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Aigbavboa, 2010, 2011), (Thwala et al., 2001)

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ARTICLES

Research Articles

SUSTAINABILITY PERFORMANCE OF INFRASTRUCTURE PROJECTS: THE CASE FOR LIFE CYCLE SUSTAINABILITY ASSESSMENT METHODOLOGY

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ABSTRACT

The contribution of the construction and infrastructure (C&I) industry to society's unsustainable consumption patterns remains legendary. The potential of sustainability assessment and rating systems to make significant contributions towards reversing this trend has been elucidated. Several variants of such systems have become prevalent in the C&I industry for deployment to projects and assets. Yet, it appears that they have focused mainly on developed countries, certain sustainability dimensions, and certain phases of the infrastructure asset's lifecycle. This observation makes this study a necessity considering the quest of countries within the developing country context such as South Africa to bridge the attendant infrastructure deficit therein. Adopting a desktop research design, an extensive review of literature was conducted to unravel the current situation concerning these systems. Relevant keywords were used to source literature from established databases such as Scopus. Accordingly, articles and conference papers pertaining to the subject matter were culled from these databases and analyzed through qualitative content analysis. Findings from the emergent data lend credence to the initial propositions concerning the paucity of sustainability rating and assessment systems for civil infrastructure projects in developing countries. Furthermore, other postulations concerning the inability of the extant systems to cater adequately for the three sustainability dimensions in an integrated manner as well as the overt concentration on certain phases of the infrastructure asset lifecycle were affirmed. Based on these findings, the study proposed the adoption of an all-encompassing methodology – the life cycle sustainability assessment (LCSA) methodology – in the development of sustainability assessment and rating systems for developing countries like South Africa.

Keywords: Civil infrastructure, Life cycle sustainability assessment, South Africa, Sustainability.

1. INTRODUCTION

The *Our Common Future* report has attracted global attention to the need for citizens, governments and businesses to engage in their activities in a manner that depicts adherence to sustainable development (SD) principles (WECD, 1987). Accordingly, SD and sustainability have gained acceptance among both economic and non-economic actors (Finkbeiner et al., 2010). A recent attempt to chronicle the evolution of sustainability science identified the existence of over 20,000 papers belonging to 37,000 distinct authors from 174 countries and 2,206 cities (Bettencourt & Kaur, 2011). This describes the intensity of the sustainability discourse. Yet, the implementation of the SD concept remains a daunting challenge for organizations, economic sectors and countries (Finkbeiner et al., 2010). The construction and infrastructure (C&I) sector has been associated with underwhelming performance in this regard (Gunnell et al., 2009).

The C&I industry's potential to destabilize the environment has been reported (Bourdeau, 1999; Du Plessis, 2007; Sev, 2009). Available statistics suggest that products of the C&I sector utilize 15% of the world's fresh water resources and 40% of the world's energy and are responsible for the production of approximately 23-40% of the world's greenhouse gas emissions (Gunnell et al., 2009). Additionally, Bribián et al. (2011) assert that the combination of civil works and building construction is responsible for the consumption of 60% of materials extracted from the earth's crust. Consequently, studies have sought to propagate new approaches to sustainable project delivery (Huovila & Koskela, 1998; Raynsford, 1999; Du Plessis, 2007; Shen et al., 2007). Reports from the C&I sector indicates varied levels of sustainability uptake within the industry (Bon & Hutchinson, 2000, Du Plessis, 2007).

Various assessment and rating tools have evolved for measuring the impact of the C&I industry on the environment since 1990. Examples include the Building Research Establishment Environmental Assessment Method (BREEAM), Leadership in Energy and Environmental Design (LEED) and Civil Engineering Environmental Quality Assessment and Award Scheme (CEEQUAL). These tools have since been deployed in assessing the sustainability performance of buildings and infrastructure projects. Considering the dynamic nature of the construction industry and society, these tools have undergone significant transformation over their lifetimes (Griffiths et al., 2015). A review of these tools indicates that a few of them focus on building construction processes and the buildings whereas the infrastructure subsector of the C&I industry remains under-served (Wong, 2010; Andreas et al., 2010). Furthermore, a paucity of tools seeking to assess and rate sustainability performance of infrastructure in developing countries such as South Africa is evident (Jayawickrama et al., 2013). This constitutes a significant gap, especially in the face of the rapid urbanization rates of developing countries (UN DESA, 2014; World Bank, 2013).

To bridge this gap, this study seeks to contribute towards stimulating the discourse on the need for assessment and rating tools for sustainability performance management in infrastructure projects in developing countries. Also, it highlights the significance of a LCSA theoretical methodology in the development of such assessment and rating tools. In this study, South Africa serves as an exemplar developing economy context.

2. LITERATURE REVIEW

2.1. The Concept of Sustainability Assessment and Rating

The SD mantra has suddenly become the goal upon which future development is premised (Klöpffer, 2003). The C&I sector's reputation for destabilizing the ecosystem through its products and processes remains legendary (Ortiz et al., 2009). Kibert et al. (2000) identify environmental effects of mass materials movement between the point of extraction and usage, reduction in quantity of high quality mineral stock for industrial use, and gradual dissipation of concentrated materials because of emissions as lending support to the development of such reputation. Also, they acknowledge the sector's efforts towards ameliorating such problems. These strides towards SD seem to have gone unnoticed owing to the absence of a widely accepted apparatus for measuring and managing implementation performance. Corroborating this view, Finkbeiner et al. (2010) and Berardi (2012) insist that the challenge confronting SD implementation was stakeholders' ability to agree on performance measurement and management procedures. Crawley and Aho (1999) reiterate the importance of such assessments for construction projects and materials used in their delivery.

Sustainability assessment has been described as a process through which the probable impacts of particular activities and their alternatives are identified, predicted, and evaluated (Devuyst, 2000; Zamagni et al., 2013). Shaw et al. (2012) maintain that increased uptake of sustainability assessment by various organizations for the delivery and operation stages of construction projects such as infrastructure will lead to the attainment of beneficial outcomes. The decision-making capabilities of a sustainability assessment mechanism has also been highlighted (Ding, 2008). Whilst reiterating the insufficiency of the C&I sector's reliance on project designs to either achieve SDGs or a reduction of environmental impacts, she explains that sustainable assessment tools can assist in arriving at decisions on whether a variant of a proposed project is capable of enabling the attainment of the SD ethos. Sustainability assessment and rating have evolved from the C&I sector's desire to contribute positively towards the attainment of sustainability. In apparent recognition of the impacts which various processes and products inherent in the industry had on the environment, stakeholders immediately sought to ameliorate these impacts.

Initially, such efforts were associated with the amelioration of environmental impacts. However, with renewed advocacy for the industry to look beyond the issue of environmental impacts, the attention of the sector was drawn to other pillars of sustainability, namely economic and social pillars. A combination of these aspects culminated in the development of sustainability assessment. Affirming the importance of these pillars in the C&I industry, Berardi (2012) refers to the description of 1SO 15392 of construction sustainability as the ability to accord adequate consideration of sustainable development in terms of its three primary aspects, namely economic, environmental, and social, whilst meeting the stipulated requirements for technical and functional performance within construction projects. According to Bond et al. (2012), instead of their assessment on an individual basis to yield better outcomes, the inherent potential of the systematic assessment of these pillars of sustainability in projects has made the option an attractive proposition for the C&I industry. Reflecting further on the attributes of effective sustainable assessment, Bond et al. (2012) suggest that the initiatives should be designed in a context-specific manner. In this way they highlight the peculiarities of the macro and micro economy in the assessment. Resulting from a combination of individual assessment schemes for environment,

economic and social impacts respectively, the following attributes are considered imperative for effective sustainability assessment initiatives, namely a comprehensive and systematic nature; improved stakeholder engagement; the ability to span intergenerational periods; and immediate as well as long-term consequences of alternative options evaluated systematically for informed decision-making (Bond et al., 2012). According to Shaw et al. (2012), sustainability assessment strives to achieve certain objectives such as presenting credible data to reflect the degree of sustainability in the early stages of the construction project lifecycle; providing guidance to the project design decisions; employing a set of criteria and indicators for assessing the project's monitoring tools; ensuring adequate utilization of the plan-do-check-act procedure through constant monitoring, measuring and interpreting of data; and benchmarking such data against best practices.

Reiterating the salient nature of sustainability assessment and rating systems, various studies attribute the progress made in the building subsector of the C&I sector to the prevalence of such systems within the subsector (Larsson, 1999; Mateus & Bragança, 2011; World Green Business Council, 2013; Poveda & Young, 2015). Relying on information from the Building Research Establishment (BRE), Poveda and Young (2015) admit to the existence of approximately 600 assessment and rating systems which are focused on this subsector globally. However, a paucity of sustainability assessment initiatives within the infrastructure subsector has been observed (Jayawickrama et al., 2013; Wong, 2010; Clevenger et al., 2013). This paucity happens to be pronounced in the developing world where only two countries, namely South Africa and Brazil, have assessment and rating schemes, albeit for buildings and building processes (Berardi, 2012). This study is predicated on this observation. Developing countries are currently embarking on aggressive infrastructural development programmes in their quest to increase their standing on the national competitiveness rankings as well as the Human Development Index (HDI). Consequently, such development programmes will have tremendous impact on the attainment of SD principles; hence the imperative nature of assessment and rating mechanisms for measuring and managing such potential impacts. Furthermore, the use of such mechanisms as decision-making tools will allow these economies to decide on how to attain infrastructure sustainability.

2.2. Sustainable Infrastructure Assessment and Rating Systems: State-of-the-art

The term 'sustainable infrastructure' continues to defy widely accepted definition. Yet attempts to create a dichotomy between sustainable infrastructure, sustainability of infrastructure, and infrastructure sustainability have been noticed in relevant literature (Stapledon, 2012; Vanegas, 2003; UN ESCAP, 2007). For instance, Stapledon (2012) avers that whereas infrastructure sustainability is concerned with the design, delivery, operation and final deconstruction of the infrastructure asset, sustainable infrastructure deals with an asset's 'fit-for-purpose' nature. Vanegas (2003) describes the sustainability of infrastructure as concerning what the infrastructure asset does (products, goods and services), how it does it (operations, procedures, and practices), and with what resource (natural resources requirements). Also, the UN ESCAP (2007) report entitled 'Greening Growth in Asia and the Pacific' observes that any attempt at improving the sustainability levels of any infrastructure asset must accord prime attention to eco-efficiency. Andreas et al. (2010) argue that the critical factor for the attainment of sustainable infrastructure systems lies in the ability of such systems to address inter- and intra-generational demands within the confines of extant resources. Summarily, sustainable infrastructure can be

used to connote infrastructure assets which are aligned to the principles of sustainability and sustainable development.

The construction and operation of infrastructure does possess a reputation for intensive energy consumption and other aspects of environmental degradation (Park et al., 2003). Alam and Kumar (2013) lament the paucity of assessment schemes for civil infrastructure, especially as it pertains to road infrastructure. They reiterate the useful nature of such schemes in the integration of various aspects of sustainability into the distinct phases of infrastructure project design, construction, and operation. Griffiths et al. (2015) reaffirm the inadequacy of literature on the assessment and rating of infrastructure projects. They state that these assessment tools are indeed necessary as they provide a platform for measuring sustainability performance in civil infrastructure projects whilst also providing project stakeholders with a road map on how to attain successful performance. The introduction of the foremost version of CEEQUAL in the United Kingdom in 2003, thirteen years after the adoption of BREEAM (1990) further serves as a testimony to the negation of infrastructure sustainability assessment and rating. According to Griffiths et al. (2015), the systems focusing on infrastructure can be delineated along the lines of their approach to the assessment and rating exercise. They identify two major categories, namely assessment and rating tools that rely on self-assessment approaches and those that can avail themselves of third-party verification and certification. Nevertheless, they add that the tools requiring third-party verification are usually more rigorous. Some of these schemes have been described as generic and can be applied towards assessing and rating civil infrastructure projects; others have been acclaimed to be sector specific (Alam et al., 2013). An example of the latter is the GreenRoads assessment and rating system whereas the CEEQUAL represents the former in this regard. Whilst it must be acknowledged that a flurry of activities has started to occur within the realm of civil infrastructure assessment and rating in recent times, such initiatives are still absent in developing countries such as South Africa.

3. RESEARCH METHODOLOGY

This study relies on a qualitative desktop research design. This method has been suggested as being instrumental to the conduct of literature synthesis research projects such as this (Suri, 2011). Accordingly, relevant databases such as Science Direct, Scopus, and ISI Web of Science were identified and consulted. The authors relied on a combination of a set of keywords such as sustainability assessment and rating, lifecycle thinking, lifecycle approach, lifecycle costing, lifecycle analysis, lifecycle assessment, social-lifecycle analysis, lifecycle sustainability assessment, project lifecycle, material lifecycle assessment, and South Africa. Following from a cursory search of these databases, a plethora of relevant articles and technical reports was identified. Most of the articles utilized emanated from the following journals: *Lifecycle Assessment, International Journal of Project Management, Cleaner Production, Construction and Building Materials, Building Research and Information, Ecological Indicators* and *Environmental Technology*. Further to this, a number of conference papers were discovered from the search and utilized. A qualitative content analysis was conducted on the preselected publications. Data was sought from these publications based on pre-set themes derived from the study's objectives.

The following civil engineering assessment and rating system were identified from the articles consulted: CEEQUAL, GreenLITES, GreenRoads, EnVision, Infrastructure Sustainability (IS), LEED for Neighbourhood Development (LEED-ND), Infrastructure Voluntary Evaluation Sustainability Tool (INVEST), BE^{2}ST-In-Highways and Illinois Livable and Sustainable

Transportation (I-LAST). These tools only focused on the developed country context. The features of these tools are provided in Table 1.

4. FINDINGS

The findings from the qualitative content analysis of selected articles, technical reports and conference papers were structured according to the objectives of the present study. Therefore, the authors identified the various lifecycle assessment and analysis tools presently being deployed in the assessment and rating of civil engineering projects and assets globally. The presentation of these tools enables an understanding of the shortcomings of the extant tools, especially as it concerns the underpinning methodology for these tools (LCA, LCC, S-LCA, and the like); the country context for which they are developed (developed and/or developing country context); the economic sector in which the asset is deployed and others.

Furthermore, the section deals with discussions on the need for the assessment and rating tools to truly embrace the concept of lifecycle thinking as well as conducting a review of the South African assessment and rating context for civil infrastructure.

Table 1. Features of Various Infrastructure Sustainability Assessment Systems

Number	Assessment and Rating system	*Infrastructure Lifecycle phases covered*						*Type of Infrastructure*								Percentage of Concentration (100%)			*Country Context*	
		Planning	*Design*	*Construction*	*Operation and Maintenance*	*Decommissioning and End of Life*		*Highways*	*Water Storage*	*Water Treatment*	*Energy Generation*	*Landscaping*	*Information and Communication*	*Systems*		*Social*	*Economic*	Environmental	*Developed*	*Developing*
1	BE2ST-IN-Highways	X	X	-	-	-		X	-	-	-	-	-			N/A	N/A	N/A	X	-
2	Envision	X	X	X	X	-		X	X	X	X	X		X		22%	38%	100%	X	-
3	Green guide for Roads	X	X	-	-	-		X	-	-	-	-	-			45%	55%	100%	X	-
4	GreenLITES	X	X	X	X	-		X	-	-	-	-	-			10%	25%	100%	X	-
5	Greenpave	X	X	X	X	-		X	-	-	-	-	-			12%	50%	100%	X	-
6	Greenroads	X	X	X	-	-		X	-	-	-	X	-			25%	53%	100%	X	-
7	I-Last	X	X	O	-	-		X	-	-	-	-	-			19%	39%	100%	X	-
8	INVEST	X	X	X	X	-		X	-	-	-	-	-			30%	65%	100%	X	-
9	CEEQUAL	X	X	X	X	-		X	X	X	X	X		X		25%	45%	100%	X	-
10	STARS	X	X	X	X	-		X	-	-	-	-	-			N/A	N/A	N/A	X	-
11	Infrastructure Sustainability	X	X	X	X	-		X	X	X	X	X		X		N/A	N/A	N/A	X	-

(X) = applicable; (-) = not applicable; (o) = under development; and (N/A) = not available
(Source: Adapted from Griffiths et al., 2015; Simson et al., 2015; Shaw et al., 2012)

Table 1 is self-explanatory, and the limitations of extant sustainability assessment and rating mechanisms can be deciphered. Such limitations include the inability of the various systems to cover the entire life cycle of the infrastructure asset; the non-consideration of the social and economic impact assessments; the non-generic nature, and non-consideration of the developing world context. These observations have been corroborated by Shaw et al. (2012) and Diaz-Sarachaga et al. (2016). These limitations are capable of undermining the efficiency and effectiveness of sustainability assessment and rating mechanisms. Also, they can cause these mechanisms to deliver incomplete assessments, subsequently leading to poor decision making and sustainability performance management in infrastructure projects.

4.1. A Life-Cycle Thinking Approach

Admittedly, society's desire for an amelioration of the impact of the C&I sector's activities on the ecosystem requires a credible methodology. Such methodology should take into consideration the whole-of-life impact on the environment of not only the final asset, but also the processes and products contributing to the development of the final asset. Infrastructure assets are analogous to living organisms as they all possess a life cycle, usually a cradle-to-grave cycle. The life cycle of products is delineated across the following facets, namely product design, raw material extraction and processing, manufacturing of the product, packaging and distribution to the consumer, product use and maintenance, and the end-of-life management: reuse, recycling, and disposal (Udo de Haes & Van Rooijen, 2005). The use of a life cycle thinking (LCT) approach stems from the need to appraise various interactions which occur between the ecosystem and the activities and materials applied during the assets' delivery stages. The UNEP report categorizes life cycle approaches into two distinct aspects, namely the analytical and practical aspects. The former is concerned with the scientific assessment of the effects of planned decisions whereas the latter focuses on the use of policy or corporate programmes in the assessment of such effects. According to Guinée (2016) and Neugebauer et al. (2015), LCT approaches are increasingly being relied upon to analyze various scenarios available to society for catering for the needs of future generations. The features of an LCT approach are elucidated in the life cycle analysis (LCA) (Heijungs et al., 2010; Corominas et al., 2013). The LCA remains the most commonly used assessment approach within the vast array of LCT assessment methodologies mentioned previously (Berardi, 2012). This is as a result of its professed suitability for the appraisal of environmental impacts of civil engineering and building works as well as the materials applied therein (Glass et al., 2013). This suitability is premised on its ability to delineate primary activities and the materials utilized within the project development and delivery processes, assessing the impacts of these activities and materials individually on the environment from exploration and extraction to decommissioning at the end of life (Berardi, 2012).

However, for credible, comparable and transparent LCA assessments, the stakeholders within the various sectors need to arrive at a consensus on sector-specific indices to be applied (Santero et al., 2011). Alam and Kumar (2013) define LCA as a systematic set of procedures for compiling and examining the inputs and outputs of materials, energy and associated environmental impacts directly attributable to the functioning of a product or service system throughout its life cycle. A UNEP report on the LCA describes it as a procedure for assessing the impacts which a particular product may have on the environment over its life cycle (UNEP, 1996). Corroborating this view, Ghumra et al. (2009) add that the LCA seeks to provide a whole-of-life understanding

of the entire processes and products applied towards the realization of an asset. These processes usually assume the cradle-to-grave or cradle-to-cradle dimension (Ortiz et al., 2009). In reiterating the role of the LCA in fostering effective decision making, Ghumra et al. (2009) state that the approach can be directed towards making decisions concerning resource utilization during project delivery. The UNEP report (UNEP, 1996) lends credence to this observation as it views the LCA as capable of affecting decisions on material selection, based on the material's potential impact on the environment during project planning and design stages. Alam and Kumar cite a variety of sources that allude to the scientific disposition of the LCA in the optimization of whole-of-life usage of resources and minimization of emissions during project delivery (Alam & Kumar, 2013). Furthermore, the ability of the LCA to serve as a platform for comparing various products on the basis of the same functional quality endears it to potential assessors (Berardi, 2012; Corominas et al., 2013). The LCA's capability to prevent problem shifting between various stages of a project's life cycle has also been observed (Udo de Haes & Van Rooijen, 2005). Buttressing this assertion, Klöpffer (2003) reiterates the futility of engendering improvements in one phase of a product's life cycle when such improvements may lead to negative consequences in the subsequent phases of the product's life cycle as such negative consequences may outweigh whatever improvements might have been attained earlier.

Within the C&I sector, the application of the LCT-based methods occurs along two different dimensions: the building material and component combinations (BMCC), and the whole process of the construction (WPC) (Ortiz et al., 2009). LCA assessments have been applied severally across facets of the C&I sector such as dwellings, commercial buildings and civil engineering. However, more tools and methods have been developed for the assessment of dwellings and commercial buildings in comparison to the few tools and methods applied to infrastructure projects. Tools and methods applied towards the assessment of dwellings and commercial buildings include BREEAM, LEEDS, SEDA, ATHENA, BEE, and Green Star.

The review of assessment and rating tools in the preceding section shows that most of the tools applied towards the appraisal of civil engineering projects did fully not rely on the LCT methodology. Such non-reliance on a given methodology negates the credibility of these methods (Crawley & Aho, 1999). According to Crawley and Aho (1999), methodological transparency is critical to the success of any assessment and rating method, particularly as it pertains to the philosophical and practice-oriented perspective. It remains to be seen how the civil engineering-related assessment and rating tools can deliver credible and objective impact assessments, especially within the developing economies context where the challenges border on the triple bottom line (TBL) of sustainability and not just environmental concerns (Gibberd, 2005). Because of this, the UNEP has once more assumed a leading role in championing for the development and subsequent adoption of a life cycle-thinking approach that integrates aspects of economic, social and environmental criteria in the conduct of sustainability assessments for products, processes and materials respectively (Ciroth et al., 2012). The life cycle sustainability assessment (LCSA) framework has since resulted from this advocacy.

4.2. Understanding the South African Infrastructure Sustainability Assessment and Rating Context

In admitting to the global utilization of sustainability assessment and rating systems with the exception of Africa and Latin America, Berardi (2012) singles out South Africa and Brazil as countries in the aforementioned regions that have embraced the use of these systems. But in South Africa available assessment and rating tools have concentrated on residential, educational and commercial buildings (Gunnell et al., 2009; Gibberd, 2005). This focus on buildings can be attributed to the country's strategic proclivity towards engendering SD in the aftermath of the World Summit for Sustainable Development in 2002. This proclivity for SD and the development of the green buildings concept in South Africa notwithstanding, events relating to the need for energy and water security, increasing global awareness of climate change, and increased demand from multinational corporations operating within South Africa which occurred between 2007 and 2008 heightened the level of awareness among the populace, leading to increased demands for sustainable buildings (Gunnell et.al., 2009; Ampofo-Anti, 2012). Furthermore, Ampofo-Anti (2012) attributes the rise in SD awareness to the role of the media and the government through the effective communication and enactment of pro-SD legislations by successive governments in the country.

Environmental labelling and rating systems were introduced into the building sector as the demand for sustainable buildings among clients increased. Some of these tools include Green Star SA, Sustainable Building Assessment Tool (SBAT), EcoStandard South Africa, Energy Labelling standard for buildings, South African National Eco-labelling Scheme, the Materials Manufacturing Industry Initiative and the Built Environment Sustainability Tool (BEST) (Gibberd, 2008; Gibberd, 2015; Ampofo-Anti, 2012). The first version of the Green Star SA system, which was modelled after the Australian Green Star rating system, was launched in 2008 (Gunnell et al., 2009). It focuses solely on the environmental performance of buildings and is premised on a point-scoring system. This is seen as a shortcoming and the SBAT was subsequently introduced to correct this anomaly. The SBAT incorporates aspects of the social, economic and environment criteria in assessing the sustainability performance of buildings. The social criteria applied consist of the following: occupants' comfort, inclusive environments, access to facilities, participation and control, and education, health, and safety. On the other hand, the economic criteria include local economy, efficiency, adaptability, on-going costs, and capital costs. The environmental criteria assessed include water, waste, energy, site, materials and components (Gibberd, 2008). Retief (2007) argues that the concept of sustainability assessment is non-existent in South Africa, admitting that strategic environmental assessment (SEA) was prevalent and enabled by the country's legislation. He posits that the National Environmental Management Act (NEMA) 1998 and the National Framework for Sustainable Development were established to ensure that all environmental assessment activities carried out within South Africa are premised on SD attainment. Accordingly, South Africa's leading position in the conduct of strategic environmental assessment (SEA) is based on the legislative support and the cases of successful SEA assessments conducted therein (Patel & Giordano, 2014). But Patel and Giordano (2014) bemoan the lack of documented information pertaining to the use of SEAs and other forms of environmental assessment mechanisms such as environmental impact assessment (EIA) in South Africa.

However, the environmental labelling, assessment and rating systems available in South African seem to neglect infrastructure projects. To date, there is no assessment and rating system

for assessing the impact of infrastructure projects and assets on the ecosystem within South Africa known to the authors. Wall and Rust (2015) emphasise this observation when they reiterate the absence of rating tools for evaluating South African infrastructure. This gap poses a challenge to the country's infrastructure development aspirations. In recent times, the South African government has not minced words about its determination to invest strategically in infrastructure. This aspiration has seen the establishment of the Presidential Infrastructure Coordinating Commission (PICC) and the development of the National Infrastructure Development Plan (NIDP) as part of the National Development Plan. Strategic Integrated Projects (SIPs) are an integral part of the NIDP. These SIPs are aligned to the attainment of social, economic and environmental aspects of SD. According to the report of the Development Bank of South Africa (DBSA) on the state of infrastructure in the country, five questions were considered in the choice of projects to be integrated into the SIP programme. These questions comprise the following: the extent to which the infrastructure is aligned to the socio-economic context; the ability of the project to demonstrate its economic potential; the viability of the project; the extent to which the cost of delivering the infrastructure asset can be equitably covered, and the presence of adequate implementation competencies. Although the list shows that certain aspects of SD were taken into consideration, it would appear that a significant proportion was not considered. More so, the absence of a structured approach for carrying out sustainability assessment on these projects poses considerable concern regarding their ability to achieve enhanced sustainability performance.

Patel and Giordano (2014) lament the shortcomings of the Infrastructure Development Act (2013), an Act upon which the SIPs are anchored concerning environment assessments, despite the belief that South Africa was reaching its environmental boundaries. The Act mandates that environmental assessments for SIP must be done according to the terms prescribed in the NEMA and fails to distinguish between SEA and EIA. An example of the shortcomings for which the Act has been heavily criticized includes the abridging of the project life cycle in such a manner that it curtails the environmental assessment process (Patel & Giordano, 2014). Also, the Act is silent on social impact assessments of potential projects. These shortcomings negate the drive for a green economy within the country context from a sustainable infrastructure perspective. Obviously, without effective assessment and rating systems in place, these projects would sustain low sustainability performance, inadvertently affecting the country's desire to contribute immensely towards the attainment of a green economy. This need makes this study imperative.

5. DISCUSSION

The LCSA as a Veritable Assessment and Rating System for South African Civil Infrastructure

The growing advocacy for the integration of sustainability ethos into the design, delivery, and subsequent operation of infrastructure assets has been observed (Shaw et al., 2012). This advocacy has issued the challenge of providing an appropriate apparatus for measuring the sustainability performance of civil engineering assets, the processes involved in their delivery, and the materials utilized in these processes on a whole-of-life basis in a systemic manner. In what may appear to be a solution to this imbroglio, the concept of the LCSA has been proposed (Ciroth et al., 2012; Finkbeiner et al., 2010; Heijungs et al., 2010; Guinée, 2016). This approach to sustainability assessment acknowledges the existence of various LCA approaches such as the Social Life Cycle Analysis (S-LCA) and the Life Cycle Costing (LCC) tools, and their utility

within the realm of social impact assessment and economic impact assessment activities. However, proponents of the LCSA aver that the use of these assessment tools in the past have not been conducted in a reductionist manner. As such, the individual results obtained from the application of these alternative tools cannot be aggregated to constitute a sustainability assessment endeavour. Prior to these agitations for the systemic integration of these sustainability aspects, scholars have long observed the failings of the LCA and sought to integrate it with other tools such as the LCC (Norris, 2001), and economic and social aspects (Weidema, 2006; Klöpffer, 2003) to boost the effectiveness of the LCA by broadening its current scope beyond environmental impacts (Guinée, 2016; Heijungs et al., 2010). But proponents of the LCSA maintain that the new approach would avail stakeholders with the opportunity to carry out assessments whilst taking into consideration the sustainability triple bottom line in a systemic manner. It is expected that this systemic integration will engender effective life cycle sustainability performance management of a product or civil engineering asset (Ciroth et al., 2012). It is opined that the successful conduct of an LCSA for a particular product will provide results which will not only portray the product's negative impacts but also its benefits, thus allowing for trade-offs to be agreed upon during the planning and design stages (Ciroth et al., 2012; Neugebauer et al., 2015). This much is attested to by Klöpffer and Renner (2008). In making a case for the development of an integrated life cycle impact assessment and rating method, they proposed the formula presented below for the computation of the LCSA.

LCSA= Environmental LCA (E-LCA) + LCC + Social LCA (S-LCA)

The LCC is described as an apparatus for calculating the entire life cycle costs associated with an asset's whole-of-life (Udo de Haes & Van Rooijen, 2005). It has been known to assist in decision-making, particularly as it concerns the design and development of new products or assets. Judging from the foregoing, its affinity to the economic aspect of the sustainability TBL cannot be disputed. In terms of similarity, the process of conducting an LCC is identical to the processes highlighted in ISO 14040 for LCA analysis. On the other hand, the S-LCA focuses on the assessment of the social and socio-economic aspects of products and processes alongside their potential impacts, whether negative or positive, during various aspects of their life cycle (Ciroth et al., 2012). In their contribution, Benoît et al. (2010) assert that the S-LCA allows for the identification of key social and socio-economic issues occasioned by the production, use and disposal of products and assets. They opine that the technique is best suited for the purposes of increasing knowledge, informing choices, and engendering improvement of social conditions within product life cycles. Its recent prominence has been attributed to the need to improve upon the social conditions of stakeholders affected by the life cycle activities of a product being assessed. The absence of a standardized set of quantitative indicators is a major challenge to the S-LCA's effectiveness (Vinyes et al., 2013; Ostermeyer et al., 2013; Finkbeiner et al., 2010; Klöpffer, 2008).

Since this formula has since gained popularity among life cycle impact assessment scholars such as Finkbeiner et al. (2010) and Klöpffer (2003; 2008), there are still some reservations pertaining to its applicability. These reservations evolve from the perceived difficulty of potential assessors to carry out in-depth accurate and integrated life cycle inventories across the three different aspects (Heijungs et al., 2010). According to Finkbeiner et al. (2010), LCSA's potential

to contribute to effective decision-making is challenged by the difficulty experienced in understanding and explaining its results to a non-expert audience.

There is no evidence yet to suggest that the C&I industry has embraced the LCSA concept in the assessment and rating of infrastructure projects through any of the extant tools thus far. Likewise, there is no indication of the adoption of any tool relying on this methodology within the developing country context. This much was admitted by Ciroth et al. (2012). In these reports, the absence of assessment and rating tools for civil engineering assets in developing countries was identified, prompting the advocacy for the development of such tools to be considered in the future.

As a developing country, South Africa lacks such tools. Studies have highlighted the fact that the country was pushing its environmental threshold and as such, any attempts at embarking on new infrastructure projects should be adequately considered from a sustainability perspective.

Furthermore, the country's socio-economic dimensions indicate a need for the social and economic impacts of proposed infrastructure projects to be considered at the inception stage. This would ensure that the infrastructure investments are made in such a manner that would augur well for society along environmental, social and economic sustainability dimensions. But the present NEMA legislation which serves as a platform for the application of SEA and EIA does not take these aspects, particularly the social dimensions, into cognizance. An LCSA-enabled platform will cater for this deficiency as it will integrate these dimensions into various phases of the infrastructure lifecycle, hence enabling an incomplete and holistic assessment and rating procedure. Furthermore, this will lead to effective decision-making based on complete data sets, unlike what is tenable under the SEA and EIA regime in South Africa. Additionally, proponents of the LCSA methodology acknowledge the high level of transparency which it brings to sustainability assessment exercises (Neugebauer et al., 2015; Heijungs et al., 2010). Furthermore, they assert that it enables the identification and adoption of possible trade-offs between the three pillars of sustainability in a product assessment. This attribute is indeed imperative within the South African infrastructure delivery context. Inasmuch as the country has been identified as pushing on the threshold of environmental degradation, a consideration of the country's history, the increasing levels of poverty in urban areas and the declining standards on the Human Development Index (HDI) accentuates the need for holistic sustainability assessment exercises to be adopted. This is especially so in the case of critical infrastructure delivery programmes such as the SIP.

Notwithstanding its merits, it must be acknowledged that the LCSA methodology is still at a nascent stage. As such, its application is somewhat limited (Neugebauer et al., 2015). This is particularly so in the context of the C&I sector where the LCA, EIA, SEA, and LCC have continued to play dominant roles in sustainability assessment and rating procedures. As is the case with new strategies or methodologies, implementation challenges are always posed to their successful uptake by relevant stakeholders. The LCSA fares no better. A review of thirty relevant articles resulting from a bibliometric analysis conducted by Guinée (2016) highlights twelve (12) challenges to the successful implementation of the LCSA. Of this number, challenges such as an absence of effective platforms or mechanisms for communicating LCSA results, lack of practical scenarios of LCSA application, and the absence of data for carrying out aspects such as SLCA were predominant. Similarly, Neugebauer et al. (2015) observe the variance in maturity levels between the LCA, LCC and SLCA components of the LCSA. Whereas the LCA has an established methodology as encapsulated in ISO 14040, the LCC and the SLCA are devoid of such established

methodologies, thus lacking appropriate impact assessment criteria. Such variance, they admit, poses a challenge to the broad implementation of sustainability assessment as it makes the identification and selection of indicators difficult. Furthermore, they mention the absence of an appropriate indicator selection process which is duly accepted by all institutions within a geographical or sectoral context.

Summarily, it can be deduced that the LCSA would be most beneficial within the developing country context owing to its ability to enable a holistic assessment of environmental, economic and social impact factors, engendering necessary trade-offs between competing impacts. No doubt, these trade-offs would allow for the reflection of context-specific peculiarities and hence allow for accurate decision-making processes within the infrastructure subsector of the C&I sector.

6. CONCLUSIONS AND RECOMMENDATIONS

The C&I sector has been identified as one sector through which society can achieve its SD aspirations. Accordingly, the sector has made significant strides by changing processes and embracing innovative practices towards achieving pro-SD goals. The need for an effective and efficient decision-making process as well as the absence of an apparatus for the measurement and management of these sustainability-oriented efforts of the sector contributed to the introduction of the sustainability assessment and rating systems.

Such systems not only enabled the measurement and management of the impacts of the sector's activities and products but also sought to incentivise stakeholders who were able to achieve more with less impact on the TBL. Whilst the use of these systems has been most prevalent within the building subsector of the C&I sector, the infrastructure subsector has remained largely under-served. Also, from a list of eleven (11) pro-infrastructure sustainability assessment and rating systems identified from a review of relevant literature, none was applicable to the developing country context. This gap is obvious and needs to be addressed considering the increasing urbanization and demand for infrastructure in the developing world. Furthermore, these systems did not assess sustainability aspects in a holistic manner and failed to cater for various impacts which occur across the entire life cycle of the infrastructure project. This observation accentuates the need for an LCT approach which considers the TBL in a holistic manner, enabling as it were trade-offs between them. This was the premise upon which the LCSA methodology is being proposed.

Based on a review of the benefits associated with the LCSA, this study makes a case for its adoption as a platform for decision making as well as subsequent measurement and management of sustainable infrastructure endeavours in developing countries such as South Africa. In acknowledging the nascent nature of the LCSA, this study provides an overview of its shortcomings and efforts which are being carried out to towards resolving them.

This study seeks to contribute toward stimulating the discourse on the sustainability assessment and rating of infrastructure projects through a broadening of the LCA technique to encompass other parts of the TBL. Furthermore, it seeks to highlight the deficiencies of extant infrastructure sustainability assessment and rating tools concerning their applicability within the developing country context. Also, it is expected that this study would elicit increased awareness pertaining to the subject matter among relevant stakeholders in South Africa. Such stimulation of this discourse should inevitably lead to more studies focusing on the development of appropriate frameworks for selecting indicators for the not yet matured S-LCA as well as a context-specific

LSCA-enabled framework for carrying out sustainability assessment and rating within the developing country context.

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INTEGRATING INDOOR THERMAL COMFORT OPPORTUNITIES FROM TRADITIONAL BUILDING TYPES INTO THE DELIVERY AND MANAGEMENT OF SUSTAINABLE BUILT ENVIRONMENTS

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ABSTRACT

Amid the various contemporary strategies for the delivery and management of sustainable development in the African context, not much emphasis has been placed on searching for the existence or otherwise of thermal opportunities from the inherent building types of our forebearers. This paper therefore, through case study design approach, reports the developmental trend of indoor thermal comfort opportunities of building types with the design and construction traits representing the historic eras of pre-colonial, colonial and contemporary in Okigwe, Nigeria. The primary data were obtained from field observations made for 366 days (1 November 2015 – 31 October 2016) on the indoor and outdoor temperature and relative humidity values using Tinytag Explorer 4.9 Germini data loggers and secondary data from the nearest meteorological station, Imo State International Cargo Airport, Owerri, Nigeria. The mean annual outdoor temperature and relative humidity values were 29.0^0C and 69.9% respectively. Analyses of the results using a one-way ANOVA test for differences were statistically significant: indoor air temperature [F (2, 1095) = 77.56, p = 0.0001] and relative humidity [F (2, 1095) = 5.76, p = 0.0001]. Further interrogation using the Tukey's HSD (honest significant difference) post-hoc comparison test amongst the building types revealed that indoor air temperature (27.83^0C) and relative humidity (71%) of pre-colonial building type were significantly different from those of colonial (28.43^0C and 67.39%) and contemporary building types (29.27^0C and 66.75%). The paper recommends that the valid traditional practices as expressed in the pre-colonial building types be re-integrated into the delivery and management of sustainable development in Nigeria. Thus, it concluded that opportunities abound in the indoor thermal comfort traceable to the traditional building (pre-colonial) types of our forebearers as they performed thermally better than colonial and contemporary building types.

Keywords: Contemporary building, Indoor thermal comfort, Okigwe-Nigeria, Sustainable development, Traditional building

1. INTRODUCTION

Optimum comfort is necessary because many health-related challenges and low productivity are traceable to poor design of buildings, especially when it has been established that humankind spends a prolonged time inside buildings performing activities (Koenigsberger et al., 1973; Nematchoua et al., 2014). Different climates, cultures and traditions similar to the diverse regions throughout the world are not gifted with all buildings materials either in type or in quantity; hence forms and types of shelter differ (Obinegbo, 2011). Each culture, tradition and region developed

its architecture based on the availability of these materials and its ability to use them within the domain of their knowledge competence. Mud (known as *aja ulo* in the Igbo language of eastern Nigeria), timber (*osisi*), bamboo (*achara*), palm midribs (*ogugu*), thatch (*akilika*) and rope (*udo*) were the principal materials used for building construction before the independence (pre-colonial) of Nigeria from the British colonialists (Nsude, 1987). During the era of the British colonialists, the building industry became influenced by their systems, materials and techniques. This was followed by hybridized building types that combined traits of traditional and foreign systems, materials and techniques (Adeyemi, 1987).

With the 1960 independence of Nigeria, the adoption and utilization of the systems, materials and techniques learnt from the colonialists reshaped the architecture of our forebearers. This was the beginning of contemporary architecture that promotes the use of electro-mechanical devices for comfort solutions. The invention of steel, glass, plywood and other materials gave more stimuli to the evolution of contemporary building types. However, compatibility with the climatic and socio-cultural milieu of the locale remains the albatross and the search for comfort and well-being of the occupants persists (Adeyemi, 1987).

The global rise in average temperature as one of the consequences of climate change results in more energy requirements for space cooling as well as concern for developing energy-conscious buildings. These issues have taken the architects and other environmental designers and planners to task for their continued reliance on imported mechanical and artificial systems, materials and techniques (Roaf et al., 2009). While attaining the desired indoor thermal comfort levels, different systems, materials and techniques were manipulated by humankind as evidenced in the components and methods of construction of buildings in the pre-colonial, colonial and contemporary historic eras.

The adaptation of building forms and materials for fabric composition from pre-colonial, colonial and contemporary times were based on fashions and socio-economic and cultural status definitions. Amid the different contemporary strategies for the delivery and management of sustainable development in the African context, not much emphasis has been placed on searching for the existence or otherwise of thermal opportunities from the inherent building types of our forebearers. Therefore, this paper, through a case study design approach, reports the developmental trend of indoor thermal comfort opportunities of building types with the design and construction traits representing the historic eras of pre-colonial, colonial and contemporary in Okigwe, Nigeria.

2. LITERATURE REVIEW

The global attainment of sustainable development in design and construction requires consideration of the needs of the present without compromising the ability of future generations to meet their own needs (El-Betar, 2017). Further, El-Betar (2017) stated that environmental friendliness, economic feasibility as well as healthiness and occupants' comfort should be the hallmark of sustainability in the construction sector. Buildings as part of the construction sector account for nearly half of all energy consumption and raw materials use around the globe and are equally responsible for a third of the total global greenhouse gas (GHG) emissions (Attmann, 2016; Alrashed et al., 2017) The forms and materials of the building envelopes constitute the interface between external and internal environments and, as such, control the energy efficiency, indoor thermal conditions and functional performance of buildings. The building envelope is

described as the climate moderator and also provides the first line of defence against the impact of the external climate on the indoor environment (Lee & Tiong, 2007).

Several strategies have been adopted by humankind to ensure acceptable thermal comfort, one of which is the use of varying forms and materials for the composition of the envelope of buildings. Others are seasonal and diurnal migrations from hot to humid areas or vice versa, or from one part of the space in the building to another in search of comfort. Equally evolved were systems of warming and cooling through heating, ventilation and air-conditioning (HVAC) and the development of life-styles and energy-consciousness toward the built environment (Roaf et al., 2009).

Givoni (1981) stated that whenever a beam of radiant heat energy strikes the surface of any solid body, it is either reflected away, absorbed or transmitted by the surface of that body. This demonstrates that building envelopes gain more heat during the day and conversely lose heat during the nights. Heat is also gained and lost through the building envelope as in the human body, thus rationalizing the significance of building envelopes and their composition in the discursive field of indoor thermal environment. However, heat is said to be transferred when there is a temperature difference between two bodies, probably between bodies of higher and lower temperatures.

The human body is very sensitive to temperature and for maintaining deep body temperature and thermal balance, the total heat gained must be equal to the total heat lost. The temperature of the human body and the interior of buildings must be maintained within a narrow range to avoid discomfort, and within a somewhat wider range to avoid danger from heat loss or cold stress. Properties of materials that constitute building envelope components are evaluated in terms of their absorptivity, conductivity and thermal capacity, as well as air-to-air transmittance (U-value), solar gain factor, time lag and admittance. Summarily, the physical built environment can also affect the thermal environment, thereby contributing to the control of the body temperature

The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) defined thermal comfort as that condition of mind which expresses satisfaction with the thermal environment (ASHRAE, 2004). Several studies such as those of Koranteng et al. (2015), Cui et al. (2013) and Djongyang et al. (2010) identified four environmental factors, namely air temperature, relative humidity, mean radiant temperature, and air velocity as well as two personal factors of metabolic rate and clothing insulation as the factors that define thermal comfort and also established the indices for its measurement. However, air temperature was singled out as the main parameter affecting design since it determines the sensation of occupants within the spaces (Al Horr et al., 2016). Koenigsberger et al. (1973) emphasized that treatment and selection of materials for the building envelope influence its thermal behaviour and aid in the reduction of the heat load. Alhaddad et al. (2013) through a simulation study revealed that indigenous materials have significantly better thermal properties as compared to contemporary building materials in Sana'a, Yemen. In another related study at Kumasi, Ghana by Koranteng et al. (2015), it was reported that materials' differences do not have any significant effect on indoor comfort but rather the orientation of the building. However, Croome (1991) and Al Horr et al. (2006) opined that human activities and aspirations can only be optimized when indoor environmental conditions are comfortable.

