Infrastructure as a driver for economic growth and integration in African: what is the way forward?
Edited by the International Conference on Infrastructure Development in Africa

South Africa

ADOPTING INNOVATIVE METHODS IN THE GHANAIAN CONSTRUCTION INDUSTRY

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Increased demand for building infrastructure delivery advocates for innovative construction methods. This paper examines the concept and application of Modern Method of Construction used in the South-West UK, and the Innovative Building Technologies in South Africa. It assesses the methods, current use, off-site manufacturing; identifies and evaluates aspects of the construction process typically used with the aim of identifying and analysing the barriers and merits for the adoption in the Ghanaian construction industry. The research design adopts a qualitative method and case study of two housing projects as part of a broader study to determine an appropriate innovative construction method to meet project targets of time, cost, quality and improved delivery for the Ghanaian industry. The study finds; convenience; speed; reduced cost and improved delivery as the key success factors though there is less than 5% use of the innovative methods in the entire sector for mainly repetitive housing, schools and hospital projects. Negative end-users perception of building quality and low satisfaction; less government intervention through education; promotion; availability of off-site contractors and materials were also the barriers identified. Management contract is adopted in most cases hence the risk transferred to the management contractors. Lessons learnt are outlined and recommendation made for government action plans to mitigate the barriers during its implementation in the Ghanaian construction industry.

Keywords: barriers, housing, modern method of construction, stakeholders, success factors.

1 INTRODUCTION

Shelter remains a basic need for human survival. According to the UN, absolute poverty is "a condition characterised by severe deprivation of basic human needs, including shelter. Poor and inadequate quality housing has always resulted in social vices; crime and drug abuse. Coupled with the increased demand for infrastructure delivery in Ghana, innovation for enhanced delivery is imperative. The construction industry nevertheless plays a critical role in achieving this socio-economic developmental need by providing the buildings needed (Ofori, 2012). Ofori (2015) opines that the construction industry's contribution to economic growth and long-term national development is widely known, particularly to developing countries. Similarly, Baker (2004) suggests the provision of adequate accommodation has important economic implications. Every effort aimed at enhancing building infrastructure delivery must be embraced.

The increased demand for housing as a result of increased demographic trends, rising income among others, decrease in housing delivery in the UK in 2001 triggered this urgent need (Baker, 2004). The early 2000's demand raised the concerns about whether traditional methods are able to meet housing demand and quality standards hence the consideration of an innovative approach (Housing Forum, 2002; Barker, 2003; ODPM, 2003). Kempton and Syms (2009) states that the delivery of large number of homes remain a challenge for the house building industry and its associate stakeholders. The Modern Method of Construction's (MMC) offsite manufacturing production, assembling techniques promising cheaper and timely affordable housing delivery was considered. Similarly, a backlog of social infrastructure provision in South Africa coupled with stakeholders' urgent demand for housing provision led to the adoption of the Innovative Building Technologies (IBTs) similar to the MMCs used in the UK. Ghana remains glued to the traditional method of construction though similar situation of increased demand for housing units, hospitals and school buildings exists and in spite of the enormous demand. Ghana like South Africa, as a result urbanization, increased income levels and a drive to educate the citizenry has building infrastructure backlog (Getfund Act, 2000). In addition, the reality remains that most projects have not been successfully delivered (Ahadzie, 2010). Project success particularly on public housing projects remains a problem in Ghana (Konadu-Agyemang, 2001; Ahadzie, 2010). Project success factors globally have been associated with time, cost, quality and satisfaction (Pinto and Slevin, 1988: PMI, 2013).

This study (1) assesses the current use off-site manufacturing, production and assembly techniques in the housing sector in selected case study areas; (2) identifies and evaluates aspects of the construction process typically used; (3) enumerates and analyses barriers and success factors to this innovation; finally recommends on government action plans to mitigate the challenges. A qualitative research method involving in-depth literature review and structured questionnaire interview of key stakeholders in the construction sector. A descriptive survey technique is used in analyzing data findings collected from major stakeholders in the building industry: the house builders; tenants; building owners; local authorities; developers and designers.

