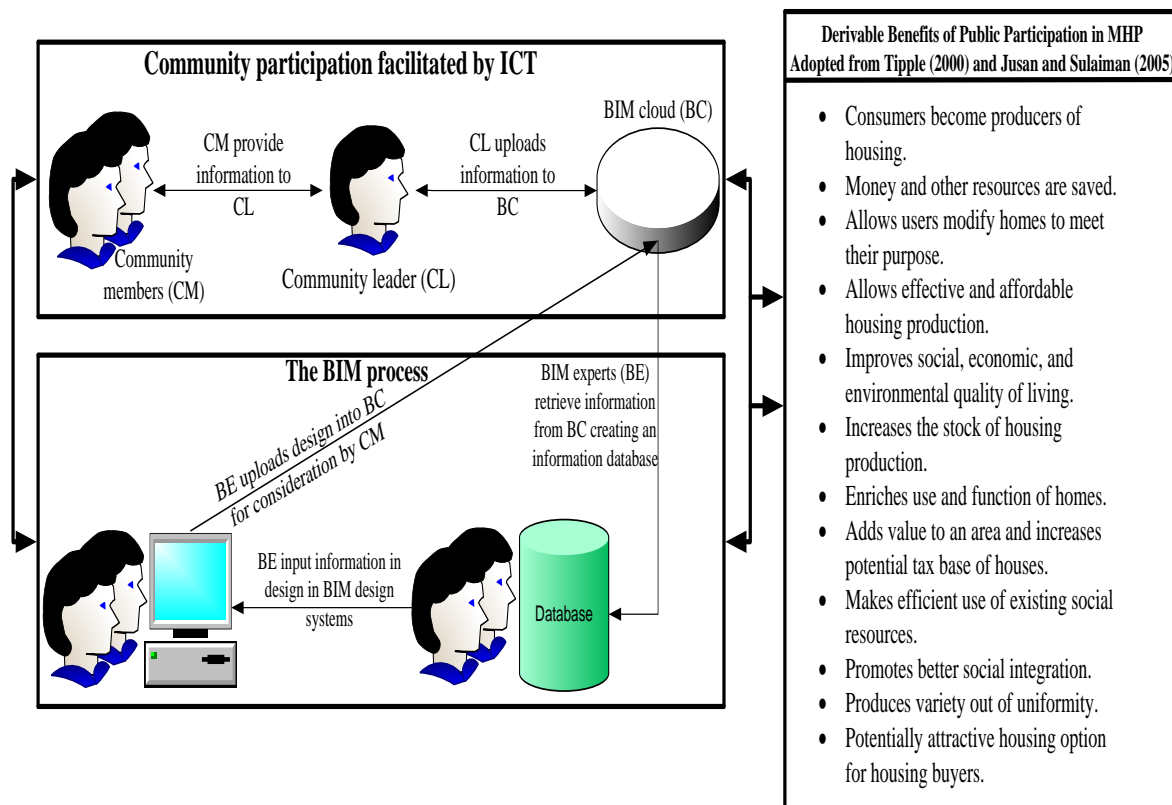
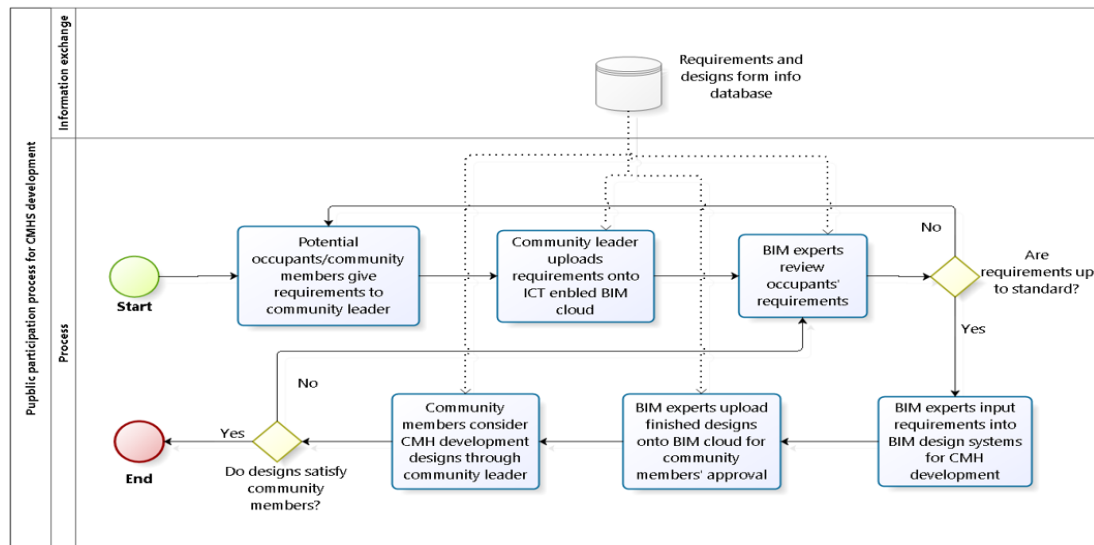**Figure 3: BIM-ICT based public participation conceptual map for CMH development**
Source: Authors (2020)

Figure 4: BIM-ICT Based Process Model for CMHS Delivery
Source: Author (2020)

Conclusions

Housing is an integral element of social welfare and an urgent response to meet the growing infrastructure deficit occasioned by urban sprawl. Recent years have been characterized by the need to customise mass housing in order to meet the desired liveability conditions of occupants. Nigeria and most other nations of Africa adopt a somewhat generic mass housing programmes that do not reflect the specific needs of the end users. Housing infrastructure users desire distinct housing conditions to reflect their personal desires, socio-cultural biases, religious inclinations, eco-political divergences, etc. In order to meet such housing conditions, it is imperative for mass housing designers, public utility organisations, financial institutions and mass housing policy makers to integrate end users at early stages of project development cycle. The need to adopt Customized Mass Housing Scheme (CMHS) for sustainable housing delivery where the public needs are fully integrated in the critical decision-making processes of MHP is critical. Thus, this in-depth and critical literature review has explored the domain of public participation in MHP in order to gain insight and explore the various public participatory approaches possible, in order to propose an integrated BIM/ICT based public participatory framework for customised MHP. Consequently, the study revealed that most of the participatory approaches do not include in their decision-making processes all the parties required to be involved in CMHS. The study also revealed that BIM/ICT based public participatory approaches have the needed effectiveness to push for genuine public participation in CMHS. BIM has been widely adopted as a tool that can curb the inefficiencies of the built environment as it serves as a platform for real-time collaboration of project stakeholders. The conceptualized BIM/ICT framework can aid public participation in Customised MHP; hence ensuring a bottom-up approach instead of the conventional top-down approach that fails to meet users' peculiar requirements.

Recommendations

Arising from the discussion of findings and conclusion reached on the study, the following recommendations are made:

(i)The use of 'citizen control' in MHP to allow participants to negotiate with project power holders in order to share the responsibilities of decision making.
(ii)To take maximum advantage of the compatibility of BIM and ICT techniques to develop an interface that ensures user participation in the delivery of CMHS.
(iii)A suggested wide adoption of BIM/ICT framework developed by the researchers in order to reap the benefits of public participation in customised MHP that meets users' requirements, needs, and preferences.

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