Journal of Construction Project Management and Innovation Vol. 4 (S1): 912-932, 2014
ISSN 2223-7852

AN ASSESSMENT OF PROFESSIONALS' PERCEPTION OF THE SUSTAINABILITY PERFORMANCE OF INFRASTRUCTURE PROJECTS IN NIGERIA

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ABSTRACT

Construction activities lead to the provision of infrastructure. However, these activities have undesirable impact on the environment. Various management approaches have evolved to guide construction participants in achieving better sustainability performance of infrastructure project. However, methods for evaluating the sustainability performance of infrastructure projects across economic, social and environmental aspects are not covered in literature. This paper aimed to assess professionals' perception of sustainability performance of infrastructure projects in Nigeria. The research adopted a questionnaire survey of professionals in the Nigerian Construction industry. 100 questionnaires were distributed and a total of 72 valid responses were obtained and used in the analysis. The research found that sustainability performance of infrastructure projects in Nigeria fall between moderate performances to high performance. Some factors whose performance falls below a set standard and adversely affect sustainability performance include ozone protection, modular and standardised design, discharge of water. The study recommends that government policies which incorporate the assessment of proposed infrastructure across social, economic and environmental impacts should be formulated to improve sustainability performance of infrastructure projects.

Keywords: Built environment, Infrastructure projects, Sustainable development, Sustainability performance, Nigeria

1. INTRODUCTION

Sustainable development is commonly defined as a development that meets the needs of the present without compromising the ability of future generation to meet their own needs (World Commission on Environment and Development (WCED), 1987). According to the World Bank Group (2008), infrastructure assets are the most critical components for the sustainable development of emerging countries, as they provide their communities with the necessary conditions to reach their economic, social, and environmental goals. It is considered that the proper development and operation of infrastructure projects can contribute significantly to the mission of sustainable development (Hong, 2008).

Infrastructure project is a kind of public goods in which government policy has an important role to influence the impacts of project on economic development and social needs (Shen, Wu, & Zhang, 2011). They include a wide range of construction works such as power plant, highways, railways, rural and urban electrification, transport, telecommunication facilities, the provision of water and sanitation, and safe disposal of waste, housing, education and health facilities. The development and progress of human society subsist on physical infrastructure for distributing resources and services to the public (Organization for Economic Cooperation and Development (OECD), 2006; Akintayo et al, 2011). Thus, Infrastructure facilities provide foundation and play an essential role in contributing to economic growth, raising the quality of life and poverty reduction (World Bank, 1994; OECD, 2006).

While infrastructure projects make significant contribution to economic and social development, they cause less desirable consequence to the environment if they are not properly implemented (Hong, 2008). In the same vein, Miyatake (1996) observed that the mission of the construction industry is that of creating built environment better for humans, he however warned that in pursuing this mission, we should now seriously pay attention to the fact that, should we continue the practice of conventional construction through which the prosperity as well as the fate of our days has been built, this missions of ours would not be pursued sustainable into the next century and beyond. Meanwhile, literature is replete with proofs that the construction industry and its activities have significant impact on the environment (Kibert, 1994; Roodman and Lenssen, 1995; Hill and Bowen, 1997; Ofori, 2000; Du Plessis, 2002; Dania et al., 2007; and Ameh et al., 2010). For example, the use of water for construction purpose damage soil and reduce the amount of portable water available for industrial and household use (World Bank, 1994; OECD, 2001a; OECD, 2006).

Appreciation of this has led to several studies from different perspectives. For example, Choguill (1996) proposed principles for policy formulation in order to improve infrastructure sustainability through serving and cooperating with communities. Rackwitz et al (2005) introduced maintenance strategy for improving infrastructure effectiveness based on cost benefit analysis with focus on project performance during operation stage. Ugwu and Haupt (2007) proposed an indicator system for assessing infrastructure sustainability with focusing on project operation stage. Shen et al. (2004) noted that since project performance traditionally refers to the outcomes of construction cost, time, and quality; the identification of dynamic factors in the existing studies mainly concerns these three aspects. When the contents of project performance are extended to incorporating project sustainable performance, factors affecting project performance need to be reviewed. Hence, it therefore becomes a pressing issue to find ways for gaining better sustainability performance for implementing infrastructure work in developing countries (Hong, 2008).

2. THE CONCEPT OF SUSTAINABLE DEVELOPMENT

2.1. The Definition of Sustainable Development

The concept of sustainable development was contextually defined by the World Commission on Environment and Development as 'development which meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987), and this concept has been widely accepted by many firms, institutions and governments across the globe (Hong, 2008).

Since the 'Brundtland Report' on the World Commission on Environment, numerous definitions of sustainable development have been proposed. Research efforts made to define the concept of sustainable development can also be found extensively in other publications. For example, Liddle (1994) defines sustainable development as a 'constraint on present consumption to ensure that future generations will inherit a resource base no less than the previous generation inherited'. Lozar (1993) defines it as 'maximizing the use of natural resources for permanent construction and minimising environmental degradation over the life-cycle of the construction application'. Although a single and unique definition of sustainable development does not exist among these various studies, a clear understanding of the key features and principles of sustainable development is important.

2.1.2 The Principles of Sustainable Development

The terms "sustainability" and "sustainable development" are sources of confusion. They are sometimes used interchangeably. However, Du Plesis (2002) noted that if one considers the motivation behind the concept of sustainable development, these interpretations are misleading and incorrect. He however noted that the objective is to sustain the species homo sapiens (that is to support it and keep it alive) and put forward the relationship between the terms as follows; Sustainability is the condition or state which would allow the continued existence of homo sapiens, and provide a safe, healthy and productive life in harmony with nature and local cultural and spiritual values. It is the goal to be achieved. Sustainable development is then the kind of development we need to pursue in order to achieve the state of sustainability. It is a continuous process of maintaining a dynamic balance between the demands of people for equity, prosperity and quality of life, and what is ecologically possible. It is what needs to be done. According to Du Plesis (2002) to get this, it become necessary to achieve a measure of social and economic equity between individuals, as well as between communities, nations and generations. We have to find a way to equitably distribute wealth (in the form of access to resources and opportunities) and increase prosperity for all. This line of reasoning leads to the so-called three pillars of sustainable development – people (social development), the planet (ecological protection) and prosperity (economic development).