1.1 Housing Need

Housing is a basic human need, fundamental to economic and social well-being (Baker, 2004). The UN Centre for Human Settlement (2003) asserts that housing inadequacy remains in spite of efforts and policies by governments. Housing problem is both qualitative and quantitative (Aigbavboa, 2010). Inadequate and poor quality housing have always generated social vices while globally, squatter settlements are associated with crime and drug abuse. Similarly, Yong (2008) informs that housing provides people, the physical, social and psychological needs. This, the South Africa national Constitution asserts as Human Right while in the UK, the government's is compelled to address the challenges of social housing in the absence of affordable housing.

The first case study is on housing in the South West Region, UK where:

- Housing challenges are as a result of House buyers being influenced by the negative perceptions of the post-war prefabricated buildings, resist any innovations in housing contrary to the traditional methods (Edge *et al., 2002).*
- Current barriers to the offsite utilisation relate to a perceived higher capital cost, the difficulty to achieve economies of scale, complex interfacing between systems,

the inability to freeze design early and the nature of the UK planning system (Pan *et al.*, 2007).

- Been the fastest growing population in England (12.5% between 1981 and 2001, compared to 5% for England), requires an additional half a million households by 2021 but lacks qualified professional.
- Research indicates increase in backlog of those without self-contained accommodation since 1996 from 450,000 to 462,000 in 2001/02 and households in temporary accommodation doubled (Baker, 2004)
- According to the Academy for Sustainable Communities UK, there is an eminent shortage of qualified professionals and labour with the necessary skills to deliver (http://www.southwesthousing.co.uk/).

The second case study considers the use of Innovative Building Technologies for housing delivery in South Africa:

- The past ten years have seen a serious rise in service delivery protests, from 13 in 2004, rising to a peak of 470 in 2012, before falling to 287 in 2013. These protests have become steadily more disruptive and violent, with 11 people killed in 2013. Consistently, the most-cited grievances revolve around land and housing (Matsepane and Zikhona, 2013).
- Since 1994, more than 3 million housing units (including both subsidised and rental housing) have been delivered to poor and low-income households. South Africa nevertheless sits today with a housing backlog of 2.1 million units larger than it began (Tomlinson, 2015)
- The Council for Scientific and Industrial Research (CSIR) recommended to the Presidential Infrastructure Coordinating Commission in 2013 to adopt Innovative Building Technologies (IBTs) in social infrastructure delivery in South Africa (CSIR, 2014a)

1.2 Modern Method of Construction (MMC)

The Modern Method of Construction MMC, embraces a range of technologies and processes involving various forms of supply chain specifications, prefabrication and off-site assembly OSM. Prefabricated housing was employed in the UK housing high demand in the 1960's as temporary homes. However, the poor building materials quality and workmanship, led to negative public attitudes and perception (Postnote Dec, 2009). Nevertheless, MMC today reflects technical improvements in prefabrication, encompassing an effective usage of materials reducing cost and construction time. An estimated 25,000 homes or 15% of new buildings are built using MMC. Offsite-MMC is estimated to have a market share of 2.1% (Goodier and Gibbs, 2005).

MMC is mainly used in the UK prototype designs of hospitals, schools, and homes. The principal market for OSM is for components and assemblies rather than whole buildings. Specification of preassembled pipe work, prefinished windows and door sets, modular lighting and other systems has made a significant contribution to increasing the quality and performance standards of buildings with little impact on out-turn cost. MMC speeds up housing delivery, enables high standards of design quality thereby reducing resource consumption. Consequently, it is promoted as a means of improving quality, reducing time spent on site, on-site safety, reducing waste and overcoming skills shortages in the UK housing sector. (englishpartnership.co.uk). In addition, offsite

technologies offer reductions in cost, time, defects, health and safety risks, environmental impact, whole life performance and profits (Sparksman *et al.,* 1999; Gibb, 1999; Housing Forum, 2002; Parry *et al.*, 2003; Venables *et al.*, 2004; Build offsite, 2005). The Baker Report, UK recommends 25% of new application approvals be granted to developers with MMC and OSM.