The design challenge in warm-humid climates revolves around the mitigation of the adverse effects of elevated temperatures and humidity. Despite concerted global efforts toward the

reduction of energy consumption for sustainable development, there is still a paucity of studies on the thermal performance of building envelopes or fabrics spanning the pre-colonial, colonial and contemporary periods in Nigeria. Wahab (2015) noted that other aspects of thermal comfort studies carried out by Sharma and Ali in 1986, Ogunsote and Pruncal-Ogunsote in 2002, Ajibola in 2001 and Adunola in 2012 concentrated on the thermal performance of residential buildings and their occupants' responses to thermal environment without looking at the influence of the envelope composition on the indoor environmental variables of air temperature and relative humidity.

Therefore, this study investigated the indoor thermal comfort qualities of air temperature and relative humidity of residential buildings in Okigwe, Nigeria, spanning pre-colonial, colonial and contemporary historic eras, with a view to drawing lessons from their fabric composition for the advancement of sustainable development in design and construction. The specific study objectives were to determine the indoor air temperature and relative humidity values of the building types and it was hypothesized that no statistically significant differences existed between the indoor air temperature and relative humidity values of these building types.

3. RESEARCH METHODOLOGY

3.1. The Study Area

Okigwe, a semi-urban city in the warm humid climate of Nigeria, lies between latitudes 5^0 30' and 5^0 57' north of the Equator and longitudes 7^0 04' and 7^0 26' east of the Greenwich Meridian. It experiences dry and rainy (wet) seasons. The mean annual temperature value is 26.4^0C with 27.6^0C, 25.0^0C and 2.6^0C as maximum, minimum and range values respectively. The annual precipitation is over 2000mm. Relative humidity is high in the mornings and during rainy seasons, ranging from 80% to 100% while in the afternoons and dry seasons it drops to between 60% and 80% respectively. Okigwe experiences the conventional type of rainfall owing to its proximity to the equatorial belt. Rainfall is heaviest during the months of June and July.

3.2. Research Design

This paper reports findings from a parent study on a comparison of indoor thermal comfort conditions of traditional and contemporary buildings in the dry season at Okigwe, Nigeria. The parent study was done with the aim of establishing design criteria for a thermally comfortable environment and the objectives examined thermal design characteristics and sensations of the occupants. It also determined indoor environmental variables of air temperature and relative humidity and compared their thermal sensations, indoor air temperature and relative humidity values.

To gain an in-depth understanding of the phenomenon of indoor and outdoor air temperature, the case study research design approach was adopted. The primary data were collected on three purposively sampled existing residential buildings representing the fabric composition of pre-colonial, colonial and contemporary building types, whereas the secondary data were obtained from the nearest meteorological station, Imo State International Cargo Airport, Owerri, Nigeria.

From Table 1 it can be learnt that the pre-colonial building type was a bungalow with mud walls, thatch roof and rammed earth floor with no ceiling cover. It is located between latitude 5^0 48' 57" N and longitude 7^0 18' 45" E. The colonial building type was a bungalow constructed with

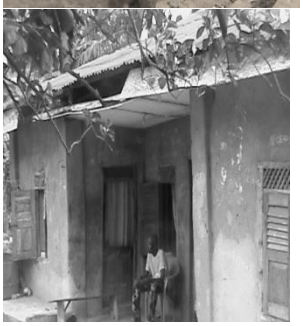
mud walls and roofed with corrugated iron metal sheets. It had partial ceiling cover internally and none externally except for the open entrance foyer area. The floor finish was made of rammed earth. It lies between latitude 5^0 49' 16" N and longitude 7^0 19' 04" E. It had the characteristics of both pre-colonial (mud walls) and colonial (corrugated iron metals sheets) building types. The contemporary building type was a bungalow made of sandcrete blocks as walling material, corrugated iron metal as roofing sheets and cement/sand screed as flooring material. It had asbestos ceiling sheets and is located between latitude 5^0 44' 48" N and longitude 7^0 11' 36" E.

3.3. Data Collection

The indoor environmental variables of air temperature and relative humidity were monitored simultaneously on an hourly basis for 366 days (1 November 2015 to 31 October 2016). Tinytag Explorer 4.9 Germini Data Loggers (an air temperature range of -25^0C to +85^0C and a relative humidity range of 0% to 100%) were mounted on a height of 1200mm above the finished floor level. Table 2 shows annual mean minimum and maximum values and a statistical summary of indoor air temperature (^{0}C) and relative humidity values of the pre-colonial, colonial and contemporary building types from November 2015 to October 2016.

Table 1. Envelope Characteristics of the Sampled Building Types

Type	Pre-Colonial Building type	Colonial Building type	Contemporary Building type
Nature	Bungalow	Bungalow	Bungalow
Roof	Thatch (akilika)	Iron metal sheets	Iron metal sheets
Wall	Mud (aja-ulo)	Mud (aja-ulo)	Sandcrete Blockwall sheets
Floor	Rammed earth	Rammed earth	Cement/Sand screed
Ceiling	No ceiling	Partially	Asbestos sheets
Latitude	5^0 48' 57" N	5^0 49' 16" N	5^0 44' 48" N
Longitude	7^0 18' 45" E	7^0 19' 04" E	7^0 11' 36" E

Photo			
			

(Source: Fieldwork, 2016)

3.3.1. Data on Indoor Air Temperature and Relative Humidity Values

Table 2. Statistical Summary of Indoor and Outdoor Air Temperature (^{0}C) and Relative Humidity (%) of the Sampled Building Types from November 2015 – October 2016

	Pre-Colonial Building Type	Colonial Building Type	Contemporary Building Type
		Indoor Air Temperature	
Frequency		366	
Annual Mean Temp. (^{0}C)	27.83	28.43	29.47
Annual Min. Temp. (^{0}C)	24.60	25.18	25.44
Annual Max Temp. (^{0}C)	32.13	32.49	33.00
Standard Deviation	1.57	1.55	1.59
		Indoor Relative Humidity	
Annual Mean RH (%)	70.89	67.39	66.75
Annual Min. RH (%)	19.76	19.26	19.77
Annual Max RH (%)	90.83	87.08	87.36
Standard Deviation	18.61	17.14	17.44
		Outdoor Temperature	
Annual Mean Outdoor Temp. (^{0}C)		29.00	
Annual Mean Outdoor RH (%)		69.9	

(Source: Fieldwork, 2016; Meteorological Station, Imo State International Cargo Airport, 2016)

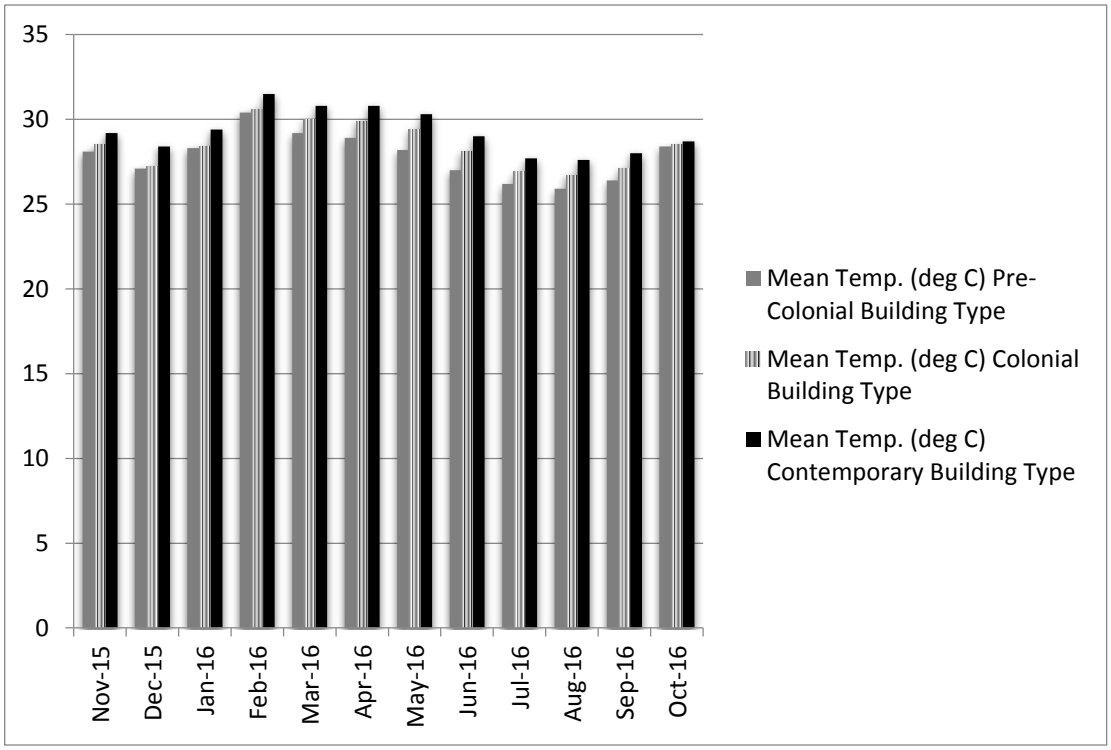


Figure 1. Comparison Chart between the Monthly Mean Indoor Air Temperature (^{0}C) Values of the Sampled Building Types from November 2015 – October 2016

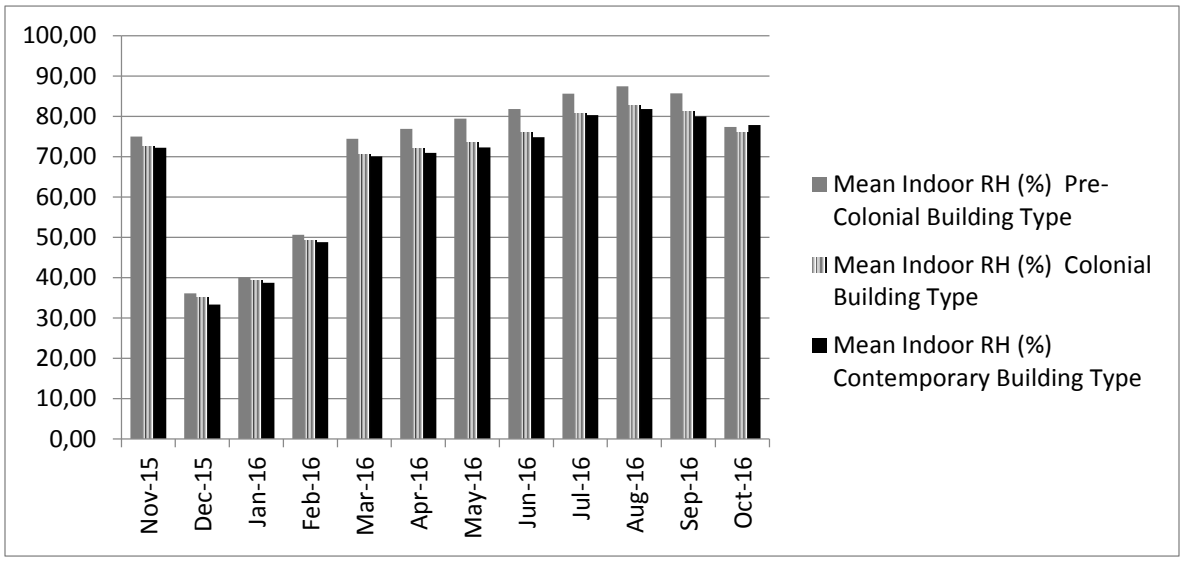


Figure 2. Comparison Chart between the Monthly Mean Indoor Relative Humidity (%) Values of the Sampled Building Types from November 2015 – October 2016

4. FINDINGS AND DISCUSSION

Table 2 shows that the mean and standard deviation of indoor air temperature values of pre-colonial building type were 27.83^{0}C, and 1.57^{0}C respectively, whereas 32.13^{0}C and 24.60^{0}C were recorded as maximum and minimum respectively. The colonial building type had M = 28.43^{0}C, and SD = 1.55^{0}C, with maximum and minimum indoor air temperature values as 32.49^{0}C and 25.18^{0}C. In the contemporary building type, M = 29.27^{0}C, and SD = 1.59^{0}C, and maximum and minimum indoor air temperature values of 33.00^{0}C and 24.44^{0}C were recorded. Furthermore, the mean and standard deviation of indoor relative humidity for the pre-colonial building type were 71% and 19% respectively. The maximum and minimum indoor relative humidity values of 91% and 20% respectively were recorded. The colonial building type had M = 67%, and SD = 17% with maximum and minimum indoor relative humidity values as 87% and 19% respectively. In the contemporary building type, M = 67%, and SD = 17%, maximum and minimum indoor relative humidity values were obtained as 87% and 20% respectively. The mean annual outdoor temperature and relative humidity values were 29.0^{0}C and 69.9% respectively.

Two null hypotheses were postulated on the non-existence of statistically significant differences between indoor air temperature and relative humidity values of the building types and were tested at 95% confidence level. A one-way ANOVA test shown in Table 3 was conducted to compare the indoor thermal comfort conditions of the three building types, namely pre-colonial, colonial and contemporary, using their indoor air temperature values. The result showed that the overall F was significant [F (2, 1095) = 77.56, p = 0.0001]. Another ANOVA test shown in Table 4 was conducted to compare the indoor thermal comfort conditions of the three building types, namely pre-colonial, colonial and contemporary, using their indoor relative humidity values. The result also showed that the overall F was significant [F (2, 1095) = 5.76, p = 0.0001].

Tukey's HSD (honest significant difference) post-hoc analyses were conducted given the statistically significant omnibus ANOVA F-tests as reported in Tables 3 and 4. The tests were conducted on all possible pair-wise comparisons. The null hypothesis for indoor air temperature was rejected because the absolute mean difference of the paired group was larger than the critical value calculated as 0.2264. The following pairs of groups were found to be significantly different: pre-colonial building type (M = 27.83^{0}C, SD = 1.57^{0}C) with colonial building type (M = 28.43^{0}C, SD = 1.55^{0}C); pre-colonial building type (M = 27.83^{0}C, SD = 1.57^{0}C) with contemporary building type (M = 29.27^{0}C, SD = 1.59^{0}C), and colonial building type (M = 28.43^{0}C, SD = 1.55^{0}C) with contemporary building type (M = 29.27^{0}C, SD = 1.59^{0}C). However, the result shown in Table 5 indicates that a mean difference of 1.44^{0}C exists between pre-colonial and contemporary building types; 0.84^{0}C between colonial and contemporary building types and the least mean difference of 0.6^{0}C was determined for pre-colonial and colonial building types.

Table 3. ANOVA Test for Indoor Air Temperature (^{0}C) of the Building Types

	Source of variation	SS	df	MS	F	Sig
Indoor air temperature of the building types	Between groups	382.60	2	191.30	77.56	0.0001
	Within groups	2700.80	1095	2.47		
	Total	3083.40	1097			

Table 4. ANOVA Test for Indoor Relative Humidity RH (%) of the Building Types

	Source of variation	SS	df	MS	F	Sig
Indoor RH						
	Between groups	3621.62	2	1810.81	5.76	0.0001
	Within groups	344524.34	1095	314.63		
	Total	348145.96	1097			

Table 5. Post-Hoc Comparison for Indoor Air Temperature (^{0}C) of the Building Types

Buildings/ Mean (^{0}C)	Group (^{0}C)	Absolute Mean difference (^{0}C)	Critical value	Significant
Pre-colonial building type (27.83)	Colonial (28.43)	0.6	0.2264	Significant
	Contemporary (29.27)	1.44	0.2264	Significant
Colonial building type (28.43)	Pre-colonial (27.83)	0.6	0.2264	Significant
	Contemporary (29.27)	0.84	0.2264	Significant
Contemporary building type (29.27)	Pre-colonial (27.83)	1.44	0.2264	Significant
	Colonial (28.43)	0.84	0.2264	Significant

Table 6. Post-Hoc Comparison for Indoor Relative Humidity (%) of the Building Types

Buildings/ Mean (%)	Group (%)	Absolute Mean difference (^{0}C)	Critical value	Significant
Pre-colonial building type (70.89)	Colonial (67.39)	3.5	2.56	Significant
	Contemporary (66.75)	4.14	2.56	Significant
Colonial building type (67.39)	Pre-colonial (70.89)	3.5	2.56	Significant
	Contemporary (66.75)	0.64	2.56	Not significant
Contemporary building type (66.75)	Pre-colonial (70.89)	4.14	2.56	Significant
	Colonial (67.39)	0.64	2.56	Not Significant

For indoor relative humidity, the null hypothesis was rejected because the absolute mean difference of the paired groups was larger than the critical value calculated as 2.56. The following pairs of groups were found to be significantly different: Pre-colonial building type (M = 71%, SD = 19%) with colonial building type (M = 67%, SD = 17%); and pre-colonial building type (M = 71%, SD = 19%) with contemporary building type (M = 67%, SD = 17%). However, there was no significant difference between the pair of colonial building type (M = 67%, SD = 17%) with contemporary building type (M = 67%, SD = 17%). From Table 6 the highest mean difference of 4.4% was observed between pre-colonial and contemporary building types, followed by 3.5% between pre-colonial and colonial building types. The least mean difference of 0.64% was between pre-colonial and contemporary building types and it showed that no significant difference existed in the indoor relative humidity values of the two building types.

In understanding the envelope characteristics of the building types, Lee and Tiong (2007) and Evans (1980) aptly described the building envelope as the climate moderator and the interface between external and internal environments. The composition of the different materials and methods of construction of buildings in the pre-colonial, colonial and contemporary historic eras as evidenced from Table 1 were not the same. This corroborates the view of Obinegbo (2011) that forms, and types of shelter differ. It was also reported by Koenisberger et al. (1973) that the treatment and selection of materials for the building envelopes influence its thermal performance and aid in the reduction of the heat load. It should be noted that only the contemporary building type had a form of ceiling cover with asbestos sheets. Thermal barriers between roof and interior spaces reduce the internal surface temperature of the interior spaces as low as possible.

From the analyses, there were significant differences indicating that the internal environment of the building types under investigation reacted differently to the totality of transmitted and absorbed heat from the incident solar beam radiation because of the interplay between the materials of their fabric compositions. In both indoor air temperature and relative humidity cases, the pre-colonial building type differed significantly with the annual mean indoor air temperature value of 27.83^{0}C which is lower than the colonial and contemporary building types by 0.6^{0}C and 1.44^{0}C respectively. Similarly, the annual mean relative humidity value of 71% for the pre-colonial

building type is higher than the 67% and 67% of the colonial and contemporary building types respectively as shown in Figure 2.

In all ramifications, the materials for the envelope (wall and roof) composition of pre-colonial building type, namely mud (known as *aja ulo* in the Igbo language of eastern Nigeria), timber (*osisi*), bamboo (*achara*), palm midribs (*ogug*u), thatch (*akilika*) and rope (*udo*), played significant roles in its better thermal performance. As shown in Figure 1, the consistently lower mean monthly indoor temperature values as against those of the colonial and contemporary building types made the pre-colonial building type to be described as a building type with excellent thermal properties (Evans, 1980). Despite the absence of a thermal barrier in the form of ceiling cover, the pre-colonial building type recorded a lower indoor air temperature. Also, in comparison with the annual mean outdoor temperature value of 29.0^0C, the pre-colonial building type better modified the relationship between external and internal environments with a difference of 1.17^0C than colonial and contemporary building types.

The findings of this study aligned with those of Alhaddad et al. (2013) in Sana'a, Yemen, where the effects of different building materials on the indoor thermal comfort of residential buildings were compared and it was found that indigenous materials performed significantly better than contemporary building materials. Koranteng et al. (2015) in Kumasi, Ghana studied the effect of different wall materials at different orientations on indoor thermal comfort of residential buildings. The findings differed from this study because it examined only the effects of orientation and wall materials, whereas the effects of the components of the building fabric on indoor thermal comfort were investigated in this study.

The development of indoor thermal comfort performance of the building types with advancement of time appeared rather worrisome and retrogressive. The mean difference between pre-colonial and colonial was 0.84^0C; pre-colonial and contemporary 1.44^0C. This implies that the systems, materials and forms of contemporary building types ordinarily did not improve the efforts of our forebearers if it were not for the assistance provided by electro-mechanical devices. Despite these inherent opportunities, the traditional practices of our forebearers as expressed in these inspired and ingenious buildings of the pre-colonial era are being discarded in favour of contemporary systems, materials and techniques which have continually and negatively impacted on energy consumption and environmental resources as noted by De Dear and Brager (1998).

5. CONCLUSIONS AND RECOMMENDATIONS

This study investigated the forms and materials of the building envelopes since they constitute the interface between external and internal environments and consequently control the energy efficiency, indoor environment and functional performance of the buildings. The study also observed the indoor air temperature and relative humidity values and determined the differences between thermal performances of the building types spanning pre-colonial, colonial and contemporary historic eras. These relationships and differences were investigated with the aim of drawing lessons from their fabric composition for the advancement of sustainable development in design and construction.

The study revealed that in terms of indoor air temperature and relative humidity, the thermal performances of the building types were significantly different, indicating that their fabric compositions affected indoor levels of thermal comfort. However, with regard to indoor air temperature, the pre-colonial building type performed best when compared with the 1.44^0C and

0.6^0C of the contemporary and colonial building types respectively. The colonial building type performed better than the contemporary building type with a mean difference of 0.84^0C. As per relative humidity, the pre-colonial building type recorded higher values than contemporary and colonial building types by 4.14% and 3.5% respectively. There was no significant difference between colonial and contemporary building types in terms of relative humidity. Therefore, it can be interpreted that solar beam radiation on the fabric of pre-colonial building type in Okigwe, Nigeria yielded a lower indoor air temperature which meant a cooler indoor environment than colonial and contemporary building types.

One of the global concerns for sustainable development is the reduction of energy consumption in the construction sector since buildings have been adjudged as major contributors to the global greenhouse gas (GHG) emissions. The study thus recommends that the materials for roof, wall and floor compositions as in pre-colonial building type should be integrated in the discursive field of the delivery and management of building designs and construction for sustainable development as they possess good inherent indoor thermal comfort qualities that provide an acceptable indoor thermally comfortable environment. Furthermore, research and development should be encouraged for the promotion of African-based knowledge systems and their integration into curricula programmes of African centres of learning.

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CONVENTIONAL AND SUSTAINABLE BUILDINGS: A COMPARATIVE BENEFIT AND COST ANALYSIS

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ABSTRACT

The study examines conventional and sustainable buildings and whether there are significant differences between these two building types based on benefit and cost. The rationale for the examination is the general belief among stakeholders that although there is an increasing need to provide sustainable and affordable buildings for both housing and commercial purposes, buildings procured using sustainable construction initiatives are significantly more expensive than those constructed through a conventional construction approach. The study adopted a quantitative research approach using semi-structured questionnaires involving a combination of both open and close-ended questions in eliciting objective and subjective benefit and cost information on sustainable and conventional buildings from purposively selected construction industry stakeholders in South Africa. The study results indicate that there were perceived cost advantages in both conventional and sustainable buildings and that the cost difference between both sustainable and conventional buildings is less significant than perceived by construction stakeholders. This challenged previous ideas about a significant cost difference between both building types. The study thus concludes that since the cost difference between the two buildings is insignificant, the government should encourage sustainable building development through incentives and legislation because of its ecological advantage. The results of the study are of significance because it provides a business case to support the active development of sustainable buildings due to the insignificant difference in cost between sustainable and conventional buildings and the environmental benefits of sustainable buildings. However, the results are limited by the smallness of the sample size which is because stakeholders who have experience in the construction of both sustainable and conventional buildings are few and are not therefore generally distributed in the target population. A more extensive study, which includes other cities such as Cape Town, Durban and Pretoria, and which will confirm the findings of this research, is recommended.

Keywords: Cost, Conventional building, Construction method, Sustainable building

1. INTRODUCTION

Sustainable construction is a combination of sustainable building features including water efficiency, energy and atmosphere, material and resources, the indoor environment of a building, sustainable sites, innovation and the construction process. According to Du Plessis et al. (2002), sustainable construction practices mean that all the principles of green buildings are initiated, from the extraction of raw materials to the deconstruction and disposal of waste material. Du Plessis et al. (2002) refer to conventional practices as an agenda that accentuates the problems of poverty and underdevelopment by using more environmental resources. In this paper, the term 'green building practices' is used interchangeably with 'sustainable construction methods'.

McNamara (2010) identifies some reasons for the slow adoption of green building practices on construction projects as people's or companies' mindsets regarding the implementation of these techniques; technology and economics of a country; lack of clarity from government or any higher authority regarding green building legislation requirements, making it difficult to monitor and guide people in the industry; and the costs incurred by real estate developers, construction companies, tenants and owners, both directly and indirectly. For example, this has meant that construction company employees and suppliers undergo training regarding green building techniques and practices so that they are compliant with environmental standards. Ali (2009) posits that even though an investor might gain through benefits such as low maintenance costs, the payback on the investment made in going green could take years. Furthermore, investors are often skeptical about green buildings practices owing to the perceived higher cost and financial implications that are associated with them (UNEP, 2009).

According to Kruse (2004), there are calls for the construction industry to adopt green building practices and to refrain from conventional construction methods owing to their negative impact on the environment, including climate change. The continuous use of conventional building practices, which include heavy loads, use of cranes on site, and electrical hot work by firms in the industry, contribute to environmental degradation and major changes to the climate, such as global warming leading to torrential rains and floods. Lack of working documents that mandate the use of green building techniques by construction stakeholders and the perception of high costs linked to green buildings have probably led to the continuous use of conventional building methods in South Africa. Though the majority of stakeholders in the construction industry are aware of green building projects, they are unaware of the actual cost of these green-building projects compared to conventional projects and are also unaware of what constitutes green building practices (Kaplow, 2010). This study therefore examines conventional and sustainable methods used on construction projects in South Africa, their benefits and whether there are significant differences between these practices (conventional and sustainable) based on cost. This is towards understanding the issues relating to the perceived low adoption of sustainable construction methods on projects.

2. OVERVIEW OF THE CHARACTERISTICS OF CONVENTIONAL AND SUSTAINABLE CONSTRUCTION

This section gives an overview of the characteristics of the conventional and sustainable construction, consisting of a review of construction stakeholders, stakeholders' level of awareness of sustainable construction methods, the cost of sustainable versus conventional construction, and the advantages and disadvantages of sustainable and conventional construction.

2.1. Construction Stakeholders

Governments are major stakeholders in all public projects, and their regulatory bodies get to formulate rules and guidelines for sustainable construction (Windapo & Goulding, 2015; DPW, 2007). Other stakeholders who have an impact on the planning and construction of a project are the design team members. The design team members influence the design of a project, materials to be used, disposal of materials, and the financial side of the project (McNamara, 2010). The other stakeholders who are active in advocating for environmental and green building construction are non-governmental organizations (NGOs) and community-based organizations (CBOs). These organizations usually play a 'watchdog role', which includes the monitoring and evaluation of environmental and climate issues (Du Plessis et al., 2002). These organizations include the United Nations Environment Programme (UNEP), the Council for Scientific and Industrial Research (CSIR), the International Environmental Technology Centre (IETC), the Green Building Council of South Africa (GBCSA), the Council for Research and Innovation in Building and Construction (CIB), the Construction Industry Development Board of South Africa (cob) and Agenda 21.

2.2. Stakeholders' Level of Awareness of Sustainable Construction Methods

Previous studies by Webb (2005) based on a survey conducted in the United States of America, as well as studies by Umar and Kamidi (2012) and Windapo and Goulding (2015) show that most stakeholders are not aware of sustainable construction methods and initiatives or the role that they should play when it comes to these. Webb (2005) established that a significant number of experts in the field of green building identify green building practices as an energy-saving approach, and regard materials as an important focus as opposed to water efficiency and air quality. This point is also emphasized by Umar and Kamidi (2012), Copiello and Bonifaci (2015), and Stephan and Stephan (2016), who determined that green building is perceived mainly as energy efficiency. Jay et al. (2013) note that the problem of awareness is linked to a lack of understanding regarding sustainability. Ecological matters drive sustainability, but the expanded form of sustainability includes economic and social development as well (Littig & Griebler, 2005). Windapo (2014) found that economic considerations drive most green building initiatives and trying to balance economic and social matters with environmental matters can become a problem.

2.3. Cost of Sustainable versus Conventional Construction

There is a cost differential between building projects constructed using conventional construction methods and those in which sustainable methods are used. The perception amongst construction scholars is that the construction costs of green buildings (the final product of the sustainable construction process) are very high. For example, a study by Adamson (2004) found that the initial costs of a green building are slightly higher than, or match, those of conventional buildings. Kaplow (2010) also found in a study of 107 projects in New York City, out of which 63 undertook green building practices under the LEED rating certification (a green building rating used in the USA), that the cost per square foot of green building projects was $440, compared to $436 per square foot for conventional buildings, and the median costs of design fees for green-star rated buildings were $0.56 per square foot, compared to $0.30 for conventional projects. In a related study, Cruywagen (2013) established that the cost difference between green and conventional buildings is approximately 7.58% based on a case study of a four-star rated green building that was upgraded to five stars in Johannesburg, South Africa and that costs decrease as the green building methods used are improved.

According to Du Toit (2014), sceptics of sustainable construction methods argue that there are substantial cost premiums to be paid when constructing a green building. However, the advocates of green buildings such as Matthiessen and Morris (2004) argue that these extra costs can be quickly recovered through the faster lease-up, rental premiums and increased market valuation of the green building. Matthiessen and Morris also argue that by making use of experienced green building consultants in the design and supervision of the project, the cost can be controlled, and extra costs usually incurred by green buildings can be curbed. Also, according to the Natural Resource Defence Council (NRDC 2014), if the investor or developer intends to construct another building, they could benefit from using the same design and supervision team.

Matthiessen and Morris (2004) posit that the cost difference between the two construction types is insignificant when compared to the benefits that investors and occupants accrue after the project has been completed. They add that the level of the cost difference is dependent on the design of the building and whether it is sustainable. Suttel (2006) agrees and states that green buildings can be constructed at little or no extra cost as long as the initial design is thoroughly done. Suttel (2006) notes that there is no data for calculating the comparative costs of a conventional building versus those of a green building or vice versa and posits that this has led to the general idea that green buildings are more expensive than conventional buildings and to the continuous implementation of conventional construction practices.

2.4. Advantages and Disadvantages of Sustainable Construction

Cruywagen (2013) identifies the advantages of green building practices as including the recycling of construction waste for later use, the use of locally available building materials, controlling pollution (noise, light and air), protection of natural habitats, limiting stormwater runoff, efficient and low maintenance of buildings, and the use of low-emitting materials and less harmful equipment on projects. Suttel (2006) groups the potential benefits of green buildings according to the different aspects of life affected by them. He elaborates that these benefits are dependent on design and construction teams working together in the initial stages of the project. The three classes he identifies are environmental benefits, economic benefits and social benefits.

The environmental benefits of green buildings are: (1) the enhancement and protection of biodiversity and the ecosystems. As noted by Du Plessis et al. (2002), green buildings are concerned about the ecosystem's well-being, and their design and construction incorporate the environment and try to minimize damage or disturbance to it as much as possible; (2) the improvement of air and water quality. Green building projects seek to improve the quality of the air and water involved in the project and this is one of the nine criteria for achieving green star rating (Green Building Council of South Africa [GBCSA], 2013); (3) the reduction of waste streams. Components are designed to fit together with less wastage, and therefore designers must ensure that their design has minimal wastage regarding layout: that is, the design should be efficient enough for most of a tile to be used (GBCSA, 2013); and (4) the conservation and restoration of natural resources. At the design stage of a project, the designers specify the material to be used for a project based on the availability of that resource in the area.

The economic benefits of green buildings are: (1) reduced operating costs. This is a major pull factor for most investors or clients because, for example, the operational cost of a high electrical bill, which would be caused by conventional air conditioning, can be minimized (Wessels, 2012); and (2) the profitable trade in green products and services. Currently there is a relatively short supply of green building products in the market, so they are relatively costly. This has led to less competition and more profits made on green building components and services. The

social benefits of green buildings are: (1) the enhancement of occupant comfort and health. For example, the green building project, the No. 1 Silo in Cape Town, uses natural water from the sea to cool the building, which improves air quality as occupants breathe natural air as opposed to air-conditioned air (Wessels, 2012); and (2) improvement in aesthetic qualities. Most green buildings are designed with huge glass windows to allow natural light to enter, which make these buildings appealing.

Du Plessis et al. (2002) identify the disadvantage of going green as sacrifices by current generations for the benefit of future generations. Cruywagen (2013) concurs, calling this problem "…the present perception of future utility". This occurs when there is uncertainty in accounting for the world's future, and a problem of dealing with unease in making decisions based on this uncertain future. Therefore, the disadvantage of green buildings is that investors are asked to trade current benefits offered by conventional buildings with the promise of future benefits, calling for a moral cost-benefit analysis where stakeholders are forced to consider future generations' well-being. Other disadvantages are, firstly, the cost. The general perception is that green buildings are costlier when compared to conventional buildings (Matthiessen & Morris, 2004); secondly, air-cooling features, supplementing the use of natural cooling components, with the use of mechanical appliances (Labour Law Centre Report, 2011); thirdly, labour laws. Labour laws have not yet been developed and green building projects still use conventional laws and this can be problematic; and finally, the delay in obtaining green building permits because of its unconventional approach.

2.5. Advantages and Disadvantages of Conventional Construction

According to Osterberger et al. (2003), conventional construction is based on the assumption of "anticipated loading, common practices, use of traditional materials", and the construction of buildings of a typical size and shape. Owing to the current demand for innovative materials, and the increased complexity and size of projects, conventional construction is no longer adequate. Davis et al. (2008) mention that conventional construction has advantages, such as accountability caused by competitive selection based on an abundant supply of contractors, suppliers, consultants and subcontractors in the construction market who are willing to bid and execute work; prior experience on how to execute construction tasks; the construction practices used have been tried and tested; and consultants have rates to work with from previous project estimates and this makes the management of a conventional building project easier as available historical information can be used.

Disadvantages of conventional construction identified in literature are: (1) conventional construction is based on history, and it is therefore difficult to determine when the construction techniques are inadequate; and (2) the general practices of conventional building construction are transferred from project to project even though the techniques do not necessarily suit the project at hand. It is noted that this one-size-fits-all style of construction has led to other disadvantages, which include the carrying over of bad practices such as mismanagement and waste of resources (Osterberger et al., 2003; Tam et al., 2007).

3. RESEARCH METHODOLOGY

This research is based on a quantitative approach, and the data was collected quantitatively by sending out semi-structured questionnaires (with a combination of both open and close-ended questions) to the clients and design team members who worked for organizations that were

involved in the delivery process of four green star-rated buildings in the Johannesburg area of South Africa. It was not the intention of the research to do a multi-case study but rather to use the four green star-rated buildings to reach respondents who have probably worked on both green and conventional building projects. The use of a quantitative approach was driven by the need to answer questions related to the costs and benefits of green and conventional buildings. The research analyses and summarizes the costs and benefits of using sustainable/green construction practices against those of conventional construction. Therefore, the following hypothesis (H_A) was stated to guide the direction of the study:

H_A: The construction costs of sustainable/green buildings are significantly higher than those of conventional buildings.

This study therefore proceeded as follows: (1) a literature review of topics related to sustainable and conventional construction; (2) data collection using semi-structured questionnaires sent to project clients or representatives and other project stakeholders; (3) data analysis to establish whether there are any trends or common denominators between the two practices; and (4) a review of the findings and interpretation of the data collected.

3.1. Research Design

A survey research design was used in eliciting data from a study population who have worked on both green and conventional building projects. This is because it was not easy to identify respondents who have experience in both methods of construction and the view was that a survey approach would facilitate this. The research conducted was based on an objective view of reality and a positivist paradigm. A quantitative approach was therefore used in the research to present the data in a numerical format, prove or disprove the hypothesis stated to guide the direction of the study and generalize the concepts appropriately in a conclusion. This method is supported by *Boundless Journal* (2014) which notes that for a researcher to draw a statistical generalization across an entire population, a survey using a quantitative approach should be used.

3.2. Study Population

The population for this research comprised the consultants, contractors, government department, and green building advocating organizations which were involved in the delivery of four green star-rated building projects within the Johannesburg area of South Africa. The assumption was that the individuals targeted for the research were able to answer questions related to the costs of sustainable/green versus conventional construction. The choice of Johannesburg was based on the information that there were sixteen green building projects registered in the Gauteng Province compared to the other provinces in South Africa, and the City of Johannesburg alone had four green star-rated projects as of January 2013 (GBCSA, 20013). The four green star-rated building projects investigated are the Nedbank offices in Sandton, Vodafone Site Solution Innovation Centre, Forty on Oak in Melrose Arch, and Upper Grayston Office Park. Information relating to these products was obtained from the GBCSA website.

3.3. Sampling Technique and Sample Size

According to Leedy and Ormod (2010), sampling aims to describe a population based on information observed or provided by a selected few members of that population. The sample obtained for this research should therefore be a representative of construction stakeholders who can answer questions about green and conventional building projects. A purposive sampling

technique was therefore used in selecting the study respondents. This research identified eight (8) types of construction stakeholders – found within professional quantity surveying firms, architectural firms, management consultants, contracting organizations, the GBCSA, and the Public Works Authority Department of Johannesburg – involved in the delivery process of the identified four green star-rated building projects in the Johannesburg area. The intention was not to study or use these projects as case studies but rather as a means of identifying possible respondents and collecting relevant data.

Table 1 shows the classification and number of respondents selected from each stakeholder group involved in the construction of the four green star-rated buildings in the targeted area. A sample size of forty respondents was selected with the assumption that at least thirty responses representing the target population would be obtained, giving a more accurate conclusion (Xu, 1999). This sample size depends on aspects such as the population of construction stakeholders on each project and the confidence level.

It is acknowledged that selecting project stakeholders involved in the delivery process of four green star-rated building projects in the Johannesburg area as the target population to represent a whole population is a form of bias. However, an effort was made to eliminate further bias by selecting respondents from different companies, professions and organisations involved in the project delivery process.

Table 1. Distribution of Respondents by Organization and Profession

Professional/Department	No. of respondents
Contractor/sub-contractors	12
Architects	4
Client	4
Engineers	4
Government	4
Green Building Advocates	4
PQS	4
Project Manager	4
Total	**40**

3.4. Method of Data Collection

Semi-structured questionnaires were used as primary data collection instruments. The semi-structured questionnaire contained both open and closed-ended questions and was distributed via electronic means to the targeted stakeholders and companies between October 2013 and February 2014. From the forty (40) questionnaires sent to the respondents, twenty (20) were returned complete, representing a 50% response rate. The reasons for this response rate were firstly, that some consulting companies, such as AECOM, Solid Green and Abland, had a presence in more than one green building project: the survey distribution list shows that Solid Green was the green building consultant at the Melrose Arch, Alice Lane and Lakeside Projects, thereby narrowing the pool of respondents; secondly, probably the fact that the respondents had limited knowledge of green building methods (only six of the targeted respondents have experience in sustainable construction - see Table 2); and thirdly, that the information about finances of a project is usually kept confidential.

3.5. Method of Data Analysis

The collected questionnaires were first checked for completeness and grouped according to responses. For this study, data were extracted from the completed questionnaires and presented in graphs and charts using Microsoft analytical tools and Statistical Package for the Social Sciences (SPSS) software. The data were then analysed using descriptive analysis techniques (bar charts and percentages tables). Data from open-ended responses were analysed thematically by taking the narrative formats from questionnaires and representing the data statistically by grouping the responses according to the standard responses. The hypothesis developed to guide the direction of the study was tested using the t-test inferential statistical analysis technique.

4. DATA PRESENTATION AND ANALYSIS

The data collected in the study are presented under the following sub-sections:

4.1. Distribution of Respondents by Representative Organizations

Data collected revealed that a significant number of the respondents are affiliated to quantity surveying firms (22%) and construction companies (22%), followed by government departments (17%), client organizations (13%), green building organizations (9%), engineering firms (9%), project management firms (4%) and architectural firms (4%).

4.2. Experience in Sustainable and Conventional Construction Methods

The study sought to know whether the respondents have experience in sustainable construction methods. This question was posed as a multiple-choice question with a 'Yes' or 'No' response. Table 2 shows that 30% (6) of respondents acknowledged having experience in sustainable construction methods while 70% (14) indicated that they do not have experience in that area.

Table 2. Experience in Sustainable Construction

Experience in Sustainable Construction		Total No. Respondents
Yes	No	
6	14	20

The study also sought to uncover whether respondents have conventional construction experience, which is the standard building practice adopted on projects in South Africa. Data collected in this regard show that 90% (18) of the respondents have conventional construction experience while 10% (2) have none. The two respondents that indicated that they do not have conventional construction experience are both affiliated with green building organizations.

4.3. Sustainable Construction Methods used on Subject Projects

The study sought to find out from the six respondents involved in green building projects which green building practices were implemented on their projects as stipulated by the GBCSA rating standards. This question allowed respondents to give multiple responses, dependent on the practices that they used on their projects. The data collected in this regard are presented in

Table 3.

For a building to be classified as green, there are specific practices and steps that must be followed. These practices are stipulated in the contract of each project and usually determine the rating the building is given (GBCSA, 2013). Table 3 reveals that 67% of the respondents indicated that they did use local and renewable materials, while 50% use waste and water control practices. Efficient and effective transportation and controlled dust and sulphur emissions recorded 33%, 33% and 17% respectively. Other respondents not involved in green building projects indicated answers based on conventional projects. It is important to note that all projects, including conventional projects, adopt green building legislation requirements and some of these overlap with the GBCSA policies.

Table 3. Green Building Practices Implemented in Subjects' Project

Green Building Practices	No. of Respondents	Mean Percentage Response Rate
Local and renewable material	4	67%
Waste and water control	3	50%
Efficient and effective transport and supply chain	2	33%
Control dust pollution	2	33%
Use of low sulphur emitting equipment	1	17%

4.4. Similarities and Differences between Sustainable and Conventional Construction Methods

The six respondents that acknowledged experience in sustainable and conventional construction methods were asked to indicate similarities and differences between the two methods by answering an open-ended question. Data collected in this regard are presented in Table 4.

Table 4. Similarities and Differences between Sustainable and Conventional Construction Methods

Similarities	Frequency
Same basic structure/similar workflow and documentation	5
Locally available materials	2
Same construction techniques, practices and methodology	2

Differences	Frequency
Greater consideration of green products/specifications/certification of material sources.	3
Green buildings are environmentally conscious (e.g. in terms of waste, carbon emissions etc.).	3
Green buildings are more energy efficient to run.	2
Time. Audit trail of the material source to be documented/Green building development takes longer/adherence to green star rating tool requirements can be onerous.	2
Green buildings are more expensive.	2
Construction methods used differ.	1
Life cycle assessments consider operation and maintenance costs - more than construction cost.	1

The most common similarity noted between the two construction practices was the similar workflow and documentation. One respondent viewed sustainable construction practices as merely an addition or adjustment to conventional practices. A difference between the two practices, which was noted, was the cost differences between the two construction methods, with respondents noting the higher costs of sustainable construction when compared to conventional construction. Another difference highlighted is that sustainable/green construction practices tend to be more environmentally conscious regarding materials used and waste generated when compared to conventional construction practices. This supports the alternative hypothesis that the cost of green buildings is significantly higher than that of conventional buildings.

4.5. Benefits of Sustainable and Conventional Construction Methods

The benefits of sustainable and conventional construction methods were investigated in the study. Respondents were allowed to tick multiple answers and responses provided are presented in Table 5 and Figure 1. While Table 5 reveals that all respondents indicated that their green building projects experienced reduced heating and cooling costs, followed by noise reduction, improved air quality and increased property value in ranking order, Figure 1 shows that the applicable benefits of using conventional building methods on projects are easy access to data and rates, a readily available workforce, time-saving, locally available building materials, the ease of knowledge transfer and experience, and reduced construction costs in ranking order.