Sustainability has been conveniently divided into three constituent parts: economic, environmental and social sustainability. There has generally been recognition of the three dimensions of sustainable development (Harris, 2000; OECD, 2001a; WB, 2003).

3. AGENDA 21 FOR SUSTAINABLE CONSTRUCTION

The Agenda 21 (UNCED, 1992) endorsed in Rio in 1992 presents a comprehensive blueprint of action related to sustainable development, and puts forward the need to integrate environment and development at the policy, planning and management levels. As there is a growing interest in sustainable construction, many researchers have dedicated themselves to it. The Agenda 21 on Sustainable Construction is intended to be a global intermediary between those general Agendas in existence, i.e. the Brundtland Report and the Habitat Agenda, and the required national and regional Agendas for the built environment and the construction sector currently or in the course of development. The three principal objectives for this Agenda 21 for Sustainable Construction are:

- to create a global framework and terminology that will add value to all national or regional, and sub-sectorial agendas;
- to create an agenda for CIB activities in the field, and for coordinating CIB with its specialized partner organizations, and
- to provide a source document for definition of R&D activities.

4. EXISTING APPROACHES FOR PROJECT EVALUATION

4.1 Economic Analysis

Economic analysis or economic appraisal is an effective approach to evaluate the costs and benefits of projects, from society's viewpoint, in order to select the most beneficial investment from a range of options (Langston, 1999). It is commonly used in the public sector and generally applied to large-scale infrastructure projects. The costs and benefits include 'intangibles' that cannot easily be measured in monetary terms and 'externalities' that affect society as a whole. It seeks to assess the net benefits of alternative projects to society as whole rather than to a particular client or providing authority. It takes account of the preferences of individuals in the community by calculation of a single overall figure to indicate the net social benefits of the project. Economic analysis proceeds in four essential steps: (a) identifying relevant costs and benefits; (b) valuing costs and benefits; (c) comparing costs and benefits; and (d) selecting the project.

4.2 Financial Analysis

Financial analysis or financial appraisal is a technique for assessing the financial viability of projects from the perspective of an individual organisation. Financial analysis of competing project options will indicate the extent to which each project affects the financial objectives of the organisation. The financial viability of a project is essentially indicated by the extent to which the financial benefits associated with the project exceed financial costs over the useful life of the project.

The analysis procedures of financial evaluation include (1) identifying relevant costs and benefits; (2) valuing costs and benefits at market prices; (3) measuring the financial viability of a project; and (4) conducting uncertainty and risk analysis.

4.3 Life-Cycle Assessment

A life-cycle assessment (LCA, also known as life-cycle analysis, eco-balance or cradle-to-grave analysis) is the investigation and valuation of a project's multiple aspects, including cost and environmental performance, from the perspective of a project life-cycle. It is a variant input-out analysis focusing on physical rather than just monetary flows (Hong, 2008).Life-cycle assessment of project's environmental effect investigates the impact on the environment from raw materials acquisition through the manufacturing, use/reuse, maintenance, recycling and waste management activities, i.e. from cradle to grave (White et al, 1993, 1995). It addresses all environmental factors and their inputs at any stage (primarily energy and raw materials) and all outputs at any stage (release to air, water and land). These inputs and outputs are considered as burdens on the environment. These burdens are then assessed as environmental impacts. Conducting LCAs for alternative products or projects provides for comparison of overall and relative environmental impacts, the intention being to allow for the trade-offs associated with each option to be assessed, rather than merely identifying the best option.

4.4 Environmental Impact Assessment (EIA)

Environmental impact assessment (EIA) in developing a construction project is a process by which information about the likely effects of a development on the environment is assessed (Council on Environment Quality, 1978). The process includes predicting and evaluating the project's impact on the environment, with the conclusions being used for decision-making. EIA aims to prevent environmental degradation by giving decision-makers better information about the consequences that development actions could have on the environment (Thompson et al, 1997). EIA is an important tool, providing decision-makers with both quantitative and qualitative information and value judgments about the environment and therefore a better understanding of the consequences of their actions (Brookes and Pollard, 2001). The three stages of the Environmental Impact Assessment include screening, scoping and consideration of alternatives. The consideration of alternative solutions for improvements should be an essential element of the EIA process and has been described as 'the heart of the environmental impact statement (EIS) in the USA' (Council on Environment Quality, 1978).

Alternatives are usually identified by reference to the type and scale of the project, location and processes will be influenced by economic, technical or regulatory considerations, and EIA should ensure that environmental criteria are added to the list. The decision on the project thus take place in a true decision-making framework, rather than involving relatively minor decisions about the mitigation of a particular action on an ad-hoc basis. An effective approach to analysing alternative solutions in developing a construction project is provided by the World Bank (1996). A table or matrix can be used to summarise the information for each alternative, incorporating systematic approaches involving scaling, rating or ranking. If environmental and social impacts are broadly similar then technical or economic factors can be used for further analysis. More complex analysis may be required if a choice cannot be made using the matrix: for example, multi-attribute decision-making techniques, which incorporate the values of the key interested parties.

Various steps are involved, including identification of the entities to be evaluated (e.g. alternatives) and then the identification and structuring of environmental attributes (e.g. noise level) to be measured.