Typically used systems include Panellised Construction categorised as open and closed panels. Open panels have skeletal structure only, flat panels of timber, steel or structurally insulated panels (SIPS). Produced off-site (factory environment) and assembled on site as three dimensional structure. This includes the Premier Interlink Littlehey II 2-storey prison house that won the 2010 BREEAM award. Modular or Volumetric Construction also has three dimensional structures off-site manufactured and transported to site. Modules are delivered in variety of forms as empty shells or with complete services, features and external finishes including theatre, laboratories, kitchens, bathrooms and classrooms fully fitted.

Source: (http://www.MMC Co.uk)

The main barriers identifies with MMC are the negative perception on the post-war prefab and innovations contrary to the traditional building appearance. Pan, et al (2007) identified designers also as over cautious of the failure of the prefab designs, technical difficulties due to the fragmented structure of the supplied chain and high initial cost.

Similarly, there is public believe that traditional homes offer robust, permanent, good sound and thermal insulation, résistance to environmental changes and best price on resale which cannot be offered by the OSM-MMC. Other barriers identified are time saving which do not compare to switch because of delays in planning approvals, absence of economies of scale for the required cost savings, investors not seeing commercial benefit of the risk in view of the stand of mortgage lenders and consumers, lack of developed skills on part of developers and contractors to meet demand, the cautious approach of mortgage lenders and the difficulty in getting insurance and warranty from the National House Building Company, NHBC (Baker, 2004).

The need for government to work with all OSM stakeholders for the its adaption, formulation of a policy to have 25% of new buildings approval, conscious effort for efficiency in delivery to reduce cost, a strategic development with NHBC,HBF and development of OSM schemes are essential (Baker,2004). In addition, leadership commitment, customer focus, integrated process, quality driven and people centred programmes are necessary (Egan, 1998). The Housing Corporation and English Partnerships are doing their bit to encourage innovation by requiring that 25% of funded units be constructed using "modern methods of construction". In addition to prefabricated components and assemblies such as wiring looms or unitized curtain wall, Building.co.uk.

1.3 Stakeholders

Meeting stakeholder satisfaction and needs is a project success measure (PMI, 2013). Construction projects have several interested participants acting as groups or individuals who can affect or are affected by the objectives of an organization or its projects outcome. These are referred to as project stakeholders. Stakeholders have vested interest in the success of a project and the environment within which the project operates (McElroy et al., 2000). In addition, stakeholders influence, or could be influenced by an organization, support or be antagonistic to an organisation (Necombe, 2003). Project managers need to accept that stakeholders have a claim or interest in a project and its activities (Nguyen *et al*., 2009).

Researchers over the years have identified construction project stakeholders to include; client, project managers, site personnel, contractors, sub-contractors, local government, communities, media, professional bodies, members of parliament, politicians and political parties (Eyiah-Botwe, 2015). Scholars have also mentioned client, project management team, consultant, design team, contractor, subcontractor, supplier, employees, local community, funding institutions, banks, government authorities, end-users, developers, insurance companies as also stakeholders (Chinyio & Akintoye 2008; Yang, 2009; Chinyio and Olomolaiye, 2010). Key stakeholders have major impact on the success of housing project outcomes and these include end-users, developers, funding institutions, government authorities and the project team.

1.4 Innovative Building Technologies (IBTs)

Innovative Building Technologies' (IBTs) as employed in South Africa refer to methods that do not comply with the National Building Regulation Standards Act, (Act 107, 1977) but rather fit-for-purpose (CSIR, 2014a). According to CSIR, 2014b report IBT is

a generic term used to describe the use of alternative building systems, products and materials, preferably made in a factory, either in part or whole, and assembled on site. The Council for Scientific and Industrial Research (CSIR) South Africa and the Presidential Infrastructure Coordinating Commission (PICC) in 2013 identified the adoption of the Innovative Building Technologies (IBTs) as a value method solution to South Africa's social infrastructure demand backlog solution (Van Wyn and Mphahlele, 2015). Consequently the PICC resolved to adopt IBTs for about 60% of its committed projects. This emanated from a report of study by CSIR which had assessed similar innovations adopted for social developments in other parts of the world (CSIR, 2014a). In addition, IBTs are classified as heavy; light; onsite; offsite; light steel frame; heavy panels and hybrids. The IBTs are therefore similar to MMCs in the UK, Australia and Brazil. They are used for houses, housing, schools and clinics.