Table 5. The Benefits of Sustainable Construction

Benefits of sustainable construction	Mean percentage response average
Reduced heat and cooling costs	100%
Noise reduction	63%
Improved air quality	38%
Increase in property value	13%

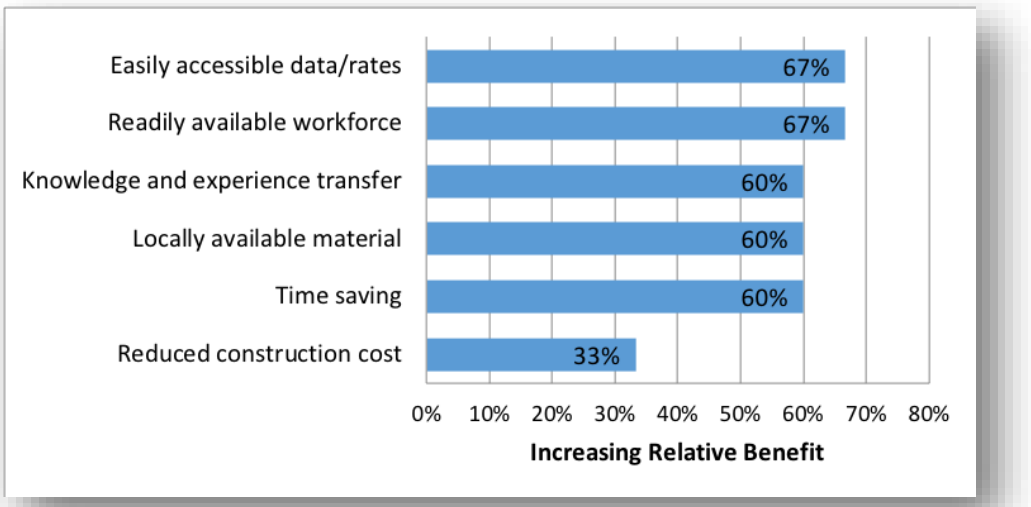

Figure 1. Benefits of Conventional Construction Methods

4.6. Hypothesis Testing

The study tested the following alternate hypothesis:

H_A: The construction costs of sustainable/green buildings are significantly higher than those of conventional buildings.

Respondents were requested to provide data on the construction costs of green and conventional buildings per m² for use in testing Hypothesis H_A. The cost data collected in this regard are presented in Table 6. Only the answers of the respondents who were involved in both green and conventional building projects were considered. Based on the data collected, it was established that the average construction cost per square meter of conventional buildings is R 7 066, while that of green buildings is R 8 576. The average percentage difference between the costs of the two building types is 8.55%. The calculated t-value of -2.631 is less than the tabulated value. Based on these findings, the null hypothesis, which states that the cost of green buildings is not significantly higher than that of conventional buildings, is accepted. Although the data were collected through non-random means, it is assumed that the sample data collected are normally distributed because all buildings that have been certified green in the Johannesburg area as at the time of the study were surveyed and data collected on these projects may not be significantly different to that which is available in South Africa.

Table 6. Construction Cost Comparison between Conventional and Green Buildings

	Construction Cost per m²		
Respondent	Conventional buildings	Green buildings	Percentage difference
1	R6 000	9.31%	9.31%
2	R10 000	R14 500	14%
3	R10 000	R12 000	10%
4	R6 800	R7 500	8%
5	R6 000	R6 500	5%
6	R3 600	R4 400	5%
Average	R7 066	R8 576	8.55%
T-Test Statistics			
	t	**Degree of Freedom**	**Sig. (2-tailed)**
	-2.361	5	0.065

Key: R = South African Rand; 1Rand = 0.083 US dollars (05/02/18)

5. DISCUSSION OF FINDINGS

The study revealed that the benefits of sustainable construction are reduced heat and cooling costs, and noise reduction, while the benefits of conventional construction are the availability of information, as well as an experienced workforce because of the common practices used across projects. It was also found that most green buildings benefited from decreased energy and water consumption. The respondents noted that the higher cost of green buildings when compared to conventional buildings, and the fact that there are only a few green building projects in South Africa, making it difficult to transfer experience, access green building information, and find experts to work on these projects are the disadvantage of green buildings.

The study also established that the average percentage cost difference between the cost of green buildings and that of conventional buildings is 8.55%, with the former higher than the latter. Also, all respondents who had worked on both green and conventional building projects acknowledged a cost difference between the two. However, the cost difference between these two building types is not statistically significant. This finding is aligned with findings of previous studies on cost differentials between the two building types by Matthiessen and Morris (2004) and Cruywagen (2013). While Matthiessen and Morris (2004) found the cost differential between the two types of buildings to be 8.6%, Cruywagen (2013) found this difference to be 7.8%. The findings of these earlier studies further validate the results of this research.

Clients and contractors who are affected by the cost differential prefer to use the conventional methods of construction on their projects. In the long run, if the costs are reduced and the practices that have been tried and tested yield a positive result, the industry will embrace sustainable construction practices as they conserve the environment for future generations. Sacrificing the tangible benefits of conventional projects for the promised future benefits of the green building projects is probably difficult for clients, contractors and investors to embrace.

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6. CONCLUSIONS AND RECOMMENDATIONS

This paper examined conventional and sustainable/green buildings and whether there are significant differences between these two building types based on benefit and cost. The study established that the practices prevalent in all green star-rated buildings are the use of local and renewable materials, waste and water control; that the benefits of sustainable construction are decreased energy and waste consumption; and that green building costs more than conventional buildings by an average of 8.5%. However, the construction costs of green buildings are not significantly different from those of conventional/brown buildings. Based on these research findings, the study concludes firstly, that the construction cost difference between green building projects and conventional building projects, though statistically insignificant, results in fewer stakeholders implementing sustainable construction initiatives on their projects although the practices and methodology of the two methods have many similarities and few differences; secondly, that the contractor and clients will seek out cheaper ways of project delivery unless the government introduce regulations that make the use of green building practices mandatory on construction projects; and thirdly, that there is a business case for the use of green building practices with their attendant environmental benefits in the project delivery process.

It is therefore recommended that statutory legislation, which makes the use of green building practices such as waste management, should be enacted and made mandatory on construction projects to minimize the impact of construction activities on the environment. This should be incorporated into tender requirements and considered during tender adjudication whereby contractors submit waste management plans used for this purpose. There needs to be rewards such as tax breaks and incentives to acknowledge construction stakeholders who employ green building techniques on their projects even though these projects are not intended to be green-star rated. By doing so, more stakeholders will be encouraged to implement sustainable construction initiatives on their projects. Furthermore, the use of recycled materials needs to be encouraged by the government to reduce the costs of sourcing of new raw materials and processing. Another recommendation is that all construction personnel on a project should undergo an induction that makes them environmentally aware. By involving site personnel, more stakeholders will become aware of sustainable construction methods, and with time, these will become standard practice in the construction industry.

The findings of this study are limited by the fact that the project quantity surveyors who were involved in the initial stage of the project were not the same individuals who handled the execution/construction stage, limiting the information to the project phase in which the professional was involved. Another limitation was that there were some professionals who were involved in more than one green building project; hence their answers were not defined by a specific project. The third limitation was that the information obtained from contractors and subcontractors was limited to construction professionals employed by the main contractor and not necessarily decision-making management staff. The results of the study are also limited by the smallness of the sample size which is because there are only a few stakeholders who have experience in the use of both sustainable and conventional methods and are not therefore generally distributed in the target population. Future research that compares the costs of operating and maintaining a green building to the costs of operating and maintaining a conventional building and which includes other cities in South Africa such as Cape Town, Durban and Pretoria is recommended because a major advantage of green buildings is that of low maintenance and operational costs: an extensive study will confirm the findings of this research.

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EVALUATION OF LEVEL OF ADOPTION OF SUSTAINABILITY PRACTICES AMONG CONSTRUCTION FIRMS IN THE NIGER DELTA STATES OF NIGERIA

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ABSTRACT

The need for sustainable development in Niger Delta, Nigeria cannot be overemphasized. Hence the aim of this research is to evaluate the level of adoption of sustainability practices among construction firms in Niger Delta, Nigeria. Data were obtained using 1179 copies of a structured questionnaire, administered through a random sampling technique. The methods of data analysis were simple percentage, mean score, the Kruskal-Wallis test and the Bonferron-Dunn test. The average mean score of 2.91 indicates that the overall level of adoption of sustainability practices among construction firms in Niger Delta is moderate. The P-value of 0.001 is less than 0.05 significance level; hence, the hypothesis was rejected. This indicates that there is a significant difference in the level of adoption of sustainability practices among the states in the Niger Delta, Nigeria. This implies that construction firms operating in each of the states in Niger Delta did not record the same level of adoption of sustainability practices. This study concluded that firms' location has a significant impact on the level of adoption of sustainability practices by the construction firms in Niger Delta. This study recommends that the government should pass into law legislations that would encourage the adoption of sustainability practices by the construction firms in Niger Delta, Nigeria. This study also recommends that construction firms should improve on their level of adoption of sustainability practices in Niger Delta by increasing top management support, human resource management, employee empowerment, training and educating employees on sustainability practices and increasing the amount of resources allocated to sustainability.

Keywords: Adoption level, Construction firms, Sustainability practices, Niger Delta, Nigeria

1. INTRODUCTION

There is a wide range of threats to the environment and socio-economic development in the world today. The construction industry is one of the industries contributing to these threats. The construction industry has been argued to be an important industry for the development of every society. However, it takes up many non-renewable resources and contributes to natural resources' depletion as well as being responsible for high levels of pollution, climate change and other environmental threats (Klang et al., 2003). Suliman and Abdelnaser (2009) observed that construction accounts for an estimated 40% of all resources consumption and produces about 40% of all wastes, including greenhouse gas emissions. The study of Ijigah et al. (2013) also revealed major environmental impacts of building construction projects to include environmental pollution, depletion of resources and habitat destruction causing destruction of the ecosystem, desertification, and soil erosion, and increasing material wastage. Similarly, Saroop and Allopi (2014) elucidated that the construction industry globally is one of the main contributors to the depletion of natural resources and a major cause of unwanted side effects such as air and water pollution, solid waste, deforestation, health hazards, global warming, and other negative consequences. The construction industry has a role to play in ensuring a healthy liveable environment and equitable access to social infrastructure and sustainable development in developing countries (Kheni & Akoogo, 2015). This will help in achieving the sustainable development goal in developing countries. According to Chambers (1993), sustainability is defined as "…that which is capable of being sustained; in ecology, the amount or degree to which the earth's resources may be exploited without deleterious effects". Sustainability at the firm level refers to meeting social and environmental needs in addition to the firm's profitability (Porter, 2008). Furthermore, Brundtland (1987) reported that the only way to balance the eternal trade-off between economic development and environmental protection was through a new approach, namely sustainable development (SD).

Brundtland (1987) defined sustainable development (SD) as development that meets the needs of the present without comprising the ability of future generations to meet their needs. Furthermore, sustainable construction is the application of sustainable development principles in the construction industry. Parkin (2000) described sustainable construction as a construction process that incorporates the basic themes of sustainable development, and it aims at reducing the environmental impact of a building over its entire lifespan, providing safety and comfort to its occupants and at the same time enhancing its economic viability (Addis & Talbot, 2001). In Nigeria, the government indicated its commitment to sustainable development by convening several awareness campaigns and conferences (Federal Ministry of Environment Housing & Urban Development, 2008). The Green Building Council of Nigeria was conceived, and professional bodies allied to the sector are taking a keen interest (Akindoyeni, 2012), but the effort has not yielded the desired results. In other words, Nigeria is lagging behind world developments associated with sustainability within the construction sector and beyond (Dania et al., 2013). Waziri et al. (2015) studied green construction practices implementation in Nigeria. The study indicated that sustainable practices are somewhat implemented at firm level while they are moderately implemented at both individual and project level. Waziri et al. (2015) stated that the level of sustainability practices' adoption in Nigeria falls below the international standard. Other studies carried out on sustainability issues in Nigeria include those of Ikediashi et al. (2012), Ujene (2014), Ijaiya (2014), Ekung et al. (2014), and Barde and Tela (2015), with very scanty studies in Niger Delta in particular.

The Niger Delta that is located in the southern part of Nigeria has some peculiar characteristics including the climate, terrain, vegetation, culture, economic activities and value system. The Niger Delta region of Nigeria produces a significant portion of the aggregate oil wealth of Nigeria. Since 1956 when oil was first discovered in Oloibiri in Southern Nigeria,

the Niger Delta region has accounted for over 90 % of Nigeria's oil income (Ujene, 2014). However, the region has perennially suffered from environmental neglect, crumbling infrastructure and services, high unemployment, social deprivation, abject poverty and endemic conflict. Apart from the environmental degeneration suffered due to oil exploration, construction activities also add to the degeneration of the environment. This has led to calls for firms operating in the Niger Delta to demonstrate the value of their investments to Nigeria by undertaking increased community development initiatives that provide direct social benefits such as local employment, new infrastructure, schools, and improved health care delivery (Ijaiya, 2014). As such, this study evaluated the level of adoption of sustainability practices among construction firms in Niger Delta, Nigeria. The study also tested the hypothesis which states that there is no significant difference in the level of adoption of sustainability practices among the construction firms operating in Niger Delta, Nigeria.

2. THEORETICAL DEVELOPMENT FOR THE STUDY

In order to underpin the study with an appropriate theoretical lens, the study used the critical theory and institutional theory as the theoretical basis for this study. As such, the following sub-sections further discuss these theories.

2.1. Critical Theory

The central goal of critical theory in organizational studies is to form societies and workplaces which are free from domination. In this context, critical theory promotes an equal opportunity for members to contribute to the development of systems which meet human needs and lead to progressive development (Ogbor, 2001). The purpose of critical theory is to create a body of knowledge that seeks to achieve an emancipator interest through a critique of consciousness and ideology (Ogbor, 2001). Environmental degradation and the implication for the rights of the Niger Delta people both to a safe environment and to meaningful living within their location are the cause of the continuing conflict and tension between the people and the government and corporations (Akhakpe, 2012; Odoemene, 2011). This theory was applied in this study because of the need to establish the level of adoption of sustainability practices among construction firms in order to create an enhanced body of knowledge of sustainability at firm level. This will in turn reduce the level of conflict and tension between the firms and the people of Niger Delta.

2.2. Institutional Theory

Institutional theory was first suggested by Selznick (1948), who argued that the behaviour of a company could be influenced by its institutional environment. The central idea of this theory states that "…organizations must conform to the established rules and norms of dominant institutions in order to gain support and be perceived as legitimate" (John et al., 2001). Institutional theory has also been widely applied in sustainability research when considering cross-industry and cross-location comparisons. The expansion of the notion of sustainability necessarily takes different paths in different industries and locations (Chen, 2015). In other words, specific institutional settings within a particular location or industry can influence how the organization engages in sustainability activities as well as the level of engagement and performance. This theory was applied in this study because it served as a basis for establishing the effect of sustainability factors and firm characteristics on the level of adoption of sustainability practices of construction firms in the study area.

3. EXTANT LITERATURE ON SUSTAINABILITY PRACTICES OF CONSTRUCTION FIRMS

Sustainability at the firm level refers to meeting social and environmental needs in addition to the firm's profitability (Porter, 2008). The variables for measuring the level of sustainability adoption are the firm sustainability practices as identified within the body of literature (Al-Jamea, 2014; Inkoom, 2013; Eccles et al., 2012; Freeman et al., 2007; Sommerville & Craig, 2006; Widen, 2003). These variables include leadership, knowledge management practices, organizational innovativeness, organizational culture, corporate governance, stakeholder engagement, transparency and measurement, corporate social responsibility, employment practices and protection of the environment. They are further discussed in the following sub-sections.

3.1. Leadership in Construction Firms

There are several areas in the construction industry in which an understanding of the role individual sustainability leaders is needed. With the current pressure on construction organizations to integrate sustainability in their operations and business strategies, there is an increasing demand for leaders who can stimulate a sustainability vision to become part of organizational identity. These individual leaders are the key players in the creation, development and growth of successful sustainability strategies, and ultimately serve as role models from whom new sustainability ideas can be subsequently disseminated into the wider organization (Inkoom, 2013).

3.2. Knowledge Management Practices

Knowledge management (KM) can be described as a systematic process of discovering, choosing, arranging, refining and presenting information in such a way that it improves an employee's comprehension relative to a specific area of interest (Sommerville & Craig, 2006). Emmitt and Gorse (2003) stated KM is the process by which information is created, captured, stored, shared, transferred, implemented, exploited, and measured to meet the needs of an organisation. In other words, KM is the discipline of creating a thriving work and learning environment that fosters the continuous creation, aggregation, use, and re-use of both organisational and personal knowledge in the pursuit of new business value (Quintas, 2005). This process and action-oriented definition of KM indicates that it may be applicable to the improvement of the organisational performance. This is because the construction industry, which is a major sector for the delivery of key government programmes or infrastructure, is an industry that is heterogeneous, diverse, multi-organisational, and dominated by small and medium-size enterprises (SMEs). The high levels of service inputs characterised by professional knowledge or expertise relative to a specific technical or functional domain may qualify the industry as a knowledge-intensive industry. In fact, documented research findings indicated that design, architecture, surveying, and other construction services are knowledge-intensive service sectors (Egbu & Robinson, 2005). Within any organisation, KM may perhaps have the same degree of importance as labour, plant, and materials (Sommerville & Craig, 2006).

3.3. Organizational Innovativeness

Innovation is the application of new knowledge in an industry in the form of new products, new processes, social change, and organisational change (Widen, 2003). According

to the Organisation for Economic Co-operation and Development (OECD) (2005), innovation is defined as a new or significantly improved product (good or service), process (production or delivery method), marketing method (packaging, promotion, or pricing) or managerial method (internal practice). Innovation is neither a single nor an instantaneous act, but rather it is a whole sequence of events that occur over time, and that involve all activities related to bringing new products to the market (Jones & Saad, 2003).

3.4. Organizational Culture

The relationship between organizational culture and sustainability adoption is well documented in the literature (Sharma, 2002; Wong & Avery, 2009; Linnenluecke & Griffiths, 2010; D'Incognito et al., 2013; Al-Jamea, 2014). The culture within an organization, according to Trong Tuan (2012), is a continuous process of identity building and re-building and meaning-making within an organization which enables its social integration as well as the sustainability of its sub-divisions. It is defined in this study as construction firms' pattern of shared values and beliefs shaping their organizational functions and explaining the norms for behaviour within the organization.

3.5. Corporate Governance

The responsibilities of the board of directors and the incentives provided to top management are two fundamental attributes of the corporate governance system. Boards of directors perform a monitoring and advising role and ensure that management is making decisions in a way that is consistent with organizational objectives. Eccles et al. (2012) posited that for organizations that consider environmental and social objectives as core issues for their strategy and operations, the board of directors is more likely to have direct responsibility over such issues; it is also more likely that top management compensation will be a function of sustainability metrics in addition to other traditional financial performance metrics.

Other functions include assisting management in setting strategy, establishing goals, integrating sustainability into daily business activities, reviewing new and innovative technologies that will permit the company to achieve sustainable growth, reviewing partnerships and relationships that support the company's sustainable growth, and reviewing the communication and marketing strategies relating to sustainable growth. Another important governance feature is the set of metrics that are linked to senior executive compensation. High sustainability firms are more likely to align senior executive incentives with environmental, social, and external (customer) perception performance metrics, in addition to financial metrics.

3.6. Stakeholder Engagement

Engagement is necessary for understanding the stakeholders' needs and expectations in order to make decisions about how best to address them (Freeman et al., 2007).With regard to stakeholder management, prior literature has suggested and empirically shown that it is directly linked to superior financial performance by enabling firms to develop intangible assets in the form of strong long-term relationships, which can become sources of competitive advantage (Hillman & Keim, 2001). In other words, superior stakeholder engagement is fundamentally based on the firm's ability to establish such relationships with key stakeholders over time. Similarly, it has been argued that when a firm is able to credibly commit to contracting with its stakeholders on the basis of mutual trust and cooperation and a

longer-term horizon as opposed to contracting, the firm will experience reduced agency costs, transactions costs, and costs associated with team production (Foo, 2007; Cheng et al., 2011).

3.7. Transparency and Measurement

The transparency principle is about disclosure of information to company stakeholders. Epstein (2008) noted that transparent companies provide full disclosure to existing and potential investors and lenders of fair and open communication related to the past, present, and likely future financial performance of the company. They identify their stakeholders and recognize that they are accountable to internal and external stakeholders, understanding both their informational needs and their concerns about the company's effects on their lives. Performance measurement is essential for management to determine how well it is executing on its strategy and to make any necessary corrections (Kaplan & Norton, 2008). The quality, comparability, and credibility of information are enhanced by internal and external audit procedures that verify the accuracy of this information or the extent to which practices are being followed.

3.8. Corporate Social Responsibility

Crowther (2000) defined corporate social responsibility (CSR) as an approach to reporting a firm's activities which stresses the need for the identification of socially relevant behaviour, the determination of those to whom the company is accountable for its social performance and the development of appropriate measures and reporting techniques. It is also seen to be the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as at the local community and society at large (World Business Council for Sustainable Development, 2002). Thus, by implication, CSR involves a voluntary act by organizations to integrate social and environmental concerns in their undertakings with numerous stakeholders. The stakeholders include all the members belonging to the corporation's social environs which contribute to or are involved in the corporation's activity. Branco and Rodrigues (2006) supported this view as well.

3.9. Employment Practices

This principle of corporate sustainability embodies the type of management practices in which organizations engage (Epstein, 2008). Adoption of this principle means that firms engage in management practices that promote personal and professional employee development, diversity and empowerment. These organizations regard employees as valued partners in the business, respecting their right to fair labour practices, competitive wages and benefits, and a safe, family-friendly work environment. They recognised that concern for and investing in employees is in the best long-term interests of the employees, the community, and the company. Consequently, they strive to increase and maintain high levels of employee satisfaction and respect international and industry standards for human rights. To do this they offer programmes such as tuition reimbursement, family leave time, and career development opportunities.

3.10. Protection of the Environment

In order to adopt sustainable principles, companies must define their commitment to the natural environment. Organizations espousing this principle strive to protect and restore the

environment and promote sustainable development with products, processes, services, and other activities. These organizations are committed to minimizing the use of energy and natural resources and decreasing waste and emissions. At a minimum, they comply with all existing international, national, and local regulations and industry standards regarding emissions and waste. They strive for continuous improvement in the efficiency with which they use resources and strive to reduce the environmental impact of their activities. They are committed to maximizing the use and production of recycled and recyclable materials.

According to Inkoom (2013), the following variables are used to measure firms' commitment to environmental protection. These include building designs, construction practices and technologies that are environmentally friendly and sustainable; effective communication of sustainability and other environmental management issues among contractors, suppliers and other professionals engaged by the organisation; standardized management systems such as ISO 14001 or environmental management systems (EMS) in their organisation; the use of practices such as implementing effective environmental management programmes and engaging professional who are ISO 14000 certified; and the inclusion of sustainability and other environmental management measures in tendering requirements.

Nwokoro (2011) also identified the following variables for measuring firms' and organisations' commitment to the protection of the environment. These include conducting periodic environmental audits of the firm; developing special training programmes for upgrading knowledge and skills in various disciplines required for environmental management; implementing appropriate technology that recognises the need to save on energy and which is cost-effective; facilitating management control of environmental practices; developing environmental management plans to reverse environmental degradation, protect human health and the environment; and installing effective machinery to enhance environmental awareness through public enlightenment.

4. RESEARCH METHODOLOGY

The survey research design was used to evaluate the level of adoption of sustainability practices among construction firms operating within the Niger Delta region of Nigeria. In addition to the review of related literature, the bulk of data for this research was sourced from construction firms in Niger Delta, Nigeria through a questionnaire survey. The population for the study comprised the construction firms operating within the Niger Delta region of Nigeria. The population frame for the study was established as evidenced from the Corporate Affairs Commission of Nigeria. This was established to be 1781 as shown in Table 1. The population was stratified based on states in the Niger Delta region and proportional representation was applied to distribute the sample size among the various states in Niger Delta (Table 1). Data were obtained using 1179 copies of a structured questionnaire, administered through a random sampling technique. Data were collected on a five-point scale of 1, 2, 3, 4 and 5 and were assigned to the options of no adoption, low adoption, moderate adoption, high adoption and very high adoption respectively.

Simple percentages were used to analyze the background information regarding the construction firms among the states in Niger Delta region. In order to rank and determine the level of adoption of sustainability practices among construction firms in Niger Delta, the mean item score was used. The level of adoption of sustainability practices was analyzed using the mean score and the decision rule is that any sustainability practice whose mean falls between 1.0 -1.8 is of no adoption, 1.8-2.6 is of low adoption, 2.6-3.4 is of moderate adoption, 3.4-4.2 have high adoption and 4.2-5.0 is regarded as having very high adoption. This is in agreement with Kazaz et al. (2008). In testing the hypothesis postulated for the study, the Kruskal-Wallis

test was used to explore whether there is a significant difference in the level of adoption of sustainability practices among the construction firms operating in Niger Delta, Nigeria. A post-hoc test was performed using the Bonferroni-Dunnett test to establish the source of significant variation found on some of the variables in the level of adoption of sustainability practices.

4.1. Sample Frame and Sample Size

Table 1 shows the sample frame and sample size of this study. The sample size was determined using the Yamane (1967) equation as shown below:

$$n = \frac{N}{1 + N\ (e)^2}$$

where n = Sample size
N = Finite population
e = Level of significance (0.05).
1 = Unity

This study adopted the Yamane (1967) equation for determining sample size because of its simplicity, reliability and validity. These have encouraged its wider acceptance and usage among researchers over a long period of time.

Table 1. Sample Frame and Sample Size of Construction Firms in Niger Delta

State	Sample Frame	Sample Size
Abia	165	117
Akwa Ibom	214	139
Bayelsa	128	97
Cross River	223	143
Delta	200	133
Edo	237	149
Imo	143	105
Ondo	221	142
Rivers	250	154
Total	**1781**	**1179**

5. DATA PRESENTATION AND DISCUSSION OF RESULTS

This section contains the results of the analysis of data collected for the study. It contains the descriptive results of the response rate of the questionnaires distributed to the firms. This section also contains the results of evaluation of the level of adoption of sustainability practices among construction firms in Niger Delta, Nigeria and the result of the hypothesis.

5.1. Questionnaire Distribution and Response in the Study

One of the research instruments used in this study was the structured questionnaire. The questionnaire was administered among the construction firms operating in Niger Delta, Nigeria. The results of the analysis were presented in Table 2.

Table 2 showed that the number of questionnaires administered to the construction firms in Niger Delta were 117, 139, 97, 143, 133, 149, 105, 142, and 154 in Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, and Rivers States respectively. From the questionnaires distributed, the response rate ranged between 76.1% and 94.7%. Delta State received the highest response rate of 94.7% while Abia State recorded the lowest rate of 76.1 %. An overall response rate of 83.2% was achieved. Groves (2006) noted that a response rate of at least 50% is considered adequate for analysis and reporting, a response of 60% is good, and a response rate of 70% is very good. As a guide, researchers typically seek response rates of at least 70% to feel confident that their sample is representative of the sample frame. Hence, the overall response rate of 83.2% in this study is considered very good and adequate.

Table 2. Questionnaire Distribution and Response Rate

S/N	States	Number of questionnaires administered to construction firms (NO)	Number of questionnaires returned (NO)	Percentage of questionnaires returned (%)	Average of the Response Rate (%)
1	Abia	117	89	76.1	-
2	Akwa Ibom	139	113	81.3	-
3	Bayelsa	97	85	87.6	-
4	Cross River	143	112	78.3	-
5	Delta	133	126	94.7	-
6	Edo	149	114	76.5	-
7	Imo	105	92	87.6	-
8	Ondo	142	109	76.8	-
9	Rivers	154	140	90.1	-
10	TOTAL	1179	980		83.2

5.2. Firm Characteristics

Firms' characteristics comprised the age, the location, the ownership and the size of construction firms.

5.2.1. Age of Construction Firms

The analysis of the age of construction firms that were sampled in this study possessed showed that work experience of the firms ranged between the intervals of 1-5, 6-10, 11-15, 16-20 and above 20 years with their percentage distribution of 1%, 3.8%, 16.4%, 40.9% and 37.9% respectively. Table 3 reveals that majority of the construction firms have ages ranging from 16-20. Table 3 also shows that more than 95% of the firms have work experience of above ten (10) years. It therefore implies that the work experiences of the construction firms are adequate, and their responses can be relied on.

Table 3. Age of Construction Firms

Age of Firms	Frequency	Valid per cent	Cumulative per cent
1-5	10	1.0	1.0
6-10	37	3.8	4.8
11-15	161	16.4	21.2
16-20	401	40.9	62.1
20 + years	371	37.9	100.0
Total	980	100.0	

5.2.2. Location of Construction Firms

Table 4 shows the distribution of construction firms in each state in Niger Delta, Nigeria. The percentage of firms in Abia, Akwa Ibom, Bayelsa and Cross Rivers States are 9.1%, 11.5%, 8.7% and 11.4%. Others are Delta, Edo, Imo, Ondo and Rivers with their percentages of 12.9%, 11.6%, 9.4%, 11.1% and 14.3% respectively. Table 4 shows a good distribution of the construction firms among the states in Niger Delta. This implies that the results from this study represents the situation in Niger Delta and can be relied on.

Table 4. Location of Construction Firms

States	Frequency	Valid per cent	Cumulative per cent
Abia State	89	9.1	9.1
Akwa Ibom State	113	11.5	20.6
Bayelsa State	85	8.7	29.3
Cross River State	112	11.4	40.7
Delta State	126	12.9	53.6
Edo State	114	11.6	65.2
Imo State	92	9.4	74.6
Ondo State	109	11.1	85.7
Rivers State	140	14.3	100.0
Total	980	100.0	

5.2.3. Ownership of Construction Firms

The result of analysis on Table 5 shows that the locally owned construction firms account for 96.4% of the total number of firms considered in this study while the foreign owned firms account for 3.6% of the total number construction under consideration in this study. This clearly shows that the majority of the construction firms operating in Niger Delta are locally owned firms.

Table 5. Ownership of Construction Firms

Ownership of Firms	Frequency	Valid per cent	Cumulative per cent
Locally owned	945	96.4	96.4
Foreign owned	35	3.6	100.0
Total	980	100.0	

5.2.4. Size of Construction Firms under study in Niger Delta between 2007- 2016

Analysis on Table 6 shows the average percentage distribution of construction firms in Niger Delta according to their sizes over a period of ten years (2007-2016). The analysis shows that small firms account for 84.7%, medium firms account for 11.61 and large construction firms account for 3.73%. This reveals that small and medium construction firms are in the majority. This result is in consonance with Abdullah et al. (2012) and Thwala et al., (2012)

who posited that according to grouping by size of firms in the construction industry, small and medium firms (SMFs) were found to be in the majority.

Table 6. Size of Construction Firms under study in Niger Delta between 2007- 2016

S/N	YEAR	1-50		50-250		250 and above	
		Freq.	%	Freq.	%	Freq.	%
1	2007	857	87.4	88	9.0	35	3.6
2	2008	790	80.6	155	15.8	35	3.6
3	2009	842	85.9	103	10.5	35	3.6
4	2010	821	83.8	120	12.2	39	4.0
5	2011	813	83.0	129	13.2	38	3.9
6	2012	754	76.9	188	19.2	38	3.9
7	2013	811	82.8	131	13.4	38	3.9
8	2014	870	88.8	75	7.7	35	3.6
9	2015	868	88.6	77	7.9	35	3.6
10	2016	874	89.2	71	7.2	35	3.6
AVE			84.7		11.61		3.73

5.3. Level of Adoption of Sustainability Practices among Constructions Firms in Niger Delta, Nigeria

The results of the analysis of the level of adoption of sustainability practices among construction firms in Niger Delta, Nigeria were presented as follows. Table 7 shows the level of adoption of sustainability practices among construction firms in Niger Delta. The results of the analysis reveal that the level of adoption of leadership traits among firms in Abia and Imo is moderate while the level of adoption of leadership in construction among firms in Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Ondo and Rivers is high. The mean score of 3.60 shows that the overall level of the adoption of leadership traits among firms in Niger Delta is high.

Table 7 shows that the level of adoption of knowledge management among the construction firms in Niger Delta is moderate, except those firms operating in Abia State which have low levels of adoption. Table 7 also indicates that the level of adoption of brainstorming among the construction firms in Niger Delta is high. The levels of adoption of face-to-face interaction, mentoring, recruitment and training among the firms are moderate. Also, community of practice and apprenticeship have low levels of adoption among the firms. The average mean score of 2.82 also indicates that the overall level of adoption of knowledge management practices is moderate.

Table 7 reveals that the level of adoption of organizational innovativeness among the construction firms in Abia, Akwa Ibom, Bayelsa, Edo, Imo, Ondo and River is moderate. However, there is a high level of adoption of organizational innovativeness among the firms in Cross River and Delta States. The result showed that there was a high level of protection of business intellectual property among the firms, while building relationships with existing clients is also high. The results reveal that the level of delivering products and services that reduce clients' cost is high among the firms. Other innovative practices that have a high level of adoption include active monitoring of international best practice, maintaining a formal system for transferring project learning into continuous business processes and measuring how

well their changes have worked. The results also show that there is a moderate level of recruitment of experienced employees, recruitment of new graduates and usage of multi-skilled teams. Other innovative practices that have moderate levels of adoption among the construction firms in Niger Delta include enhancement of firms' business technical capability, investment in research and development, and participating in the development of industry standards and practices. The overall level of adoption of organizational innovativeness among the firms operating in Niger Delta is moderate as indicated by the average mean score of 3.30.

The level of adoption of organizational culture practices among the construction firms in Abia, Akwa Ibom, Bayelsa, Imo, Ondo and Rivers States is moderate with their mean score ranging between 2.96 and 3.22. However, the construction firms operating in Cross River, Delta and Edo display a high level of adoption of organizational culture practices. The average mean score of 3.25 shows that the overall level of the adoption of organizational culture practices is moderate among the construction firms operating in Niger Delta.

Table 7 shows that securing ownership of registration is the only corporate governance practice that has a high level of adoption among the construction firms. The corporate governance practices that have moderate levels of adoption are disclosure of objectives, disclosure of foreseeable risks, board members acting on a fully informed basis and board members acting in the interest of the firm and its shareholders. Others include the application of high ethical standards by the board, fair treatment of all shareholders by board members, the ability of the board to oversee the process of disclosure and communication, as well as objective and independent judgement by the board. Table 7 also reveals that the level of adoption of corporate governance in each of the nine states in Niger Delta is low. The average mean score of 2.41 also indicates that the overall level of adoption of corporate governance among construction firms in Niger Delta is low.

Furthermore, Table 7 reveals that there is high level of examination of opportunities and risks among the construction firms in Niger Delta. Furthermore, there are moderate levels of stakeholder identification, training of local managers, and ability of the stakeholders to express their concerns. Others that have been moderately adopted by the firms are grievance mechanisms, scope agreement, setting of targets for stakeholders, board feedback and result reporting. It was revealed that the level of public reports of the firms is low. All the construction firms operating in each state in Niger Delta, except those in Abia State, moderately engaged the stakeholders in their quest to ensure sustainable development within their area of operation. However, those firms in Abia State have a low level of stakeholder engagement. The average mean score of 2.98 indicates that the overall level of engagement of stakeholders among the construction firms is moderate.

Table 7 shows that there is high level of mapping against established standards by the construction firms. Some of the transparency and measurement strategies that were moderately adopted include information collection review, data aggregation review and document review. Others include relevant management interviews, relevant management discussions and stakeholders' consultation. The practices that had low levels of adoption by the construction firms include sustainability report external audits, auditor competency disclosure, external audits, standardized external audits and internal audits. The results also show that the level of adoption of transparency and measurement among construction firms in Bayelsa, Cross River, Delta, Edo, Imo, Ondo and River State is moderate while there is low level of adoption of transparency and measurement among firms operating in Abia and Akwa Ibom States. The average mean score of 2.91 indicates that the overall level of adoption of transparency and measurement among construction firms in Niger Delta is moderate.

Table 7 shows that the level of employment opportunities provided by the construction firms operating in Niger Delta is moderate. It also reveals that the firms provided moderate levels of infrastructural development, human capital development and peace and security. The results also show that the level of commitment of the construction firms in Niger Delta to public and private sector investment is low. Others that suffer low commitment from the firms include bio-diversity and ecosystem stability, poverty reduction, pollution control, provision of health care and development of sport, art and culture. Table 7 also reveals that the level of adoption of corporate social responsibility among the construction firms operating in Abia, Akwa Ibom, Bayelsa, Crossriver, Delta and Ondo States is low while those in Edo, Imo and River States have moderate levels of adoption of corporate social responsibility. The average mean score of 2.55 indicates that the overall level of adoption of corporate social responsibility among the construction firms in Niger Delta is low.

Employment practices adopted by construction firms in Niger Delta were evaluated and the results show that the level of training of personnel and the level of teamwork are moderate. Table 7 also shows that the levels of adoption of wage- and salary-induced motivation, social dialogue and flexible working time are low. The results show that firms operating in Edo, Imo and Rivers have moderate levels of adoption of the employment practices while those firms operating in Abia, Akwa Ibom, Bayelsa, Cross River, Delta and Ondo have low levels of adoption of employment practices. The average mean score of 2.47 shows that the overall level of adoption of employment practices among construction firms in Delta State is low.

Table 7 reveals that there is a high level of adoption of building designs, construction practices and technology that are environmentally friendly and sustainable. The levels of effective communication of sustainability and other environmental management issues among contractors, suppliers and other professionals engaged by the firms are moderate. However, standardized management systems such as ISO 14001, the implementation of effective management programmes, and the inclusion of sustainability and other environmental management measures in tendering requirement had low levels of adoption among the construction firms. Others that had low levels of adoption include periodic environmental audits of the firm, the application of technology that is energy and cost effective, the development of an environmental plan to reverse environmental degradation and protect human health, and the installation of effective machinery that enhances environmental awareness through public enlightenment. The results also show that the level of adoption of practices that protect the environment among the construction firms in each of the states in Niger Delta is low. The average mean score of 2.51 indicates that the overall level of adoption of environmental protection practices among the firms in Niger Delta is low. The mean scores ranging between 2.78 and 3.04 imply that the construction firms operating in each state of Niger Delta recorded moderate levels of adoption of sustainability practices. The average mean score of 2.91 indicates that the overall level of adoption of sustainability practices among construction firms in Niger Delta is ‘moderate level’. This study is in contrast with that of Waziri, Yusof and Osmadi (2015) who studied green construction practices and concluded that sustainable practices are slightly implemented at firm level.