4.5 Social Impact Assessment (SIA)

Social impact assessment (SIA) for a project used to be considered a component of a broader Environmental Impact Assessment, but has increasingly become a separate exercise, either in parallel with EIA or on its own. SIA is a process that promotes openness and accountability, fairness and equity, and which defends human rights in the whole process of implementing an infrastructure project (Hong, 2008).

Whilst there are many different models for conducting the SIA process, particularly for large infrastructure projects e.g. (Finsterbusch 1980; Branch et al. 1984; Burdge 1994; Inter-organisational Committee, 1994), there are commonly considered to be basic elements, summarised as ten steps (Inter-organisational Committee, 1994). They include Public involvement; Identification of alternatives; Profile baseline conditions; Scoping; Projection of estimated effects; Prediction of responses to impacts; Estimate indirect and cumulative impacts;

Changes in alternatives; Mitigation and monitoring.

5. CURRENT DEVELOPMENT

Many countries have introduced new instruments/tools over the past few years in order to improve the knowledge about the level of sustainability in each country's building stock. On one hand, it can be argued that the individual characteristics of each country, such as the climate and type of building stock, necessitate an individual sustainability rating tool for that country. The downside is that to varying degrees the rating tools for different countries are constructed on different parameters (Reed et al. 2009).

5.1 Environmental Assessment Tools

The past few years have seen a significant increase in interest and research activity in the development of building environmental assessment methods. Existing assessment models consist of two types: (a) specific models that are focused on one particular aspect, e.g. energy performance; and (b) general models that aim to obtain an overall assessment of the environmental performance of buildings or building components (Hong, 2008).

Current researches in developed countries have focused on evaluation of project performance through the development of assessment tools, such as the Building Research Establishment Environmental Assessment Method (BREEAM) (BRE, 1998), Leadership in Energy and Environmental Design (LEED) which was introduced by the U.S Green Building Council (USGBC, 2001), Building for Environment and Economic Sustainability (BEES) tool and so on. Equally, in Nigeria, studies evaluating construction projects have been carried out, for example Owabukeruyele (1999); Ibrahim et al. (2010); Bala et al.(2008b); Nwafor (2006); Abelson (2005) and Essa and Fortune (2005). The methods include economic appraisal, environmental impact assessment, social impact assessment and life cycle analysis.

While they have proved to assess the performance of construction projects in individual dimensions including social, economic and environmental aspects, these approaches are often used in isolation (Hong, 2008).Hence, the typical weakness in these applications is that the method is often used in separation and distinctively. Emphasis on sustainable development is placed in the balance together with the project performance of social, economic and environmental sustainability (Shen et al. 2007; Ibrahim and Price, 2005). This implies that human activities for development must balance different objectives and seek synergies from different aspect (Hong, 2008).

The purpose of assessing sustainability performance is to provide sustainability information that facilitates adequate decision making toward sustainable development (Munda, 2003; Oscar et al, 2011). The absence of an integrative approach has led to multiple consequences. For instance, the implementation of some infrastructure projects leading to serious environmental pollution as a result of over-emphasis to meeting social needs and economic growth. Ugwu and Haupt (2007) in their study emphasize the need for developing countries to be able to assess the sustainability performance of their infrastructure project using economic, societal and environmental matrix. Against this backdrop, this study assessed sustainability performance of infrastructure project in Nigeria with a view to tackle sustainable development issues in a comprehensive manner within the context of construction.

6. CURRENT INTEGRATED SUSTAINABILITY FRAMEWORK

6.1 Use of a Multiple-Criteria Approach for Evaluating the Sustainability Performance of Construction Projects

Ding (2005) developed a multi-criteria decision analysis approach for the measurement of project sustainable performance. A model of a sustainability index as an evaluation tool that combines economic, social and environmental criteria into an indexing algorithm has been developed. The sustainability index uses monetary and non-monetary measures to rank construction projects in terms of their contribution to sustainability. This process enables the application of the principle of trade-offs to operate in the decision-making process and thereby allows environmental values to be considered when selecting a development option. Ugwu et al. (2006) used a multiple-criteria approach to evaluating the sustainability performance of infrastructure projects. In many countries, such as Austria, Belgium, Greece and Netherlands in the European Union, it is a requirement to integrate the objects of economic, social and environmental development into a multiple-criteria decision analysis approach when evaluating transport projects (OECD, 2001).The multi-criteria approach provides a structured way of taking into account large amounts of both quantitative and qualitative information required for the comparison of options. The approach has proved valuable in providing help and guidance to the decision-maker in discovering the most desirable solution to a decision problem where several, often conflicting, criteria must be taken into consideration (Belton and Stewart, 2002).

6.2 Difficulties in the Application of Evaluation Approaches for Assessing Project Sustainability

The above discussion present typical existing methods for evaluating project performance, including economic, analysis, financial analysis, environmental impact assessment and life cycle analysis. Whist these methods can help to assess the performance of construction projects in multiple dimensions such as social, economic and environmental aspects, the typical weakness in these applications is that the method is often used in separation. Emphasis on sustainable development is placed in the balance together with the project performance of social development, economic development and environmental sustainability. However, fragmentation in using these evaluation principles cannot bring cohesive result. Fragmentation in assessing a project can entail consequence whereby the implementation of projects, particularly infrastructure types such as highway, will cause serious environmental pollution due to the over emphasis given to meeting the needs of economic and social development. On the other hand, if the implementation of a highway infrastructure projects only aims at environmental goals, it may lead to loses of economic benefits. In other cases, a highway infrastructure project may aim only at improving economic efficiency in a particular region and may then run counter to objectives related with social equity and cohesion.

Keeping the evaluation techniques of economic, social and environmental performance brings about the independence of each aspect of the project appraisal, which is aimed only at one particular aspect. Separate appraisals may no doubt be preferred by decision makers who opt for more discretion in one aspect when making decision. However preferences for individual aspect often assumed without proper justification and thus mistaken decisions can result.