Housing site, Welkom, SA

CSIR Innovation site, Pretoria

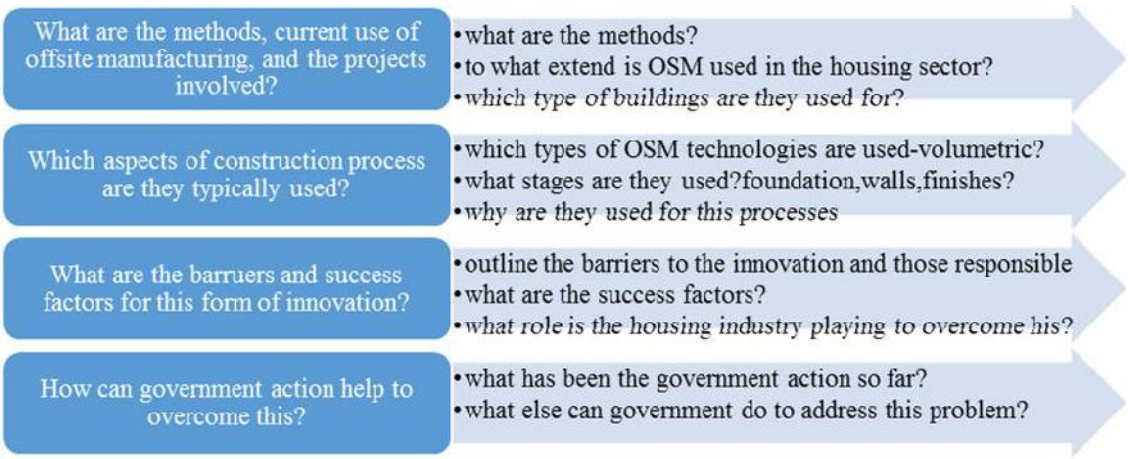
Athletes' village Maputo
Source; www.csir.co.za

2 RESEARCH DESIGN

A qualitative research method involving an in-depth literature review and case study of two innovative methods adopted by two different countries construction industries in specific regions were considered. To achieve the research aim, the study formulated four research questions as: (1) what are the methods, current use and relationship with off-site manufacturing (OSM), production and assembly techniques in the selected case study areas; (2) what aspects of the construction process are they typically used; (3) enumerates and analyses barriers and success factors to this innovation; (4) what should be the government's action plan to mitigate the challenges. The following two publications were extensively reviewed:

- Innovative Building Technologies: The Value Proposition (CSIR, 2014a)
- Review of Housing Supply. Delivering Stability; Securing our Future Housing Needs (Barker 2003: Baker, 2004)

This was followed up with site visit of a project site to Bristol in the South-West UK (2011) and Welkom in Free State, South Africa (2016). The construction methods were observed for a month, 2 project managers and Three (3) subcontractors were interviewed in each case as part of the broader study. The essence of the interviews were to validate the literature findings in relation to the research objectives and also seek the views of the stakeholders on what the government action plan should be for an enhanced and successful implementation of the innovative methods. A descriptive survey technique is used in recording findings and lesson learnt from both studies.



3 FINDINGS/LESSONS LEARNT

3.1 Modern Methods of Construction (MMC)

Three main MMCs identified are; Panelised, Modular or Volumetric and the Hybrid constructions. The Panelised has the open (skeletal frames of either timber or steel) and the closed systems (covered with a panel) are prefabricated but are assembled at the site. Similarly the *Modular or* Volumetric Construction has a three dimensional structures but off-site manufactured and transported to site. Modules are delivered in variety of forms as empty shells or with complete services, features and external finishes including theatre and laboratories by Moduleco. The last method, the Hybrid or semi volumetric has combine approaches. These are well serviced or repeatable:

kitchens, bathrooms and fully fitted classrooms. The IBT employs a method mainly to the Modular system. Parts of the building units are manufactured offsite and assembled at the site. The IBT is combined with the traditional system making it more acceptable.