Table 7. Level of Adoption of Sustainability Practices among Constructions Firms in Niger Delta, Nigeria

Sustainability Practices	Mean Score Abs N=89	Remark	M.S AKS N=113	Remark	MS BYS N=85	Remark	MS CRS N=112	Remark	MS DTS N=126	Remark	MS EDS N=114	Remark	MS IMO N=92	Remark	MS Ondo N=109	Remark	MS RIV. N=140	Remark	Combined MS N=980	Remark
Knowledge Management Practices																				
Brainstorming	3.12	M.L.AD	3.63	H.L.AD	3.59	H.L.AD	3.97	H.L.AD	3.98	H.L.AD	3.75	H.L.AD	3.65	H.L.AD	3.66	H.L.AD	3.64	H.L.AD	3.69	H.L.AD
Face -to-face interaction	2.73	M.L.AD	3.27	M.L.AD	3.02	M.L.AD	3.34	M.L.AD	3.36	M.L.AD	3.26	M.L.AD	3.13	M.L.AD	3.19	M.L.AD	3.19	M.L.AD	3.18	M.L.AD
Mentoring	2.39	L.L.AD	2.74	M.L.AD	2.55	L.L.AD	2.79	M.L.AD	2.87	M.L.AD	2.96	M.L.AD	3.22	M.L.AD	2.63	M.L.AD	2.79	M.L.AD	2.78	M.L.AD
Level of adoption of knowledge management practices among firms in Niger Delta, Nigeria	2.45	L.L.AD	2.79	M.L.AD	2.67	M.L.AD	2.83	M.L.AD	2.88	M.L.AD	2.96	M.L.AD	3.17	M.L.AD	2.73	M.L.AD	2.85	M.L.AD	2.82	M.L.AD
Organisational Innovativeness Employee Strategies																				
Recruiting experienced employees	2.48	L.L.AD	2.99	M.L.AD	2.76	M.L.AD	3.11	M.L.AD	3.15	M.L.AD	3.13	M.L.AD	3.30	M.L.AD	2.88	M.L.AD	2.96	M.L.AD	2.99	M.L.AD
Actively encouraging your employees to seek out improvements and share ideas	3.37	M.L.AD	3.85	H.L.AD	3.72	H.L.AD	3.59	H.L.AD	3.65	H.L.AD	3.38	M.L.AD	3.22	M.L.AD	3.48	H.L.AD	3.29	M.L.AD	3.50	H.L.AD
Providing or supporting training programmes for your employees	3.01	M.L.AD	2.97	M.L.AD	3.32	M.L.AD	3.46	H.L.AD	3.44	H.L.AD	3.44	H.L.AD	3.22	M.L.AD	3.12	M.L.AD	3.00	M.L.AD	3.22	M.L.AD
Technology Strategies																				
Enhancing your business's technical capabilities	3.07	M.L.AD	3.20	M.L.AD	3.31	M.L.AD	3.36	M.L.AD	3.38	M.L.AD	3.46	H.L.AD	3.00	M.L.AD	3.28	M.L.AD	3.21	M.L.AD	3.26	M.L.AD
Protecting your business's intellectual property	3.24	M.L.AD	3.42	H.L.AD	3.39	M.L.AD	3.45	H.L.AD	3.44	H.L.AD	3.51	H.L.AD	3.35	M.L.AD	3.43	H.L.AD	3.56	H.L.AD	3.43	H.L.AD
Participating in the development of industry standards and practices	3.17	M.L.AD	3.35	M.L.AD	3.41	H.L.AD	3.57	H.L.AD	3.59	H.L.AD	3.51	H.L.AD	3.13	M.L.AD	3.29	M.L.AD	3.16	M.L.AD	3.36	M.L.AD
Marketing Strategies																				
Building relationships with existing clients	4.21	V.H.L.AD	3.28	M.L.AD	3.42	H.L.AD	3.62	H.L.AD	3.64	H.L.AD	3.50	H.L.AD	3.22	M.L.AD	3.35	M.L.AD	3.36	M.L.AD	3.50	H.L.AD
Delivering products/services which reduce your clients' costs	3.09	M.L.AD	3.49	H.L.AD	3.55	H.L.AD	3.94	H.L.AD	3.90	H.L.AD	3.68	H.L.AD	3.17	M.L.AD	3.66	H.L.AD	3.51	H.L.AD	3.58	H.L.AD
Attracting new clients/customers	3.22	M.L.AD	3.24	M.L.AD	3.14	M.L.AD	3.75	H.L.AD	3.73	H.L.AD	3.38	M.L.AD	3.35	M.L.AD	3.42	H.L.AD	3.23	M.L.AD	3.40	M.L.AD

Table 7.*Continued*

Sustainability Practices	Mean Score Abs N=89	Remark	M.S AKS N=113	Remark	MS BYS N=85	Remark	MS CRS N=112	Remark	MS DTS N=126	Remark	MS EDS N=114	Remark	MS IMO N=92	Remark	MS Ondo N=109	Remark	MS RIV. N=140	Remark	Combined MS N=980	Remark
Knowledge Strategies																				
Actively monitoring international best practice	3.27	M.L.AD	3.19	M.L.AD	4.93	V. H.L.AD	3.62	H.L.AD	3.67	H.L.AD	3.50	H.L.AD	3.26	M.L.AD	4.83	V.H.L.AD	3.31	M.L.AD	3.70	H.L.AD
Maintaining a formal system for transferring project learnings into our continuous business processes	3.87	M.L.AD	3.18	M.L.AD	3.36	M.L.AD	3.58	H.L.AD	3.66	H.L.AD	3.50	H.L.AD	3.09	M.L.AD	3.57	H.L.AD	3.19	M.L.AD	3.44	H.L.AD
Measuring how well our changes have worked	3.16	M.L.AD	3.35	M.L.AD	3.53	H.L.AD	3.63	H.L.AD	3.67	H.L.AD	3.56	H.L.AD	3.22	M.L.AD	3.46	H.L.AD	3.26	M.L.AD	3.43	H.L.AD
Relationship Strategies																				
Rewarding staff for maintaining networking linkages with strategically useful industry participants	3.51	H.L.AD	3.27	M.L.AD	3.47	H.L.AD	3.53	H.L.AD	3.56	H.L.AD	3.38	M.L.AD	3.09	M.L.AD	3.42	H.L.AD	3.25	M.L.AD	3.38	M.L.AD
Pursuing partnering on projects	3.18	M.L.AD	3.22	M.L.AD	3.51	H.L.AD	3.54	H.L.AD	3.53	H.L.AD	3.51	H.L.AD	3.26	M.L.AD	3.39	M.L.AD	3.34	M.L.AD	3.39	M.L.AD
Pursuing alliance projects	3.16	M.L.AD	3.30	M.L.AD	3.48	H.L.AD	3.57	H.L.AD	3.60	H.L.AD	3.45	H.L.AD	3.00	M.L.AD	3.31	M.L.AD	3.11	M.L.AD	3.34	M.L.AD
Level of adoption of organizational innovativeness among firms in Niger Delta	3.17	M.L.AD	3.16	M.L.AD	3.37	M.L.AD	3.45	H.L.AD	3.47	H.L.AD	3.37	M.L.AD	3.21	M.L.AD	3.33	M.L.AD	3.17	M.L.AD	3.30	M.L.AD
Organizational Culture Practices																				
Power-distance: degree to which power is expected to be equally shared	3.11	M.L.AD	2.94	M.L.AD	3.31	M.L.AD	3.71	H.L.AD	3.69	H.L.AD	3.76	H.L.AD	3.13	M.L.AD	3.43	H.L.AD	3.17	M.L.AD	3.37	M.L.AD
Individualism: collectivism, degree to which individuals are encouraged to be integrated into groups	3.92	H.L.AD	2.83	M.L.AD	3.20	M.L.AD	3.45	H.L.AD	3.41	H.L.AD	3.45	H.L.AD	3.17	M.L.AD	3.36	M.L.AD	3.06	M.L.AD	3.30	M.L.AD
Performance orientation: degree to which rewards are encouraged for performance improvement and excellence	3.85	M.L.AD	3.04	M.L.AD	3.26	M.L.AD	3.48	H.L.AD	3.50	H.L.AD	3.44	H.L.AD	3.22	M.L.AD	3.18	M.L.AD	3.13	M.L.AD	3.33	M.L.AD
Level of adoption of organizational culture practices among firms in Niger Delta, Nigeria	3.14	M.L.AD	2.96	M.L.AD	3.20	M.L.AD	3.47	H.L.AD	3.46	H.L.AD	3.46	H.L.AD	3.20	M.L.AD	3.22	M.L.AD	3.14	M.L.AD	3.25	M.L.AD

Table 7. *Continued*

Sustainability Practices	Mean Score Abs N=89	Remark	M.S AKS N=113	Remark	MS BYS N=85	Remark	MS CRS N=112	Remark	MS DTS N=126	Remark	MS EDS N=114	Remark	MS IMO N=92	Remark	MS Ondo N=109	Remark	MS RIV. N=140	Remark	Combined MS N=980	Remark
Corporate Governance																				
Shareholders Right																				
Secure ownership registration	3.55	H.L.AD	4.00	H.L.AD	3.88	H.L.AD	4.53	V.H.L.AD	4.45	V.H.L.AD	3.99	H.L.AD	3.61	H.L.AD	4.09	H.L.AD	3.66	H.L.AD	3.99	H.L.AD
Shareholder input on certain key decisions is possible	2.28	L.L.AD	2.10	L.L.AD	2.24	L.L.AD	2.31	L.L.AD	2.40	L.L.AD	2.26	L.L.AD	2.27	L.L.AD	2.06	L.L.AD	2.20	L.L.AD	2.29	L.L.AD
Ownership rights of all shareholders are facilitated	2.21	L.L.AD	2.57	L.L.AD	2.27	L.L.AD	2.31	L.L.AD	2.35	L.L.AD	2.14	L.L.AD	2.34	L.L.AD	2.10	L.L.AD	2.36	L.L.AD	2.34	L.L.AD
Stakeholders in Governance																				
Legal and mutually established rights of stakeholders are respected	2.28	L.L.AD	2.66	M.L.AD	4.08	H.L.AD	2.45	L.L.AD	2.72	M.L.AD	2.20	L.L.AD	2.87	M.L.AD	2.14	L.L.AD	2.19	L.L.AD	2.57	L.L.AD
Performance-enhancing mechanisms for employee participation are permitted	2.31	L.L.AD	2.35	L.L.AD	2.33	L.L.AD	2.49	L.L.AD	2.59	L.L.AD	2.39	L.L.AD	2.83	M.L.AD	2.18	L.L.AD	2.28	L.L.AD	2.41	L.L.AD
Stakeholders have a right of access to timely, relevant, and reliable information on governance issues in which they have a right to participate	2.31	L.L.AD	2.55	L.L.AD	2.28	L.L.AD	2.49	L.L.AD	2.56	L.L.AD	2.57	L.L.AD	2.65	M.L.AD	2.28	L.L.AD	2.62	M.L.AD	2.49	L.L.AD
Transparency and Disclosure																				
Disclosure of company objectives	3.25	M.L.AD	2.77	M.L.AD	2.33	L.L.AD	2.54	L.L.AD	2.59	L.L.AD	2.58	L.L.AD	2.48	L.L.AD	2.66	M.L.AD	2.85	M.L.AD	2.67	M.L.AD
Disclosure of foreseeable risks	3.15	M.L.AD	3.02	M.L.AD	2.36	L.L.AD	2.63	M.L.AD	2.66	M.L.AD	2.51	L.L.AD	2.52	L.L.AD	2.79	M.L.AD	2.89	M.L.AD	2.73	M.L.AD
Disclosure of issues regarding employees and other stakeholders	2.35	L.L.AD	2.65	M.L.AD	2.33	L.L.AD	2.58	L.L.AD	2.64	M.L.AD	2.57	L.L.AD	2.61	M.L.AD	2.41	L.L.AD	2.79	M.L.AD	2.57	L.L.AD
The Board of Directors																				
Board members act in the interest of the company and its shareholders	2.35	L.L.AD	2.61	M.L.AD	3.05	M.L.AD	2.72	M.L.AD	2.74	M.L.AD	2.63	M.L.AD	3.22	M.L.AD	2.78	M.L.AD	2.79	M.L.AD	2.76	M.L.AD
The board applies high ethical standards	2.33	L.L.AD	2.72	M.L.AD	2.27	L.L.AD	2.81	M.L.AD	2.77	M.L.AD	2.63	M.L.AD	3.22	M.L.AD	2.43	L.L.AD	2.94	M.L.AD	2.69	M.L.AD
The board takes into account the interests of other stakeholders	2.28	L.L.AD	2.95	M.L.AD	2.27	L.L.AD	2.72	M.L.AD	2.77	M.L.AD	2.63	M.L.AD	3.22	M.L.AD	2.39	L.L.AD	2.96	M.L.AD	2.71	M.L.AD
Level of adoption of corporate governance among firms In Niger Delta	2.40	L.L.AD	2.48	L.L.AD	2.26	L.L.AD	2.43	L.L.AD	2.49	L.L.AD	2.38	L.L.AD	2.60	L.L.AD	2.25	L.L.AD	2.52	L.L.AD	2.41	L.L.AD
Stakeholders Engagement																				

Sustainability Practices	Mean Score Abs N=89	Remark	M.S AKS N=113	Remark	MS BYS N=85	Remark	MS CRS N=112	Remark	MS DTS N=126	Remark	MS EDS N=114	Remark	MS IMO N=92	Remark	MS Ondo N=109	Remark	MS RIV. N=140	Remark	Combined MS N=980	Remark
Opportunity risk examinations	2.87	M.L.AD	3.23	M.L.AD	3.36	M.L.AD	3.77	H.L.AD	3.87	H.L.AD	3.55	H.L.AD	3.22	M.L.AD	3.30	M.L.AD	3.26	M.L.AD	3.40	H.L.AD
Common understanding	2.66	M.L.AD	3.14	M.L.AD	3.01	M.L.AD	3.18	M.L.AD	3.23	M.L.AD	3.39	M.L.AD	3.22	M.L.AD	3.03	M.L.AD	3.31	M.L.AD	3.15	M.L.AD

Sustainability practices	Mean Score Abs N=89	Remark	M.S AKS N=113	Remark	MS BYS N=85	Remark	MS CRS N=112	Remark	MS DTS N=126	Remark	MS EDS N=114	Remark	MS IMO N=92	Remark	MS Ondo N=109	Remark	MS RIV. N=140	Remark	Combined MS N=980	Remark
Setting of targets for stakeholders	3.18	M.L.AD	3.26	M.L.AD	3.47	H.L.AD	3.32	M.L.AD	3.40	M.L.AD	3.62	H.L.AD	3.52	H.L.AD	3.34	M.L.AD	3.24	M.L.AD	3.37	M.L.AD
Level of adoption of stakeholders engagement among firms in Niger Delta	2.56	L.L.AD	2.87	M.L.AD	2.84	M.L.AD	3.07	M.L.AD	3.13	M.L.AD	3.15	M.L.AD	3.20	M.L.AD	2.83	M.L.AD	3.02	M.L.AD	2.98	M.L.AD
Transparency and Measurement																				
Information collection review	2.64	M.L.AD	2.73	M.L.AD	3.36	M.L.AD	3.50	H.L.AD	3.57	H.L.AD	3.69	H.L.AD	3.26	M.L.AD	3.10	M.L.AD	3.23	M.L.AD	3.25	M.L.AD
Mapping against standards	3.00	M.L.AD	3.29	M.L.AD	3.61	H.L.AD	3.49	H.L.AD	3.59	H.L.AD	3.56	H.L.AD	3.35	M.L.AD	3.50	H.L..AD	3.54	M.L.AD	3.45	H.L.AD
Sample site visits	2.94	M.L.AD	3.30	M.L.AD	3.35	M.L.AD	3.40	H.L.AD	3.48	H.L.AD	3.44	H.L.AD	3.13	M.L.AD	3.28	M.L.AD	3.41	H.L.AD	3.32	M.L.AD
Level of adoption of transparency and measurement among firms in Niger Delta, Nigeria	2.50	L.L.AD	2.54	L.L.AD	2.93	M.L.AD	3.08	M.L.AD	3.14	M.L.AD	3.14	M.L.AD	3.02	M.L.AD	2.80	M.L.AD	2.92	M.L.AD	2.91	M.L.AD
Corporate Social Responsibility																				
Provision of employment opportunities	2.76	M.L.AD	3.00	M.L.AD	3.09	M.L.AD	3.13	M.L.AD	3.16	M.L.AD	3.12	M.L.AD	2.96	M.L.AD	2.96	M.L.AD	2.98	M.L.AD	3.03	M.L.AD
Infrastructural development	2.47	L.L.AD	2.70	M.L.AD	2.73	M.L.AD	2.58	L.L.AD	2.61	M.L.AD	2.76	M.L.AD	3.00	M.L.AD	2.56	L.L.AD	2.79	M.L.AD	2.69	M.L.AD
Human capital development	2.37	L.L.AD	2.57	L.L.AD	2.66	M.L.AD	2.45	L.L.AD	2.50	L.L.AD	2.68	M.L.AD	2.91	M.L.AD	2.39	L.L.AD	3.37	M.L.AD	2.91	M.L.AD
Level of adoption of corporate social responsibility among firms in Niger Delta	2.46	L.L.AD	2.49	L.L.AD	2.43	L.L.AD	2.39	L.L.AD	2.41	L.L.AD	2.85	M.L.AD	2.80	M.L.AD	2.33	L.L.AD	2.76	M.L.AD	2.55	L.L.AD
Employment Practices																				
Training of personnel	2.12	L.L.AD	2.41	L.L.AD	2.54	L.L.AD	2.95	M.L.AD	2.95	M.L.AD	2.96	M.L.AD	2.70	M.L.AD	2.51	L.L.AD	2.64	M.L.AD	2.75	M.L.AD
Wages/salary induced motivation	2.13	L.L.AD	2.58	L.L.AD	2.15	L.L.AD	2.41	L.L.AD	2.37	L.L.AD	2.59	L.L.AD	2.74	M.L.AD	2.28	L.L.AD	2.74	M.L.AD	2.66	M.L.AD
Social dialogue	2.04	L.L.AD	2.36	L.L.AD	2.25	L.L.AD	2.54	L.L.AD	2.48	L.L.AD	2.59	L.L.AD	2.65	M.L.AD	2.25	L.L.AD	2.57	L.L.AD	2.46	L.L.AD
Level of adoption of employment practices among firms in Niger Delta	2.19	L.L.AD	2.41	L.L.AD	2.17	L.L.AD	2.51	L.L.AD	2.49	L.L.AD	2.61	M.L.AD	2.79	M.L.AD	2.26	L.L.AD	2.66	M.L.AD	2.47	L.L.AD

Sustainability practices	Mean Score Abs N=89	Remark	M.S AKS N=113	Remark	MS BYS N=85	Remark	MS CRS N=112	Remark	MS DTS N=126	Remark	MS EDS N=114	Remark	MS IMO N=92	Remark	MS Ondo N=109	Remark	MS RIV. N=140	Remark	Combined MS N=980	Remark
Protection of the Environment																				
Building designs, construction practices and technologies that are environmentally friendly and sustainable	3.13	M.L.AD	3.42	H.L.AD	3.52	H.L.AD	3.50	H.L.AD	3.57	H.L.AD	3.56	H.L.AD	3.48	H.L.AD	3.44	H.L.AD	3.57	H.L.AD	3.48	H.L.AD

Table 7.*Continued*

Sustainability Practices	Mean Score Abs N=89	Remark	M.S AKS N=113	Remark	MS BYS N=85	Remark	MS CRS N=112	Remark	MS DTS N=126	Remark	MS EDS N=114	Remark	MS IMO N=92	Remark	MS Ondo N=109	Remark	MS RIV. N=140	Remark	Combined MS N=980	Remark
Effective communication of sustainability and other environmental management issues among contractors, suppliers and other professionals engaged by the organisation	2.74	M.L.AD	2.73	M.L.AD	3.26	M.L.AD	3.23	M.L.AD	3.29	M.L.AD	3.37	M.L.AD	3.22	M.L.AD	3.03	M.L.AD	3.03	M.L.AD	3.10	M.L.AD
Standardized management systems such as ISO 14001 or Environmental Management Systems (EMS) in your organisation	2.30	L.L.AD	2.51	L.L.AD	2.47	L.L.AD	2.54	L.L.AD	2.59	L.L.AD	2.40	L.L.AD	2.56	L.LAD	2.44	L.L.AD	2.67	M.L.AD	2.58	L.L.AD
Level of adoption of protection of the environment among firms in Niger Delta	2.43	L.L.AD	2.29	L.L.AD	2.33	L.L.AD	2.57	L.L.AD	2.58	L.L.AD	2.58	L.L.AD	2.55	L.L.AD	2.34	L.L.AD	2.56	L.L.AD	2.51	L.L.AD
Level of adoption of sustainability practices among construction firms in Niger Delta	2.71	M.L.AD	2.83	M.L.AD	2.82	M.L.AD	2.96	M.L.AD	3.04	M.L.AD	3.00	M.L.AD	3.02	M.L.AD	2.78	M.L.AD	2.93	M.L.AD	2.91	M.L.AD

V.L.L.AD – Very low level of adoption, L.L.AD – Low level of adoption, M.L.AD – Moderate level of adoption, H.L.AD – High level of adoption and V.H.L.AD – Very high level of adoption

5.4. Difference in the Levels of Adoption of Sustainability Practices among the Construction Firms in Niger Delta, Nigeria

Table 8 shows the result of the Kruskal-Wallis test that was conducted to test the hypothesis which states that there is no significant difference in the levels of adoption of sustainability practices among the construction firms based on location of the firms. The P-value of 0.001 is less than 0.05 significance level, hence the hypothesis was rejected. This indicates that there is a significant difference in the level of adoption of sustainability practices among the states in Niger Delta, Nigeria. This implies that construction firms operating in each of the states in Niger Delta did not record the same level of adoption of sustainability practices. In other words, the levels of adoption of sustainability practices by the construction firms varied from one state to another. This can be attributed to the level of enforcement of rules and regulations by the various state governments in ensuring that the construction firms carry out their activities in a more environmentally friendly manner and are socially responsible.

Table 8. Kruskal-Wallis Test for Comparing Level of Adoption of Sustainability Practices among Construction Firms in Niger Delta, Nigeria

Level of Adoption of Sustainability Practices among the Construction Firms in Niger Delta, Nigeria	**N**	**MEAN RANK**	**Chi-Square**	**D.F**	***P*-Value**	**Decision @ 0.05 Sig. level**
Abia	161	585.02	51.99	8	.001	Reject
Akwa Ibom	161	675.72				
Bayelsa	161	670.62				
Cross Rivers	161	794.00				
Delta	161	825.91				
Edo	161	811.28				
Imo	161	761.19				
Ondo	161	642.89				
Rivers	161	758.37				

5.5. Post-Hoc Test on Level of Adoption of Sustainability Practices among the Construction Firms in Niger Delta, Nigeria

The result of the post-hoc test on level of adoption of sustainability practices among the construction firms in Niger Delta, Nigeria is shown in Table 9. Because of the significant level in the level of adoption of sustainability practices based on the locations, a post-hoc test was conducted on the states using the Bonferroni and Dunnest test (Bonferroni-Dunn test) to determine the source(s) of the difference. The result of Bonferroni's multiple comparisons showed that Abia State contributed to the significant difference in the level of adoption of sustainability practices in Niger Delta. This was validated by Dunnest test result, which showed that the other eight states have P-values greater than 0.05 significant level, except Abia State which has the P-value of .004. This implies that that the level of adoption of sustainability practices in Abia State is significantly different from other states in Niger Delta, Nigeria.

Table 9. Post-Hoc Test on Level of Adoption of Sustainability Practices among Construction Firms in Niger Delta, Nigeria

	(I) STATES IN NIGER DELTA	(J) STATES IN NIGER DELTA	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Bonferroni	ABIA	AKWA IBOM	-.1021	.06170	1.000	-.2998	.0955
		BAYELSA	-.1060	.06170	1.000	-.3037	.0916
		CROSS RIVERS	-.2528*	.06170	.002	-.4504	-.0551
		DELTA	-.3245*	.06170	.001	-.5222	-.1269
		EDO	-.2725*	.06170	.001	-.4702	-.0749
		IMO	-.2301*	.06170	.007	-.4278	-.0325
		ONDO	-.0688	.06170	1.000	-.2665	.1288
		RIVERS	-.2132*	.06170	.020	-.4109	-.0156
	AKWA IBOM	ABIA	.1021	.06170	1.000	-.0955	.2998
		BAYELSA	-.0039	.06170	1.000	-.2015	.1937
		CROSS RIVERS	-.1506	.06170	.531	-.3483	.0470
		DELTA	-.2224*	.06170	.012	-.4200	-.0248
		EDO	-.1704	.06170	.210	-.3680	.0272
		IMO	-.1280	.06170	1.000	-.3256	.0697
		ONDO	.0333	.06170	1.000	-.1643	.2309
		RIVERS	-.1111	.06170	1.000	-.3087	.0866
	BAYELSA	ABIA	.1060	.06170	1.000	-.0916	.3037
		AKWA IBOM	.0039	.06170	1.000	-.1937	.2015
		CROSS RIVERS	-.1467	.06170	.631	-.3444	.0509
		DELTA	-.2185*	.06170	.015	-.4161	-.0209
		EDO	-.1665	.06170	.254	-.3641	.0311
		IMO	-.1241	.06170	1.000	-.3217	.0736
		ONDO	.0372	.06170	1.000	-.1604	.2348
		RIVERS	-.1072	.06170	1.000	-.3048	.0904
	CROSS RIVERS	ABIA	.2528*	.06170	.002	.0551	.4504
		AKWA IBOM	.1506	.06170	.531	-.0470	.3483
		BAYELSA	.1467	.06170	.631	-.0509	.3444
		DELTA	-.0718	.06170	1.000	-.2694	.1259
		EDO	-.0198	.06170	1.000	-.2174	.1779
		IMO	.0226	.06170	1.000	-.1750	.2203
		ONDO	.1839	.06170	.105	-.0137	.3816
		RIVERS	.0395	.06170	1.000	-.1581	.2372
	DELTA	ABIA	.3245*	.06170	.000	.1269	.5222
		AKWA IBOM	.2224*	.06170	.012	.0248	.4200
		BAYELSA	.2185*	.06170	.015	.0209	.4161
		CROSS RIVERS	.0718	.06170	1.000	-.1259	.2694
		EDO	.0520	.06170	1.000	-.1456	.2496
		IMO	.0944	.06170	1.000	-.1032	.2921
		ONDO	.2557*	.06170	.001	.0581	.4533
		RIVERS	.1113	.06170	1.000	-.0863	.3090

Table 9. *Continued*

	(I) STATES IN NIGER DELTA	(J) STATES IN NIGER DELTA	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
	EDO	ABIA	.2725*	.06170	.001	.0749	.4702
		AKWA IBOM	.1704	.06170	.210	-.0272	.3680
		BAYELSA	.1665	.06170	.254	-.0311	.3641
		CROSS RIVERS	.0198	.06170	1.000	-.1779	.2174
		DELTA	-.0520	.06170	1.000	-.2496	.1456
		IMO	.0424	.06170	1.000	-.1552	.2400
		ONDO	.2037*	.06170	.035	.0061	.4013
		RIVERS	.0593	.06170	1.000	-.1383	.2569
	IMO	ABIA	.2301*	.06170	.007	.0325	.4278
		AKWA IBOM	.1280	.06170	1.000	-.0697	.3256
		BAYELSA	.1241	.06170	1.000	-.0736	.3217
		CROSS RIVERS	-.0226	.06170	1.000	-.2203	.1750
		DELTA	-.0944	.06170	1.000	-.2921	.1032
		EDO	-.0424	.06170	1.000	-.2400	.1552
		ONDO	.1613	.06170	.325	-.0363	.3589
		RIVERS	.0169	.06170	1.000	-.1807	.2145
	ONDO	ABIA	.0688	.06170	1.000	-.1288	.2665
		AKWA IBOM	-.0333	.06170	1.000	-.2309	.1643
		BAYELSA	-.0372	.06170	1.000	-.2348	.1604
		CROSS RIVERS	-.1839	.06170	.105	-.3816	.0137
		DELTA	-.2557*	.06170	.001	-.4533	-.0581
		EDO	-.2037*	.06170	.035	-.4013	-.0061
		IMO	-.1613	.06170	.325	-.3589	.0363
		RIVERS	-.1444	.06170	.699	-.3420	.0532
	RIVERS	ABIA	.2132*	.06170	.020	.0156	.4109
		AKWA IBOM	.1111	.06170	1.000	-.0866	.3087
		BAYELSA	.1072	.06170	1.000	-.0904	.3048
		CROSS RIVERS	-.0395	.06170	1.000	-.2372	.1581
		DELTA	-.1113	.06170	1.000	-.3090	.0863
		EDO	-.0593	.06170	1.000	-.2569	.1383
		IMO	-.0169	.06170	1.000	-.2145	.1807
		ONDO	.1444	.06170	.699	-.0532	.3420
Dunnett	ABIA	RIVERS	-.2132*	.06170	.004	-.3771	-.0494
	AKWA IBOM	RIVERS	-.1111	.06170	.336	-.2749	.0528
	BAYELSA	RIVERS	-.1072	.06170	.375	-.2710	.0567
	CROSS RIVERS	RIVERS	.0395	.06170	.990	-.1243	.2034
	DELTA	RIVERS	.1113	.06170	.334	-.0525	.2752
	EDO	RIVERS	.0593	.06170	.905	-.1045	.2231
	IMO	RIVERS	.0169	.06170	1.000	-.1470	.1807
	ONDO	RIVERS	-.1444	.06170	.111	-.3082	.0194

6. DISCUSSION OF FINDINGS

The mean scores ranging between 2.78 and 3.04 imply that the construction firms operating in each state of Niger Delta recorded moderate levels of adoption of sustainability practices. The average mean score of 2.91 indicates that the overall level of adoption of sustainability practices among construction firms in Niger Delta is 'moderate level'. This study is in contrast with that of Waziri et al., (2015) who studied green construction practices and concluded that sustainable practices are somewhat implemented at firm level in Nigeria. The P-value of 0.001 is less than a 0.05 significance level, hence the hypothesis was rejected. This indicates that there is a significant difference in the level of adoption of sustainability practices among the states in Niger Delta, Nigeria. This implies that construction firms operating in each of the states in Niger Delta did not record the same level of adoption of sustainability practices. In other words, the levels of adoption of sustainability practices by the construction firms varied from one state to another. This can be attributed to the level of enforcement of rules and regulations by the various state governments in ensuring that the construction firms carry out their activities in a more environmentally friendly manner and are also socially responsible.

The mean ranks revealed that the construction firms operating in Delta State adopted sustainability practices more than firms operating in other states. However, the mean rank showed that firms operating in Abia State adopted sustainability practices the least. Bonferroni's multiple comparisons showed that Abia State contributed to the significant difference in the level of adoption of sustainability practices in Niger Delta. This was validated by the Dunnest test result, which showed that the other eight states have P-values greater than a 0.05 significant level, except Abia State, which has a P-value of .004. This implies that the level of adoption of sustainability practices in Abia State is significantly different from other states in Niger Delta, Nigeria. This study is in consonance with Cox et al. (2009) who posited that variations in locational context have an impact on the adoption and effectiveness of sustainability practices. It was argued that institutional and social structures of the states can affect the likelihood of sustainability practices being adopted and achieving the desired outcomes.

7. CONCLUSIONS AND RECOMMENDATIONS

This study evaluated the level of adoption of sustainability practices among construction firms in Niger Delta, Nigeria. It compared the level of adoption of sustainability practices among the construction firms operating in each of the states in Niger Delta, Nigeria. The findings from the study suggests that the mean scores range between 2.78 and 3.04, which by implication means that the construction firms operating in each state of Niger Delta recorded moderate levels of adoption of sustainability practices. The average mean score of 2.91 indicates that the overall level of adoption of sustainability practices among construction firms in Niger Delta is 'moderately level'. The findings from the study also indicate that the mean ranks revealed that the construction firms operating in Delta State adopted sustainability practices more than firms operating in other states of the Niger Delta region of Nigeria and that Abia State is the state with the least adopted sustainability practices.

This study concluded that the level of adoption of sustainability practices among construction firms in Niger Delta is moderate. This indicates that construction firms in Niger Delta need to show more commitment to the adoption of sustainability practices in order to be environmentally friendly, economically viable and socially responsible. This study concluded that construction firms operating in each of the states in Niger Delta did not record the same level of adoption of sustainability practices. It is also concluded that construction firms operating in Abia State adopted sustainability practices the least. Hence, this study concludes that firms' location has a significant impact on the level of adoption of sustainability practices

by the construction firms in Niger Delta.

This study recommends that the government should pass legislation that would encourage the adoption of sustainability practices by the construction firms in Niger Delta, Nigeria. This study also recommends that construction firms should improve on their level of adoption of sustainability practices in Niger Delta by increasing top management support, human resource management, employee empowerment, training and educating of employees on sustainability practices, and the amount of resources allocated to sustainability.

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SOCIO-CULTURAL PERSPECTIVES FOR SUSTAINABLE DEVELOPMENT OF INFRASTRUCTURE IN RURAL AREAS OF INDIA

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ABSTRACT

Infrastructure is the backbone of society for socio-economic development in rural India. In the past two decades a large-scale development of social and economic infrastructure, such as schools, roads, water harvesting structures, community centres and houses has been undertaken, particularly in the community development blocks (administrative units for rural development) of India. However, despite various measures such as availability of finances, work forces and development guidelines, it is argued that the development of infrastructure does not occur at the desired level. Therefore, using the case study of the community development blocks in Odisha State of India, this investigation examined the impediments for development of infrastructure, and how sustainable development of infrastructure in rural areas of India can be attained by using a cultural theory-inspired socio-cultural perspective. A survey research method and stakeholders' discussion were followed to conduct the study. Findings suggest that the provision of finance, materials, equipment, the availability of human resources and administrative guidelines do not alone ensure sustainable development of infrastructure. Non-effective or marginal engagement of appropriate stakeholders, disagreements and wrangling among local political leaders, and bureaucratic bottlenecks are the major impediments in the development process. However, it is also revealed that a deliberative constructive engagement and trade-offs and decisions based on concessions than consensus among the various stakeholders will enable a smooth development process and the construction of infrastructure in rural India. Consequently, a cultural theory-inspired active and constructive engagement among the various social solidarities is advocated that would essentially generate the dynamics and cohesion among the stakeholders for sustainable development of infrastructure in rural areas in India.

Keywords: Cultural theory, Constructive engagement, Infrastructure, Rural, Sustainable development, Stakeholders

1. INTRODUCTION

About two-thirds of the people of India live in rural areas. These rural areas contribute significantly to the Indian economy through agriculture and food provision as well as the labour pool for all the three sectors (primary: agriculture, secondary: industry, and tertiary: service) of the economy in India. Consequently, it is argued that the importance of rural India should never be undermined. However, rural areas in the country have perennially suffered from the phenomena of lack of development, poverty and over-reliance on agriculture and related activities. Poor infrastructure was found to be most important barrier for the development of rural areas. Consequently, understanding the demographic and

economic significance and lack of appropriate infrastructure, as well as the creation and strengthening of infrastructure have been considered as vital for the development of rural areas and the country as well. In this context, government at both national level and state (provincial) level has over the years developed various programmes and schemes and put these into operation for the creation and strengthening of infrastructure in the rural areas. Some of the important programmes and schemes that have been developed and put into operation over the years include the National Rurban Mission (NRuM), the Pradhan Mantri Gram Sadak Yojana (Prime Minister's Rural Rural Roads Plan – [PMGSY]), the Pradhan Mantri Awaas Yojana (Prime Minister's Housing Plan), the Jawahar Rojgar Yojna (Jawahar Employment Scheme [JRY]), and the Indira Awas Yojna (Indira Housing Plan [IAY]), to name but a few. The government and at times certain private organizations interested in philanthropic acts avail billions of Indian Rupees for the realization of these programmes. The major focus of these plans, programmes and schemes are multi-fold, namely the creation of employment opportunities, and the creation of basic infrastructure that includes rural roads, school buildings, community centres, and water harvesting structures which could assist in both the social and economic development of the rural areas in the country.

These plans and programmes are transferred to schemes and then to projects, which are generally undertaken through the different administrative units functioning at the district, block and village levels as the case may be under the auspices of the provincial governance system. Additionally, a local governance system, namely *Zilla Parishad* (council at the district level), *Panchayat Samiti* (council at the block level) and *Gramya Panchayat* (council at the village level) created after the 73rd Amendment Act of the Constitution of India, is directly responsible for the planning and implementation of such programmes and schemes. Furthermore, administrative personnel and professionals at the different levels of the above-mentioned three administrative units implement and manage the projects. The governments also outline appropriate development guidelines from time to time for smooth operation of the programmes and the implementation and completion of the projects. However, despite the various measures undertaken, including those of making available finances, work forces and development guidelines, it is argued that the development of infrastructure does not occur at the desired level. The projects suffer from conflict, delay, non-completion, and poor quality and some sometimes fail to get off the ground.

Therefore, the objectives of this investigation are to examine what the impediments are for the development of infrastructure, and how sustainable development of infrastructure in rural areas of India can be attained by using a cultural theory-inspired socio-cultural perspective. Using three community development blocks (CDB) of Odisha State in India as the case study areas, a survey was conducted among the stakeholders to collect primary data. Further, the stakeholders' engagement and interaction and their influence on the process of development of infrastructure were examined. The data collected were analyzed by using both quantitative and qualitative methods. Findings suggest that provision of finance, materials, equipment, the availability of human resources and administrative guidelines do not alone ensure the sustainable development of infrastructure. Disagreement and wrangling among local political leaders, bureaucratic bottlenecks, the apathy of beneficiaries, and the consequent non-effective or marginal engagement of appropriate stakeholders are the major impediments in the development process. However, it is also revealed that a deliberative constructive engagement, trade-offs and decisions based on concessions than consensus among the various stakeholders will enable a smooth development process and the construction of infrastructure in rural India.

2. LITERATURE REVIEW

Among the many challenges, the creation of infrastructure is one of the most important challenges for socio-economic development (IECD, n.d.; Olshansky, 2005). In the development of infrastructure, the economic, environmental and technical implications in the planning and implementation of the project works are regarded as important. It is also evidenced from literature that resource allocation is often considered as the prime policy and adopted in general (Tatano et al., 2004). However, social considerations are usually underestimated (Das, 2016). Scholars argued that in addition to economic, environmental and technical considerations, social aspects such as social vulnerability, views and priorities of different social solidarities and stakeholders' engagement should be given due recognition (Chapman 2015; Das, 2017; Lucas & Pangbourne, 2012). Although, it is perceived as a very complex issue, scholars are of the opinion that sustainability and success can only be achieved if people and stakeholders play a key role in the governance and management process (Beck et al., 2011; Chapman, 2015; Greene & Wegener, 1997).

Literature suggests that investigation regarding the development and redevelopment of infrastructure projects has been a subject of significant research, particularly in developing countries. This includes issues relating to infrastructure development, asset management as well as the social, economic and environmental implications (Haige, 2006). However, the issues relating to stakeholders' engagement and community participation in the development of infrastructure projects, particularly in the rural areas, have been underestimated. Nevertheless, the role of stakeholders' constructive engagement has already been established in different sectors such as sustainable urban development, the planning and management of transportation systems, and the reengineering of infrastructure, to name but a few (Beck et al., 2011; Hays, 2007; Kim & Dikey, 2006; Taylor, 2007). However, owing to the lack of an appropriate thrust in the process, it is undermined, particularly in India (Das, 2016).

Understanding the severity of the issue, the Government of India enacted the 73rd Constitutional Amendment of Act in 1992 to create a three-tier governance system at the central, state and local levels. It introduced self-governance at the local level and empowered the local governments to make decisions, plans, and proposals and to implement them (GoI, 2009; Singh, 1994). The roles and responsibilities of the local bodies and the system of people's participation in the decision making are also mapped in the Amendment Act of the Constitution (GoI, 2009). However, most studies undertaken to assess the functioning of the local bodies in India point out that their performance has deteriorated over time (Aijaz, 2007; Fahim, 2009). They are confronted with inefficiency in the conduct of business, ineffective participation by the weaker sections of the population in local governance, weak financial conditions, and lack of transparency, all of which affect their performance adversely (Aijaz, 2007; Fahim, 2009). The major contributing factors are the lack of responsibility and accountability, and the lack of respect to the stakeholders. Although the Amendment Act was enacted with a spirit of governance at grassroots level and can be regarded as successfully functional from the structural point of view, the role of various stakeholders such as common citizens, business people, professionals, and civil society are largely ignored, thereby limiting the development process to a few technical and administrative hands under the auspices of local politically elected leaders (Das, 2016, 2017).

Therefore, it is argued that paradigms to strengthen the stakeholders' participation and engagement as per the spirit of the Constitution of India be developed for the sustainable development of infrastructure in rural areas of India. From the evidence available in literature globally, a number of scholars argue that such a challenge can be overcome by

creating a platform through the application of theories of social organization and governance, such as the cultural theory (Douglas & Wildavsky, 1982; Schwarz & Thompson, 1990; Thompson et al., 1990; Thompson et al., 1998; Thompson, 2008; Verweij & Thompson, 2006).

3. RESEARCH METHODS

3.1. Study Area and Project Profiles

District rural development agencies (DRDAs), community development blocks (CDBs) at block level and village panchayats in hierarchical order at the local level are the three tiers of administrative and implementing agencies of the rural infrastructure development projects. At the same time, zilla parishad, panchayat samiti and village panchayats are the local governing bodies responsible for planning, budgeting, strategic decisions and programming at district, block and village level respectively. Consequently, CDBs remain pivotal in the whole process of planning, decision making, programming and implementation. They generally act as the linkage between the two other tiers of functionaries at the district and village panchayat level. Therefore, CDBs are considered as the case studies for this study. Under this premise three CDBs in the Odisha State of India such as Odapada of Dhenkanal District (Block 1), Balipatna of Khurda District (Block 2) and Kishorenagar of Angul District (Block 3) were taken as the case study areas for investigation and survey. Three types of projects in these CDBs such as primary schools, rural roads and community centres were considered for the evaluation. The profile of projects in these study areas is presented in Table 1. The projects include 31 (31.6%) primary schools, 38 (38.8%) roads, and 29 (29.6%) community centres, giving a total of 98 projects in the three blocks.

Table 1. Profile of Projects and Stakeholders

Profile of projects							
	Project characteristics			**Total**	**Estimated project cost (USD) range**	**Estimated project duration (months)**	**Contractor**
Type of projects	**Block 1**	**Block 2**	**Block 3**				
Primary schools	15	10	6	31 (31.6%)	3000-5500	12 -18	Selected from community
Roads	16	15	7	38 (38.8%)	2500-3500	6-12	Selected from community
Community centres	12	9	8	29 (29.6%)	2000-3000	6-12	Selected from community
Total	43	34	21	98			
Stakeholders profile							
Administrative officials	3	2	2	7			
Engineers	3	3	2	8			
Local leaders	6	6	4	16			
School teachers	8	6	3	17			
Contractors	11	7	5	23			
Common citizens	44	35	20	99			
Total	75	59	36	170			

3.2. Survey, Data and Analysis

Data were collected from both primary sources and archival records. Data relating to project profiles and status of the projects were collected from archival records of the concerned CDBs and village panchayats. A stakeholders' survey was conducted to collect primary data to examine the factors that influence the success and failure of projects by using pre-tested questionnaires. The stakeholders selected for the survey were contractors, supervising engineers, administrative personnel, local leaders, school teachers, and common citizens. They were chosen based on their engagement, availability and stakes in the projects. The stakeholders for survey were selected by following two processes: Firstly, the administrative officials and engineers were selected by using a convenient sampling process because only a limited number of such personnel were engaged and available in the project development in the study area. Secondly, contractors, school teachers, local leaders and common citizens were selected by using a random sampling process. The sampling in this case was done by choosing one stakeholder from every five persons from a particular category engaged in the development of projects and who was available and willing to participate in the survey. Since the number of stakeholders in certain categories (such as administrative officials and engineers) was limited, there was no choice other than using convenient sampling or else they would have been left out of the survey process, which could have provided a skewed responses and findings. However, care was taken to avoid any bias and skewness by treating them as survey respondents. A total of 170 stakeholders (75 from Block 1, 59 from Block 2 and 36 from Block 3) were surveyed which included 41.8% of officials, teachers, engineers, contractors and local leaders who are directly associated with the projects and 58.2% of common citizens who were aware of various developmental works in the blocks.

The variables included in the questionnaire are awareness about the projects, availability of finance, cost of projects, contractor selection process, estimated and actual duration of projects, issues relating to materials, equipment, skill and supervision of projects, execution and project management issues, and challenges encountered in the projects. In addition, informal meetings were conducted by inviting stakeholders and engaging them in discussions to understand the stakeholders' engagement and participation in planning, decision-making and construction of projects and their influence on the success of the projects. The stakeholders' discussion and engagement were conducted through non-structured interviews and informal group discussions.

The data collected were analyzed both quantitatively and qualitatively. Quantitatively descriptive statistics analysis and Cronbach's alpha test of the data collected was done to observe the reliability of the data. A perception index (PI) based on an average index method was conducted to examine the various factors that influence the completion of the projects. The PIs for different variables were calculated by considering the weighted average of the perceptions of stakeholders assigned by the respondents on a particular variable on a scale ranging between 0 and 1. The formula used for calculating perception index is given in Equation (Eq.1).

$$\text{Perception index= PI=} \frac{\sum wi*xi}{\sum xi} \qquad (1)$$

xi= number of respondents assigning a particular index value

wi= index values assigned by respondents

Furthermore, the qualitative data were analyzed by using traditional (without use of any software) method of interpretation through narrative analysis to understand the politico-social and cultural perspectives for the development of infrastructure in the study area. The narrative analysis was conducted under four themes such as participation of stakeholders

and consultation with them, interference of local leaders in the projects, conflict among stakeholders and its impact on the projects, and constructive engagement among stakeholders and its impact on the projects.

4. RESULTS AND FINDINGS

It was essential to examine the completion rate of the projects and what the essential factors are that hamper the completion of projects before exploring how successful completion of projects can be achieved in the rural areas. These aspects are discussed in the following sub-sections.

4.1. Completion Rate of Project

Completion rate is an indicator of the success of projects. Therefore, the status of the competition of the projects was examined and compared to the targeted completion rate within the estimated period set by the implementing organizations (CDBs) and presented in Table 2. A discussion with the administrative officials and engineers revealed that a minimum target for a completion rate of 85% within the estimate period was generally set in all categories of projects. It was found that overall only 30.6% of the projects were completed within their estimated project period and 32.7% of the projects were completed between 51% and 99%. However, more than one third of the total projects (36.7%) were less than half complete. Among the successful projects, it was observed that the success rate of road projects (39.5%) is higher than both the types of building projects such as schools (22.5%) and community centres (27.6%). Also, it was revealed that about 48.4% of the schools and 41.4% of community centre projects were less than half complete. However, road projects have shown significant progress as about 36.8% projects were advanced to a level between 51% to 99% of completion. Thus, the completion rate of the projects is significantly below than the set targets in almost all categories of projects although the situation of road projects was more promising than both the types of building projects (schools and community centres).

Table 2. Status of Projects within Estimated Period

Projects	Total number	Targeted completion rate	Status of projects within the estimated period		
			Fully complete	51%-99% complete	≤50% complete
Schools	31	≥85%	7 (22.5%)	9 (29.1%)	15 (48.4%)
Roads	38	≥85%	15 (39.5%)	14 (36.8%)	9 (23.7%)
Community centres	29	≥85%	8 (27.6%)	9 (31.0%)	12 (41.4%)
Total	98	≥85%	30 (30.6%)	32 (32.7%)	36 (36.7%)

4.2. Factors causing Impediments of the Projects: Stakeholders' Perception

The various factors which essentially cause impediments, including disruptions and delay of the projects, in the study areas were identified from the stakeholders' discussion. These variables are a lack of planning or poor planning; the cost of projects; under-estimation of the projects compared to the market rate; unavailability of finance; timely unavailability of fund for construction; lack of adequate materials; lack of appropriate equipment; lack of human resources; lack of skills; choice or appointment of contractor;

contractor incompetence, bureaucratic bottlenecks; lack of support of executive agencies; intervention of local leaders; conflict between community, contractor and executive agencies; and lack of stakeholders engagement. The perception indices (PI) of these variables showing their influence on the completion of projects from the survey data were quantified and presented in the Table 3. However, before the PIs were calculated, the reliability and consistency of the data were tested by Cronbach α test and standard deviation (SD). The Cronbach α for the variables ranged between 0.74 and 0.83, which indicated that the responses were reliable. The lower SD values which range between 0.08 and 0.22 for different variables indicated the consistency of the responses. These tests indicated that the data collected were suitable for further analyses. Findings from PI analysis suggest that the lack of stakeholders' engagement, followed by conflict among the community, contractor and executive agencies; timely unavailability of fund for construction; bureaucratic bottlenecks; lack of support from the executive agencies, and choice of contractors are the most influential variables which impede the completion of projects. Underestimation of projects, the inability of contractors, intervention from local leaders, and the cost of projects influence the delay of projects moderately. However, lack of adequate materials, lack of human resources, unavailability of finance, lack of skills, lack of equipment, lack of planning, and lack of equipment influence the completion of projects to a lesser extent.

Table 3. Influence of Variables on the Impediments to Completion of Projects

Variables	Impediments (Perception Index)				Influence	Rank
	Schools	Roads	Community centres	Average		
Lack of planning/ poor planning	0.32	0.27	0.33	0.31	Less influential	14
Cost of projects	0.60	0.52	0.70	0.61	Moderately influential	9
Underestimation of projects	0.75	0.55	0.78	0.69	Moderately influential	6
Unavailability of finance	0.20	0.35	0.45	0.33	Less influential	12
Timely unavailability of finance	0.81	0.76	0.75	0.77	Highly influential	3
Lack of adequate materials	0.42	0.46	0.50	0.46	Less influential	10
Lack of appropriate equipment	0.24	0.36	0.31	0.30	Less influential	15
Lack of human resources	0.46	0.43	0.39	0.43	Less influential	11
Lack of skills	0.30	0.35	0.30	0.32	Less influential	13
Choice/ appointment of contractor	0.80	0.70	0.65	0.72	Highly influential	5
Contractors' inability/ incompetence	0.70	0.65	0.65	0.67	Moderately influential	7
Bureaucratic bottlenecks and lack of support from executive agency	0.75	0.80	0.65	0.74	Highly influential	4
Intervention from local leaders	0.75	0.70	0.50	0.65	Moderately influential	8
Conflict between community,	0.85	0.80	0.68	0.78	Highly influential	2

contractor and executive agencies						
Lack of stakeholders' engagement	0.85	0.81	0.74	0.80	Highly influential	1
Cronbach α for variables vary between 0.74 and 0.83; SD range between 0.08 and 0.22						

Further, qualitative discussion with the stakeholders through informal meetings and group discussion and a consequent narrative analysis under the four themes such as participation of stakeholders and consultation with them, interference of local leaders in the projects, conflict among stakeholders and its impact on the projects and constructive engagement among stakeholders and its impact on the projects revealed that stakeholders play a major role in the successful completion of the projects. For example, in the case of schools, the school management, parents of children and teaching community, and in the case of roads and community centres, the villagers and communities are the direct and indirect stakeholders. In a democratic set up and bottom-up approach of development process at the community level as empowered by the local governance system, these stakeholders should be engaged and consulted at every stage of the development process, starting from planning and programming to implementation and project handover stages. However, as found out from the discussions, the role of these stakeholders was undermined, leading to serious consequences of conflict and delay. As some community level stakeholders such as village leaders including local leaders and school teachers put it:

"*.... the villagers, and communities were not consulted or taken in to confidence even at the time of inception of the projects, as well as while appointing the contractor, and in aspects related to planning, layout, and execution. The priorities of people were also not being sought. So, many a time conflicts between the contractor, community and executive agencies occur leading to delay or halting of the construction*."