Separate evaluation of a project's economic, social and environmental performances is often conducted at different stages in time by different groups or specialist without sufficient exchange of information. Different project participant often practice their management activities and emphasize their individual viewpoints in isolation. Lack of coordination and less consideration of the relationships between these aspect increase the risk of omission or overlap, and often result in adversarial relationships among various construction and management participants when the project is implemented, making it difficult for the different project stakeholders to act in unity to improve project performance in practice. This is echoed in previous studies (Scholten and Post, 2002).

In conclusion, the discussion that relates to the use of multi-criteria approach for evaluating sustainability performance of infrastructure projects(in Section 2.7.1) of this chapter has also pointed out that the use of a multi-criteria approach can give cohesive consideration between environmental, social and economic dimensions when project performance is evaluated. And there are several methods available for this purpose. However, as Hong (2008) pointed out, one major weakness in applying such methods is that they do not consider the impact of dynamic interactions between various factors which affect the project performance over time. There are various uncertainties in the whole process of implementing a project, such as a highway infrastructure, and it is important to consider these dynamic factors in appraising the project performance.

The identification of the critical issues affecting performance and the understanding of their relationships is most important in conducting proper performance evaluation. Therefore there is a need for an appropriate measure in conducting infrastructure project assessment by taking into account various issues. The use of this evaluation approach is particularly important for large-scale infrastructure projects involving very substantial investment and a long period of construction and operation. Perhaps the contribution that that this work offer through the use of this approach can not only consider collectively all project performance dimensions - economic, social and environmental concerns - but also identify the sustainability issues that affects infrastructure across its life cycle.

7. RESEARCH METHOD

The research adopted a quantitative approach using a project sustainability performance checklist that was developed by Shen et al (2007) to assess sustainability performance of infrastructure in Nigeria. The framework set out in form of a checklist provides one with a means of assessing sustainability performance against identified Economic sustainability factors (ESF), Social sustainability factors (SSF) and Environmental sustainability factors (EnSF) and is meant to comprehensively capture project throughout a complete life cycle. Given each phase of completed infrastructure project, each sustainability dimension (economic, social and environmental) on the checklist has a number of indicators which were required to be measured on a five point scale. Using a structured questionnaire, respondents were asked to indicate on a 5-point likert scale, their assessment of sustainability performance of the infrastructure projects they have been involved with.

Using a simple random sampling procedure, the questionnaires were administered to construction industry professionals in Federal Capital Territory, Abuja, Nigeria.. Following the examples of Xiao (2002) and Nwokoro and Onukwube (2011), the sample frame is the total number of practicing professionals in the built industry in Abuja. The region was selected on the premise that it is one of the fastest growing capital and cosmopolitan city with vast construction activity and construction professional as established by Dada (2005) and Oladapo (2006). The influx of people has also brought about increased infrastructure demand.

7.1 Determination of Sample Size

To ensure adequate representation of information collected, the sample used in this survey was drawn primarily from the directories of professional organisations in the federal capital territory-Abuja. A total of 5740 practicing professionals registered with their respective professional bodies were however obtained. Because it was impractical to collect data from all these professionals in the population, sampling was necessary to make the survey possible. In order to determine a suitable size for the sample, the following formula from Czaja and Blair (1996) and Creative Research Systems (2003) was applied:

$$N = \frac{Z^2 \times P\ (1-P)}{C^2}$$

Where: N = sample size, Z = standardised variable, P = percentage picking a choice, expressed as a decimal, C = confidence interval, expressed as a decimal.

As with most other research, a confidence level of 95% was assumed (Munn and Drever, 1990; Creative Research Systems, 2003). For 95% confidence level (i.e. significance level of $\alpha = 0.05$), $z = 1.96$. Based on the need to find a balance between the level of precision, resources available and usefulness of the findings (Maisel and Persell, 1996), a confidence interval (c) of ±10% was also assumed for this research. According to Czaja and Blair (1996), when determining the sample size for a given level of accuracy, the worst case percentage picking a choice (p) should be assumed. This is given as 50% or 0.5. Based on these assumptions, the sample size was computed as follows:

$$N = \frac{1.96^2 \text{ x } 0.5\ (1 - 0.5)}{0.1^2} \qquad N = 96.04$$

The sample size is now approximately 94. To make a round figure and ensure optimal result from the professionals identified, 100 questionnaires were administered.

7.2 Method of Analysis

Each of the sustainability factors (economic, social and environmental) is measured by a number of performance indicators. One consideration in selecting a proper method for analysis is that it should not give rise to rather heavy computations and complex algorithms in the assessment exercise. For this purpose, a 'Weighted Summation or mean' method, which is one of the simplest multi-criteria evaluation methods, is adopted to calculate the values of sustainability performance (Hong, 2008).Weighted mean represent the statistical technique used to determine the average responses of the different options provided in the various parts of the survey questionnaire used. The method is used in conjunction with the Likert Scale.

The following were used as the basis for interpretations of the computed weighted mean.1.00 – 1.50 Poor performance; 1.51 – 2.50 Low performance; 2.51 – 3.50 Moderate performance; 3.51 - 4.50 High performance; 4.51 - 5.00 Very high performance.The responses from experts enabled the calculation of average responses (weighted mean) of the different options provided. Furthermore, both the reliability and validity of the survey data were checked. The test for reliability is important because they form the basis of the adequacy of the information from the questionnaire survey. In general, reliability is estimated by examining the consistency with which the respondents express their rating(Shen, Wu, & Zhang, 2011). The inter-rater reliability (IRR) test became necessary as it provided a way of quantifying the degree of agreement between the respondents who make independent rating of the factors. In this study, the Cronbach's alpha coefficient method was used to test the reliability of the classification the factors presented for assessment. A previous study suggests that a value of Cronbach's alpha of 0.7 or higher normally indicate a reliable classification (Ceng and Huang, 2005).