3.2 Extent of usage

It has however continued to be used for mainly the UK prototype designs, hospitals, schools, and homes. An estimated 25,000 homes or 15% of new buildings are built using modern method of construction. OSM-MMC is estimated to have a market share of 2.1% (Goodier and Gibbs, 2005). These were confirmed by project the project managers and site staff interviewed for their opinions. The Presidential Infrastructure Coordinating Commission (PICC) in 2013 agreed to use IBT system for 60% of its project mainly social housing, schools and clinics. This was confirmed during the visit to Welkom RDP housing site where all the housing units adopt this system. Similarly it has been used at the CSIR innovative village in Pretoria and Stag Student Lodge in Stellenbosch (CSIR, 2014b).

3.3 Areas used in construction

On the aspect of construction that they are typically used, the study revealed that they are normally used as superstructure features: walls, roof, ceiling and as complete unit if it is the hybrid type. Again this was observed during the site visit. In South Africa, studies have shown that IBT is used also as building roof and wall features mainly for low housing projects. Equally IBT is used for light steel building constructions similar to the volumetric construction in the South West UK region. IBT is used mainly for superstructure construction such as roof structure at the Welkom RDP site.

3.4 Barriers and success factors

The study identified negative perception of people on the post-war prefabrication and innovations contrary to the traditional building appearance as a major barrier. In addition, project managers, site staff and house owners confirmed the public rather preference of the traditional homes offer of robustness, permanent nature, good sound and thermal insulation. Résistance to environmental changes and higher resale were considered as missing from the modern house built with OSM-MMC. This barrier is further aggravated by designers been over cautious of the possible failure of the prefabricated designs. Technical difficulties; high costs and the fragmented structure of the supplied chain were also barrier factors (Pan et al., 2007). Additionally, the study identified delays in planning approvals, absence of economies of scale for significant cost savings, investors position on the high risk, developers and contractors lack of developed skills to meet demand, the cautious approach of mortgage lenders, the difficulty in getting insurance and warranty from the National House Building Company, NHBC as confirming literature (Baker, 2004).

This paper identified speed of housing delivery, high standards of design quality with reduced resource consumption, time spent on site and material waste, improving on-site safety and overcoming skills shortages in the construction of housing. The success of OSM and MMCs depend much on the components and assemblies rather than whole buildings, improved quality and performance standards of buildings with little impact

on out-turn cost. Likewise in South Africa, speed of delivery, improved resource utilization and building appearance.

3.5 Government intervention

According to Baker (2004) the UK government needs to work with all OSM stakeholders for the adaption, and policy formulation to have 25% of all new buildings to use MMCs. Furthermore, approval, efficiency in delivery to reduce cost and a strategic development with funding and insurance institutions are essential. Egan (1998) opined that leadership commitment, customer focus, integrated process, quality driven and people centred programmes are necessary. As a result, the UK Housing Corporation seeks to encourage innovation by requiring that 25% of funded units be constructed using MMCs.

Similarly, the South Africa government upon the CSIR recommendation to the Presidential Infrastructure Coordinating Commission (PICC) in 2013, resolved that 60% of their targeted social infrastructure projects will employ IBT. The adoption of the CSIR report signifies government's intervention. The study further revealed that house owners were satisfied with the government intervention due to the speed of delivery.

4 CONCLUSION

The study assessed the Modern Method of Construction and the Innovative Building Technologies as used in the housing sector in the UK and South Africa respectively and concludes that, both methods are innovative since they are different from the traditional approach to building construction. There are about four types including the Panelised, Modular or Volumetric, Hybrid constructions and the Alternative Building Systems to the traditional approach.

Firstly, the innovative methods are heavily dependent on offsite-manufacturing (OSM) and use for repetitive projects like schools, clinics, housing and social infrastructure buildings. It can be used for both structural and non-structural designs. Secondly, innovative methods are used for both complete buildings but mainly superstructure features such as walls, floors and roofing structure. Their use have addressed the problem of shortage of skills, improved utilization of resources and hence improved delivery. Thirdly, the main obstacles identified include, end-users negative perception and lack of support for funding and insurance from housing development stakeholders and delays in granting approval. The major success factors are speed and increased delivery as well as reduced site risk and economy of resources usage.

This paper therefore recommend is implementation in the Ghanaian construction industry but recommends as follows: there is the need for stakeholders' education mostly on the durability and the negative perception on prefabricated system; government must advocate for its implementation by adopting the system for social infrastructure delivery; increased skill training and availability of funding and resources.

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