Moreover, it was also found that other stakeholders such as local leaders, competing contractors, the community, transporters, material and equipment suppliers, and community level organizations engaged in social development sector were rarely consulted formally or informally in the planning and execution of projects. As per some local leaders:

"*.....there have hardly been any stakeholders' engagements among the contactors, executive agencies and communities in any aspect of the works until any conflict arise. The executive agencies, officials and contractors do the works according to their choices and preferences. In case any consultation takes place, only few preferential people known to the executive agencies and local leaders from the community were chosen and the large segment of the community were grossly neglected".*

This causes indifference, antagonism and conflicts. Furthermore, according to people from villages and communities, the local leaders usually interfere in the project execution. For example, if the location of projects, choice of contractors and suppliers are not according to the choice of the local leaders and if the officials and contractors do not acknowledge their importance, then they try to create obstacles in the execution of the projects. In other words, they forcefully impose their interest and choices in the decision-making and execution process. In this regard, some people from a community affirmed that:

"*.... elected local leaders try to put their wishes and choices as the priority. They try to create obstacles in the projects if the project is not executed according their wishes. They try to influence the officials, suppliers and contractors to delay in financing the projects, supply of materials and*

equipment and construct in time. They also at times instigate conflict among the people and different stakeholders having competing interests"

Similarly, according to a school teacher:

"*...when a contractor used low quality materials and poor specifications to construct a building to get higher profits, conflict among the community, school management and the contractor was engendered leading to stalling of the project for a long time*".

Thus, it is revealed that conflict among the contractors, beneficiaries and community arises because of the ulterior motives of the contractors for higher profit which leads to low quality construction. Furthermore, according to some people, at times the competing contractors play a crucial role in instigating the conflict.

However, there has been positive evidence of completed work, where the stakeholder was engaged constructively and was part of the development process. For example, according to a school teacher corroborated by the village level leaders

"*... the school management and community leaders were consulted in the execution of the project; the teachers and community took active interest in the work; and the contractor requested for cooperation from the people, and with the active supervision of the engineers and administrative officials, the building was completed more or less within the stipulated time of about one year*".

Similarly, in another instance, when a contractor from the community, on the recommendation and consultation of villagers, took charge of construction of a road project, the project was completed within a limited period of time. As a senior person from the village puts it in perspective-

"*…. the construction of the road was stopped for some time as the contractor and the officer in charge were not heeding to the demands of the villagers. However, once the villagers were consulted and the way forward was decided such as contactor selection, specification of road materials and execution period of the project, the project was completed in no time without any problem*".

Thus, the views of people and stakeholders corroborate the findings of the survey that lack of stakeholders' engagement and conflict and wrangling among the stakeholders cause delays in projects and sometimes lead to non-completion. However, when communities and stakeholders were appropriately engaged and consulted, the projects were successful.

4.3. Socio-cultural Perspective for Effective Stakeholders' Engagement

Three important perspectives emanated from the discussions with the stakeholders. Firstly, according to the officials and personnel engaged in the planning, programming, decision making and implementation, it is difficult to manage the stakeholders' participation because of the sheer number and diversity of stakeholders. Secondly, despite the availability of a policy for stakeholders' engagement and participation and constitutional mandate, it does not occur in reality. Thirdly, discussions with the stakeholders of various successful projects in the study areas suggested that the different stakeholder such as communities, school management committees, including teachers (in the case of school projects), and villagers have a major say in the project, starting from the initiation, planning, and contractor selection to the execution and supervision of the projects.

Similarly, according to literature, the governance of human settlements involves multiple actors and stakeholders, interdependent resources and actions, shared purposes and blurred boundaries between the public and the private, formal and informal, and state and civil society sectors (UN Habitat, 2001). Therefore, the role of governance agencies and the private sector such as contractors, suppliers, community organisations, and political leaders

cannot be underestimated. However, the active engagement of these varied actors in governance and project execution and management needs higher levels of co-ordination, negotiation and building concessions to arrive at consensus (Das, 2017).

Under these circumstances, although stakeholders' participation and engagement was essential for the success of projects, multi-actor planning and stakeholders' engagement in planning, decision making, and execution was observed to be a hugely cumbersome and difficult process. It was also observed that the conventional approaches of stakeholder participation and engagement do not assure any significant success under the prevailing conditions. Thus, in terms of the current ineffectiveness, a new socio-cultural perspective is necessary that could entail far more inclusive, strong and effective engagement among the stakeholders. A number of scholars argue that this challenge can be overcome by creating a platform through the application of theories of social organisation and governance, such as the cultural theory (Douglas & Wildavsky, 1982; Schwarz &Thompson, 1990; Thompson et al., 1990; Thompson et al., 1998; Thompson, 2008; Verweij & Thompson, 2006).

Cultural theory professes that all the stakeholders can be mapped to a four-fold typology of social solidarity: the individualist, hierarchicist, fatalist, and egalitarian (Douglas & Wildavsky 1982; Thompson et al., 1998). According to this theory, for the individualist (market forces), humans are inherently self-seeking and atomistic, and nature is benign and forgiving, and is able to recover from any exploitation. They believe that trial and error in self-organising and ego-focused networks (markets) are the way to go. Individualist actors trust others until these persons give them reason not to, and then retaliate in kind (Rapoport, 1985). They embrace equality of opportunity and promote competition, which means no accountability. For them it is fair that those who put most in, get most out.

For the hierarchicist solidarity (administration, governing and decision-making authority), the world is controllable, humans are malleable and deeply flawed but redeemable by firm, long-lasting and trustworthy institutions. Fair distribution should be by rank and station or – in the modern context – by need, with the level of need being determined by a dispassionate expert. Fatalists (the common people) do not find rhyme or reason in nature and for them humankind is fickle and untrustworthy. Consequently, fairness is not to be found in this life and there is no possibility of effecting change for the better. The egalitarian solidarity (social and community organizations) is the opposite. For them, society is fragile and intricately interconnected. Humans are essentially caring and sharing until corrupted by the coercive and non-egalitarian institutions of markets and hierarchies. To them it is not enough that people who start off equal must end up equal; trust and levelling go hand in hand, while institutions that distribute unequally are distrusted. Voluntary simplicity is regarded as the only solution to the societal problems (Beck et al., 2011; Douglas & Wildavsky, 1982; Thompson et al.,1998).

Each of the above solidarities generates its own storyline, which in turn contradicts the storylines of the others (Beck et al., 2011; Douglas & Wildavsky 1982; Thompson et al., 1998), and the complex dynamics of their interactions can steer matters in sometimes destructive or sometimes constructive directions (Beck et al., 2011). However, each solidarity finds certain elements of experience and wisdom that are missed by the others. Each offers a clear expression of the way things should be done. Therefore, it is important that all of them be taken into account to a certain extent in the state of affairs and decision making (Verweij & Thompson, 2006). A set of examples from across the world, such as resolving the problem of the water sanitation system in Kathmandu Valley, Chattahoochee in Atlanta (Beck et al, 2011), access to service delivery – particularly in sanitation and solid waste management – by the people in Kampala and ameliorating the problem of hygiene

and sanitation in Yaoundé (Parrot et al., 2009; Tukahirwa et al., 2010), show that this perspective has been found to be accurate. It was found that in all cases, the engagement of different solidarities – although some delivered clumsy solutions – provided some prospect of a collectively accepted progress (Das, 2017).

In the context of infrastructure development in the rural areas of India, there is a need for simplifying the complex stakeholders' participation and engagement and the number of stakeholders needs to be scaled down. For instance, the stakeholders should be mapped into four distinct solidarities as proposed by the cultural theory. Market forces, industries, business organisations, suppliers, and contractors should be grouped under the individualist solidarity. Hierarchicists should constitute governance system, local leaders, and executive agencies. Community organisations, NGOs, village committees, and school management should form the egalitarian solidarity, while the common citizens form the other fatalist solidarity. The principle to be followed is the relationship between participation and responsiveness. For, example, with more participation from stakeholders, more responsiveness is expected. While decisions are to be made, these solidarities or representatives of these solidarities (in order to limit the numbers to practically feasible and constructive engagement) should be allowed to indicate their needs, priorities, demands and challenges. Based on each other's storylines and constructive engagements, concessions may be made, and feasible decisions can be arrived at.

Such cases were evidenced from the successful projects in the study area. For example, in some projects where decisions were made by the different groups of stakeholders through constructive engagement on some aspects such as what projects were of priority, what the project period and duration should be, what the project cost should be, who the beneficiaries should be, who should execute the project, who the contractors should be and who the supervisors and arbitrators should be in case of conflict, those projects were successfully completed without many challenges and within the estimated time and cost. In this regard, in some projects, after a discussion in their villages, the representatives from the community from different stakeholder groups had engaged with the executive agencies proactively to be a part of project selection, planning and design, the selection of contractors, and liaison with local leaders and contractors for the smooth progress of the construction work. Also, they assisted the supervisory and implementation authorities for the smooth execution of the projects. Contractors and suppliers worked in coordination with both executive agencies and representatives from the community. The village committees and community organizations acted as the watch dogs and also assisted in conflict resolution. Such constructive engagement of the stakeholders minimized or resolved conflict, if any, kept the executive agencies and supervisors on their toes, and ensured that the contractors worked at the desired speed and according to the specifications, all of which enabled the successful completion of projects in time with appropriate quality.

Therefore, grouping the stakeholders into different solidarities will mitigate the challenges of too many of stakeholders. By minimizing the number of stakeholders to feasible entities, evidence from successful projects shows practically how projects can be successful through constructive engagement and concessions. Therefore, in a democratic set up considering the economic, environmental and technical aspects of the development of infrastructures in rural areas as important is significant. The socio-cultural perspectives such as stakeholders' constructive engagement through delineating different social solidarities, allowing each solidarity to listen to others' storylines, and arriving at concessions rather than consensus would perhaps assist in achieving sustainable and successful infrastructure development in the rural areas of the country.

5. DISCUSSION

Infrastructure development is a complex process. It becomes even more challenging in the context of the rural areas of India. It is subject to a number of social, cultural, economic, political and technical factors as well as involving a set of stakeholders with diverging demands and storylines (Beck et al., 2011). As observed from this study, the success rate in the completion of the infrastructure projects does not meet the targets set by the organizations engaged in the infrastructure development. The reasons are found to be multifold. They range from the lack of stakeholders' engagement, conflict among the community, contractor and executive agencies, unavailability of timely funds for construction, bureaucratic bottlenecks and lack of support from the executive agencies to choice of contractors. These are the major variables that impede the construction and delay the projects, as corroborated by various scholars (Aibinu, & Odeyinka 2006; Alaghbari et al., 2007; Das, 2015; Das & Emuze, 2017; Desai & Bhatt, 2013; Doloi et al., 2012). It was also found that underestimation of projects, inability of contractors, intervention from local leaders, and cost of projects influence the delay of projects moderately (Alaghbari et al., 2007; Das, 2015; Das & Emuze, 2017; Desai & Bhatt, 2013; Doloi et al., 2012). On the other hand, lack of adequate materials, lack of human resources, unavailability of finance, lack of skill, lack of equipment, lack of planning, and lack of equipment do not necessarily significantly influence the completion of projects. Further, it was ascertained that strong and effective stakeholders' engagement and conflict resolution are of paramount importance for the successful development of infrastructure projects, which corroborate the observations of scholars such as Beck et al. (2011).

In this context, the study identified that certain categories of stakeholders such as administrative officials, engineers, local leaders, school teachers, contractors and common citizens play a pivotal role in the infrastructure development projects. The successful and constructive engagement among these stakeholders and trade-offs in their demands enable successful and timely completion of the projects. Therefore, to avoid complication in the participation and engagement process, these stakeholders should form the nexus of the four-fold map of the cultural theory, namely individualists, hierarchicists, egalitarians and fatalists. The contractors or suppliers should be the individualist solidarity; administrative official and engineers belong to hierarchicist category; local leaders, school teachers and community organisations form the egalitarian solidarity, and common citizens or users of the infrastructures are the fatalist solidarity (Beck et al., 2011; Douglas & Wildavsky 1982; Thompson et al., 1998). A definite relationship needs to be established between the identified stakeholder solidarities and the four strands of the cultural theory in rural India. In this context, local leaders and community organizations (egalitarians) with the help of common citizens (fatalists) can delineate the priorities and demands for different infrastructure projects and liaise with administrative officers and engineers (hierarchicists) for their approval and initiation. The hierarchicists, in this case the administrative officers and engineers, prepare the detailed project and invite tenders or call for expression of interest from the individualist solidarity such as contractors and suppliers for the execution of the projects. However, the contractors and suppliers (individualists) should be selected by the hierarchicists in consultation with the both egalitarian solidarity such as local leaders, school teachers (in case of schools) and community organizations and representatives from the users i.e. the villagers (fatalists- the common citizens). Similarly, the common citizens and egalitarian groups should be given responsibilities as the watchdog to see that the projects

run according to the schedule, assist in conflict resolution and check the quality of the work. Thus, combined effort and constructive engagement with clear roles and responsibilities and concessions with regard to the demands of each other would assist in the sustainable development of the infrastructure projects in the rural India.

6. CONCLUSIONS

Infrastructure development is vital for the progress of rural India. The governments at the central and state levels have been taking measures to reinforce the rural infrastructure for a long time. However, experience shows that the development of infrastructure has been a serious challenge. Usually the projects exceed the stipulated estimated time and overrun the cost to complete. At times, it also becomes difficult to get off the ground. As observed from this investigation, only about 30.6% of the projects were completed within the estimated time. Therefore, this study examined the various impediments for development of infrastructure, and how a cultural theory-inspired socio-cultural perspective can engender the sustainable development of infrastructure in the rural areas of India. For this purpose, three community development blocks of Odisha State in India were used as the case study areas. A survey research method was used for the collection of data and both quantitative and qualitative analyses of the data collected were conducted. Also, the stakeholders' engagement and interaction and their influence on the process of development of infrastructure were examined through stakeholders' discussions and narrative analyses. It was revealed that the provision of finance, materials, and equipment; the availability of human resources; and administrative guidelines are not sufficient to ensure the successful completion of infrastructure projects. Lack of stakeholders' constructive engagement; conflict among the community, contractor and executive agencies; unavailability of timely funds for construction and bureaucratic bottlenecks; lack of support from the executive agencies; and choice of contractors are the major obstacles in the infrastructure development process. Narratives from stakeholders' discussion also revealed that stakeholders' effective participation and engagement hold the key to the success of the projects. Consequently, it was found that a deliberative constructive engagement, trade-offs and decisions based on concessions rather than consensus among the various stakeholders enable a smooth development process and construction of infrastructure in rural India. Thus, it is advocated that a cultural theory-inspired active and constructive engagement among the relevant actors in the various social solidarities will essentially generate the dynamics and cohesion among the stakeholders and would ultimately enable the sustainable development of infrastructure in rural areas in India.

The study has certain limitations as it is based on limited survey data from the three CDBs in Odisha State, India. Furthermore, the analyses were conducted on an aggregate basis rather than on individual projects. In addition, the socio-cultural perspective and stakeholders' engagement were limited to the conceptual level. Therefore, there is a need for further study at the individual project level to examine the intricacies of project success as well as exploring a robust mechanism of socio-cultural perspectives for effective stakeholders' engagement that could enhance successful infrastructure development in rural India, which is the further scope of the study.

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CONSTRAINTS AND CHALLENGES IN THE IMPLEMENTATION OF TOTAL QUALITY MANAGEMENT (TQM) IN CONTRACTING ORGANISATIONS

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ABSTRACT

Total quality management (TQM) is managing people and business processes to ensure complete customer satisfaction at every stage. As building projects get larger and become more complex, clients require a higher quality standard for project delivery with lower construction costs. This study intends to assess the constraints and challenges in the implementation of the TQM of construction companies. The cross-sectional research design was used for this study and the population entailed construction professionals in indigenous and expatriate construction companies in Nigeria. A random sampling procedure was used to select the respondents. A total of 50 questionnaires were distributed and 30 were retrieved and used for the analysis. It gave a response rate of 60%. Statistical Package for Social Science (SPSS) 17th version was used to analyse the data, using descriptive statistics and the relative importance index (RII) to calculate the level of importance of the factors. The study shows that the factors affecting the implementation of TQM are management commitment factors, the role of the quality department, and training and education. The challenges of TQM are lack of available quality system documentation, lack of understanding of the process requirement, and the high cost to implement TQM. In conclusion, Nigeria construction companies do not have quality control and assurance manuals that will be a guide to monitor the quality of the end products. Therefore, most projects are abandoned as a result of poor quality workmanship. It was recommended that Nigeria construction companies should develop a framework for quality standard and for competing with their counterparts globally.

Keywords: Construction industry, Contracting organization, Nigeria, Organizational culture, Total quality management.

1. INTRODUCTION

Total quality management (TQM) is a way of managing people and business processes to ensure complete customer satisfaction at every stage. It emphasizes a commitment to quality, communication of the quality message, and recognition of the need to change the culture of an organisation to create total quality. Customer satisfaction is one of the main objectives of TQM which directs organisational efforts towards the goal of TQM. TQM also enhances innovative processes in an organization through continual improvement, thus ensuring sustainable development (Bon & Mustafa, 2013). According to Ugboro and Obeng (2000), with the full adoption and implementation of TQM, there should be a turnaround in corporate culture and management approaches as compared to the traditional way of management in which top management gives orders and employees merely obey them.

TQM is the management philosophy and company practices that aim to harness the human and material resources of an organisation in the most effective way to achieve the objectives of the organisation. The TQM concept is an aspect of continuous improvement which aims at quality as a key parameter of any successful business, hence the quality of a product or service is essential to TQM. According to Phenga and Teo (2004), TQM is a "journey", hence a change in behaviour and the culture of the organisation. TQM entails managing construction activities, the stakeholders, and the construction process from the early stage of the project till the completion stage. TQM focuses on meeting clients' requirements by providing quality services at a cost that provides value to the client. TQM can be sustained through the leadership style at all levels of the organisation (Alwi et al., 2011).

TQM is a successful philosophy in the manufacturing sector (Bakar et al., 2011) but the construction industry is behind other industries in implementing this concept. However, it can be adopted to improve quality and productivity and to ensure that clients get good value for money (Phenga & Teo, 2004). TQM also ensures a reduction in quality costs (Iruobe et al., 2010) and better employee job satisfaction because they do not need to attend to defects and client complaints (Phenga & Teo, 2004). Further benefits are recognition by clients, work carried out correctly from the design stage and closer subcontractors' and suppliers' cordial relationships. TQM performance can be measured through top management commitment, customer involvement and satisfaction, employee involvement and empowerment, customer-supplier relationship and process improvement and management (Ahmadinejad et al., 2005; Baidoun, 2004; Atar, 2013).

Hernandez and Aspinwall (2008) cited in Odusami et al. (2010) opined that the construction industry in the UK had taken up the challenges of quality management, leading to an increase in market shares and an improvement in customer satisfaction. However, in Nigeria corruption practices and a renewal of the oil boom have led to poor quality construction projects, scarcity of materials, poor workmanship, poor quality output, delay,cost overrun and collapse of work due to not adhering to quality management. According to Arditi and Gunaydin (1997), management commitment to improvement in the USA is very important; hence construction professionals should ensure adequate quality training and enter into partnering agreements among the parties in the construction process in order to ensure quality end products. However, a feedback loop would ensure the improvement of the original quality associated with the organisation. A clear understanding of the project scope, drawing, specification, and communication would aid the quality process.

To be competitive in today's market, it is necessary for construction companies, especially in developing countries such as Nigeria, to provide quality and value to their clients.

Contractors who are the suppliers of construction services must address the needs of the clients for projects' success because clients' needs mirror the economic pressure and challenges faced by the contractors and the construction professionals. Hence the old adversarial procedure of managing construction projects should be put aside and a better means of developing direct relationships with the client should be adopted through teamwork at the job site.

TQM is widely used in manufacturing, the health sector and other industries but is rarely used in the construction industry (Pheng & Teo, 2003; Sodangi et al., 2010). TQM is a new approach in the construction industry (Madar, 2015). In relation to performance, TQM ensures client satisfaction, reduced wastage, an increase in productivity, "just in time", low cost, and teamwork among the stakeholders and workers on construction sites (Madar, 2015; Al-Shdaifat, 2015). However, the construction industry requires a cultural change for the implementation of TQM from the top managers. The construction industry only requires TQM to provide a competitive advantage and improve their financial performance. TQM should be established to provide quality management at all phases of projects since client satisfaction is the main prerequisite for quality management. Hence this study intends to assess the factors mitigating the TQM of construction companies to ensure clients' satisfaction and project delivery within time, cost and quality standards.

2. LITERATURE REVIEW

The construction industry globally reflects the national construction demand by promoting industry performance, competitiveness and improved value for clients (Milford, 2009). Thus, the construction industry is an industry that contributes to a nation's social and economic development (Adeagbo, 2014). It was realized in Singapore that the industry required skilled work for performance, while in South Africa there must be an enabling environment for the transformation of the industry. Hong Kong required a better procurement process for a better performance of the industry (Milford, 2009). These countries require an increase in the international competitiveness of their construction sector in order to secure a high proportion of business.

However, the industry also enhances employment generation and contributes to the gross domestic product (GDP) and gross fixed capital formation (GFCF) of any country (Okoye, 2016). It is only the construction sector that occurs twice in the national account of every nation (Lopes, 1998). The GFCF entails the total value of all new construction which includes construction works (building and civil engineering works). This also includes all capital alternatives that improve the lifespan of the project.

In 2006, it was reported that the construction industry was responsible for an average of 5 to 7% improvement of the GDP growth and over 42% of the GFCF over the previous four decades (Olatunji & Bashorun, 2006). According to a study by Anyanwu et al. (2013), agriculture was identified as contributing the highest share of the GDP, and the lowest contributor to the GDP from 1990 to 2008 in Nigeria was the building and construction sector, although the construction industry in Nigeria was identified as a fast growing sector of the economy, which recorded a growth rate of more than 20% between 2006 and 2007. However, this growth has not been commensurate with the growth of Nigeria's total GDP as the overall contribution of the construction sector to the country's GDP remains very low (Okoye, 2016).

The construction industry in Nigeria is growing in complexity and in order to be competitive at the global level (Agwu, 2012) total quality management should be strictly adhered to in order to ensure clients' satisfaction and profitability. Many Nigerian construction

companies only have comprehensive quality plans as safety plans as opined by Hinze (1997) cited in Agwu (2012) but the quality of the plan does not necessarily correlate with the company's quality performance. Quality in each phase is affected by the quality in the preceding phase; therefore customer service in each phase is important for the overall quality performance of the process (Odusami et al., 2010). Quality is therefore an important feature of any construction company because the safety of the construction companies and the stakeholders depends on the quality of the structure (Idoro, 2010).

Haupt and Whiteman (2004) and Bubshait and Al-Atiq (1999) reiterate that TQM as a management system has not been as effective in the construction industry as it has been in other industries because of a lack of an adequate budget, failure to plan for quality, inadequate training at all levels except for top or senior management positions (Gunning & McCallion, 2007), and little recognition given to those who strive for quality improvement on their projects. Contractors have failed in setting out adequate funds required for the accomplishment of improving and maintaining the requisite quality expected of construction products and services.

According to Willar et al. (2009), the all-encompassing management philosophy termed total quality management (TQM) has generated a tremendous amount of interest and has emerged in the forefront of a major management movement, influencing many sectors of the economy worldwide. The subject matter has gained some commitment on the part of the management of most contracting organizations, thereby increasing the level of quality culture available in those organizations. TQM consists of management principles aimed at achieving quality performance in all aspects, i.e. product, service, process, profit and productivity (Sodangi et al., 2010; Idrus & Sodangi, 2010). The fundamental difference between the QA/QC (quality assurance/quality control) approach and TQM is that the former is a 'top-down' approach, whereas the latter is a centralized approach consisting of management principles aimed at achieving quality performance in all aspects, i.e. product, service, process, profit, and productivity. The principles of TQM have been widely used by the manufacturing and service industries, and they have seemingly been welcomed by the construction industry as an opportunity to improve construction quality management (Sodangi et al., 2010). The success of applying TQM to the construction industry would be felt in a short time. Considerable research has been directed at implementing TQM in the construction industry. Most of this deals with the specific building blocks of TQM (e.g. service quality, continuous improvement), with some attention focused on identifying opportunities, barriers to and procedures for implementing TQM in construction firms.

Zadry and Yusof (2007) developed the theory of constraints (TOC): this is to assist organizations to think about the problems, develop breakthrough solutions and implement those solutions successfully by using decision tree analysis. The TOC can be assimilated into TQM implementation as a mechanism to ensure the profitability and productivity of an organization. According to Panuwatwanich and Nguyen (2017), not all industries that implemented TQM have positive satisfaction. Thus Suwandeji (2015) opined that for public organizations, the TQM factors affecting their implementation are leadership, training, organizational structure, communication, incentives, measurements and evaluation, and teamwork. In addition, they noted that for the management of strong teamwork, appropriate training, incentives and evaluation, and effective communication contributed to public organization success.

Panuwatwwanich and Nguyen (2017) indicated that the failure of TQM implementation is primarily due to lack of integration of TQM with cultural change. It is a rather a complex project for an organisation. However, researchers have identified the types of organizational culture which ensure successful TQM implementation and relate these organization cultures to each other to show their relationship positively and negatively to TQM performance (Prajogo & McDermott, 2005; Zu et al., 2009; Gimenez–Espin et al., 2013). The organisational culture includes clan, adhocracy, hierarchy, and market culture. Changing things is easier than changing people, thus problem solving is easier than the cultural change aspect of the TQM process.

3. RESEARCH METHODOLOGY

Survey research was used for this study and the population consisted of construction professionals in construction companies in Nigeria. The construction professionals were made up of quantity surveyors, engineers, builders and architects in both indigenous and expatriate construction companies. A random sampling technique was used; thus, every respondent had an equal chance of being selected. A total of 50 questionnaires were distributed and 30 were duly filled in and returned for the purpose of analysis. This showed an average response rate of 60%. SPSS 17th version was used for the analysis of data. Frequency, percentage and relative importance index (RII) were applied to this study:

$$\text{RII} = \frac{5n5 + 4n4 + 3n3 + 2n2 + n1}{5(n5 + n4 + n3 + n2 + n1)}$$

where: 5 - very important, 4 - important, 3 - moderately important, 2 - of little importance, 1- not important

4. FINDINGS AND DISCUSSION

4.1 . Demographical information of respondents

4.1.1. Professional qualification of respondents

Figure 1 is a graphical representation of respondents. The bar chart depicts that 14 of the respondents are project managers, eight (8) are engineers, three (3) are architects and builders and two (2) are quantity surveyors. It shows that TQM is an aspect of project management which entails quality assurance and control, hence the project managers should have adequate skills in the knowledge of quality management. This is in support of a study by Madar (2015), namely that TQM is an aspect of corporate management.

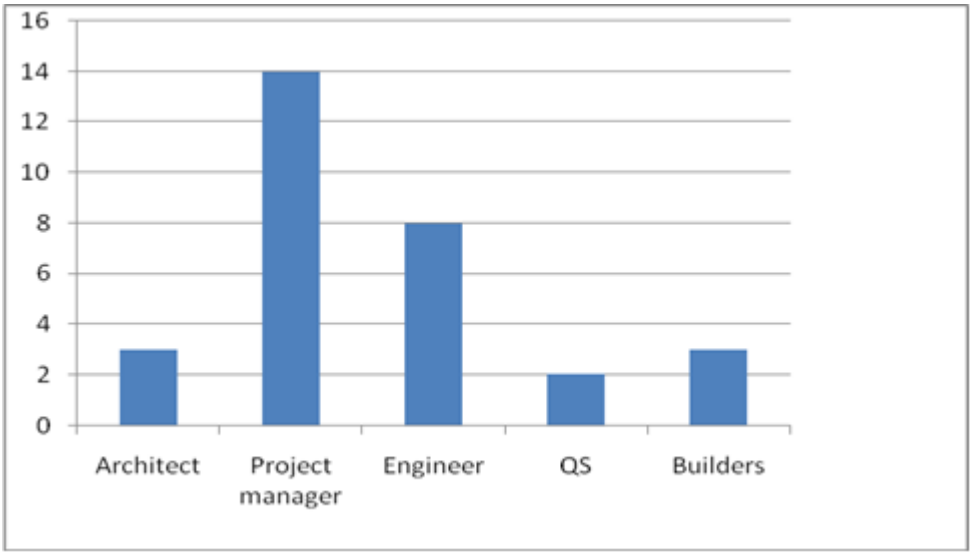

Figure 1. Professional Qualification of the Respondents

4.1.2. Numbers of years in the construction companies

Figure 2 represents the number of years respondents have spent in construction companies. It shows that 10 of the respondents have spent between three (3) and six (6) years in construction companies, seven (7) have spent between 11 and 15 years while six (6) have spent no fewer than three (3) years. This confirms that the respondents have adequate experience within the construction companies to be able to provide information on the total quality management of contracting organisations.

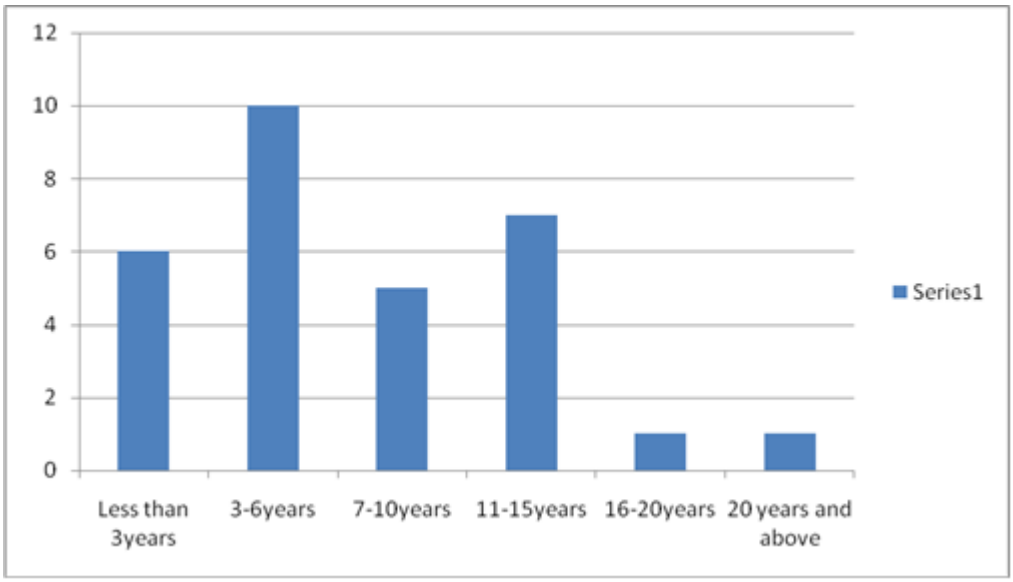

Figure 2. Numbers of Years in Construction Companies

4.2. Factors affecting Implementation of TQM

The results of the factors affecting the implementation of TQM are displayed in Table 1. The identified factors are management commitment factors, the role of the quality department, training and education, employee involvement, supplier partnership, project design, quality policies, quality data reporting and clients' satisfaction orientation. Each of these major factors consists of sub-factors as shown in Table 1.

For management commitment factors, the most significant factors are 'top management assumes responsibility for quality performance' (RII =0.93), 'acceptance of responsibilities for quality by the departmental head' (RII= 0.89) and 'clear consistent communication of mission statements and objectives' (RII=.0.89). For the role of the quality department, 'the establishment of the quality department' (RII=0.88), 'the effectiveness of quality awareness' (RII=0.82) and 'the effectiveness of the department' (RII =0.81) are important factors for the implementation of TQM.

'Quality related training given to managers, supervisors and employees' (RII=0.89), 'specific work skill training given to employees through the company' (RII=0.85) and 'training in problem identification, solving skills and quality improvement skills' (RII=0.82) are important factors affecting the training and education for implementation of TQM. For the employer involvement factor, 'quality circle or worker involvement in type organization' (RII=0.81), 'recognition of employees for superior quality performance' (RII=0.78) and 'participation in quality decisions by non-supervisory employees' (RII=0.77) are relatively important factors, while 'suppliers' partnership', 'use of supplier rating system' (RII=0.83), 'selection of the supplier based on quality instead of price' (RII=0.82) and 'clarity of specification provided by supplier' (RII-0.81) are major significant factors.

'Coordination among professionals involved in project design' (RII=0.91), 'analysis of client's requirement' (RII=0.89) and 'clarity of project design' (RII=0.88) are considered the most important project design factors. For quality policies, 'implementation of strategies focused on quality' (RII=0.89), 'self-inspection of work by workers and inspection' (RII=0.87), and 'review and checking' (RII=0.87) are important factors while for quality data and reporting, the relatively important index factors that are deemed important are 'extent to which quality data are available to managers and supervisors' (RII=0.82), 'extent to which quality data are used as tools to manage quality' (RII=0.80) and 'extent to which quality data are available to employees' (RII=0.80). 'Determinations of improvements in clients' satisfaction' (RII=0.89) and 'commitment to clients through the strengthening of policies' (RII=0.87) are major significant clients' satisfaction orientation factors for TQM implementation.

Table 1. Factors Affecting the Implementation of TQM

Factors Implementing TQM	RII	R
A. Management commitment factors		
Top management assumes responsibility for quality performance	**0.93**	**1**
Acceptance of responsibilities for quality by departmental head	**0.89**	**2**
Clear, consistent communication of mission statements and objectives	**0.89**	**2**
Top management supports long-term quality improvement process	**0.87**	**4**
Degree top management considers quality improvement as a way to increase profits	**0.85**	**5**
Degree of comprehensiveness of the quality plan within the company	**0.83**	**6**
Specificity of quality goals within the company	**0.82**	**7**
Quality goals and policy are understood within the company	**0.82**	**7**
Importance attached to quality by the top management	**0.81**	**9**
Commitment of the top management to employees training	**0.78**	**10**
B. Role of quality department		
Establishment of quality department	**0.88**	**1**
Effectiveness of the quality awareness	**0.82**	**2**
Effectiveness of the quality department	**0.81**	**3**
Visibility of quality department	**0.80**	**4**
Quality department accesses to top management	**0.79**	**5**
Utilization of quality staff professionals as consulting resources	**0.79**	**5**
Autonomy of the quality department	**0.75**	**7**
C. Training and education		
Quality related training is given to managers, supervisors, and employees	**0.89**	**1**
Specific work skill training is given to employees through the company	**0.85**	**2**
Training in problem identification, solving skills and quality improvement skills	**0.82**	**3**
Programmes to develop teamwork among employees	**0.81**	**4**
Training in the total quality concept	**0.81**	**4**
Quality awareness building among employees	**0.79**	**6**
Availability of resources for employee training	**0.79**	**6**
Training for employees to implement quality circle type programme	**0.78**	**7**
Training in interactive skills	**0.77**	**8**
Employees are trained in statistical improvements techniques	**0.69**	**9**
Training in advanced statistical techniques in the company	**0.62**	**10**
D. Employee involvement		
Quality circle or worker involvement in type organisation	**0.81**	**1**
Recognition of employees for superior quality performance	**0.78**	**2**
Participation in quality decision by non-supervisory employees	**0.77**	**3**
Involvement of lower level workers in decision making by top management	**0.67**	**4**
E. Supplier partnership		
Use of supplier rating system	**0.83**	**1**
Selection of the supplier based on quality instead of price	**0.82**	**2**
Clarity of specifications provided by the supplier	**0.81**	**3**
Technical assistance to improve the quality and responsiveness of suppliers	**0.78**	**4**
Involvement of the supplier in the project development process	**0.67**	**5**
F. Project design		
Coordination among professionals involved in project design	**0.91**	**1**
Analysis of clients' requirement	**0.89**	**2**
Clarity of project design	**0.88**	**3**
Determination of quality standard	**0.87**	**4**
Design of the implementation system	**0.85**	**5**
G. Quality policies		
Implementation of strategies focused on quality	**0.89**	**1**
Self-inspection of work by workers	**0.87**	**2**
Inspection, review, and checking	**0.87**	**2**

Policy of preventive equipment maintenance	**0.84**	**4**
Clarity of work or process instructions given to the employees	**0.84**	**4**
Use of acceptance sampling to acceptance lots of batches of work	**0.81**	**6**
Zero defect as the quality performance standard	**0.79**	**7**
Use of statistical control charts to control process	**0.75**	**8**
H. Quality data and reporting		
Extent to which quality data are available to managers and supervisors	**0.82**	**1**
Extent to which quality data are used as tools to manage quality	**0.80**	**2**
Extent to which quality data are available to employees	**0.80**	**2**
Extent to which quality data, control charts are displayed at employees' work site	**0.76**	**4**
I. Client's satisfaction orientation		
Determination of improvements in clients' satisfaction	**0.89**	**1**
Commitments to clients through strengthening of policies	**0.87**	**2**
Comparisons of clients' satisfaction with competitors and internal indicators	**0.85**	**3**

4.3. Maintenance Factors of TQM in Contracting Organization

The respondents were told to rank the level of importance to the various maintenance factors of TQM. From Table 2, it can be seen that 'management committee' (MIS=0.93) and 'quality awareness and review' (MIS=0.91) were the most significant factors responsible for the implementation of TQM. Other significant factors included 'develop a quality improvement plan' (MIS=0.87), 'quality measurement' (MIS=0.86) and 'identify clients' requirements' (MIS=0.85). 'Establish an ad hoc committee for zero defect programme' (MIS=0.74), 'do it all over age' (MIS =0.73) and 'supervisor' (MIS=0.66) were the lowest ranked factors for the implementation of TQM.

Table 2. Factors Responsible for the Successful Maintenance of TQM in Contracting Organizations

Maintenance Factors	MIS	Rank
Management commitment	0.93	1
Quality awareness and review	0.91	2
Develop a quality improvement team	0.87	3
Quality measurement	0.86	4
Identify clients' requirement	0.85	5
Goal setting	0.85	5
Cost of quality	0.84	7
Analyze feedback	0.84	7
Define specification	0.83	9
Application of evaluation measurement	0.81	10
Error causes removed	0.81	10
Zero defect day in a year/month/week	0.81	10
Correction action	0.81	10
Recognition of people	0.79	14
Quality councils	0.76	15
Establish an ad hoc committee for the zero defect programme	0.74	16
Do it all over the age	0.73	17
Supervisor training	0.66	18

MIS – Mean Item Score

4.4. Challenges in the Implementation of TQM in Contracting Organisations

Table 3 shows that 'lack of available quality system documentation' (MIS=0.75), 'lack of understanding in the process requirement' (MIS=0.75), 'high cost to implement' (MIS=0.74), 'lack of TQM exposure' (MIS=0.74) and 'lack of planning' (MIS=0.74) were the most important challenges faced in the implementation of TQM in contracting organizations. The lowest ranked challenges as rated by the respondents were 'the difficulty of verbal communication' (MIS=0.64), 'lack of subordinate propensity to follow orders' (MIS=0.60) and 'lack of time to implement TQM/time consuming'(MIS=0.59).

Table 3. Challenges in the Implementation of TQM in Contracting Organisations

Constraints on implementation of TQM	MIS	Rank
Lack of available quality system documentation	0.75	1
Lack of understanding of the process requirement	0.75	1
High cost to implement TQM	0.74	3
Lack of planning to implement TQM	0.74	3
Lack of TQM exposure	0.74	3
Lack of continuous professional development	0.73	6
Lack of documentation of suppliers, materials, and services	0.72	7
Lack of awareness of benefit of TQM	0.71	8
Lack of support from the top management	0.71	8
Lack of understanding the TQM	0.70	10
Difficulty of verbal communication	0.64	11
Lack of subordinate propensity to follow orders	0.60	12
Lack of time to implement TQM/time consuming	0.59	13

4.5. Discussion of Findings

The analysis shows that the factors affecting the implementation of TQM in Nigerian contracting organisations are grouped into the following factors, namely management commitment factors, the role of quality department, training and education, employee involvement, supplier partnership, project design, quality data and reporting and clients' satisfaction orientation. From these major factors, the various factors identified are 'top management assumes responsibility for quality performance', 'acceptance of responsibilities for quality by departmental head', 'clear consistent communication of mission statements' and 'objectives', 'establishment of quality department', and 'effectiveness of quality awareness'. Further factors are 'effectiveness of the department', 'supervisors and employees', 'specific work skill training given to employees through the company', 'training in problem identification and solving skills' 'quality improvement skills', 'quality circle' or 'worker involvement in type of organization', 'recognition of employees for superior quality performance', and 'participation in quality decisions by non-supervisory employees'. In addition, 'use of supplier rating system', 'selection of the supplier based on quality instead of price', 'clarity of specification provided by supplier', 'coordination among professionals involved in project design', and 'analysis of clients' requirements' were noted as factors

affecting TQM. Other factors were 'clarity of project design', 'implementation of strategies focused on quality,' 'self-inspection of work by workers', 'inspection, review and checking', 'extent to which quality data are available to managers and supervisors', 'extent to which quality data are used as tools to manage quality', 'extent to which quality data are available to employees', 'determination of improvements in clients' satisfaction' and 'commitment to clients through strengthening of policies'. According to Suwandej (2015), factors identified as affecting TQM were training, teamwork, leadership, communication and organizational structure. These are in agreement with the findings of this study. Other factors identified by other researchers were human resources utilization, management process control, strategic quality planning and top management knowledge (Lewis et al., 2006; Soltani et al., 2008; Abdallah et al., 2009).

The maintenance factors responsible for successful implementation of TQM are 'management commitment', 'quality awareness and review' and 'developing a quality improvement team'. However, the following difficulties are faced by the stakeholders in the implementation of TQM in Nigeria as identified in this study, namely 'a lack of available quality system documentation', 'lack of understanding of the process requirement', 'high cost to implement', 'lack of TQM exposure' and 'lack of planning'. If addressed, identified challenges will enable Nigerian construction companies to compete in the global market. Dahiya and Bhatia (2013) identified quality culture, autocratic style of leadership, the improper channel of communication and lack of employee committee as a challenge for the implementation of TQM. Their findings are in line with this study. It shows that for the implementation of TQM in an organization, adequate planning through proper channels of communication is important.

5. CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the factors affecting the implementation of TQM in the Nigerian construction companies are management commitment factors, the role of the quality department, training and education, employee involvement, supplier partnerships, project design, quality data and reporting, and clients' satisfaction orientation. However, the construction companies are also faced with the challenges of lack of available quality system documentation, lack of understanding of the process requirement, high cost to implement TQM, lack of TQM exposure and lack of planning. These issues prevent the Nigerian construction companies from competing with their global counterparts and the clients are not satisfied with the end products, hence there are cases of cost overrun, delays and collapsing of the building. Nigerian construction companies should develop strategies or a framework for the effective implementation of TQM so that they are able to compete in the global market. The total quality manual should be enforced to ensure quality control and quality assurance mechanisms in all construction processes.