8. RESULTS AND DISCUSSIONS

8.1 Characteristics of Respondents

A total of 100 questionnaires were administered to respondents in government establishments, contracting organisations, consultancies and professionals in private practice. The questionnaire is divided into two sections; the first section of the questionnaire relates to the demographic background of the respondents while in the second section respondents were required to indicate their perception of the sustainability performance of the infrastructure projects that they have been involved in the pastby ticking any of the scale of 1-5, 1 being poor performance and 5being very high performance. Table 1 shows the breakdown of the respondents by profession and responses received from respondents.

Table 1: Response to survey by profession

Respondents	Distribution	Responses	Percent
Architects	20	16	22.22
Builders	20	14	19.44
Quantity Surveyors	20	20	27.78
Engineers	20	12	16.67
Others	20	10	13.89
Total	**100**	**72**	**100.00**

Table 2: Qualification of Respondents

Qualification	Number	Percentage
HND/B.Sc only	12	16.67
HND/B.Sc plus relevant professional qualification	41	56.94
Postgraduate Qualification	19	26.39
Total	**72**	**100.00**

From table 2, at least 56% of the respondents had a first degree and professional qualification while about 26% had post graduate qualifications. About 36% (26) of the respondents have had over 21years of work experience in the construction industry and about 52% have work between 11 to 20 years. This lends credibility to the response generated in this survey.

8.2 Respondents' Response on the Infrastructure they have specialised in

The different range of infrastructure on which respondents based their assessment include power supply, highways, railways, rural and urban electrification, telecommunication, housing and urban development, education, health care facilities, airports/ports, water supply resources, integrated infrastructure and others. The result shows 44 (61%) have been engaged in connection with housing and urban development, 9 (12.5%) respondents linked their assessment to integrated infrastructure project the rest 26.5% were spread across other infrastructure. Though the study is carried out to assess infrastructure projects, the result here indicate that more implication can be drawn with reference to housing and urban development.

8.3 Respondents' assessment of sustainability performance of infrastructure projects

The study covers majorly knowledge acquired by professionals on completed infrastructure project with respect to their sustainability performance in Nigeria. Built industry professionals‟ perception is assessed in order to make an empirical judgment on sustainability performance of infrastructure.

Respondents‟ indicated their perception on the sustainability performance of the infrastructure projects that they have been involved with in the past forms the basis for analysis and these were collated and harmonised (Table 3). Furthermore, the responses on housing and urban development were considered being the most prevalent sector that the respondents were engaged in.

The table shows the weighted mean (W.M), standard deviation (S.D), ranking(R) and the performance of the factors. The table shows that the weighted means of the respondents‟ perception of the degree of sustainability performance of infrastructure projects falls between 3.86 and 2.85. From the categorisation of the weighted mean given in chapter three, this indicates that all the factors of sustainability performance of infrastructure have been adjudged to perform either moderately or high. The dispersion of values about a central value, i.e., the weighted mean, permits an assessment of the strength of the collective respondents‟ perceptions, thus, as indicated by Tastle et al. (2005) a collective set of ordinal scale values that yield a narrow dispersion can logically be viewed as possessing a greater agreement. The low values for standard deviation indicate a high degree of consistency in respondents‟ opinion.

Table 3: Assessment of sustainability performance of infrastructure projects (Inception Phase)

Project Inception Phase					
ESF – I		.M	.D	nk	Performance
Supply and demand	Evaluating local, regional, national, and even global market supply and demand of similar products/projects and in the future current	.58	835	2	High
Marketing forecast	Predicting market size, pricing, marketing strategies, and marketing targets	3.43	.932	1	Moderate
Scale and business scope	Project scale and the business scope during project operation are essential attributes to the project profitability	3.67	.787		High
Effects on local economy	A project should serve both the local economy and take advantage of the infrastructure in the local economy to generate economic benefits	3.78	1.01		High
Life cycle cost analysis	Analysis should not be given to elementary but total cost for building-up, operating, maintaining, and disposing a construction project over its life	3.60	1.00	1	High
Life cycle profit analysis	Analysis should not be focused on stage or sectional profits but the total profit from operating a construction project across its life cycle	3.72	.923		High
Capital budget	Capital budget should be defined to planning and controlling project total cost	3.61	.943	0	High
Finance plan	Defining and planning project finance schedule, for example, when, how, and how much to finance	3.60	1.04	1	High
Investment plan	Arrangement of fixed and liquid capital for investment, and a cash flow plan at project inception stage	3.69	.922		High
SSF – I					
Land use	Considering that the land selection for project site should protect cropland and natural resources	3.51	.872	6	High
Conserving cultural heritage	Avoiding negative impacts from project development on any cultural heritage	3.49	.919	8	Moderate
Employment	Project implementation should be able to provide local employment opportunities	3.74	.964		High
Infrastructure capacity-building	The project improves local infrastructure capacity, such as drainage, sewage, power, road, and communication, transportation, dining, recreation, shopping, education, financing, and medical	3.44	1.01	0	Moderate
Community amenities	Provision of community amenities for the harmonization of new settlements and local communities	3.42	1.03	2	Moderate
Safety assessment	Assessment should be conducted to identify any future safety risks to the public and project users	3.64	.997		High
EnSF-I					