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SUSTAINABLE WASTE ALTERNATIVE AS CEMENT REPLACEMENT IN PAVEMENT STABILIZATION

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ABSTRACT

In recent years, the philosophy of recycling has influenced national development. This has resulted in a growing demand to minimize waste and foster the recycling of products such as fly ash. Several million tonnes of fly ash is being produced every day globally and the disposal of the fly ash represents a serious obstacle to the electricity industries in South Africa. Accumulations of these fly ash landfill dump sites have reached alarmingly high levels, requiring immediate attention for their disposal. Solutions to reduce landfill sites from the waste by-products of coal combustion are becoming critical owing to the increased growth in landfill sites yearly. This study proposes a reduction in fly ash landfill waste and its suitability for use in pavement construction as a cement replacement in stabilizing sub-grade, sub-base and base course layers in South African roads. The method adopted constitutes testing fly ash for use as a substitute engineering material for soil stabilization in pavement construction.

Keywords: Fly ash, Waste disposal, Stabilisation, Cementitious, Replacement, Pavement

1. INTRODUCTION

The global demand for coal has grown steadily over the past 30 years but increased more rapidly recently owing to the influences of growth in India and China. Coal growth has been the fastest growing fuel source than any other fuel in the past ten years (Hall, 2011). The coal industry provides 80% of South Africa's total primary energy requirements and is core to economic development with 92.8% of coal use providing electricity. Fly ash is a thermally altered mineral matter which is a waste by-product generated from the combustion of coal for power generating. The need for its safe disposal has been recognized not only in South Africa but worldwide. Disposal of fly ash is of major environmental concern due to the possible release of contaminants to ground and surface water after disposal (Hassett et al., 2001).

The main focus of this research is to show that fly ash can be used as a cement replacement in the stabilization of road pavement materials. The purpose is to provide conclusive results by using fly ash to solve sub-grade and sub-base problems in areas where

feasible material is not readily available and in areas where there is an increase in demand for cement/lime where little or no cement/lime is required as an additive. It will also provide an advantage in that fly ash, which is normally disposed of at a considerable cost, can now have an economic value.

2. FLY ASH DISPOSAL

The management and disposal of the fly ash produced by coal-fired power plants have caused a major problem in many parts of the world, including South Africa. Disposal of fly ash constitutes a problem not only because of large volumes generated but also due to the possibility of environmental impacts (National Inventory, 2001). The environmental impact study for reutilization of fly ash in construction has produced positive results. In its natural state, it is regarded as a hazardous material, but when mixed with bottom ash, falls in the category of non-hazardous material (Mostafa Hassan & Adedeji, 2016).

2.1 Physical Properties of Fly Ash

Fly ash contains high amounts of silicon dioxide and calcium oxide, and as a result, fly ash is a very cementitious by-product. The main component of fly ash is silicon dioxide, which is present in two forms, namely amorphous – rounded and smooth, and crystalline – sharp, pointed and hazardous aluminium oxide and iron oxide (Mehta, 1998; Ismail et al., 2007; Fly Ash Facts for Highway Engineers, 2003).

Fly ash consists of silt-sized particles, which are spherical in shape, and range in size from 0.5 microns to 100 microns. The unique spherical shape and particle size distribution of fly ash make it good mineral filler in various engineering applications (Fly Ash Facts for Highway Engineers, 2003). Fly ash is commonly used as a pozzolan in ordinary Portland cement applications. Its colour varies from tan to dark grey, depending on the chemical and mineral constituents (Fly Ash Facts for Highway Engineers, 2003). Tan to light colours are associated with lime contents while brownish colours are associated with iron contents. Dark grey to black is attributed to a high unburned carbon content (Mehta, 1998).

2.2 Mechanical Properties of Fly Ash

During combustion at very high temperature minerals become fluid after which the minerals are cooled rapidly at the post-combustion zone. Fly ash is generally highly heterogeneous and consists of a mixture of glassy particles with various crystalline phases and a vitreous phase (Rotaru et al., 2010). The surface area of fly ash increases as particle size decreases. This is due to smaller particles containing large surface concentrations of potentially toxic trace elements (Oppenshaw, 1992). Fineness is an important property of fly ash contributing to pozzolanic reactivity (Fly Ash Facts for Highway Engineers, 2003; Mehta, 1998; Rotaru et al., 2010).

2.3 Chemical Properties of Fly Ash

Fly ash is heterogeneous, consisting of a mixture of glassy particles with various identifiable crystalline phases such as quartz, mullite and various iron oxides (Ojo, 2010). The pozzolanic property is directly proportional to the amount of free lime and indirectly proportional to the amount of unburnt carbon. Fly ash generated from power stations contains some soluble oxides such as CaO and MgO. The chemical composition of fly ash is typically made up of major elements such as Si, Ca, Al, Mg, Fe, Na and K (Oppenshaw, 1992). The chemical properties and composition provide the greatest variability to fly ash. Studies have shown that fly ash samples from various areas vary in pH levels (Oppenshaw, 1992; Gitari et al., 2009). Most of the major elements exist in the core of the fly ash, which is relatively stable as the elements have probably not been volatized in the combustion process (Oppenshaw, 1992; Rotaru et al., 2010; Reynolds et al., 2002).

2.4 Classification of Fly Ash

Fly ash is classified worldwide into two classes, namely Class C and Class F. Class C is a result of burning of younger lignite or sub-bituminous coal. It is pozzolanic in nature but also contains self-cementing properties. Mixed with water, the ash will harden and gain strength over time and it contains more than 20% lime. Class C primarily consists of calcium alumino-sulphate glass, quartz, tricalcium aluminate and free lime and is also referred to as high calcium fly ash (Fly Ash Facts for Highway Engineers, 2003). Class F is a result of burning of old harder anthracite and bituminous coal. The ash is pozzolanic in nature and contains less than 20% lime. It therefore needs a cementing agent such as ordinary Portland cement (OPC), quicklime or hydrated lime with the presence of water to react and produce cementitious compounds. Class F fly ash primarily consists of an alumino-silicate glass, quartz, mullite and magnetite, referred to as low calcium fly ash (Fly Ash Facts for Highway Engineers, 2003).

3. RESEARCH METHODOLOGY

Fly ash testing is classified according to the world standard test method ASTM 618 (ASTM618, 2011). In South Africa, fly ash is classified according to SANS 1491-2 (SANS 1491-2, 2005). Soil stabilization causes chemical reactions which bind fly ash particles therefore the chances of pollution due to the use of fly ash in road works are negligible.

3.1. Soil Stabilization with Fly Ash Replacement

Lime and cement stabilization have been modified by modern laboratory and field tests to fulfil a variety of stabilization requirements (SAPEM, 2011). Improvement in terms of compression, shear, bearing or load deflection value results in strength gains and resistance to deformation. Durability is indicated in terms of resistance to moisture absorption, softening, strength reduction, freezing and thawing, and wetting and drying cycles (SAPEM, 2011). This study examines three different types of stabilizer agents and how the combination of each of the separate materials can exhibit different strengths versus time characteristics. The basic design steps considered for laboratory stabilization of the fly ash materials obtained include initial consumption of lime/stabilizer, maximum dry density and optimum moisture content of laboratory-mixed cementitiously stabilized materials, indirect tensile strength, and the CSIR erosion test.

3.2. Laboratory Test and Evaluation

Three sources of fly ash have been used, two from Kendal Power Station and one from Lethabo Power Station. Two of the fly ashes are air classified and one type is directly sourced

from the ash dump at Kendal Power Station. Fly ash is air classified owing to its capability of providing product quality by controlling the fineness and reducing the loss of ignition (LOI) (Ash Resources, 2012). The three fly ashes selected are Durapozz, Pozzfill and Kendal dump ash.

3.2.1. Durapozz

Durapozz air classified fly ash from Lethabo Power Station is an internationally recognized high-quality fly ash. Durapozz is mostly used in concrete mixes where it contributes to a reduced carbon dioxide (CO2) footprint. Durapozz is spherical in particle shape, has a fine particle size and is pozzolanically reactive (Ash Resources, 2012).

3.2.2. Pozzfill

Pozzfill air classified fly ash from Kendal Power Station conforms to some of the requirements of SANS 50450 (2011), SANS 50197-1 (2000), or EN450-1 (2001). Pozzfill is extensively used as reactive cementitious filler in South Africa. The unique combination of chemical and physical properties enables the product to impart significant features and benefits in cementitious systems (Ash Resources, 2012). Pozzfill for this study was sourced from the Kendal Power Station. Pozzfill is also proven in road sub-base, and asphalt and refractory applications.

3.2.3. Kendall Dump Ash

Kendal dump ash is directly sampled from the ash dumps at the Kendal Power Station. Apart from Durapozz and Pozzfill, an untreated sample was taken directly from the landfill dumpsite at the Kendal Power Station.

In this study, a high percentage of fly ash was required to satisfy the demand requirement for strength. Research has shown that the percentage of fly ash added for stabilization varies between 10% to approximately 20%, depending on the quality of the fly ash. With this in mind, the initial consumption of cement and lime (ICC) test was completed with the following mixtures:

% fly ash: 6, 9, 12, 15, 18, 21 and 24 each mixed with 1% Lafarge CEM II 32, 5 B-M(S-V), % fly ash: 6, 9, 12, 15, 18, 21 and 24 each mixed with 1% AfriSam CEM II 32, 5 B-M(S-V).

The ICC test carried out gives an indication of the pH levels the material will stabilize to meet the required strength and satisfy demand. The ICC results for the mixture with average pH readings stabilized between 9% and 15% with 1% cement are shown (see Figures 3.1 to 3.6):

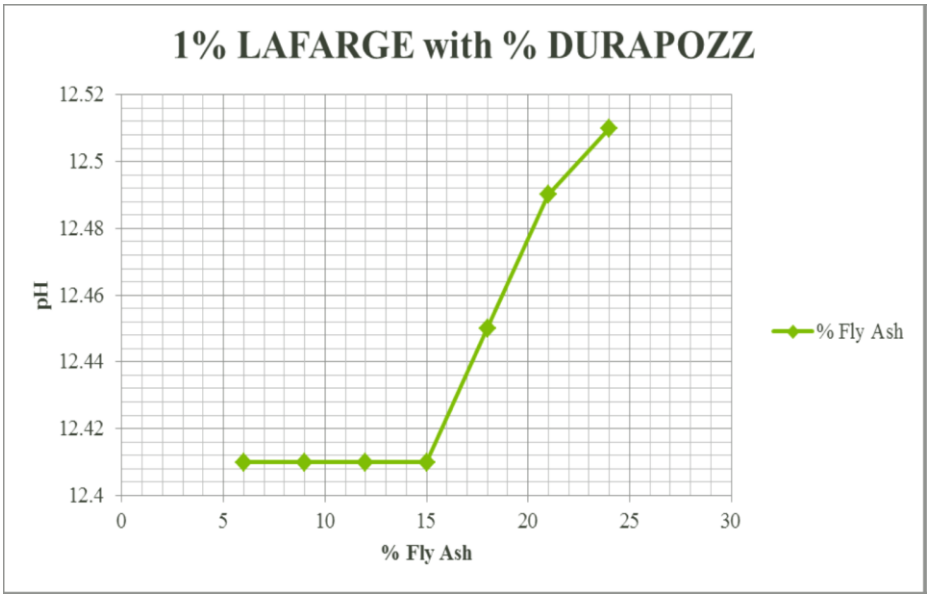

Figure 3.1. Durapozz Fly Ash Percentages Mixed with 1% Lafarge Cement and G5 Material

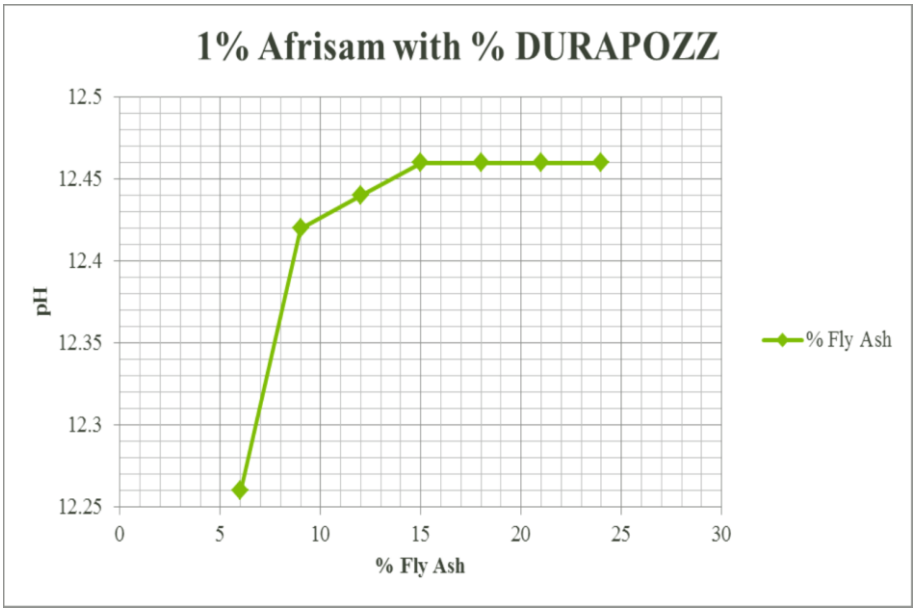

Figure 3.2. Durapozz Fly Ash Percentages mixed with 1% AFriSam Cement and G5 Material

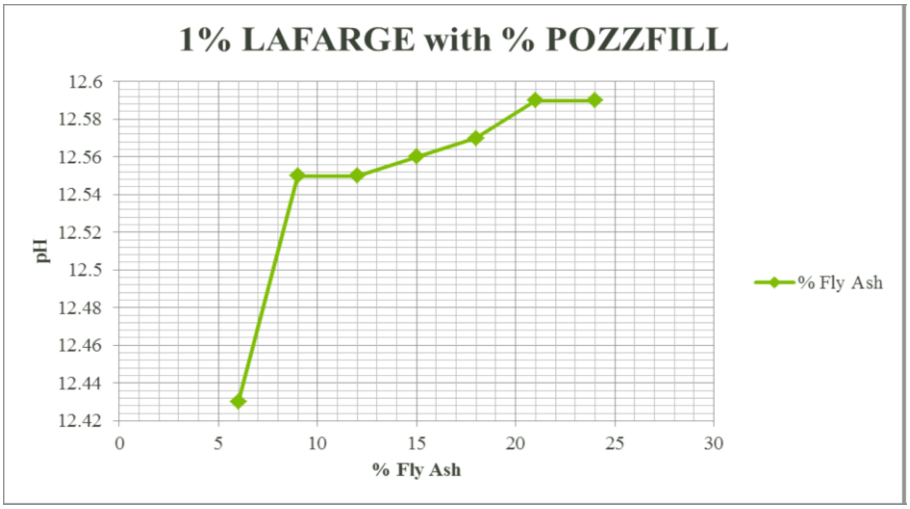

Figure 3.3. Pozzfill Fly Ash Percentages Mixed with 1% Lafarge Cement and G5 Material

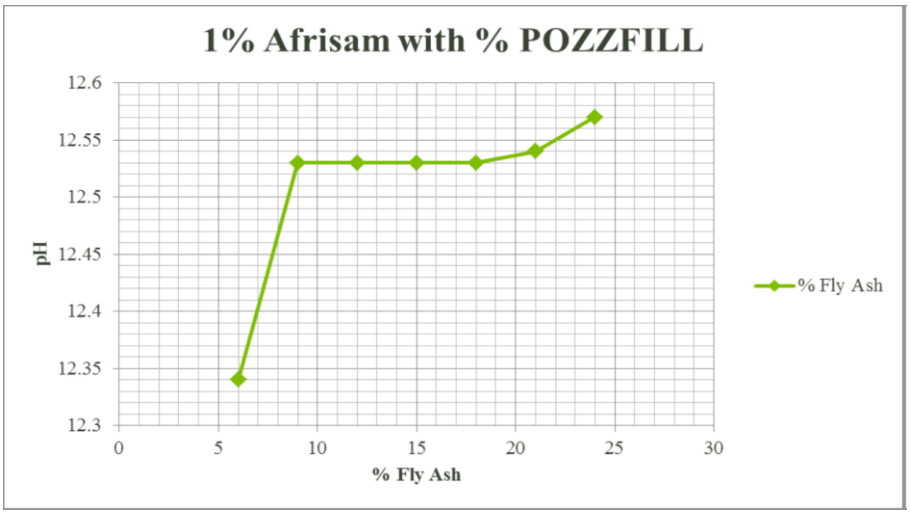

Figure 3.4. Pozzfill Fly Ash Percentages Mixed with 1% AfriSam Cement and G5 Material

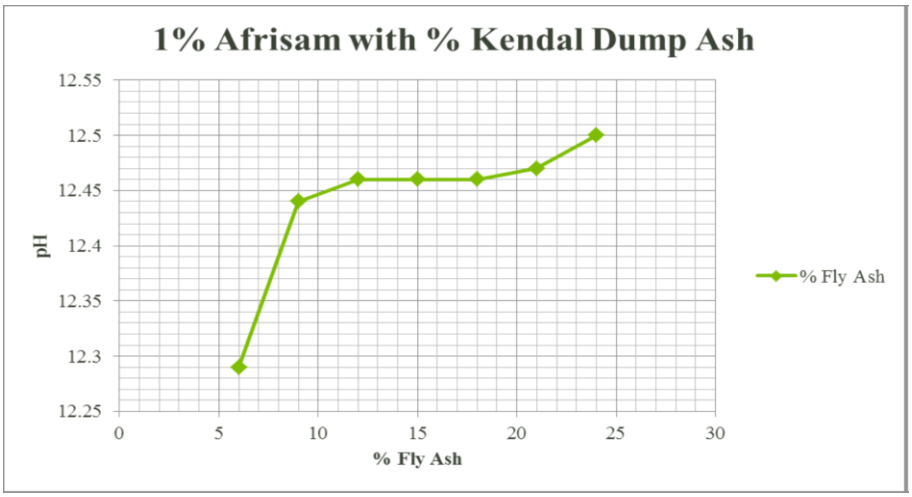

Figure 3.5. Dump Fly Ash Percentages Mixed with 1% AfriSam Cement and G5 Material

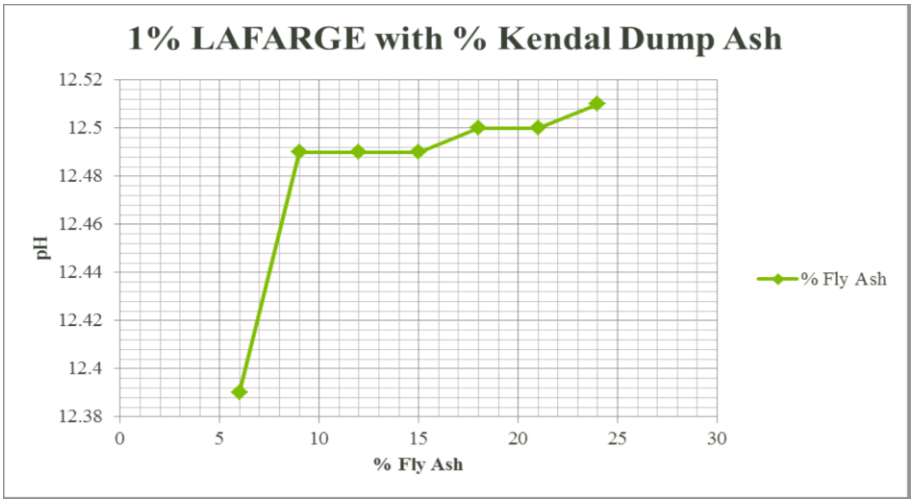

Figure 3.6. Dump Fly Ash Percentages Mixed with 1% Lafarge Cement and G5 Material

3.3. Maximum Dry Density (MDD)

The MDD of the laboratory test results for the selected material indicate the compaction versus moisture content curve using the specified compaction effort (Method A7 – TMH1, 1986). The strength test quality control of the maximum dry density and optimum moisture content of the material with fly ash with 16% to 22% replacement is shown in the following figures (see Figures 3.7 and 3.8):

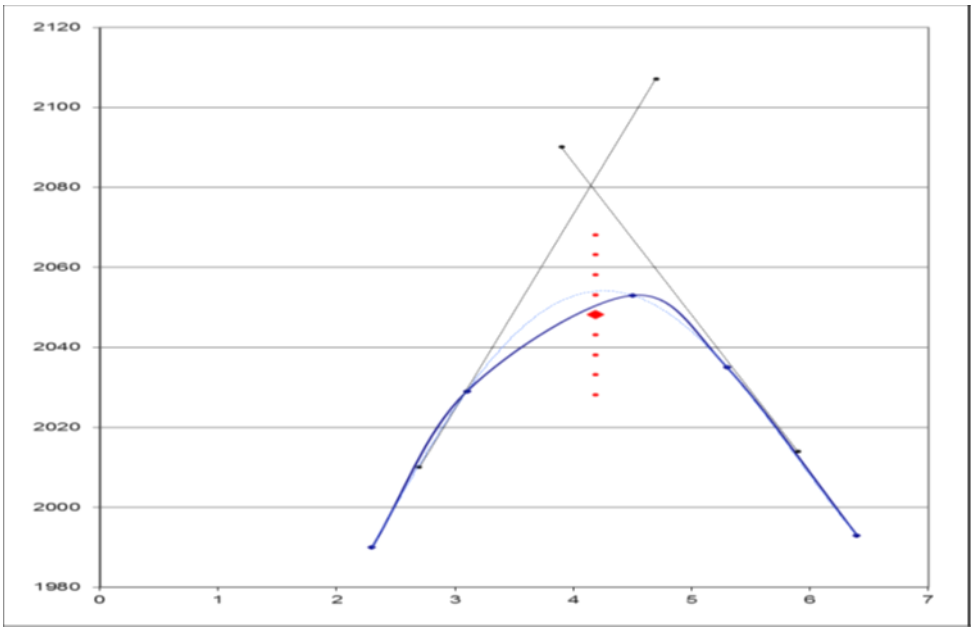

Figure 3.7. Average MDD Curve for the G5 Stabilised with 1% Cement and 18% Fly Ash

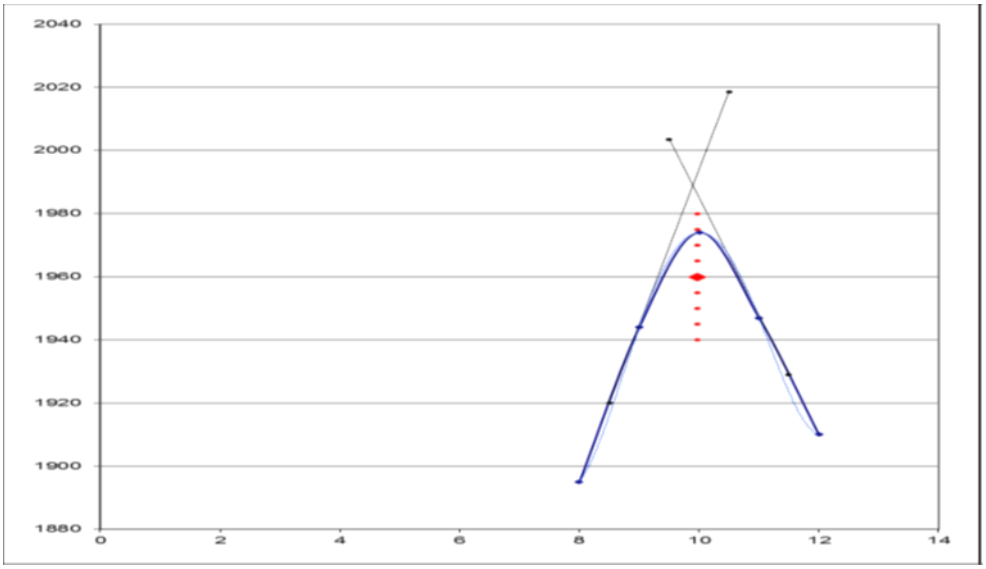

Figure 3.8. Average MDD Curve for the G5 Stabilised with 1% Cement and 22% Fly Ash

3.4. Unconfined Compressive Strength (UCS)

The determination of the shearing resistance of the stabilized soil with a percent replacement of a G5 material with 1% Lafarge and 1% AfriSam cement was carried out to evaluate the impact fly ash has on the UCS/ITS of the soil as used for engineering purpose. The tables below (see Tables 3.1 to 3.4) show the suitability of the material and its respective classification.

Table 3.1. 16% Fly Ash with 1% Cement

	Dump Ash		Pozzfill		Durapozz	
	LAFARGE	**AFRISAM**	**LAFARGE**	**AFRISAM**	**LAFARGE**	**AFRISAM**
UCS @100%	1939	1956	3750	3310	2850	2114
ITS @100%	90	98	397	304	403	249
Classification COLTO	None	None	C3	C3	C3	C3
			Suitable for sub-base construction			

Table 3.2. 18% Fly Ash with 1% Cement

	Dump Ash		Pozzfill		Durapozz	
	LAFARGE	**AFRISAM**	**LAFARGE**	**AFRISAM**	**LAFARGE**	**AFRISAM**
UCS @100%	2741	1945	3639	3539	2133	2865
ITS @100%	172	149	322	376	318	232
Classification COLTO	None	None	C3	C3	C3	C4
			Suitable for sub-base construction			

Table 3.3. 20% Fly Ash with 1% Cement

	Dump Ash		Pozzfill		Durapozz	
	LAFARGE	**AFRISAM**	**LAFARGE**	**AFRISAM**	**LAFARGE**	**AFRISAM**
UCS @100%	1759	1900	3135	3830	2403	2320
ITS @100%	60	81	470	327	205	283
Classification COLTO	None	None	C3	C3	C4	C3
	Suitable for sub-base construction					

Table 3.4. 22% Fly Ash with 1% Cement

	Dump Ash		Pozzfill		Durapozz	
	LAFARGE	**AFRISAM**	**LAFARGE**	**AFRISAM**	**LAFARGE**	**AFRISAM**
UCS @100%	1994	1969	2001	2298	1893	1822
ITS @100%	113	203	306	312	228	249
Classification COLTO	None	C4	C3	C3	C4	C4
	Suitable for sub-base construction					

3.5. The Indirect Tensile Strength Test

The ITS test carried out on the fly ash sample was done to evaluate the tensile properties conforming to requirements for use as highway material. This was basically done to evaluate the deformation characteristics of the stabilized material. Research has shown that cohesive or tensile characteristics of sub-base significantly affect the performance of the pavement (Hudson et al., 1968). A total of twenty-four samples were tested, out of which eight samples showed a decline in the ITS results while thirteen showed an improvement in the soil classification from a C4 to C3. The other four samples maintained a C4 soil classification. Table 3.5 shows the ITS test results for fly ash and G5 material stabilized with cement.

Table 3.5. ITS Results for G5 Material Stabilized with Lafarge and AfriSam

Cement Type	**Description**	**%**	**Test**	**Atterberg Limits (TMH1 A2-A4) <0.425mm**			**UCS & ITS (TMH1 A14 & A16T)**					
				LL	PI	LS	90%	93%	95%	97%	98%	100%
LAFARGE	G5 Classified Material	1.0	ITS		NP	0.0	50	79	406	143	165	223
AFRISAM	G5 Classified Material	1.0	ITS		NP	0.0	45	74	103	143	169	235

The test carried out shows that fly ash mixtures showed an upward trend between 16% fly ash and 18% fly ash mixtures. The LAFARGE cement shows a substantial improvement

with fly ash mixtures mixed in 16%; the AFRISAM cement mixture showed an improvement at 18% fly ash mixture. This study proposes fly ash testing according to the following mixtures:

1% Lafarge mixed with 16% dump ash, 1% Lafarge mixed with 16% Pozzfill, 1% Lafarge mixed with 16% Durapozz, 1% AfriSam mixed with 18% dump ash, 1% AfriSam mixed with 18% Pozzfill, and 1% mixed with 18% Durapozz. The reason for the low percentage of fly ash mixture is towards cost reduction in the construction phase. The less the admixture required, the less the cost implication.

3.6. Wet/dry Brushing Test (WDD)

The wet/dry brushing test (WDD) was performed to ensure long-term durability (strength gain, permeability, dimensional stability over a long period of time under service conditions) of the road material considered for this study. The WDD determined by the calculation of the percentage material loss after 12 cycles is shown in Table 3.6:

Table 3.6. Wet Dry Durability Results

Wet and Dry Durability Results	
Sample Description	**% Soil Cement Loss**
1% LAFARGE + G5	23.7
1% AFRISAM + G5	20.1
1% LAFARGE + 16% DURAPOZZ	32.9
1% LAFARGE + 16% POZZFILL	10.1
1% LAFARGE + 16% DUMP ASH	29.4
1% LAFARGE + 18% DURAPOZZ	10.3
1% LAFARGE + 18% POZZFILL	9.1
1% LAFARGE + 18% DUMP ASH	54

4. RESULTS AND DISCUSSION

The results of the UCS and ITS when fly ash is added indicate that ITS test results on the sample have the potential to improve the tensile properties of the soil material to be used as highway construction materials. The composite mixture of the stabilizing material and the soil sample indicate that the materials OMC and MDD will sustain design traffic loads through the design period of the sub-base layer. The Lafarge mixed with 16% dump ash showed a weaker result, but still suitable for C4 classified material. The 1% Lafarge mixed with 16% Pozzfill showed a significant improvement of the test results and can be used for a C3 stabilized material with substantial durability properties. Consequently, the 1% AfriSam mixed with 16% Durapozz and 16% Pozzfill showed a significant improvement in the durability and can be used

as a C3 stabilized material. However, the dump ash fails to comply with the maximum C4 loss of 30%.

5. CONCLUSIONS AND RECOMMENDATION

The fly ash for stabilization design was evaluated according to specifications as set out in ASTM 618 (1994). The three fly ash materials chosen for this study were Kendal dump ash, Durapozz and Pozzfill. Kendal dump ash was sampled directly from the dump sites while Durapozz and Pozzfill were sourced from the supplier. These are processed fly ashes. Durapozz is the highest quality processed ash that conforms to international standards, while Pozzfill only conforms to certain international standards. The fly ash samples obtained went through a thorough testing analysis: although the results were not uniform, they did have a platform for fly ash as a suitable choice of material for soil stabilization owing to its cementitious property, especially when reacted with cement. All three fly ash samples showed high values of SiO2 which forms stable cementitious compounds with Ca (OH_2) and allows pozzolanic reactions to continue for a longer period of time. This is critical as stabilized pavement layers are designed to remain stable for an estimated period of 20 years. Although the dump ash still needs to be studied in depth, it can be said that each individual stockpile needs to be thoroughly assessed. The dump ash has shown that it is unpredictable and would be recommended for the stabilization of clay materials, creating better working platforms to support the pavement layers above.

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IS THE CONCEPT OF WASTE UNIVERSAL? HANDLING BUILDING DEMOLITION BY-PRODUCTS IN THE CITY OF KANO, NIGERIA

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ABSTRACT

While old and new studies such as the works of Henry Lewis Morgan in 1871 on kinship and Geert Hofstede in 1980 on management theories show that what works in one cultural setting may not work in another, the United Nation policies on environmental governance to-date tend to be a uniform approach for all nations irrespective of the differences in cultural orientation. This paper investigates and demonstrates that in the context of construction and demolition wastes, what may be considered as waste in one society may be a wealth in another society; and the waste management policies that work in one society may not work in another. Therefore the one-way traffic approach in international environmental governance whereby the waste management practices of the rich countries are considered as a perfect model to be emulated by the poorer countries may be wrong. In some instance, such as the building demolition management practices in Nigeria, the systems of the developing countries may even be more sustainable than what is obtainable in the rich countries. Instead of dismissing the systems of the developing countries as informal and inferior, such systems may be holding the key to the sustainable solutions for waste management that the world needs so much.

***Keywords*:** Building, Demolition, Waste, Nigeria, Sustainability

1. INTRODUCTION

Until the seminal works of Henry Lewis Morgan were published in the latter part of the 19th century, anthropologists expected an English equivalent from the society that was the subject of their study when describing kinship relationship. However, Morgan (1871) discovered that different societies adopt different naming schemes for relations, and these are influenced by the social structures and marital traditions of the peoples, which may be completely different from those of the English society. Morgan's seminal work opened a window into the different concepts and classifications of kinship and the use of terms to describe kinship relations (Maxwell, 1992; Morgan, 1871).

In another relatively more recent seminal work on management theories by Geert Hofstede (1980), a survey of over a hundred thousand employees of the same multinational corporation from 40 countries was conducted twice over a period of six years. The sample from each country was basically uniform in terms of age, gender, job description, and employer, with the only difference being their national culture. The responses to approximately 150 questions which predominantly related to the beliefs and values of the respondents coincided with the cultural orientations groupings. This finding prompted the researcher to conclude that

the management theories that work in one country may not work in another country owing to the differences in cultural orientations, beliefs and values (Hofstede, 1980).

The work of Morgan on kinship and that of Hofstede on management theories are not only a century apart, but addressed different subject areas; nevertheless, the two studies share a common theme. Both the studies show how the same subject can have different meanings and approaches in different societies owing to differences in beliefs, values and cultural orientations. Additionally, the two studies challenged the tendency of making generalized assumptions and interpretations across cultural boundaries. Nonetheless, concerning global environmental governance and sustainability policies initiatives, the tendency remains to formulate a common approach for all nations as in the Millennium Development Goals (MDG) and its successor, the Sustainable Development Goals (SDG) (Griggs, 2013).

As a typical example, one of the key mandates of the Nigerian National Environmental Standards and Regulations Enforcement Agency (NESREA) is "…enforcing compliance with provisions of international agreements, protocols, conventions and treaties on the environment to which Nigeria is a signatory" (Ladan, 2012; NESREA, 2013). The emphasis on issues that are identified as international should be noted as against local issues of priority that may be unique to the local environment. On the other hand, are the international conventions and protocols relevant in every local context?

The aim of this paper is to prove that the international convention whereby the by-products of building demolition may be considered as a category of waste that degenerates the natural environment as well as constituting a threat of exhaustion to the natural resources reserves may not be relevant in the Nigerian context, as the materials from building demolition are not considered as waste in this society. In the same manner that Morgan's work shows that the approach and terms used in describing kinship relationship in English society are not applicable in many other societies, and in the same way that Hofstede demonstrated why the American management theories may not be applicable elsewhere, similarly the concept of building demolition waste and waste management that works elsewhere may not work in the Nigerian context. The uniqueness of the Nigerian context of handling demolition by-products begins with a definition of what waste is.

2. THE CONCEPT OF WASTE IN CONSTRUCTION AND THE NIGERIAN CASE

As described by Hawkes (2011), the beginning of unsustainable architecture tallies with the start of industrialization. Industrialization gave rise to the culture of consumerism whereby society consumes manufactured goods and the materials are thrown away as waste at the end-of-service in a linear pattern (Leonard, 2010), otherwise described as cradle-to-grave consumption (McDonough & Braungart, 2009). There are alternative definitions of waste; nonetheless, the World Health Organization's (WHO) definition of waste, namely "…something which the owner no longer wants at a given place and time and which has no current or perceived market value" is adopted in this study as being a global agency and its emphasis being on "market value" (Royal Commission on Environmental Pollution, 1985).

There are different categories of wastes according to how it is generated, such as agricultural, household and mining wastes; or how it is handled, such as biodegradable, recyclable, and hazardous waste (Nowak et al., 2009; Royal Commission on Environmental Pollution, 1985). Nevertheless, the scope of this paper is limited to building demolition waste. In line with the WHO's definition of waste, materials from the demolition of buildings with no current or perceived market value and which are no longer wanted by the owner constitute an environmental and regulatory challenge in some societies, more especially in the industrialized

nations of Europe and America. According to Osmani (2012) and the UK Green Building Council (2013), 90 to 120 million tonnes of waste are associated with construction and demolition (C&D), with more than 10% being unused materials that are no longer wanted. Such a scale of waste generated from buildings in developed countries calls for efforts to reverse the trend towards more sustainable practices such as reusing building materials in construction, recycling aggregates in concrete, giving new life to old wood, the mission of the American Construction and Demolition Recycling Association, and efforts of private corporations (Brito & Saikia, 2013; Construction & Demolition Recycling Association, 2016; Fast, 2001; Kibert, 1993; Pacheco-Torgal et al., 2013; Sassi, 2008). Nevertheless, according to the findings of this research, the story is completely different in other societies such as Nigeria, where the by-products of building demolition are not perceived as waste, more especially if the WHO's market value definition of waste is adopted.

3. METHODOLOGY

This study is based on a descriptive study of a society in the Nigerian city of Kano. According to the official census figures, Kano is the most populated region in Nigeria (National Population Commission, 2016). Case study strategy is used in this inquiry considering the practice of handling demolition waste as a concurrent phenomenon and the concepts of sustainability and the industrial ecology as theoretical presuppositions. In this research, the investigator has no control over the variables in the building demolition waste management practices in the Nigerian cities. Case study is a synchronous study of situations whereby the subject is not distinct from the context with the lowest researcher's control over events (Yin, 1981, 2009). Moreover, a case study is considered convenient for exploratory and descriptive inquiries that seek to answer the 'How*?'* and 'What?' questions, and therefore considered appropriate for this study.

The unit of analysis in this research is the community of *Yangwangwan*, referring to the group of stakeholders dealing with salvaged building materials in the local Hausa language used in the city of Kano. Consequently, participants were selected on purpose from active players in the industry with first-hand experience in at least one building demolition project. Every person who could potentially supply information was selected and expected to identify the next three participants for the research in a snowball fashion; however, this could not be implemented in practice. Therefore, 12 out of the 16 research participants were selected directly by the researcher. According to the original design of the research, an equal quota of three participants from each of the seven stakeholder groups was expected to participate in the research. Nonetheless, the quota selection of participants could not be implemented in practice. This was partly owing to a number of the participants belonging to more than one stakeholder group and partly because of the uneven willingness and availability of the participants across the stakeholder groups. A total of sixteen people from across all the stakeholder groups participated in the research (see Figure 1).

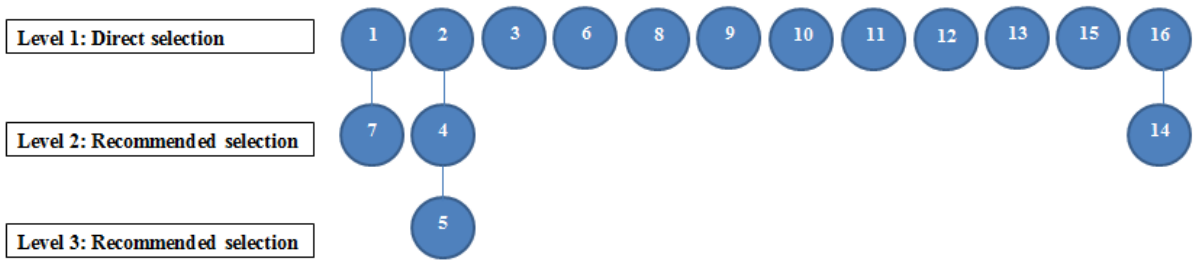

Figure 1. Research Participants' Selection

An in-depth semi-structured interview was administered to the participants guided by themes developed from the best practices of waste managements across different sectors with an emphasis on the lessons from natural ecological systems. Subsequently, the interviews were transcribed verbatim for analysis using the QDA Miner software.

5. ARE THERE MATERIALS FROM BUILDING DEMOLITION THAT ARE THROWN INTO THE LANDFILL?

From the response of the research participants there is virtually zero demolition waste that goes to the landfill when buildings are demolished in Nigeria. According to one of the participants:

"There are very negligible; including nails, nails are reusable or can be sold as scrap metal for recycling. Even timber that cannot be used in buildings can be used for firewood for cooking. This is yet another industry; there are people who specialize in that, getting timber from demolished building that cannot be used for anything but cooking. Everything is useable including the sand; you can use it for refilling or even in concrete work- i.e. as a recycled aggregate"(ENIE06).

These descriptions suggest that some materials from demolished buildings in Nigeria are taken for recycling, some are used as fuel to generate energy, and others are reused in another construction project. This method coincides with the prescription of the European Union Commission (EC) Framework directive on waste (Council Directive 75/442/EEC, 1975) known as waste hierarchy and the CIB principles of sustainable construction (Kibert, 2005). However, of particular notice are the statements that very negligible amounts of materials are deposited in the landfill.

In two studies by B. Nabegu (2008) and A. B. Nabegu (2010), solid waste was collected for three months from landfills in three different areas of Kano according to the Gordon guide for data collection in cities, and the samples were separated into groups for analysis. In the second study, secondary data was collected from the only government agency responsible for the management of municipal solid waste, the Kano State Refuse Management and Sanitation Board (REMASAB). The different classifications of the solid wastes in these studies include biodegradable matter, industrial waste, and non-biodegradable matter, including some glass and metals. However, there was no mention of demolition and construction waste whatsoever. The small pieces of glass and metals might likely have been from household items such as bottles and cans and probably a very insignificant quantity from building demolition. This buttressed the claim that negligible amounts of materials from building demolition are deposited in the landfill. However, the question remains as to what the fate of these materials is if not taken to the landfill.

According to the statement of another participant:

"Actually very few items may be taken to the refuse dump; even the ceiling boards were taken to the refuse dump because it was damaged by rainfall. Otherwise, it should have been marketable as it is useable for other purposes. Like the aluminium roofing sheets that are used for making cooking pots" (ENIE01)

This reveals that the materials from demolition sites are marketable commodities that may be taken to the market for sale. When the materials are taken to the market, they are either sold or reprocessed to produce other products such as the household items as mentioned by ENIE01 (see Figures 1, 2 and 3). This practice of reusing the unwanted materials from one process (building demolition) as raw materials for producing another product (household item) can be described as an industrial ecology. Industrial ecology is a biomimetic concept of organizing human industrial activities to resemble the natural ecological systems where there is no waste. In natural systems there is no waste; the waste of one process becomes the raw material for another process. Industrial ecology was recognized as a highly sustainable system and was the main theme of the National Technology Strategy Policy of Clinton's administration in the US (Benyus, 1997). Additional information worthy of attention from the statement of ENIE06 is the existence of specialist stakeholders who specialize in dealing with the salvaged materials from building demolition.

Figure 1. Poultry Feeder from Salvaged Materials

Figure 2. Cooking Pots, Bread Moulds: Work in Progress

Figure 3. Coal Stove Made from Combination of Salvaged Roofing Sheets

These specialist stakeholder groups, collectively referred to as *yangwangwan* in the local Hausa language, perform the important task of handling the end-of-life management of buildings with virtually zero waste. As narrated by one of the participants who was a project manager for one of the decommissioned public buildings:

"When the community realized the structure was to be decommissioned, while the systematic demolition was starting, there was mass scramble, or rather mass participation by the people around, because of the need of the people to take the scraps and used them in their houses. A schedule that was to take about two weeks was finished in two days. We made a budget to pay for the decommissioning and package the salvaged materials aside and think of what to be done with it- rather to sell, auction, or give free to the people. I can assure you, we were unable to retrieve up to 5%; the people did the work, themselves! They removed all the rods (reinforcements), and all the components; the scene looked like one of the Nigerian festivals was going on there! The site became a market; a real market, people were removing roofing sheets, removing ceilings, packing it in different places, and in fact, there was a mini-market

in the places. The needy people, those that wanted to use it (in personal properties) were packing it to their own homes; and some were packing it making stalls for sale" (ENIE13).

In demolition projects involving public buildings, salvaged materials are not recognized officially. The contractors are officially paid to cart away the debris from site; nonetheless, this is not practical as members of the public come to scramble for it (ENIE02, 2014). There are instances whereby interested parties pay the contractors or the truck drivers for the rubble to be delivered to their construction site. This practice is so popular among the locals that a term *Kwashale* in the native Hausa language is used to describe projects involving carting away the debris from sites (ENIE10). This is against the practices in the industrialised countries whereby the by-products of building demolition are often treated as waste, posing environmental challenges and necessitating several initiatives for finding solutions (DOE, 2012; Price et al., 2009).

The salvaged building materials market is an industry in the Nigerian economy with various categories of stakeholders. In addition to the basic stakeholders such as building owners whose engagement with the industry is only ad hoc and circumstantial, there are specialized operators in the salvaging of building materials that are divided into three categories. The first category are traders that buy and sell the salvaged materials in the locally well-known salvaged materials markets located in different locations of the study area, the Kano metropolis (ENIE01; ENIE04; ENIE14).

The second category who refer to themselves as tinkers reprocess the salvaged materials into different products before they are resold on the market (ENIE07). Some of these products include cooking pots, kerosene stoves, coal stoves, bread moulds, poultry feeders, or even a freezer (See pictures 1, 2 and 3).

The third category of *Yangwangwan* are the self-employed scroungers who may engage with demolition sites to save as much of any valuable material, including breaking concrete elements to salvage the reinforcements.

The foregoing account has demonstrated that far from being waste, i.e. materials with no market value, salvaged building materials in Nigeria are merchandise as well as the backbone of an important industry in the economy. Moreover, "…when we close our books and pen our eyes…" (De Soto, 2001), we should be able to see that it is an organized industry comprising different layers of stakeholders performing different functions, while the market is as sophisticated as any other. If we can delve into the lives of the players in this industry, we should be able to see through their eyes that it is not waste but rather wealth; or rethink the concept of what is a waste and understand that sustainability may be universal (Goodland & Daly, 1996). However, the concept of waste is not universal.

5. CONCLUSION

As a countermeasure to the perceived unsustainable production and consumption and the resultant waste generated, "The Future We Want", the main document of the World Summit on Sustainable Development 2012 (Rio+20), recommends that all nations should advance policies, strategies, laws and regulation for sustainable waste management (United Nations Environment Programme, 2013). The United Nations' guideline assumed that, whilst 98% of the waste is collected in the rich countries, only 40% is reported to be collected in the poorer countries whereas most is dumped in open landfills (United Nations Environment Programme, 2013).

Moreover, the solid waste management system in the developed countries is often described as an organized "formal" sector, while that of the developing countries of Africa, Asia, and Latin America is referred to as the "informal" sector (Velis et al., 2012), despite the

environmental, economic, and social benefits of such systems. The term 'informal' was defined as "…the informal solid waste sector refers to individuals or enterprises who are involved in recycling and waste management activities but are not sponsored, financed recognized or allowed by the formal solid waste authorities, or who operate in violation of or in competition with formal authorities"(Velis et al., 2012*).* The Oxford Dictionary (2015) defines the term 'formal' as "done in accordance with convention or etiquette" and "officially sanctioned or recognized".

Ironically, it was acknowledged that these informal players are sometimes capable of paying taxes, and are sometimes registered by the authorities (Velis et al., 2012). This supports the assertion earlier in this paper that there is a tendency in the global environmental governance to assume that any system that is not in conformity with the convention and etiquette of the economically advanced countries is informal and inferior. However, this paper argues that such generalized assumptions are not applicable to the Nigerian practice of handling building demolition by-products that are traditionally not considered as waste in every sense, but rather as a marketable commodity. Moreover, the Nigerian system is relatively more sustainable as it is more environmentally, economically, and socially friendly.

Contrary to the tendency of dismissing these systems as informal and inferior, these systems should be studied deeply and positively for potential inspiration on how to reorganize the so called 'formal sectors' in the fashion of the otherwise 'informal sectors' in order to produce zero waste, thus becoming more sustainable. In the words of Benyus (1997), it is now an extraordinary time that the urban westerners should learn from the wisdoms of the pre-industrial societies how to live in harmony and sustainably on earth. The idea of getting inspiration for sustainable solutions from the wisdom of the pre-industrial societies is referred to as ethnomimicry, which is the subject of another discussion.

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IMPACT OF MATERIALS MANAGEMENT PRACTICES IN THE NIGERIAN BUILDING CONSTRUCTION INDUSTRY

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ABSTRACT

Construction materials are a major cost component in any construction project. A factor that affects the performance of construction projects to a large extent is the poor management of materials during site activities. This research centred on the impact of materials management practices in the Nigerian construction industry. The study assessed the impact of materials management with the emphasis on building projects. Data were collected with the aid of questionnaires administered to professionals on construction sites. The data generated were analysed using descriptive statistics. The research findings indicate that the main impacts of effective materials management practices are reduced cost of materials, good quality control, better field material control, better handling of materials, adequate storage of materials on site, improvements in productivity, and completion of project on time. Based on the findings, it was concluded effective materials management practices improve the overall handling of materials for more efficiency and effectiveness on construction sites. The paper recommends that there should be proper planning of material management practices right from the inception of project execution and it should also be practised on all sites, whether large, medium or small, and by all categories of construction industry so as to ensure timely project execution and standard work delivery within reasonable cost, time and quality.

Keywords: Impact, Logistic, Planning, Practices, Procurement

1. INTRODUCTION

Materials management practice is a procedure that coordinates planning, assessing the requirement, sourcing, purchasing, transporting, storing and controlling of materials, minimizing the wastage and optimizing the profitability by reducing cost of material (Phu & Cho, 2014). Management of construction material is a new practice in the construction industry (Harris & McCaffer, 2013). In the present situation, the management and the designers are mainly concerned with how to control cost without any emphasis on material management measures (Wahab & Lawal, 2011). On the whole, it is accepted that cost of materials accounts for a significant percentage of the total cost of construction projects (Kerzner, 2013). Therefore, a critical management of materials on site should be adopted. According to Adafin et al. (2010), construction material management is of central importance to the economic development of

the construction industry. Ajayi et al. (2017) define construction material management as a reduction in the amount and environmental effect of material waste generated by reducing the amount of materials consumed in a project. Muleya and Kamalondo (2017) also identify material management as an integrated process of designing, constructing new structures or re-modelling existing structures, using materials more efficiently with a view to significantly contributing to the construction industry's performance improvement as well as solving material waste management problems. Several authors from different parts of the world have shown that material waste from the construction firm represents a relatively large percentage of the production costs (Saidu & Shakantu, 2016). The poor management of materials leads to an increase in the total cost of building projects (Ameh & Itodo, 2013).

However, there is no project that can start without an adequate supply of materials: apart from the careful planning of materials required by the builder, it has the advantage of fostering a good relationship with the suppliers, many of whom would have been selected owing to their fulfilment of orders to the standard required and meeting delivery times over a number of years (Adeyinka et al., 2014). According to Patel and Vyas (2011), building materials account for 60 to 70% of the direct cost of a project, while the remaining 30 to 40% comprises the labour cost. Therefore, efficient procurement and handling of materials represent a key role in the successful completion of the work. The management of materials on construction project to reduce, reuse, and recycle has a serious bearing on the cost, quality, time and impact of the project on the environment (Dania et al., 2007). Moreover, Adewuyi (2012) notes that there is a significant relationship between the level of materials waste on site and the cost overrun of a project. The cost of material waste which exists on sites represents an unnecessary cost in construction which can either be eliminated or reduced (Bekr, 2014).

2. IMPACTS OF MATERIALS MANAGEMENT ON CONSTRUCTION PROJECTS

The effective practice of materials management plays a key role in the successful completion of a project. The impact of effective materials management practices on construction projects includes the following:

Environmental impact: This includes the conservation of natural resources, reduction of energy consumption, conservation of landfill space and reduction of environmental impacts across the life cycle by decreasing the demand for virgin products (Van Ewijk & Stegemann, 2016).

Economic impact: It includes a reduction in disposal costs and may reduce the transportation of material costs which leads to a reduction of the overall project costs and a reduction in purchasing costs since non-virgin materials are often less expensive than virgin resources. In addition, it makes contractors more competitive with their bids at reduced costs and it creates employment opportunities and economic activities in the reuse and recycling industries (Beamon, 2008).

Performance impact: This includes the reclamation of salvaged or reused materials which can perform as well as or better than virgin products in many applications, as well as a reduction in the overall costs of materials, better handling of materials, and a reduction in duplicated orders. It also means that materials will be on site when needed and in the quantities required, as well as improvements in labour productivity, improvements in project schedule, quality control, better field material control, better relations with suppliers, a reduction in materials surplus, reduced storage of materials on site, labour savings, stock reduction, purchase savings, and better cash flow management (Jensen, 2014).

Other impacts of materials management practices that could benefit the construction industry include reduced cost of materials, improvements in productivity, projects constructed

on time or sooner than expected, purchase saving, providing adequate storage of material on site, improvements in project schedule, effective design site layout so as to aid in the management of materials on site, installation of materials hoists on site to aid in the movement of materials, good relations with suppliers, effective handling of materials, control of materials on site, quality work, reduced materials wastage, and better cash flow management (Albert, 2014).

2.1. Materials Management Practices

Materials management practices involve the planning, procurement, handling, stock and waste control, and logistics surrounding materials on construction projects. A good materials management environment enables proper materials handling on construction sites. In order to better understand materials management, the following processes are discussed: planning, procurement, logistics, handling, stock and waste control.

Planning: The materials planning process covers setting up and maintaining the records of each part used in each plant to determine target inventory levels and delivery frequency (Tanko et al., 2017). Effective management of the materials record will help the flow of materials at the site in order to avoid several problems such as materials that are out of stock and materials that have not been delivered. It also provides guides to all the subsequent activities and this could have a great impact on the project plan.

Procurement: The objective of procurement in materials management is to provide quality materials at the right time and place, and at an agreed budget. Adeyinka et al. (2014) state that procurement is about organizing the purchasing of materials, issuing delivery schedules to suppliers and following-up to make sure that suppliers deliver on time.

Handling: Handling of materials is the flow component that provides for their movement and placement. The importance of appropriate handling of materials is highlighted by the fact that they are expensive and require critical decisions. Owing to the frequency of handling materials there are quality considerations when designing a material handling system. It is important to know the type of materials handling system since it enhances the production process, provides effective utilisation of manpower, increases production and improves system flexibility (Dania et al., 2007).

Stock and waste control: Stock control ensures all items such as raw materials, processed materials, and components for assembly, consumables stores, general stores, maintenance materials and spares work in progress and finished products are available when required (Harris & Coffer, 2013). Waste can be reduced through the careful consideration of the need for minimisation and better reuse of materials in both the design and construction phases. Given these facts, there is a need for materials storage on site to avoid waste, loss and damage of materials which affect the operations on the construction project.

Logistics: This is a concept that emphasizes movement and it encompasses planning, implementing, and controlling the flow and storage of all goods from raw materials to the finished product to meet customer requirements (Ogunde et al., 2017). Raw materials for construction are usually varied, bulky and heavy and require proper handling in the supplying process. The primary focus of the logistics in any construction projects is to improve coordination and communication between project participations during the design and construction phases, particularly in the materials flow control process (Fleischman et al., 2014).

3. RESEARCH METHOD

The methods used for this study include extensive searching of relevant literature relating to the study such as textbooks, magazines, journals, and the Internet. Primary data were

collected in Lagos, Abuja and Kaduna. The sample frame for this study consisted of architects, builders, civil engineers, quantity surveyors and others. A structured questionnaire was administered to the sample frame, after selecting them by means of a simple random sampling technique. A sample size of 90 was chosen for this study to which 30 questionnaires were administered to each of the two states and Abuja. After preliminary analysis of the data the number of usable questionnaires for analysis amounted to 19 from Lagos, 21 from Abuja, and 16 from Kaduna. Overall, a total of 56 questionnaires were returned completed in a usable format. A return rate of 62% was achieved which was considered sufficient for the study. Data analyses were undertaken using descriptive statistics. Frequency means, and percentages were used to express the statistical result. This was achieved using Microsoft Excel and the Statistical Package for the Social Sciences (SPSS).

4. RESULTS AND DISCUSSION

This section presents the results for the study.

Table 1. Person in Charge of Managing Materials in Construction Project

Responses	Frequency	Percentage %
General Manager	9	16.1
Project Manager	13	23.2
Site Manager	8	14.3
Store Manager	23	41.1
Others	3	5.4
Total	56	100.0

Table 1 shows that the person in charge of managing material is the store manager in 41.1% of projects, followed by the project manager in 23.2% projects, and then the general manager in 16.1% of the projects while site engineers were in charge in 14.1% and others amounted to 5.4%.

Table 2. Person Responsible for Ordering Materials

Responses	Frequency	Percentage %
General Manager	4	7.1
Site Engineer	6	10.7
Procurement Dept.	36	64.3
Project Manager	9	16.1
Others	1	1.8
Total	56	100.0

Table 2 shows that 64.3% of the respondents indicated that the procurement department was responsible for ordering materials, 16.1% indicated the project manager as being responsible for this duty, 10.7% identified the site engineer while 7.1% of the respondents indicated that the general manager was responsible for ordering of materials and 1.8% indicated others.

Table 3. Method of Purchasing of Material

Responses	Frequency	Percentage %
Bulk purchase	43	76.8
In pieces	13	23.2
Total	56	100.0

The table shows that the majority of the respondents favoured bulk purchases whenever purchasing construction materials.

Table 4. Planning for Project

Responses	Frequency	Percentage %
Before tender	12	21.4
After award of contract	36	64.3
During construction process	8	14.3
Total	56	100.0

Table 4 shows how the materials planner starts planning for projects. From the table, 64.3% of the respondents agreed planning commenced after the award of contract, 21.4% favoured before tender while 14.3% observed that planning took place during the construction process.

Table 5. Assessment of Materials

Responses	Frequency	Percentage %
Testing	9	16.1
Selection	31	55.4
Measurement	16	28.6
Total	56	100.0

From Table 5 above, the study shows that selection of materials was ranked as the highest consideration for assessing materials in the Nigerian building construction industry with 55.4%, followed by the measurement of materials with 28.6%, while 16.1% agreed on testing materials.

Table 6. Impacts of Materials Management Practices

S/n Impacts	Mean	Std. Dev.
1. Reduce cost of materials	4.785	.414
2. Improvements in labour productivity	4.517	.632
3. Project constructed on time or earlier than expected	4.303	.658
4. Purchase saving	4.553	.501
5. Providing adequate storage of material on site	4.482	.504
6. Reduction in duplicated orders	4.392	.528
7. Improvements in project schedule	4.535	.601
8. Effective design site layout so as to aid in the management of materials on site	4.607	.651
9. Installation of materials hoists on site to aid in the movement of materials	4.553	.630
10. Better relations with suppliers	4.500	.572
11. Better handling of materials	4.714	.455
12. Better field material control	4.678	.471
13. Quality control	4.571	.499
14. Reduced materials surplus	4.821	.386
15. Better cash flow management	4.446	.600

The results reveal the most common ways through which the impacts of materials management practices contribute to the success of construction projects. These are reduced cost of materials, quality control, better field material control, better handling of materials, adequate storage of material on site, improvements in productivity, and completion of project on time. It was observed that the respondents strongly agree on the impacts of materials management practices in the construction industry with mean value of 4.0 and above.

6. CONCLUSIONS AND RECOMMENDATION

This research examined the impacts of materials management practices in the Nigerian building construction industry. This paper describes the impacts of materials management in

three categories, namely the environmental impact, economic impact and performance impact. Based on the findings from this research, the following conclusions are drawn.

The study shows the impact of materials management practices as improving the overall handling of materials for more efficiency and effectiveness on the construction site. This is because poor handling of construction materials affects the overall performance of construction projects in terms of cost, time, quality and productivity. Materials management practices also improve the success rate of project planning and execution, thus lowering the project cost. Moreover, the minimisation of materials wastage during the construction phases is important in order to avoid loss of profits.

There should be proper planning of material management practices right from the inception of project execution and it should also be practised on all sites whether large, medium or small, and by all categories of the construction industry so as to ensure timely project execution and standard work delivery within reasonable cost, time and quality.

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COMPARATIVE STUDY ON GREEN AND SUSTAINABLE BUILDING POLICIES IN DEVELOPED AND DEVELOPING COUNTRIES

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ABSTRACT

Political authorities in developing countries of Africa have begun to develop plans that will address green and sustainable buildings, an issue in which developed countries have had far-reaching experience. This study analyzed literature on green building policies of the United States of America (USA) and the Netherlands in order to identify important lessons that might be relevant for the development of such policies in two developing African countries, namely Nigeria and South Africa. The USA and the Netherlands were chosen because of their progression and long history of green building policies which could have practical utility to Nigeria and South Africa's green building policies. Through a comparative study on green and sustainable building policies in the USA and the Netherlands, it was revealed that developed countries have more elaborate and robust green and sustainable building policies and implementation programmes that could have practical utility for green building developers and investors than those of developing countries. The study concluded that emerging countries, in addition to learning from the provisions of the green building policies of the USA and the Netherlands, could adopt stronger research agendas for green and sustainable building policy issues and regulations. Based on the findings and conclusions drawn, the following recommendations have, among others, been proffered, namely that government intervention at the federal level in Nigeria and South Africa is necessary to ensure sustainable green building policy formulation and implementation, and that efforts should be made by South Africa and Nigeria in particular to increase sensitization on the benefits of sustainable green building features among developers, investors and the public.

Keywords: Developed and developing countries, Policies and programmes, Green building, Sustainability

1. INTRODUCTION

Over the past few decades there has been the necessity for African countries to begin to learn and adopt strategies and methods for green and sustainable building policies from developed countries. This call is for a shift in policy from environmental issues to the wider concept of green and sustainable development. This is in recognition of the fact that the extent and urgency of environmental problems in Africa will require a concerted and integrated policy across social, environmental and economic sectors (Gibberd, 2012). In developing countries of Africa, the average standard of living is far lower than that in developed countries and in many cases basic human needs are lacking (Davies & Nutley, 1999). Thus, policy development that aims to address these basic needs while avoiding negative environmental impacts. Unlike developing countries, developed countries have tried to develop and maintain a long history of

policy and standards that drive green building construction and development (Circo, 2008). This approach is reflected in the wide range of green building assessment methods and guides such as Leadership in Energy and Environmental Design (LEED) in the USA, the Netherlands BREEAM-NL, the Dutch Green Building Council (GBC), and the growing number of certified green buildings in these countries (Bernardi et al., 2017). For example, the USA and Netherlands are among the first developed countries to initiate and put into practice policies for green building. The USA started to give attention to issues of green building after the oil embargo of 1973. Although interest among Americans had faded by the 1980s, it later picked up in 1991 with the first municipal green building initiative taking root in Austin, Texas (Retzlaff, 2005). The Netherlands first began to devote serious attention to green building in 1973. However, its green building policy and implementation programme began to receive adequate attention during the mid-1980s and advanced considerably during the mid-1990s (Retzlaff, 2008).

In contrast, interest in green buildings in developing countries such as Nigeria and South Africa has only started in recent times. In South Africa, green building initiatives could be said to have effectively begun in 2007 with the launch of the Green Building Council of South Africa (GBCSA) (Goosen, 2009). As for Nigeria, the country has just embarked on the development of policies and plans for green building during the past few years (WSP, 2014). For instance, in 2014, it registered the Green Building Council of Nigeria (GBCN) with the World Green Building Council (WGBC) on a probationary membership basis (WSP, 2014). Investigations have also shown that countries and states that adopt green building policies for their buildings have better prospects of delivering high-performance green buildings that reduce their environmental footprint, energy use, and operational cost, enhance employee productivity, and promote a collaborative and innovative workplace (Darren & Tetsuo, 2014). Such countries experience situations where developers and clients voluntarily pursue certification for their real estate projects (Darren & Tetsuo, 2014).

On a wider scope, top building-related issues that concern nations most in their consideration of an effective green building policy is the rising evidence that the building sector is a major consumer of resources and energy globally. For instance, the building sector accounts for approximately 44% of society's total material use and a large proportion of more than 50% of primary resources in developed countries (Nelms et al., 2005). Moreover, in developing countries more than 50% of energy is used in buildings for occupants' comfort (Gebberd, 2012: Energy Commission of Nigeria, 2014). More worrisome is the fact that adequate and effective policies are yet to be initiated by policy makers to regulate and cut the energy consumption by buildings across the countries of Africa. According to Gebberd (2012), attention to sustainability and energy efficiency in Africa should gradually shift to policy makers who are considered to represent conduits for achieving energy efficiency and sustainability in building. However, in their determination to reduce the rise in energy use and pursue sustainable infrastructural growth, most African countries such as Nigeria and South Africa in particular have initiated programmes that specifically target green building as a process of mitigating global climate change. Yet, a key factor that is significant, but lacking is the absence of robust policy development and expansion.

While policy development initiatives of countries such as the USA and the Netherlands are elaborate and robust, South Africa's and in particular Nigeria's green building policies are still in their infant stages and developing (WSP, 2014). Several studies (Retzlaff, 2009; Dahiru et al., 2014; Nduka & Adegboyega, 2014; Onuoha et al., 2017) suggest that the development of green and sustainable building policies in developed and developing countries is founded on the history of policies and programmes in addition to political systems and cultural context. Because of this significant difference, developed and developing countries could be at different levels of green and sustainable building policies' development and implementation. This study

is predicated on the basis that there are likely to be potential benefits and lessons relevant to developing countries such as Nigeria and South Africa from developed countries if a general explanation of the green building policies of the USA and Netherlands is examined. Thus, the study focuses on the specific theory, historical policy developments and contemporary state of green building policies in the USA, the Netherlands, Nigeria and South Africa with substantial emphasis on the evolving concepts of green buildings, research and education, policy development and methods of building assessment and not on specific policy techniques such as zoning and building codes.

2. THE STUDY AREAS – WHY DEVELOPED AND DEVELOPING COUNTRIES?

Studies (Chin-Ho & Chiu 2006; Zhang et al., 2011) have shown that green and sustainable policies could be localized as policy makers may pay attention to issues of sustainability that influence their locality. However, recent studies have shown that in many respects there can never be a truly localized policy (McGraw-Hill Construction, 2013: Nguyena & Graya, 2016). This is especially the case now that green and sustainable building is becoming less localized to one part of a geographical region owing to the global marketplace being increasingly motivated by prevailing concerns on world climate change (McGraw-Hill Construction, 2013). There may be locally occurring policies (such as within a city or country) but all policies are often affected to a greater extent by the global or wider policies within the state, or between regions and nations (Lawson et al., 2009). Given the significant momentum towards increased international sustainable policy integration to check climate change, the study areas, namely the USA, the Netherlands, Nigeria and South Africa, are active signatories to the Kyoto Protocol and members of the United Nations Framework Convention on Climate Change (UNFCCC) that commits state parties to reduce greenhouse gas emissions (US Department of State, 2015). Although, the study areas are in different climate zones and regions, they experience common natural disasters such as floods, storms, and wildfires which could have clear implications for green and sustainable buildings. Besides, the countries practise green building and sustainability. However, investigation shows that developed countries (the USA and the Netherlands) have tried harder to develop and maintain a long history of policy and standards that drive green and sustainable building construction and development than developing countries (Nigeria and South Africa) (Circo, 2008; Retzlaff, 2009; Onuoha, 2017). The implication is that at the moment there is more policy development and expansion on green and sustainable buildings in the USA and the Netherlands. This is reflected in the growing number of green and sustainable building across these countries (Retzlaff, 2009).

It is on this basis that there has been emphasis on a collaborative relationship between developed and developing countries in evolving policies towards fostering a more effective international response to green building construction through knowledge sharing and policy transfer. For example, there are foreign relations within the European Union, transatlantic relations, Arctic issues and United Nations affairs. These include better integration of sustainable building into the EU's Common Foreign and Security Policy, as well as the Lisbon Agenda, and incorporating climate change and environmental sustainability in the work of a wide range of bodies under the United Nations (Drexhage et al., 2006). Secondly, given the increasing political priority to energy security in developed countries, and how the promotion of climate-friendly energy solutions and adequate reliable supplies of energy in tandem with green building policy context could address environmental challenges, developed and developing countries have reinforced their roles of partnership for knowledge sharing in order to enhance the ability and willingness of developing nations to meet the challenges of climate change (Drexhage et al., 2006).

On the other hand, South Africa and Nigeria in particular are important actors on the African and global stage for developed countries. Thus, the two African countries are the greatest trading and diplomatic partners of the US and the Netherlands. For instance, Nigeria has remained a good partner of the US and the Netherlands in energy capacity building and oil, with Shell Petroleum, a Dutch company, as a major player in the nation's oil and gas industry (Oyinloye, 2015). Trade between the Netherlands and Nigeria was N80.9 billion in the second quarter of 2015 (Oyinloye, 2015). Furthermore, the US goods exports to Nigeria in 2014 stood at USD5.9 billion, down 7.3% from the previous year while US imports from Nigeria were USD3.8billion, down 67.2% (US Department of State, 2015). The US primarily exports refined petroleum products, used vehicles, cereals, and machinery. Crude oil and petroleum products continued to account for 96% of Nigerian exports to the US in 2014 (US Department of State, 2015). Foreign direct investment (FDI) in Nigeria continues to be led by the oil and gas sector. However, there are substantial investments from the US and Netherlands in Nigeria's power, telecommunication, real estate, and agricultural sectors (US Department of State, 2015).

Moreover, between 1994 and 2011 South Africa signed major bilateral agreements with the US, ranging from Statement of Intent concerning Cooperation in Sustainable Energy Development and the Mitigation of Greenhouse Gases, to Framework Agreement concerning cooperation in the Scientific, Technological and Environmental Fields (Department of International Relations and Cooperation, South Africa, 2018). Furthermore, there exists a memorandum of understanding between the Department of Energy of the US and the South African government on Collaboration in Energy Policy, Science, Technology and Development. Also, during the period the Netherlands entered into a bilateral agreement with South Africa on housing cooperation and arrangement on a project "Housing for a Healthier Future for South Africa" as part of activities implemented jointly in pursuance of the objectives of the United Nations Framework Convention on Climate Change (Department of International Relations and Cooperation, South Africa, 2018). Meanwhile Nigeria has within the period entered into a bilateral agreement on energy and investment with the USA (US Department of State, 2015). So, it is the opinion of this study that this cordial bilateral relationship could elicit a cross-regional study of this nature on green building policy and encourage a fundamental shift from localized information on and perception of green and sustainable building policies to a global one.

3. COMPARATIVE RESEARCH AND POLICY IN GREEN BUILDING

Comparative research or analysis is a broad term that includes both quantitative and qualitative comparison of social entities. Social entities may be based on many lines such as geographical or political ones in the form of cross-national or regional comparisons (Mills et al., 2006). Thus, comparative entails research within and across disciplines, states, nations, continents, regions, cities, suburbs and estates (Lawson et al., 2009). The inference is that comparative studies may be on different scales and for difference purposes but with the intent of promoting an exchange of information, knowledge sharing, catalyzed policy development and theoretical debate across states and regions (Lawson et al., 2009). Endan (1984) defined the concept of comparative study on policy analysis as: "...Studies that typically involve cross-national assessment of similar systems to determine whether the effects on policy are culturally specific or the result of the policy making system''. According to Endan (1984), the focus of these studies is a systematic evaluation of the contextual and experiential knowledge gained from a given policy so that generalizations made can be tested. This is mainly significant now that green and sustainable building is an emerging concept and is becoming less localized to one part of geographical region owing to an increasing global marketplace motivated by prevailing concerns on world climate change (McGraw-Hill Construction, 2013: Nurul & Zainul, 2013).

However, to realize what Pugh (1995) called "structural change in sustainable housing", Wolman (1992) and Allen (2003) argued that policies and bases for solving housing and building problems can be adopted for use in another culture. This is in realization of what Rose (1991) described as "lesson drawing", what Wolman (1992) called "policy transfer" and what Allen (2003) termed "learning exercise". Also, this approach is suited to what Allen (2003) observed as: "Researching the broader political and cultural context within which housing...policies exist should not be seen as an irrelevant self-indulgence. Rather, it should be seen as an effort of lesson, learning, and exercise''. However, comparative studies on green and sustainable building for the purpose of policy transfer have had to confront arguments that "…policies are the cultural products of history, time and place (Mills et al., 2006). Nonetheless, beyond this position, this study is of the opinion that knowledge of policy instruments and outcomes in one country does inform analysis of issues in another country. For example, the growing cross-regional studies and rapid exchange of information concerning regulations and policies on green and sustainable building is a proof of this.

A further example is that of Bakar-Abu et al. (2011) proposing an assessment model for housing sustainability in Malaysia using CASBEE, BREEAM, and LEED rating tools while Waidyasekara and De Silva (2012) comparatively rated Malaysian GBI rating systems in terms of water efficiency and conservation using green building policies of the UK, USA, Hong Kong, Australia, Singapore, India, South Africa, and New Zealand. Again, Bahaudin et al. (2014) and Abdullah et al. (2015) compared the green and assessment criteria on sustainable rating systems of Malaysia, Singapore, the USA, Indonesia, South Korea and Asian countries. This suggests that with the appropriate regard for knowledge transferability, comparative research on green and sustainable building can provide a catalyst for policy developments elsewhere. Thus, new policy ideas may arise from the stimulus of information about how things are done elsewhere and exposure to different approaches can challenge insular beliefs about the causes of problems and the effects of policy instruments. Therefore, understanding the differences among green and sustainable building policies of the developed and developing world can improve the understanding of the processes of green and sustainable buildings. Thus, it is the contention of this study that this cross-country comparison study will be an added advantage, especially for Nigeria and South Africa, to learn from others' experiences to benchmark themselves.

4. GREEN AND SUSTAINABLE BUILDING POLICIES IN USA

In the USA, investigations show that issue of green and sustainable building began to receive serious attention after the oil embargo of 1973 but never became a policy issue in the country until about ten years later (Retzlaff, 2009). In fact, the first municipal green building initiative in the USA was constructed in 1991 in Austin, Texas. Busch et al. (2008) and Rosenberg (2001) further added that the policy covered only the evaluation of single family homes. It was later extended to cover commercial, multifamily, and public buildings over time. Following this breakthrough of the Austin policy on green buildings, other cities and counties in the USA began to develop green building policies to include such factors as tax incentives, density bonuses, zoning requirements, government building mandates and comprehensive green building programmes (Kibert, 2002; Del, 2004; King & King, 2005; Retzlaff, 2005; Circo, 2008; Retzlaff, 2009). This is a display of the government of the USA's commitment to initiating programmes aimed at achieving green economy.

However, it is not obvious how many green and sustainable building policies have been adopted in the USA today even though, according to Retzlaff (2005) and Rainwater (2007), a survey of 661 of the largest cities in America indicates that 92 of them had green building policies and programmes in place. In fact, a database of green building policy assembled by scholars at the University of Wisconsin in 2009 showed more than 194 programmes (Gruder,

2009). Furthermore, a wide range of policies and initiatives aimed at assessing the sustainability of buildings in the USA have been developed by successive governments to support green building development. A generally used method in this regard is LEED which has multiple assessment systems for the development of different types of buildings, including neighborhood designs.

5. GREEN AND SUSTAINABLE BUILDING POLICIES IN NETHERLANDS

In the Netherlands, green building began to receive serious political attention in 1973. This was after the imposition of the oil embargo against many western countries by the Organization of Petroleum Exporting Countries (OPEC). The consequent volatility in the energy market as a result of this embargo forced the Dutch government to re-examine the county's energy consumption policy, including buildings. This led to the adoption of the Dutch Energy Policy document in 1974, including the completion of several subsidized green buildings (Melchert, 2007). In fact, green building policy in Netherlands became institutionalized in the 1980s. This was as a result of the report of the Brundtland Commission of 1987 that focused on the status of the natural environment (Hajer, 1995; Gouldson & Murphy, 1998).

This also led to the approval of the country's first National Environmental Policy Plan (NEPP) in 1989 which gave high priority to the construction industry). Further to its commitment to the growth and development of green building, the Dutch government released its second plan focusing on the importance of separating economic growth and pollution in 1993. In 1995, an action plan for sustainable construction was prepared. This plan outlined broad goals and policies for all areas of green buildings, including energy consumption, water use and air quality. It was updated in 1997 and 1999 when the implementation of green building programmes were left to the discretion of the municipalities (Bossink, 2002). Furthermore, by 1998 and 2001, the third and fourth plans were put in place. These plans sought to promote the overall prosperity and balance the quality of life and environmental objectives respectively (VROM, 2001; Sunikka, 2001).

However, in 1996, the national government became much more involved in green building policies by preparing national sustainable building packages. Consequently, four packages which addressed the residential and non-residential buildings, infrastructure and urban planning were released. The packages contained extensive and detailed specifications for green buildings from the urban design scale to the building component scale (Melchert, 2007). They were presented in a clear format that classified sustainable measures according to the sets of environmental issues to which they contributed. These national packages were based on life cycle analysis to appraise the sustainability of each measure and to give it corresponding cost information (Van Bueren & Tenheuvelof, 2005). These packages were typical of the Dutch environmental policy which is that the construction industry was expected to take part in the consultations to develop voluntary steps for sustainable buildings that the industry should follow.

In the Netherlands, the government was expanding sustainable green building programmes and at the same time finding ways to address global climate change so as to reduce greenhouse gas emissions. The Dutch government on its own went further in 1995 to enact the Energy Performance Standard that specified the amount of energy that new industrial and office buildings would be allowed to use. Existing buildings were also required to reduce their energy use by 25% over ten years (Retzlaff, 2009). However, the issuance of the NEPP in the 1990s gave the local authorities greater autonomy, thereby making the decision-making process in the Netherlands more open and flexible. Consequently, industry groups came to be consulted on many issues and the system of communication and open negotiation on

environmental policy matters occurred in almost every industry (Arentsen et al., 2000). For instance, regulators worked hard to negotiate covenants that could reduce pollution in the construction industry. Keijzer (2000) notes that the covenants covered 90% of the pollution, waste disposal, recycling and energy use of the industry, construction and energy sectors.

By the late 1990s, sustainable building policies in the Netherlands had contained a variety of instruments, strategies (including demonstration projects), mandatory policies, voluntary incentives, and covenants with industry groups. But these innovations, according to Bontje (2003), became manifest in 2002 when a right-wing coalition assumed control of the government and support waned for the hierarchical top-down approach to planning and environmental policy previously carried out by the Ministry of Housing, Spatial Planning and the Environment.

6. NIGERIAN GREEN AND SUSTAINABLE BUILDING TRENDS AND POLICIES

Nigeria is presently developing its policy framework for green building (WSP, 2014). As an initial move towards developing green building, it registered the Green Building Council of Nigeria (GBCN) with the World Green Building Council (WGBC) in 2014 (WSP, 2014; Nduka & Ogunsamni, 2015). The GBCN has the responsibility of developing the rating system for the assessment of sustainable buildings in Nigeria, but it is at the moment in the process of developing a policy system for green buildings. Thus, Nigeria has not yet developed any green building rating tool that could be used for office, retail, multi-unit residential, public and educational building projects in Nigeria. However, the Nigerian government has currently allowed the Green Building Council of South Africa (GBCSA) to certify green buildings for her. The certification is called Green Star South Africa-Nigeria (Green Star SA-Nigeria).

It is not clear whether Nigeria has the intention of adopting further policies to promote green building owing to some observable deficiencies in Green Star SA–Nigeria such as in the areas of weighting standards specifically on energy efficiency, management and innovations (Nduka & Ogunsamni, 2015). The Green Star SA rating tool (Green Star SA-Nigeria) is based on nine major categories, namely management, indoor environmental quality, energy, transport, water, materials, land use ecology, emissions and innovations. Currently, the GBCN has agreed with the GBCSA on adopting the Green Star SA rating tool pending such time that the GBCN developed its rating tool. At the moment, Nigerian professionals are being trained as Green Star SA-Nigeria assessors who presently join the GBCSA Star SA-accredited professionals to assess and certify green buildings in Nigeria (WSP, 2014). The GBCN, in consultation with industry professionals and academics, have made modifications to and recommendations on Green Star SA-Nigeria specific to the Nigerian context. This is with regard to legislation, policies and sustainability practices.

However, the impact is yet to be felt by Nigerians (Nduka & Ogunsamni, 2015). This is because an average Nigerian, including professionals in the built environment, is not fully aware of or still less sure of green building and its associated benefits. Moreover, Nigeria has not formulated a significant policy on an environmental rating scheme, and by implication has not shown a serious leadership role to pursue green building policies and programmes that have an impact on the real estate construction industry. However, it has registered about 317,039 gross square area of green buildings (United State of America's Green Building Council, 2015). Moreover, Nigeria has made efforts at ensuring environmental sustainability by establishing various agencies and policies aimed at encouraging sustainability. These include the National Policy on the Environment (NPE), the Environmental Protection Agency Act (1988), the National Council on the Environment (NCE), the National Policy on Climate Change and Response Strategy, and the National Environmental Standards and Regulations Enforcement Agency (NESREA) (Nwokoro & Onukwube, 2011).

7. SOUTH AFRICAN GREEN AND SUSTAINABLE BUILDING TRENDS AND POLICIES

As part of the concerted efforts towards strengthening the campaign and promotion of green and sustainable building initiatives, in 2007 the South African government launched the Green Building Council of South Africa (GBCSA). The GBCSA became the thirteenth full member of the WGBC in September 2008. The launch and registration of the GBCSA at the WGBC is a display of government commitment in initiating programmes aimed at achieving green economy in South Africa. Key objectives of the GBCSA programme include promoting green building practices in the commercial property industry, facilitating the implementation of green building practice by acting as a recourse centre, enabling the objective measurement of green building practices by developing and operating a green building rating system, and improving the knowledge and skills base of green building in the industry by enabling and offering training and education (Goosen, 2009).

The GBCSA launched the Green Star Rating tool in South Africa in November 2008. The tool was adopted from the Australian Green Star system because it was the easiest to customise to the South African context (Goosen, 2009). The Green Star SA is a comprehensive rating system for evaluating the environmental design and performance of South African buildings. The rating tool enables stakeholders in the industry to determine the environmental impact of their developments and receive recognition for their design contribution. Green Star SA is a voluntary green building rating system comprising eight categories including energy, water, materials, emissions, and the like. It recognizes and rewards initiatives that reduce the environmental impact of development.

Unlike the USA and the Netherlands, it is difficult to make a fair judgement on the progress or success of the GBCSA, especially in the areas of policy development networks and expansion, and critical research programmes. For example, studies by Gibberd, (2005) and Goosen (2009) have shown that barriers to the implementation of green and sustainable building principles in South Africa are a lack of understanding and awareness of green star principles, and limited understanding of the concept among industry professionals (Goosen, 2009). While the above-mentioned paucity of literature on green building has a narrow focus with less emphasis on developing green building policies and skills in South Africa, a few private construction companies and architects have less sustainable construction skills (Creamer Media Engineering News, 2013). Furthermore, the Green Star SA rating system is not designed to become regulation, though individual organizations or government departments are encouraged to require it for their own buildings (Goosen, 2009). This suggests that while regulation sets minimum standards, Green Star SA tends to recognise leadership at the upper end of the green scale. Although each Green Star SA rating reflects a different market sector (office, retail, or multi-unit residential), the first tool that has been effectively developed is Green Star SA-Office which was published in July 2008. Its Version 1 (Green Star SA – Office v1) was subsequently released in November 2008 (Goosen, 2009). Thus, it is not clear whether GBCSA has released the tools for other building types, for example, retail, hotel, multi-unit residential, conference centres, and industrial.

Nonetheless, in South Africa a wide range of policy and initiatives has been developed by the government to support this approach. These include the Integrated Sustainable Rural Development Strategy, the State of the Environment Reports, Driving Competitiveness, an integrated Industrial Strategy for Sustainable Employment and Growth, the New Partnership for Africa's Development, the White Paper on Integrated Pollution and Waste Management, the White Paper on Environmental Management Policy and the South Africa Human Development Report (10) (Gibberd, 2001). Furthermore, the South African Bureau of Standards (SABS) has developed the South African National Standards (SANS) 204 series of

standards to provide a framework for energy-efficient buildings. The standard will result in minimum requirements for buildings as opposed to best practice. It is believed that SANS 204 would result in energy efficiencies of around 40% in commercial buildings. SANS 204 is presently only a voluntary standard but is expected to become mandatory for all new buildings in the next two or three years once it has been incorporated into the National Building Regulations.

Furthermore, the Sustainable Building Assessment Tool (SBAT) has been developed to rectify major sustainable building and construction problems in South Africa (Gibberd, 2008). SBAT does this by measuring sustainability performance in the built environment against 15 social, economic and environmental criteria (Gibberd, 2008; Van Wyk, 2008). The social criteria include occupant comfort, inclusive environments, access to facilities, participation, control, education, health and safety. The economic criteria include local economy, efficiency, adaptability, ongoing costs, and capital costs. The environmental criteria include water, energy, waste, site, materials and components. Performance in these areas is measured out of five (5) and presented on a radar diagram. Importantly, SBAT is aimed at assessing not only the performance of buildings in terms of sustainability but also assessing the extent of the building's contribution to supporting and developing more sustainable systems around it (Van Wyk, 2008). What is worrisome is that SBAT at this stage cannot provide a comprehensive assessment of the extent to which buildings can support sustainability (Gibberd, 2001). Thus, its aim has been to provide an indicative guide to the performance of buildings in terms of sustainability through the collection and interpretation of a number of simple performance indicators. It is based on the premise that experts believe that a sustainable policy development network is urgently required to support sustainability in the building and construction industry, even if it is not yet fully understood (Gibberd, 2001).

8. METHODOLOGY

This study adopted a comparative method of analysis. A comparative method of analysis examines pattern of similarities and differences across a moderate number of cases. Like qualitative analysis, comparative studies consider how the different parts of each case are relevant to the investigation or fit together in order to draw lessons and shortcomings so as to make conclusion (Mills et al., 2006). There are rising bodies of cross-national and regional comparative studies, including the cross-regional similarities and differences in investigations between developed and developing countries on sustainability in building construction, housing, real estate investment performance and real estate practice (Alabi, 2012; Bawa, 2013; Olusegun et al., 2015; Onuoha, 2017). Thus, this study, using the review of literature approach, examined the differences between two developed countries (the USA and the Netherlands), and two developing countries (Nigeria and South Africa) The justification for the choice of the USA and the Netherlands is because of their progression and long history of green building policies which could have practical utility to Nigerian and South Africa green building policies. Besides, both countries have a temperate climate except in a few states in the US that are tropical. The countries practise green building and sustainability. In addition, the Netherlands is a member of the European Union (EU) and has worked closely with the USA. The government of the USA and the European Union have an existing agreement on the coordination of an energy-efficiency labelling programme for office equipment (Brussels, 2013). The objective of the agreement is to coordinate energy-efficiency labelling programmes for office equipment and reassess the potential for maximizing energy savings and sentimental benefits by stimulating the supply of and demand for energy-efficient products (Brussels, 2013). At the international organization index, the Netherlands work closely with the USA as members of the World Trade Organization (WTO) and the Organization for Economic Cooperation and Development (OECD) (US Department of State, 2016).

In terms of Nigeria and South Africa, the two countries were chosen because they are among the few countries in Africa that practise green building and sustainability though South Africa takes the lead. For example, in the meantime, Nigeria uses the South African Green Star SA for green building certification and rating (WSP, 2014). Furthermore, Nigeria has long had diplomatic relations with South Africa and has signed various bilateral agreements with South Africa. These agreements range from an agreement to train Nigerian green building assessors in South Africa (WSP, 2014) to the establishment of a Bi-National Commission of Cooperation to agreement on Educational Co-operation and Research (Department of International Relations and Cooperation, South Africa, 2018)

9. FINDINGS AND DISCUSSIONS

Through the analysis of literature from the study areas, this study identified four broad themes in green and sustainable building policies among developed and developing countries. Literature from both developed and developing countries emphasizes these four subject matters to a large extent, although there is a much larger field of literature on green and sustainable building policy in developed countries than on developing countries. The four major findings from the literature are subsequently discussed.

9.1. Early Green Building Development

The study found that the development of green building policies in developed countries such as the USA and Netherlands and developing countries such as Nigeria and South Africa is founded on a history of policies and programmes. Although the countries are highly dependent on historical policy changes, the green building policies of the USA and Netherlands have, however, been built over more years than those of Nigeria and South Africa. The USA and Netherlands began to encourage green buildings several years before Nigeria and South Africa. Besides, green building policies in the USA and Netherlands have central government influence but are more decentralized as each state has a role to play in green building development. On the part of South Africa and in particular Nigeria, interest in green buildings started in recent times and the countries today do not have the same long-standing policy of action as the USA and Netherlands have. Thus, the emergence of green buildings in South Africa and in particular Nigeria has been much later. The implication is that the growth in the number of green buildings is much slower today in South Africa and Nigeria (Alabi, 2012) relative to the USA and Netherlands.

Although political authorities in Nigeria and South Africa have developed plans and policies for green and sustainable buildings, this has not resulted in significant expansion in the number of green and sustainable buildings. For example, the LEED certification update shows that only one green building, the Heritage Place with a square footage of 97,187, has received final certification in Nigeria (Gray, 2015). As at the moment, Nigerian green building policy systems are built more on national influence from the Federal Government with less participation from the states. Along these lines, Nigeria in particular ought to gain from the green building movement in the US and the Netherlands which is built upon a history of policy and cultural shifts, while South Africa could leverage on the US Netherlands' long policy history to improve on her green building policy to make it strong enough to impact significantly on green building development. For example, policies that are strongly market focused and have strong tools to promoting green and sustainable offices designations are ideal. Thus, green building issues in South Africa and Nigeria, as in many other policy matters, have to be built upon a path-dependent history of changes, both in public attitudes and policy formulation.