Eco-environmental sensitivity	Avoiding as much as possible the irretrievable impacts on the surroundings from implementing a project	3.22	.04	7	Moderate
Ecological assessment	Examining potential ecological risks and benefits associated with the proposed project	3.28	.02	2	Moderate
Air assessment	Examining potential air pollution from the proposed project and its impact on the local climate.	3.12	.09	4	Moderate
Water assessment	Examining potential water pollution from the proposed project, including both surface and ground water, and project's consumption on water resources	3.39	.943	4	Moderate
Noise assessment	Examining potential noise pollution during both project construction and operation stages	3.03	.02	0	Moderate
Waste assessment	Examining waste generation at both project construction and operation stages	3.29	.926	1	Moderate

Table 4: Assessment of sustainability performance of infrastructure projects (Design Phase)

Project Design Phase					
ESF – II		.M	.D	nk	Performance
Consideration of life cycle cost	Consider the total cost involved in project life cycle, including site formation, construction, operation, maintenance cost and demolition cost	.69	.944		High
project layout	Consideration being given to standard dimension in design specifications	.86	.969		High
Materials choice	Consideration being given to economy, durability and availability for material selection	.51	.934	6	High
SSF – II					
Safety design	Considerations are given in designing process for emergencies such as fire, earthquake, flood, radiation, and eco-environmental accidents	.33	.04	8	Moderate
Security consideration	Installation of security alarm and security screen	.25	.96	5	Moderate
EnSF – II					
Designer	Knowledgeable of energy savings and environmental issues	.33	.993	8	Moderate
Life cycle design	Effective communications among designers, clients, environmental professionals, and relevant governmental staff to ensure all environmental requirements are incorporated into the design process	.36	.924	6	Moderate
Environmentally conscious design	Incorporation of all environmental considerations into project design for construction, operation, demolition, recycling, and disposal	.12	.992	4	Moderate
Modular and standardised design	Use of modular and standardised components to enhance buildability and to reduce waste generation	.93	.998	6	Moderate

Table 5: Assessment of sustainability performance of infrastructure projects (Construction Phase)

Project Construction Stage					
ESF – III		.M	.D	nk	Performance
Loan interests	Consideration given to the interests for the capital cost paid for both a fixed loan and liquid capital	.31	.988	0	Moderate
Opportunity cost	Fixed and liquid capital tied up to project will loose opportunities of investing in other projects	.6	.833	1	High
Labour cost	Salaries paid to human resources, such as general construction workers, plumbers, carpenters, masons, etc.	.47	.888	9	Moderate
Professional fees	Fees paid to various professionals and consultants such as engineers, environmental, ecological, geological, and legal experts	.56	.933	4	High
Materials cost	Costs for all types of materials such as concrete, lime, steel, timber and brick	.65	.842		High
Energy cost	Costs for consuming various types of energy such as electricity, oil, gas, coal	.43	.869	1	Moderate
Water cost	Costs for using water resources and for dealing with surface & ground water	.5	.822	7	Moderate
Equipment cost	Costs for using various tools, vehicles, and tower cranes	.51	.919	6	Moderate

Equipment purchase cost	Costs for purchasing various equipment such as plants, elevators, escalators, and HVAC systems	.51	.993	6	High
Installation cost	Costs for the installation of all kinds of equipment and facilities	.39	1.00	6	Moderate
Site security	Various types of measures for protecting the site safety	.35	.937	4	Moderate
SSF – III					
Direct employment	Provisions of working opportunities from implementing the project to local labour market, including construction workers, professionals, & engineers	3.75	.868		High
Indirect employment	Employment generated by up-&-downstream industries & services to construction	3.51	.839	6	High
Construction safety	Safety measures, facilities, & insurance for working staff	3.56	1.01	4	High
Public safety	Provision of warning boards and signal systems, safety measures and facilities for the public	3.65	.966		High
Improvement of infrastructure	Provisions of better drainage, sewage, road, message, heating, and electrical systems	3.57	.917	3	High
Infrastructure burden	Demand for water, road, energy, services and space for implementing the project	3.53	.804	5	High
EnSF – III					
Land use pollution	Utilising land effectively and the measures taken to avoiding land pollution	.32	.853	9	Moderate
Natural habitat destruction	Protection of living environment for both human being and animals	.26	.872	4	Moderate
Air pollution	Generation of CO2, CO, SO2, NO2, and NO	.19	.799	0	Moderate
Noise pollution	Noise and vibration induced from project operation	3.21	.948	8	Moderate
Discharges/pollution	Release of chemical waste and organic pollutants to water ways	2.96	.911	5	Moderate
Waste generation	Waste produced from project operation	3.26	.964	4	Moderate
Comfort disturbance	Effects on people's living environment and the balance on eco-systems	3.08	.931	7	Moderate
Energy and resource consumption	Saving energy & resources consumption including electrical, water & resources	3.10	.906	6	Moderate
Health and safety risks	Ensure on-site health and safety by reducing the number of accidents, providing on-site supervision, and providing training programs to employees	3.35	1.04	7	Moderate
Using renewable materials	Using typical renewable materials such as bamboo, cork, fast-growing poplar, and wheat straw cabinetry, which are reproducible	3.01	.796	1	Moderate
Ozone protection	Reducing the release of chlorofluorocarbons and hydro-chlorofluorocarbons thus protecting the ozone layer	2.85	.867	7	Moderate
Off-site fabrication	Reducing on-site waste by using off-site fabrication	3.24	.927	6	Moderate
Material reuse	Reuse of building components, rubble, earth, concrete, steel and timber	3.07	.861	8	Moderate
Structural operations	Consideration being given to the reduction of earthwork and excavation, reinforcement, concreting and waste treatment during structural operation	3.07	.793	8	Moderate
Project Construction Stage					
EnSF – III		M	.D	nk	Performn
External & internal operations	Controlling environmental impacts from walling, roofing, insulation, component installation, plumbing and drainage, painting, landscaping, and waste treatment	2.97	.919	4	Moderate
Health & Safety	Emphasising on site hygiene, provision of health care	3.42	.915	2	Moderate
Project organisation	Environmental management task force, resource coordination, supervision and cooperation culture	3.33	.993	8	Moderate
Envirn'tal mgt. resources	Resource inputs for implementing environmental management, including labour, plant, materials and finance	3.11	.943	5	Moderate
Organisational policy	Establishment of environment management system, application of envrn'talmgt standards, project manuals, programs, progress control reports	3.24	.682	6	Moderate
Communication of environmental mgt information	Managing project environmental information through information management expertise and information management facilities	3.17	.888	1	Moderate
Environmental mgt technology	Environmental experts, environmental management facilities, energy and resource saving technology, pollution and waste reduction technology	3.12	.903	4	Moderate

Environmental regulations	Environmental protection law and regulations on Construction activities	3.17	.993	1	Moderate

Table 6: Assessment of sustainability performance of infrastructure projects (Operation Phase)

Project Operation Phase					
ESF – IV		.M	.D	nk	Performanc
Distribution of project income	Reinvestment, dividends, and paybacks	.26	.904	4	Moderate
Balance sheet from project	Develop a balance sheet to continuously check with the project cost and time	.22	.953	7	Moderate
Labour cost	Salaries for managerial staff, workers, professionals & Engineers	.6	.899	1	High
General expenses	Daily water, electricity, gas, and consumables	.49	.872	8	Moderate
Materials cost	Various materials for project operation and maintenance	.42	.868	2	Moderate
Logistics costs	Materials procurement, stock costs, and transportation	.58	.835	2	High
Marketing costs	Resource investment for market analysis, advertising, promotion	.06	.854	9	Moderate
Training costs	Training employees for improving the quality of human resources	.99	1.13	3	Moderate
Improvement of local econ. environment	Consideration being given to benefit economically to the local society	.22	1.08	7	Moderate
SSF – IV					
Direct employment	Costs for employing workers, managers, and professionals in project operation	3.44	.803	0	Moderate
Indirect employment	Employment associated with project operation along up-and-down stream industries	3.21	.838	8	Moderate
Provision of services	Benefits of improving living standard to local communities	3.29	.971	1	Moderate
Provision of facilities	Provision of spaces and facilities beneficial to the development of local communities	3.21	1.05	8	Moderate
EnSF – IV					
Land contamination	Release of chemical wastes through dumping and landfills	3.13	.948	4	Moderate
Air pollution	Generation of various chemicals such as CO2, CO, SO2,	3.24	1.03	6	Moderate
Water pollution	Release of chemical wastes & organic pollutants to water ways	3.25	.946	5	Moderate
Noise pollution	Noise and vibration induced from project operation	3.33	.888	8	Moderate
Waste generation	Wastes produced from project operations	3.26	.877	6	Moderate
Ecological impacts	Negative impacts from project operations to flora, fauna, and ecosystems	3.22	.843	7	Moderate
Energy consumption	Energy consumption on electrical, lighting and other energy appliances	3.38	.971	5	Moderate
Water consumption	Water usage for production of hygiene, cooling & heating	3.31	.929	0	Moderate
Raw material consumption	Use of both renewable and non-renewable raw materials	3.08	.884	7	Moderate
Training to employees	Providing various environmental education and training programs to different levels of employees	3.00	.949	2	Moderate
Envirt'l friendly operation of f	Improving productivity, reducing the generation of pollution, & reducing resource consumption facilities	.08	.96	7	Moderate

Table 7: Assessment of sustainability performance of infrastructure projects (Demolition Phase)

Project Demolition Phase					
ESF – V		.M	.D	nk	Performance
Labour cost	Human resources provided for planning, managing and operating project demolition	.41	.950	3	Moderate

Energy used for demolition	Crushing, transporting and relocating	.44	.712	0	Moderate
Waste disposal costs	Costs for waste loading and unloading, transportation, charges for disposals	.58	.839	2	High
Compensation to project stakeholders	Compensating to affected parties during demolition process	.31	.950	0	Moderate
Dissolve/deploy project staff	Provision of pensions, unemployment compensation	.11	.979	5	Moderate
Compensation to the polluted environment	Compensation made for the damaged environment to the local residents, land, water, and ecosystem	.06	1.05	9	Moderate
Land value for redevelopment	The value of the land after demolition for re-development	.21	1.01	8	Moderate
Residual value	Valuable residues, such as steel, brick, timber, glass, equipment for reuse and recycle	.03	1.03	0	Moderate
SSF – V					
Land for new development	Provision of land upon the completion of demolition to allow new project in line with the demands of local community	.2	.839	9	Moderate
Job opportunity	Provision of jobs during project demolition for site work, transportation and disposal	.27	.844	3	Moderate
Operational safety	Presence of safety risks to labours and the public during project demolition from explosion, dismantling, toxic materials, and radioactive materials	.21	.844	8	Moderate
Communication to the public	Promotion on the public awareness of the project demolition and the possible impacts to the public	.2	.995	9	Moderate
EnSF – V					
Demolition plan	Adequate demolition plan on hazard materials and waste reduction or recycle	3.10	.06	6	Moderate
Demolition control	Supervision and control on the demolition activities to protect the environment	3.31	.965	0	Moderate
Environment-friendly demolition method	Adoption of technologies to alleviate the disturbance on eco-environment systems and neighbourhood, and to maximise waste reusing and recycling	3.15	.09	2	Moderate
Environmental information & policy	Communication of Knowledge about environmental policies, regulations, legislations, and environmental techniques	3.11	.05	5	Moderate
Waste classification	Classification of demolition wastes for enabling effective treatment and disposal	3.14	.15	3	Moderate
Special waste treatment	Special treatment given to toxic materials, heavy metals, radioactive chemicals released from demolition	3.15	.1	2	Moderate
Waste recycling and reuse	Recycling and reclaiming of useful materials such as steel, brick, glass, timber, and some equipment	3.01	.1	1	Moderate

9. RELIABILITY ANALYSIS

The Cronbach's alpha coefficient method was used to test the data reliability. Cronbach's alpha is helping to determine whether it is justifiable to interpret scores that has been aggregated together. The calculation results show that the Cronbach's alpha coefficients are between 0.971 and 0.972. This value is considered optimally sufficient to make interpretation since they are more than 0.7.