9.2. System and Standard for Green Building Assessment and Certification

Although some literature in the study areas (Gibberd, 2001; Retzlaff, 2009; Melchert, 2007; Nduka & Ogunsamni, 2015) has advocated improved systems and standards of green building assessment and certification, over a decade there has been a greater focus of this in the US and Netherlands than in South Africa and Nigeria. For example, there is evidence that the US and Netherlands have improved from assessment to effective implementation compared with South Africa and Nigeria. Perhaps this is because the US and Netherlands have pursued more elaborate green building policies such as developing a rating tool which has become a sustainable building standard in both countries. Thus, there is less emphasis on developing a tool and methods of green building assessment and implementation than on achieving results. On the other hand, while South Africa is in the implementation stage, Nigeria is in the process of developing her own rating tool. Therefore, much of Nigeria's attention at the moment is geared towards developing assessment systems rather than implementation.

Although, Nigeria uses the South Africa's Green Star rating criteria at the moment, the Green Star point values to key sustainable issues in green building are low relative to LEED measures and benchmarks. All the same, since the US and Netherlands have greater experience in green building relative to South Africa and Nigeria, in addition to the adoption of LEED's rating tool, South Africa and Nigeria can analyse the technical details of the various building assessment systems in the US and Netherlands such as their approach to various environmental issues and spatial scales, their underlying values, and how they determine criteria and points. This will help South African and Nigerian professionals examine certain key issues of sustainability and reduce the difficulties in achieving the required quantification. For example, green building is at embryonic stage in Nigeria and as such, could create the problem of quantifying the benefits inherent in walkable neighbourhoods, and diverse communities. All these are sources of credit to LEED for new developments which could be exploited by Nigerian industry professionals.

9.3. Inevitability of Strong Research Programmes and Education

The findings from the literature review identified the need for improved strong research and education policies for green buildings in South Africa and in Nigeria in particular. Though there could be cross-national differences in emphasis, studies by Retzlaff (2009) and Melchert (2007) suggest that the US and Netherlands have shown more commitment in educating developers and city inhabitants about green buildings than Nigeria and South Africa have. For example, while the US and Netherlands scholarships and grants to institutions focus more on research and education to promote the innovation of green buildings and green building policies (Chio, 2010; Retzlaff, 2009; Trencher et al., 2013), Nigeria is yet to fully integrate the education and research on green building into her educational curriculum (WSP, 2014). Again, whereas some of the research on green buildings in the US and Netherlands has taken place through demonstration projects designed to showcase new advances in building technologies (Chio, 2010; Retzlaff, 2009; Trencher et al., 3013), South Africa and Nigeria in particular have shown less interest in green technology and innovations (Gibberd, 2001; Onuoha, 2017). As a result, there has been an implementation deficit in Nigerian and obvious lapses in South African green and sustainable policies.

From the forgoing, it is obvious that there is clear difference in green building education and research between the two examples of developed and developing countries. Whereas developed countries have more elaborate educational and research programmes targeted towards green building, developing countries are yet to fully initiate and implement sustainable green building educational policies and research in their educational systems. The inference from the above literature is that education and research on green building is less in South Africa and low in Nigeria when compared with developed countries. For example, there are a growing number of research studies and sources of literature in the US and Netherlands that focus more

on educating stakeholders about green building than in Nigeria (Onuoha, 2017). Nigeria's literature presently focuses more on awareness of the new knowledge of green building. But unlike developed countries, the Nigerian government and experts in the building industry have not given much attention to research and education; as such, there has been the problem of awareness (Nduka & Ogunsamni, 2015; Onuoha, 2017). Thus, Nigeria can learn from the experience of the USA and Netherlands in research and education pertaining to green buildings.

9.4. Policy/Programme Development and Effectiveness

Currently, a significant green building initiative factor that is lacking in South Africa and Nigeria in particular but not in the US and Netherlands is effective policy development and expansion (Retzlaff, 2009). Although Nigeria and South Africa in particular have recorded successes in green building policy initiatives and development, neither country, especially Nigeria, has initiated elaborate green building policies that are effective enough to stimulate and maintain standards, ensure quality, and regulate green building market forces. Again, green building policies, especially in the area of policy provision for green tax incentives in South Africa and particularly in Nigeria, are still beset with notable criticisms when compared with those of the US and Netherlands. This could be because the policies are not strongly market driven or adequately enticing to attract investors, especially in the areas of qualifying persons, qualifying costs, standardization of rating tools, incentives, stamp duty exclusion, and absence of clarity. There are cases where green taxes are more pro-supply with little or no process for sensitizing the demand side to ensure both investors have a balanced perception of green building investment.

Nigeria uses the South Africa Green Star rating tool which has not, however, significantly spurred green building investments in Nigeria. The use of the Green Star in Nigeria rating should be considered as temporary as its continued use does not demonstrate serious commitment to green building on the part of Nigeria. Again, owing to more enabling green building policies in the US and Netherlands, a greater number of industry professionals have more green building skills than their counterparts in Nigeria and South Africa, while literature on green buildings (Gibberd, 2005; Goosen 2009) is narrow focused with less emphasis on the development of green building policies and skills in South Africa and Nigeria in particular, although a small number of private construction companies and architects have a few sustainable construction skills (Gibberd, 2001; Onuoha, 2017). Thus, this study sees this inadequacy in green building industry as a barrier to the development and implementation of sustainable building policies and programmes in Nigeria and South Africa. Thus, Nigeria and South Africa can learn from the US and Netherlands where green building policies were developed by a network of professionals already active in the field of green building, a situation that has contributed to learning and innovation over time. This will help establish cordial relationships among industry professionals on discussions on policy initiation and implementation. This would be easier when the parties are already knowledgeable themselves.

10. CONCLUSIONS AND RECOMMENDATIONS

Regardless of the many differences in policy, and social and economic backgrounds among the study areas, this study has demonstrated some similarities in green building policy research. For example, irrespective of the point values, the South African Green Star and Green Star SA-Nigeria policy rating tools covered the key sustainability criteria and measurement items in the same way as the US and the Netherlands. The key sustainability criteria include energy efficiency, indoor environmental quality, sustainable site planning and management, materials and resources, water efficiency, and innovation. However, owing to a long history of

green building activities in the US and the Netherlands, many differences exist from which South Africa, and in particular Nigeria, can draw important lessons.

Firstly, the US and the Dutch experience has shown that conscious efforts should be made by South Africa and Nigeria in particular to increase the sensitization of green building features among developers, investors and the public on the benefits of sustainable construction practice. For example, constructing or retrofitting a building to green building requires policy awareness of materials and innovation in building technology and design before new products and techniques go onto the market. Secondly, the South African and Nigerian governments can show leadership in green building by adopting some LEED research agendas for green building policy issues and regulations. Also, some LEED policies and incentives, especially in the area of green technology, that are strong enough to sensitize green building could be similarly adopted. Furthermore, the US and the Dutch experience suggests that Nigeria needs to develop her own rating tools as the use of South Africa Green Star in the interim may not sufficiently improve her green building practices while South Africa should improve on her rating criteria for better green building practices.

On the other hand, through green technology transfer or green foreign direct investment (FDI), integrated work across geographical distances and easier information exchange could be encouraged among the study areas. For instance, environmentally friendly industry technology and practices that directly contribute to environmental progress can be transferred while more innovative means to design and construct green buildings as well as the skills to do so can be shared across country borders. Apart from the foregoing, the leadership and emphasis given to issues of green building and sustainability in the US and the Netherlands at the government level are something that South African and Nigerian authorities can learn from. Notwithstanding the differences that could exist in political context, government intervention at the federal level in Nigeria and South Africa is useful. For instance, a federal legislative policy on green building such as grants, loans, rebates and tax incentive could improve the state and local government's acceptance of green building in both countries. Again, from the experience of the two developed countries, the governments of South Africa and Nigeria could help states and local authorities in their countries that are already stressed to determine the best ways to develop environmentally friendly buildings while research and education programmes could help encourage innovation.

Similar to other studies (Chio, 2010; Onuoha, 2017), a major limitation of this study is lack of discussion on the effect of green building policy in relation to costs of investment in green building. One of the barriers to green building policy initiation and implementation in South Africa and Nigeria in particular includes uncertainties about cost. The time span for recovering the cost of investment in green buildings in South Africa and Nigeria could be prohibitively long and the investment is usually shouldered by developers who often do not enjoy the cost savings while sustainable products are assessed largely based on cost implications.

This study is of the opinion that further studies on issues of cost in relation to green building policy in and among the various countries should be conducted. This will help the government and policy makers in the countries to effectively address practical issues arising from green building development and investment. Although the wide-ranging experience of the US and the Netherlands in initiating green building policies has a longer history of interest, it also suggests that the countries have passed through the hard processes of trial and error lesson learning and knowledge sharing from other developed countries. This is essential for any evolving policy system in South Africa and Nigeria. By looking to Europe, South African and Nigerian policy-makers could articulate and formulate less difficult and more innovative green building policy systems.

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THE IMPACTS OF ECONOMIC CRISIS ON FIRM-LEVEL INNOVATION IMPLEMENTATION: IMPLICATIONS FOR SUSTAINABLE DEVELOPMENT IN THE CONSTRUCTION INDUSTRY

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ABSTRACT

Innovation is viewed by many as a driving force for sustainable economic and social change. Indeed, it has often been argued that continuous innovation is essential for sustainable developments in the construction industry. However, it has been established that economic crises negatively impact firms' capacity to implement innovations. The size of the effect and the impact on firm-level innovation differ widely across countries and industries. In the case of Nigeria, it has been argued that the rather frequent economic turbulence it experiences significantly affects firm-level innovation implementation in the local construction industry. This study identifies the key effects of economic crises on construction contractors and how these impact firm-level innovation implementations (it focuses on the factors at play in this regard). The paper provides an overview and synthesis of the literature on innovation, economic crisis, innovation persistence and sustainable development. This is supported by case studies and semi-structured interviews within construction contractors based in Abuja, Nigeria. The study finds several key effects of economic crises on construction contractors in Abuja Nigeria. These are shrinking demands for products and services, increased operating costs, increased delays in payments for jobs completed, increased difficulties in accessing credits and loans, declining revenue and profit levels, a rise in employee dissatisfaction and a surge in crime rate.

Keywords: Innovation, Innovation implementation, Innovation persistence, Sustainable development, Economic crisis, Construction contractors

1. INTRODUCTION

With the consistent robust growth in Nigeria's population, it is envisaged that the demand for the constructed product in the form of social infrastructure and amenities will continue to expand (Daramola & Ibem, 2010, Aibinu & Jagboro, 2002). The corollary of this, however, is that the demand for resources in this area will also continue to increase. Thus, the need for continuous improvements and renewal of sustainable construction practices so as to preserve the natural environment (Spence & Mulligan, 1995). However, it has been established that continuous innovation is fundamental to the development and renewal of sustainable practices in the construction industry (Seyfang & Smith, 2007; Meyer-Krahmer, 1998). But for firms operating in developing countries such as Nigeria, implementing innovations is largely dependent on the state of the economy (Archibugi & Filippetti, 2011). Indeed, several studies

have found a positive correlation between innovation and the economy cycle (Archibugi et al., 2013b; Anthony & Feinzaig, 2008, Filippetti & Archibugi, 2010). The work of Archibugi et al. (2013a) concludes that firms are often more inclined to halt innovation decisions during periods of economic crisis. Therefore, for firms operating in countries with perennial problem of economic instability such as Nigeria, the importance of understanding the specific impacts of economic crises on firms' capacity to persist with innovations with a view to designing strategies for safe and continuous implementation of firm-level innovations during economic crisis cannot be over-emphasized.

2. LITERATURE REVIEW

2.1. Sustainability in Construction

As argued by Seebode et al. (2012), discussions on 'sustainability' often provoke a sense of urgency and concern from scholars and industry practitioners. In reality, sustainable developments can only be met by developing and implementing radically new concepts for the future industrial society (Meyer-Krahmer, 1998). The capability to continually innovate is a key mechanism for organizational growth and sustainable development (Lawson & Samson, 2001). It is argued that industry practitioners are only able to engage in development "…which meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987) by being persistently innovative. In fact, the work of Ruttan (2000) finds that the rate and direction of technical change is induced by changes in relative resource endowments. This implies that sustainable developments can only be accomplished through persistent innovation.

2.2. Innovation

The overwhelming importance of innovation to wider economic and social order has continually provoked the interest of scholars from a broad range of academic endeavours and this is reflected in the multiple, albeit, largely harmonious interpretation of the innovation phenomenon by several studies. Indeed, innovation is a "concept central to economic growth and can be a source of sustained competitive advantage to firms" (Damanpour & Wischnevsky, 2006). The work of Murphy et al. (2011) stresses the importance of product innovations for economic growth. They contend that product innovation has fundamental implications for appreciating the nature of capitalism as well as the nature of competitive forces. Utterback (1974) affirms this point with his observation that product innovations are not just about increased productivity but are creative reactions to competitive and technological challenges. Furthermore, a widely-adopted definition of innovation is offered by the Organisation for Economic Co-operation and Development (OECD) (2005). It submits that:

> *"An innovation is the implantation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations"* (p. 46).

The OECD's definition emphasizes two fundamental factors: Firstly, that innovation is the implementation of something (a key distinction between innovation and invention), and secondly, that what is being implemented is new in its current form. Indeed, identifying what is new is essential for distinguishing innovation from mere change (Slappendel, 1996). However, novelty alone does not constitute innovation; it instead represents invention. To transmute from a mere invention to an innovation, Egbu (2001) points out that the new idea (service, process or product) must be successfully exploited in the marketplace. To this end, Egbu (2001) posits that an innovation is the "successful exploitation of an idea, where the idea is new to the unit of adoption". A number of authors echo this view (Thornberry, 2001; Pinchot, 1985), thus confirming that without the presence of some form of entrepreneurial activity to

exploit opportunities as they arise within organisations, innovation remains little more than an aspirational destination, rather than a tangible one.

2.3. Economic Crisis

Several environmental variables impinge on firms' capacity to innovate constantly. One of the environmental variables that hamper innovation is economic crisis. Findings from previous studies confirm that economic crises negatively impact organizations' ability to innovate (Archibugi et al., 2013a; Paunov, 2011). Indeed, Grant (2003) argues that the increased volatility in an organization's external environment (as frequently witnessed during economic crisis) often makes systematic strategic planning – a key step towards innovation - more challenging.

Most global economic crises recorded so far fit in with what Taleb (2007) describes as "Black Swans" – highly improbable events. He argues that to qualify as a "Black Swan", the event first has to be an outlier, "…as it lies outside the realm of regular expectations". Secondly, it must carry an extreme impact. Thirdly, despite its status as an 'outlier', "…human nature makes us concoct explanations for its occurrence after the fact, making it explainable and predictable". The present study views economic crisis as a period of economic recession characterized by negative GDP growth lasting at least two consecutive quarters. This excludes periods of slow but not necessarily negative economic growth which can be referred to as economic stagnation. These periods are characterized by the overall shift in many macroeconomic indicators, including falls in real output (determined by GDP), hyper-inflation, a high unemployment rate, negative alterations in demands for goods and services, and an unstable currency (Grewal & Tansuhaj, 2001).

3. EFFECTS OF ECONOMIC CRISIS ON INNOVATION - FACTORS AT PLAY

Although, the Schumpeterian economists are quick to point out that economic crisis can be a source of opportunities for entrepreneurial firms (Anthony & Feinzaig, 2008), there is, however, little or no doubt that economic crisis is often of huge concern to organizations (Grewal & Tansuhaj, 2001). These fears stem from the often-deleterious impacts economic crises have on organizations. A review of literature reveals the following as effects of economic crisis on organizations: Shrinking demand levels for products and services (OECD, 2012; Bricongne et al., 2010; Barlevy, 2007), increased operating costs (Gilchrist et al., 2017; Wang et al., 2014; Higgins, 1977), increased difficulties in accessing credit (OECD, 2012; Lerner & Tufano, 2011; Aghion et al., 2008), and declining revenue and profit levels (Donald et al., 2014; Kalemli-Ozcan et al., 2013; Pavlínek, 2015). These identified effects of economic crisis on construction-based firms are briefly discussed below.

3.1. Shrinking Aggregate Demand for Products

The OECD (2012) points out that economic downturns can reduce the demand for innovative products because they are often more expensive, as well as for durable products. The reason for this is that the acquisition of these products can often be deferred. The constructed product is a classic example of an expensive and durable product the purchase of which can be deferred during economic crisis. The OECD (2012) further notes that this could in effect mean "…fewer internal resources available to cover operational expenses"; hence, funding regimes for product research and development endeavours are often interrupted.

3.2. Increased Difficulties in Accessing Credit

Financial institutions are often at the centre of systemic economic turbulence as liquidity

usually dries up during downturns (Tong & Wei, 2010; Cornett et al., 2011; Malherbe, 2014; Diamond & Rajan, 2005). Indeed, "the volume of venture financing varies with the business cycle" (Schoar, 2005 cited in OECD, 2012). The point here is that failure in credit markets may get worse as lower cash flows mean firms have less collateral (Bernanke & Gertler, 1995). Consequently, "…investors have fewer resources to allocate across investment projects" (OECD, 2012). This often implies that firms often have to deal with a significantly constrained resource base, often causing instability in funding and funded regimes.

3.3. Increased Operating Costs

Aibinu and Jagboro (2002) point out that most construction materials and equipment utilized in Nigeria are still being imported. Mansfield et al. (1994) agree that not only a significant proportion of construction materials but also human resource and equipment are imported into Nigeria. They add that this has enormous cost implications for construction firms, especially when clients are not willing to accept increased costs passed to them in the form of increased price. A key effect of the 2015-2017 economic crisis in Nigeria was the substantial decline in the value of the naira against the dollar and other major foreign currencies. For instance, the official naira/dollar exchange rate as at April 2017 stood at $1/N366 as against $1/N190 less than two years previously (OANDA, 2017). The exchange rate on the more accessible parallel market was $1/N400 at this point. Since most imports are valued in foreign currencies (especially dollars), this meant increased costs for local construction-based firms. As with most economic crises Nigeria has witnessed in the past, the rate of inflation increased significantly. Nigeria's National Bureau of Statistics puts the CPI for February 2017 at 17.78% year on year. Again, this leads to increases in the operating costs of construction-based firms in Nigeria.

3.4. Declining Revenue and Profit Levels

Several factors as triggered by economic crises converge to cause a decline in firms' revenue and profit levels. The key contributory factors for this as identified from literature are the declining demand for products (OECD, 2012), the increase in operating costs (Gilchrist et al., 2017) and the non-payment or delays in the payments for projects as specified in contract terms (Ode & Battaineh 2002; Mansfield et al., 1994). Firms' reaction to this is often one of prioritizing survival over growth (Anthony & Feinzaig, 2008). The works of Donald et al. (2014), Kalemli-Ozcan et al. (2013), Pavlínek (2012), and Opler and Titman (1994) conclude that firm-level revenues and overall financial performance decline during economic crisis.

3.5. Summary of Literature Review

It was established through a review of related literature that a positive correlation exists between sustainable developments and continuous innovations in the construction industry. This work further noted that economic crisis hampers continuous innovation and thus sustainable developments in construction industry. To better understand the specific factors at play in this regard, this study further investigated the effects of economic crisis on construction-based firms and how these specific effects impact innovations within the organizations. The validity of the identified factors as discussed in this section was later tested empirically. This will be fully discussed in the next section.

4. RESEARCH STRATEGY AND CASE SELECTION

A case study strategy was adopted to investigate the effects of economic crisis on firm-level innovation implementations. The specific factor(s) responsible for constraining innovation implementation during economic crisis was selected as the unit of analysis within

the boundaries of construction contractors that were innovative prior to the onset of the 2015-2017 economic crisis in Nigeria. Accordingly, five case studies were selected for this study. Yin (2003) advises that in multiple case study design, case selection should be done to purposefully predict similar results or contrasting results for predictable reasons. Silverman (2001 cited in Kulatunga et al., 2011) identifies a slight variant of theoretical sampling which he terms "purposive sampling", where the "…purpose behind the case selection is not theoretically defined". This "purposive approach" in case selection allows the researcher to select cases that demonstrate characteristics in which they are interested. The author recognizes the value of theoretical selection of cases rather than the statistical or random selection and contends that for this investigation that focuses on the effects of economic crisis on firm level innovation implementations, it was necessary to select cases from a wider context where economic crisis is present and at the same time, where innovation was present before the onset of the economic crisis (Kulatunga et al., 2011). Furthermore, consideration was given to construction contracting firms that were top players in the local construction industry. The rationale for this was the established relationship between innovativeness and market leadership (Hu, 2014).

4.1. Case Study Descriptions

This section discusses the five (5) construction contracting firms that provided the boundaries within which the study was conducted. These construction firms all have significant presence in Abuja, Nigeria and together account for over 50% of public-sector related construction projects currently being implemented in Abuja. More importantly for this study, the 5 construction contractors were innovative prior to the 2015-2017 economic crisis in Nigeria. These 5 construction contractors are coded as CS1, CS2, CS3, CS4, and CS5 and are briefly discussed below.

4.1.1. Case study 1 (CS1)

Founded in Egypt in 1955, CS1 is one of the leading construction companies in the Middle East and Africa with over 77,000 employees globally. Around 5000 of these employees are in Nigeria, including around 100 expatriates who are mostly from Egypt. Their areas of expertise include public buildings, bridges, roads, airports, tunnels, water and sewage systems, power stations, and ship building. Over 95% of its clientele in Nigeria is public sector related. Its global head office is situated in Cairo, Egypt.

Prior to the commencement of the 2015 – 2017 economic crisis in Nigeria, CS1 was implementing innovative solutions that were often focused on saving money and time and enhancing the overall project performance. For instance, CS1 introduced a cloud collaboration system allowing for the remote sharing of data on a construction site in real time. This innovation digitised the design process on construction projects and allowed for better collaboration between architects and engineers.

4.1.2. Case Study 2 (CS2)

Established nearly 40 years ago, CS2 is rated among the top construction firms in Nigeria, with a staff strength of around 3000 employees, including over 80 expatriates most occupying top technical and management positions. Among the projects executed by CS2 are several housing estates, bridges, flyovers, highways, and airport runways. Nearly 100% of its clientele is public sector related. Its vision is to be amongst the top construction organizations working in the Middle East and Africa within the next five years.

Before the 2015-2017 economic crisis in Nigeria, CS2 pioneered the use of predictive software in the construction process. This innovation aided the integration of a vast number of distinct structural parts to achieve building designs, while at the same time complying with

extant regulatory requirements. The key merit of this innovation was the improvement in structural integrity of projects executed and quality standardization.

4.1.3. Case Study 3 (CS3)

CS3 is a multinational engineering and services group that includes over 30 semi-autonomous companies operating within the public and private sector. It has about 20,000 employees globally and over 6000 employees in Nigeria. CS3 retains ownership of equipment and machineries worth over N30 billion (2016 estimates). Its mission is to continuously embrace new ideas and learn continuously. 0ver 90% of its current client base (2017) is public sector related.

Prior to the onset of the 2015 - 2017 economic crisis in Nigeria, CS3 introduced the computer-generated design. This innovation enabled CS3 to produce project designs with minimal human input and thus, helped to achieve quality standardization.

4.1.4. Case Study 4 (CS4)

CS4 is a transnational construction and development group with subsidiaries in several countries. Its first foray into Nigeria was in 1956. Some of the notable construction projects CS4 has executed in Nigeria include the Obafemi Awolowo University, Ile Ife (this remains Nigeria's most beautiful university), hotels, offices, embassies, commercial and residential properties, industrial schools, hospital buildings, various regional water projects, major highways, urban and rural roads, as well as bridges and runways for major airports in Nigeria. CS4 currently employs over 4000 individuals, with expatriates forming a large portion of top management. About 90% of its client base is public sector related.

Before the 2015 - 2017 economic crisis in Nigeria, CS4 pioneered the adoption of laser scanning technology in Nigeria's construction industry. This enabled CS4 to produce a 3D map of project sites and structures. A key benefit of this innovation was that it eliminated incidents of design errors often associated with traditional surveying methods.

4.1.5 Case Study 5 (CS5)

CS5 was established in 1988. It has over time become one of the largest infrastructure and construction companies in Nigeria. It currently has over 3000 employees in Nigeria, including over 100 expatriates, mostly Israelis. CS5 is experienced in all areas of civil engineering construction such as roads, bridges, office buildings and residential buildings. Over 95% of its clientele is public sector related.

Prior to the onset of the 2015 - 2017 economic crisis in Nigeria, CS5 adopted innovative just-in-time practices in terms of raw materials ordering, forecasting and storage. This ensured that the right type and amount of raw materials were supplied at the right time. This enabled CS5 to maintain a balanced level of inventory at all times without ever having too much or too little product in stock.

4.2. Data Collection and Analysis

This study utilized semi-structured interviews as the principal instrument of data collection because of its usefulness in enabling exhaustive empirical investigations. Open-ended interviews were preferred to maximize the "…possible extent to which interviewees were free to express their views" (Kulatunga et al., 2011). The interviews focused on the themes identified from literature with emphasis on "…what and how events unfolded" from the construction contractors' perspective. Nevertheless, care was taken to ensure that the emergence of new themes or ideas was not restricted. Two key management level professionals were interviewed in each of the five construction contractors. To ensure accuracy, interview transcripts were tape-recorded and manually transcribed.

Table 1. The Participants' Assigned Codes, Roles of the Interview Participants and Interview Duration

Organisation	Assigned ID	Profession	Role	Interview duration
CS1	CECS1	Civil Engineer	Chief Engineer	47 mins
CS1	COOCS1	Project Manager	Chief Operating Officer	49 mins
CS2	HPDCS2	Architect	Head, Project Design	60 mins
CS2	GPMCS2	Estate Manager	General Project Manager	55 mins
CS3	GMOCS3	Quantity Surveyor	General Manager, Operations	62 mins
CS3	PMCS3	Project Manager	Project manager	45 mins
CS4	MDCS4	Chief Architect	Managing Director	50 mins
CS4	PMCS4	Structural Engineer	Project manager	45 mins
CS5	SMRDCS5	Architect	Senior Manager, R&D	48 mins
CS5	HOCS5	Surveyor	Head, Operations	52 mins

The qualitative data obtained was analyzed using thematic coding and cognitive mapping of the transcribed data. Thematic coding of transcribed data enabled the researcher to identify themes from dataset and label them under distinct names (Bernard, 2000). Cognitive mapping was utilized to organize and analyze concepts and to establish causal relationships between themes (Kulantunga et al., 2011). To obtain a structured and complete list of thematic codes, a combination of both deductive (generation of themes with the support of literature and assigning relevant concepts from a set of data) and inductive coding methods (generation of themes from the data itself) was adopted (Kulantunga et al., 2011).

The analysis of the qualitative data obtained was supported by NVivo 23 – computer-aided software. To perform the analysis, the interview transcripts were uploaded to the NVivo 23 software and carefully scrutinized with the aim of identifying ideas related with specific factors that constrain innovation implementation during economic crisis. As can be seen in Figure 1 below, identified concepts were subsequently assigned a unique code to reflect the specific factor at play. Subsequently such identified concepts were assigned with a code to reflect the effects of economic crisis from the construction contractors' perspective and how these effects impact innovation implementation (refer to Figure 1 for the NVivo structure). Having labelled the main codes related to the research questions using NVivo software, they were imported to Decision Explorer software to generate cognitive maps for each identified effect of economic crisis on construction contractors and for each identified impact on firms' levels of innovation implementation.

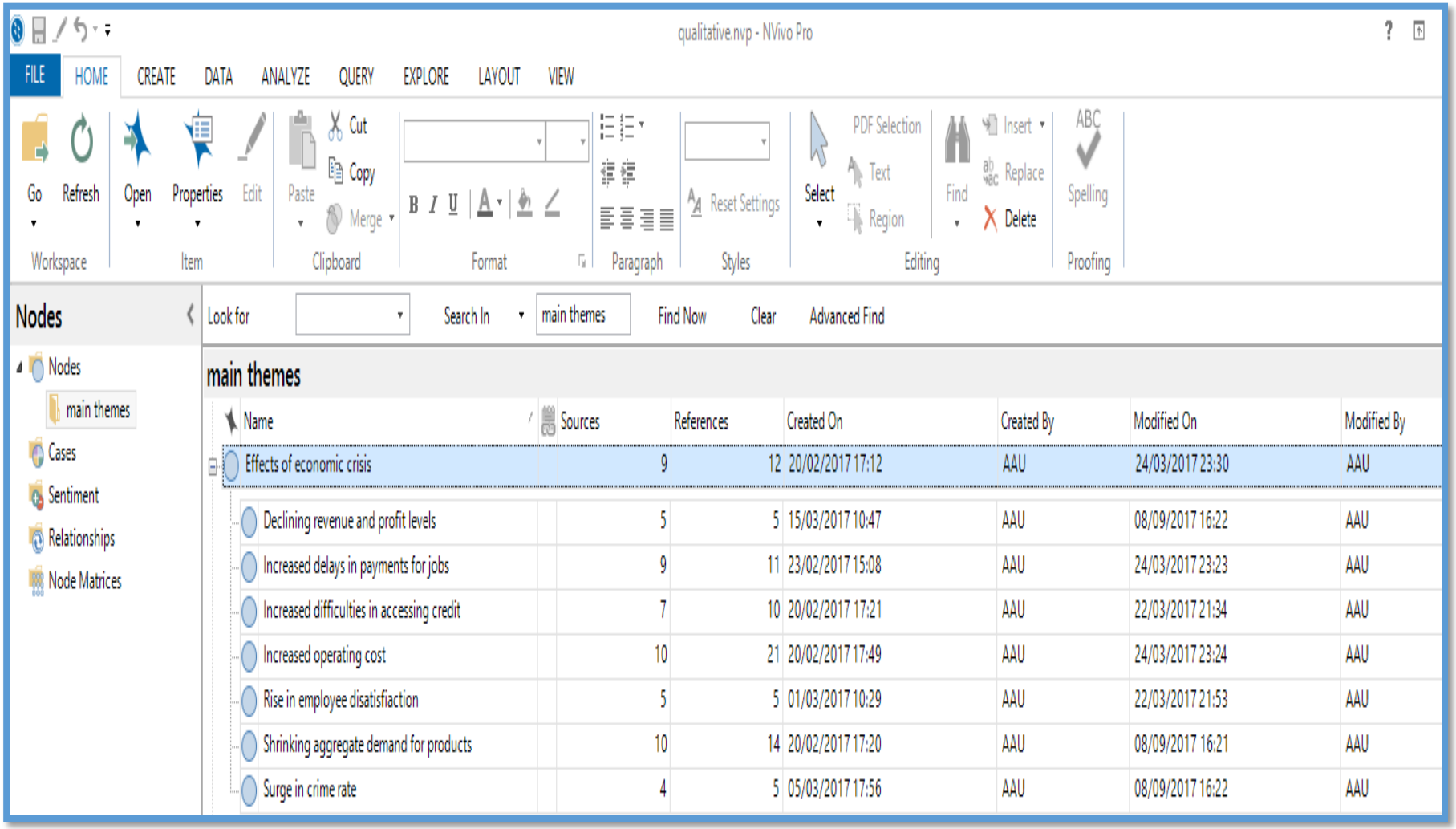

Figure 1. Codes in NVivo for the Thematic Synthesis

5. RESULTS AND DISCUSSION

To sufficiently address the research problem, this study articulates a key research question as follows: What are the effects of economic crises and how do these impact firm level innovations? This research question is explored from a construction contractor's perspective.

5.1. What are the effects of economic crisis and how does this impact firms' levels of innovations?

To further investigate the key effects of economic crisis, this study obtained empirical data from 10 key management level employees of 5 market-leading construction organizations based in Abuja. All 10 semi-structure interview participants offered their views on the key effects of economic crisis are for their respective firms. The results of the analyzed qualitative data as presented in Table 2 below reveal that all the 10 (100%) semi-structured interview participants unanimously cite 'shrinking aggregate demand for the constructed product' and 'increased operating costs' as key effects of economic crisis on their respective firms. Also, as can be seen in Table 2 below, 9 (90%) of the 10 semi-structured interview participants indicate that 'increased delays in payments for completed jobs' is a key effect of economic crisis on their organisations, while 7 (70%) participants identify 'increased difficulties in accessing credits' as a key effect. In addition, 5 (50%) participants report that 'declining revenue and profit levels' is a key effect of economic crisis. Similarly, 5 (50%) of the 10 individuals that participated in the semi-structured interview cite a 'rise in employees' job dissatisfaction' as a key effect, while four 4 (40%) participants report that a 'surge in crime rate' is a key effect of economic crisis on their respective organisations.

Table 2. Results of the Semi-Structured Interview regarding the Key Effects of Economic Crisis on Construction Contractors

Key effects of economic crisis on construction contractors	No of organisations = 5 Total No. of participants = 10		Ranking based on number of responses
	No of responses	Percentage (%) Response	
Shrinking aggregate demand for products and services	10	100%	1
Increased operating costs	10	100%	1
Increased delays in payments for jobs completed	9	90%	2
Increased difficulties in accessing credits	7	70%	3
Declining revenue and profit levels	5	50%	4
Rise in employees' job dissatisfaction	5	50%	4
Surge in crime rate	4	40%	5

The above highlighted effects of economic crisis as identified in literature and from empirical data are discussed descriptively in the next sub-sections.

5.1.1. Shrinking Aggregate Demand for the Constructed Product

As discussed in section 2.4.1 above, this factor was identified from literature as a key effect of economic crisis with substantial implications for firms' ability to continue with innovation implementation. As presented in Table 2 above, all 10 (100%) interview participants accept that the number of construction jobs being put out had been significantly reduced. For instance, CECS1 reports that:

"There are fewer jobs now than ever before. The reason being that because of tighter budgetary situations, our clients (mostly public-sector organizations) are approving fewer projects for execution".

Similarly, HPDS2 observes that:

"*Most of the jobs we do like most other top local construction contractors are public sector related. However, because of the squeeze in public finances, there is currently a significant reduction in the number of jobs being put out for bidding".*

Furthermore, the result of the analysed data gathered from sighted documents (job orders and schedules) in all the 5 construction contractors that were empirically investigated clearly indicate that job orders significantly reduced during the current economic crisis. In the case of CS3, job order documents sighted reveal that when compared to the pre-crisis demand level, the reduction in public sector related demands was over 80%. Therefore, findings from analysed empirical data on this theme lend credence to the conclusion reached in the works of OECD (2012), Bricongne et al. (2010) and Tambunan (2000) that economic crisis often causes a reduction in the demand for durable products whose purchase can be deferred. The key reasons for this as adduced by economists are (i) drop in consumer confidence (Zurawicki and Braidot, 2005) and; (ii) liquidity dry-ups (Malherbe, 2014, Cornett et al., 2011).

5.1.2. Increased Difficulties in Accessing Credit

This factor was identified from literature and discussed in section 2.4.2 above and further empirically investigated. Results of the analyzed interviews data as presented in Table 2 above indicate that 7 (70%) of the 10 interview participants report that their respective organisations experienced increased difficulty in accessing bank loans or other forms of credit. In fact, a good number of them narrate their respective firms' inability to maintain a stable funding regime because of difficulties in accessing credit. For instance, COOCS1 remarks that:

"It has been extremely challenging to access credits from commercial banks. In fact, most of our credit lines with commercial banks were withdrawn and we have had to devise other creative ways to access the much-needed fund to continue innovation implementations".

COOCS1 adds that:

"There are fewer jobs now than ever before. The reason being that because of tighter budgetary situations, our clients (mostly public-sector organizations) are approving fewer projects for execution".

The above viewpoint is further echoed by GPMCS2. He notes that:

"*It has become almost impossible to get financial help from the local banks. Their interest rates and charges have gone through the roof. As pointed out earlier, we found it almost impossible to access funds from the banks or from other institutions".*

Therefore, the results that emerged from the analyzed literature and interview data relevant to this theme suggest that increased difficulty in accessing credit and loans from banks and other financial institutions is a key effect of economic crisis for construction contractors based in Abuja Nigeria.

5.1.3. Increased Operating Costs

This factor as identified from literature (see section 2.4.3) was further empirically interrogated. The result of the semi-structured interview as presented in Table 2 indicate that all 10 (100%) interview participants agreed that increased operating cost is a key fallout of the current economic crisis. For instance, COOCS1 remarks that:

"There is a significant increase in the prices of raw materials. High rate of inflation is the reason for the hike in the prices of locally sourced raw materials while the crash in the value of the naira is the reason for the spike in the prices of imported materials. These increases have led to increases in our costs".

Likewise, MDCS4 remarks that:

"Our operating costs have gone up quite significantly. There are so many reasons for this. Firstly, we source for most of our machineries, equipment, materials abroad. A good number of our employees are expatriates who are paid in dollars. The current dollar rate is terribly high. In fact, we cannot source for forex via the official rate so the only option is the parallel market which is so high. These all translate into additional cost for us".

Therefore, finding that emerged from the empirical investigation of this theme corresponds with a key literature position on this (Gilchrist et al., 2017; Wang et al., 2014). The works of Gilchrist et al. (2017), Wang et al. (2014) and Higgins (1977) find that inflationary pressures that often characterize economic crisis impact negatively on the operating costs of firms. In fact, the work of Higgins (1977) poses an instructive question; "How much growth can a firm afford?"

5.1.4. Declining Revenue and Profit Levels

Results obtained from the analysis of semi-structured interview data as presented in Table 2 above show that 5 (50%) of the 10 interview participants report that declining revenue and profit levels is an adverse effect of the current economic crisis. For instance, GMOCS3 narrates that:

"*The high operating cost coupled with the significant decrease in the number of jobs being put out mean our revenue levels have gone down as well as our profit levels".*

Similarly, SMRDCS5 recounts that:

"Our revenues have actually gone down quite substantially".

PMCS4 corroborates the above views with his remark that:

"Our revenues have dried up. We are just managing to survive. We are now making huge losses".

The finding on this theme is consistent with the key literature position as discussed in section 2.4.4 above. The works of Donald et al. (2014), Kalemli-Ozcan et al. (2013), Pavlínek (2012) and Opler and Titman (1994) conclude that firm-level revenues and overall financial performance decline during economic crisis.

5.1.5. Increased Delays in Payments

This theme emerged from the analyzed interview data. Indeed, as presented in Table 2, 9 (90%) of the 10 semi-structured interview participants identify "increased delays in payments for jobs" as a key consequence of the current economic crisis and that this has a significant consequence for their respective firms' capacity to persist with innovations during economic crisis. They note that the extended delays in receiving payments for jobs carried out or even payment mobilization to commence approved projects have far-reaching implications for the turnaround time and overall cost of projects. PMCS4 remarks that:

"We are currently struggling to get some of our clients to make payments for jobs we had completed. Some of these jobs have been completed since 2015 and we are still asking for our

money. With the high inflation rate and crash in the value of the naira, these monies we are owed have depreciated in value".

SMRDCS5 corroborates the above views. He reports that:

"Payments for completed jobs are not being made in time. Fund mobilizations for new projects are equally not being advanced".

Results from analyzed data obtained from sighted documents and direct observations (calls made to chase up payments) appear consistent with the findings that emerged from the analyzed interview data that increased delays in payments for jobs completed is a key deleterious effect of economic crisis for construction-based firms operating in Nigeria. The reason for this is not far-fetched. Economic crisis often means lower public resources (OECD, 2012). The impacts of economic crises on Nigeria's construction industry have often been particularly telling, although this is not surprising considering that the government (federal and states) is by far the largest client of the local construction industry, accounting for over 60% of local construction orders (Ayangade et al., 2009). With a widespread paucity of funds, various levels of governments in Nigeria often have deferred payments for construction projects approved and sometimes completed and focus instead on what they consider as key priorities of governance.

5.1.6. Rise in Employees' Job Dissatisfaction

This factor emerged from the interview dataset. As presented in Table 2, 5 (50%) of the 10 semi-structured interview participants identified rising employees' dissatisfaction as a key negative effect of the current economic crisis. They argued that keeping employees motivated has become substantially more challenging during the period of economic crisis. PMCS4 points out that:

"*We know that some of our employees aren't as motivated as they were prior to this economic crisis for a number of reasons. As a result, their creativity levels have been impacted"*

while HOCS5 remarks that:

"Attracting and motivating knowledge employees is doubly more difficult during economic crisis".

It is noted that all five firms case studied had cut back on their employee numbers during the economic crisis period. In fact, CS4 reports a cutback of nearly 54% of their pre-crisis staff strength (from 26,000 pre-crisis employee levels to about 12,000 currently). Although, CS2's employee retrenchment affected just under 20% of its pre-crisis workforce, they did lose over 7000 of their workforce countrywide. This was the key reason adduced by interview participants as to why the level of employee dissatisfaction had risen. There is indeed substantial literature support for this finding. The works of Parvin and Kabir (2011) and Rosenblatt and Ruvio (1996) are instructive in this regard. As expected, employees who are satisfied with their job security perform better than those who are not satisfied with their job security (Rosenblatt and Ruvio, 1996, Rosow and Zager, 1985). Similarly, individuals satisfied with their job security are often more committed to their organizations (Iverson, 1996, Rosenblatt and Ruvio, 1996). Furthermore, the erosion in the value of the naira and the steep rise in inflation rate imply a drop in employees' real wages. Parvin and Kabir (2011) find a positive correlation between employees' remuneration and job satisfaction. Tan and Waheed (2011) conclude that there is a relation between salary and job satisfaction. They add that "…employees tend to be highly satisfied with their salary and job when they receive a desired raise". However, layoffs and lower wages could "…increase individuals' willingness to take

on greater risks and increase the availability of qualified labour during downturns" (Koellinger, 2008).

5.1.7. Surge in Crime Rate

This theme emerged from the empirical dataset. The analyzed results of the semi-structured interview as presented in Table 2 indicate that 4 (40%) of the 10 interview participants identify rising crime rate as a key effect of economic crisis and that this surge in crime rate bears implications for their respective firms' capacity to persist with innovations during economic crisis. They note the cost implication of putting in place additional security measures which were not needed pre-crisis. For instance, GPMCS2 argues that:

"Another problem I will like to point out is the steep rise in crime rate. In my opinion, this can be linked to the scorching economic situations with so many young people unemployed. A number of our employees have been kidnapped, and we have had to pay ransoms but then these incidents affected our operations".

Similarly, SMRDCS5 remarks that:

"*There is a noticeable increase in the crime rate locally. This has significant implications for our operations".*

Indeed, the internal documentations of 2 firms out of the 5 firms case-studied (security reports) reveal that these 2 firms were having to deal with a rising rate of property vandalism. In fact, a security report was cited in CS2 which shows that a member of their top management team had been kidnapped and ransom payments were demanded before his eventual release.

There is literature support for this identified effect of economic crisis (rising crime rate). The works of Deflem (2011),Gould et al. (2002), Walberg et al. (1998) and Box and Hale (1982) are instructive in this regard. They argue that adverse economic conditions can be a push factor for some criminal activities. However, there is currently no study on how the rise in crime rates impacts firms' levels of productivity and innovation implementation during economic crisis. This factor assumes greater relevance in the present study, not only because of the huge cost implications of ensuring the safety of employees, equipment and machinery but also the impact this has on the overall job satisfaction level of the large number of highly skilled expatriates who work for construction contractors in Abuja, Nigeria.

6. CONCLUSIONS

The effects of economic crisis are known to constrain innovation implementation (Archibugi et al., 2013b). This study finds that the seven factors as identified and discussed in section 3.1 converge to erode good organizational slack and cause instability in funding and funded regimes within an organization. The importance of maintaining good organizational slack (Nohria & Gulati, 1997) and stable funding and funded regimes (Ayyagari et al., 2011) to firms' levels of innovation have been noted. This study further reasons that the reduced appetite for risks by organizations during economic crisis as found in the work of Fernandes and Paunov (2015) could be linked with the erosion of good organizational slack.

Consequently, firms seeking to persist with innovations during economic crisis must first appreciate the limitations of their extant innovation management model and actively seek to design an innovation management approach that addresses the constraining factors that emerge during economic crisis. It is reasoned that this will place the firm in good stead to safely implement innovations during economic crisis. It is further articulated that it is only through implementing continuous innovations that construction industry practitioners can engage in development "…which meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).

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