10. DISCUSSIONS

The analysis of the survey response produced the weighted mean performance values for 112 factors for economic, social and environmental sustainability cut across five phases of project life cycle. The values of the weighted mean (weighted sustainability score) range from 2.85 to 3.86.

This can be interpreted as saying the sustainability performance of infrastructure project is satisfactory in Nigeria as practically all the values from respondents' data indicate moderate performance to high performance. This assessment applying generally to infrastructure projects can assist project clients, decision makers in evaluating the total sustainability performance of infrastructure and diagnosing the performance of key factors.

From the analysis above, while the application of the tool has identified within each sustainability aspect at least two factors with highest weighted performance value, it has also identified factors with the least weighted performance value. Within the economic dimension, they include "Project layout, i.e. the consideration being given to standard dimension in design specifications. The performance of this particular requirement is considered crucial as a recent finding by Shen et al. (2007) show that design process affects largely the project sustainability performance. For example, the design specifications affect functional performance of building components such as air conditioners, ventilation, lighting, electrical, heating, fire and water systems. The study by Ibrahim and Price (2005) also demonstrate that the aspect of building layout also has potential impact on the sustainability of infrastructure. It is therefore apparent that good adherence is given to translating dimensions in design specification to what is constructed. The second high ranking factor: effect on local economy (3.78), illustrates that the implementation of infrastructure projects ought to serve both the local economy and at the same time take advantage of the infrastructure in the local economy to generate economic benefits, this is deemed to be doing well.

The implementation of infrastructure projects has social impact in many regard. For example Kessides (1993) and Hong (2008) clearly noted that the provision of infrastructure affect labour productivity and access to employment, and thus the capacity to earn future income and increasing consumer demands. The result of the analysis within sustainability dimension supports this assertion as the factors with the highest value ranked to by respondents related to employment; at the construction phase is the 'direct employment' with a weighted performance score of 3.75 and at the inception phase is 'employment' factor with 3.74 score. While the first relate to the employment opportunities gained from implementing the project to the local labour market, including construction workers, professionals, and engineers. The second is connected with the ability of providing local employment opportunities arising from project implementation. Hong (2008) has therefore put forward that more employment opportunities will be provided directly or indirectly with the implementation of infrastructure projects especially in Nigeria which records high unemployment rate (Zuofa et al, 2012).

From the 50 environmental sustainability factors which form the basis for respondents' assessment, health and safety is ranked most performed. That is to say emphasis on site hygiene, provision of health care is given adequate attention in the implementation of infrastructure project, this finding contrast the studies of Fang et al. (2001) and Shen et al.(2011) who advocate for measure for poor safety management. The weighted performance value 3.42 though is indicative of the need for concerted towards improving health and safety. The other factor also ranked high is 'water assessment' at the inception stage. This relates to the examination of potential water pollution from the proposed project, including both surface and ground water, and project's consumption on water resources.

Shen and Tam (2002) observed that the control of environmental impacts from construction has become a major issue to the public. From this, it is obvious that the implementation of infrastructure projects take into account environmental protection through proper water assessment.

The identification of factors that positively affect sustainability performance of infrastructure projects though important for several reasons, equally important is those factors that have adverse effect on sustainability performance of infrastructure. The use of the tool has also identified factors that respondents' assessments have shown to moderately perform and thus will require action/improvement. The factors include ozone protection (2.85); modular and standardised design (2.93); discharge of water (2.96); external and internal operations (2.97) i.e. the control of environmental impacts from building elements, component installation, waste treatment etc., and training cost (2.99).

By examining performance across the three sustainability dimensions, it can be found that the economic factors show better performance than the social and environmental factors. The average weighted performance value for all the economic, social and environmental factors stand as 3.45, 3.43 and 3.18 respectively. It can therefore be said that considering the impact of sustainability performance from dynamic interaction between the factors economic, social and environmental standpoint, the performance level of economic factors is higher while that of the environmental sustainability factor is viewed least, This is not entirely a surprise given that scores of reports on environmental related problems have been widely identified and reported.

11. CONCLUSION

Infrastructure projects play major role in economic, social and environmental activities particularly in developing countries like Nigeria. The assessment of their sustainability performance deserves to be properly addressed. However, due to lack of effective assessment indicators in practice and failure to integrate the three major themes of sustainability, infrastructure projects are not assessed effectively vis-à-vis their sustainability performance. Using a well-captured integrated and holistic approach found in literature, this study revealed that sustainability performance of infrastructure projects in Nigeria fall within moderate performances to high performance. In assessing the sustainability performance of infrastructure projects in Nigeria, this study has also identified factors that affect the performance of sustainability performance. It is acknowledged that effective sustainability performance can only be achieved when there is a common basis of information and knowledge of project sustainability. This work is therefore presented in a way that would assist project participants with the following; (i) understand major factors affecting project sustainability performance in a consistent and holistic way, (ii) contribute to sustainability performance of infrastructure projects and (iii) provide sustainability information that facilitates adequate decision making toward sustainable development.

The following recommendations are proffered based on the findings in this study:

i. The Nigerian construction industry should propose principles for policy formulation in order to improve sustainability performance of infrastructure projects.
ii. The approach presented in this research would enable professionals, decision-makers to analyse and evaluate in a holistic manner factors that affect sustainability performance.

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