IMPACTS OF CIVIL ENGINEERING INFRASTRUCTURES IN THE SUSTAINABILITY OF THE ENVIRONMENT

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ABSTRACT

Sustainability is a critical goal for Civil Engineers, human activity, construction projects and national development. This paper x-rays various impacts of infrastructures with special focus on the planning, maintenance and implementation of civil infrastructures that preserve natural environment. The research methodology for this study includes interaction with professionals, review of literatures; reconnaissance survey of housing units using Ado-Ekiti as a case study. Information obtained was used to get an overview of the existing Environment. The study revealed that civil engineering infrastructure development projects impacted greatly on the environment especially in areas of flooding, dilapidated roads, noise pollution, water pollution, erosion, ecological disorder, decrease in size of available land and natural hazards. In the study area, 11.0% lives in compound buildings, 4.5% lives in duplex, while 7.0% lives in storey buildings. Significant number of residents in the study area lives in rooming housing units with low income per month and as such was denied of the benefits of well furnished and quality buildings. Conclusions are provided related both to pathways for engineering sustainability and to the broader ultimate objective of sustainability. Flooding can be averted and housing units can be improved by Civil Engineering interventions. Based on the findings, recommendations were made for the elimination of the negative effects and for the achievement of sustainable construction, innovative civil engineering infrastructure, national and socio-economic development.

Keywords: Socio-Economic, Impacts, Environment, Sustainability, Infrastructure

1.0 INTRODUCTION

Sustainable development is increasingly becoming a goal to which numerous countries in the world desire to achieve. Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs. In addition to natural resources, we also need social and economic resources. Overall sustainability has been defined in many ways, and is often considered to have three distinct components: environmental sustainability, economic sustainability and social sustainability. Civil Engineering infrastructures have a lot of impacts on the environment and sustainable development.

At present, most universities seem to be developing educational programs about sustainable development independently. These efforts and courses could be made more efficient and thorough and could be shared widely through a global education program using the Internet and wideband telecommunications. Practicing engineers also need to be able to learn practical methods of using sustainable technologies in their projects. Sustainable engineering is the process of designing or operating systems such that they use energy and resources sustainably, in other words, at a rate that does not compromise the natural environment, or the ability of future generations to meet their own needs.

Many factors that need to be considered and appropriately addressed in moving towards engineering sustainability are examined in this article. These include appropriate selection of resources bearing in mind sustainability criteria, the use of sustainable engineering processes, enhancement of the efficiency of engineering processes and resource use, and a holistic adoption of environmental stewardship in engineering activities. In addition, other key sustainability measures are addressed, such as economics, equity, land use, lifestyle, sociopolitical factors and population.

2.0 LITERATURE REVIEW

The concept of sustainable development is applied to this study. The concept of sustainable development was propounded by the World Commission on Environment and Development (WCED) in 1987. This concept noted that sustainable development is a development that meets the needs of the present generation without compromising the ability of future generation to meet their own needs. Development involves the purposeful change of the inherently complex environmental systems. Sustainability is inherently part of the intention of EIA and even though EIA has limitations, it has the potential of promoting sustainable development in a number of ways that are yet to receive attention in the literature (Cashmore et al., 2004).

Hacking and Guthrie (2008) refer to EIA and SEA (Strategic Environmental Assessment) as “widely promoted sustainability tools”, but even though strategic assessments are necessary to achieve sustainable development; they are intended to be done at policy level. EIA is normally done at project level and may be considered as the only lower planning level sustainability orientated tool with an adequate track record as a basis to judge its effectiveness (Hacking & Guthrie, 2008).

Sustainability is inherently part of the intention of EIA and even though EIA has limitations, it has the potential to promote sustainable development in a number of ways that are yet to receive attention in the literature (Cashmore et al., 2004). The contribution of EIA to design decisions should be regarded as a single component of incremental changes towards sustainability. The broader concept of EIA is schematically shown in Figure 1.

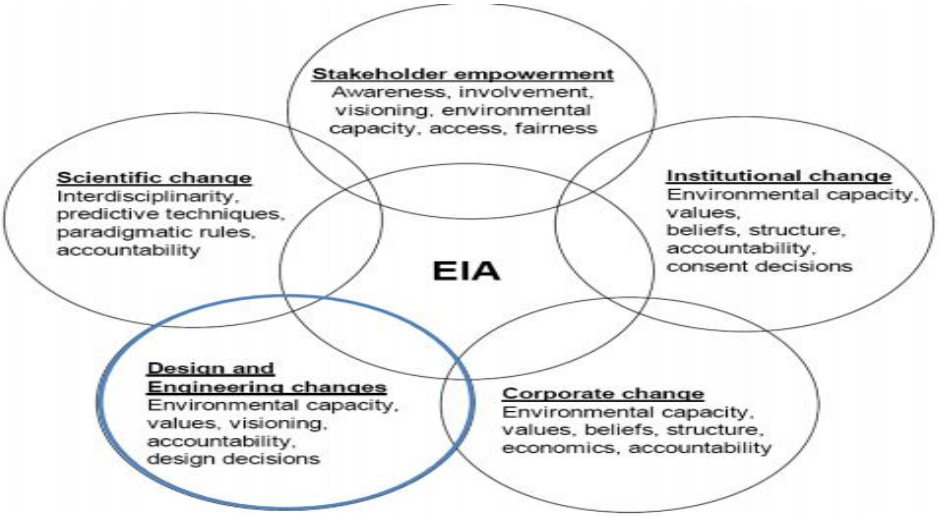

Figure 1: EIA as an agent of incremental change (Source: Cashmore et al., 2004)

Another challenge with alternatives is that they are often biased towards a predetermined outcome and in the process more environmentally sound alternatives are overlooked. As a result, inadequate alternatives can undermine the purpose of impact assessment (Steinemann, 2001). Alternatives should be identified early in the project cycle, and the consideration of alternatives should be well documented and include the views of stakeholders (DEAT, 2004). The purpose of evaluating alternatives is to compare all potential impacts of the various alternatives in order to find the most environmentally sound way of meeting the requirements of the proposal (DEAT, 2004).

Structural design codes provide the tools that engineers should use to produce safe and economic structures (Aktas et al., 2001). It has taken the industry almost a century to develop codes and standards for the design of structures that can withstand significant loads. Over the past decades, much of the focus of scholars in the field of civil engineering has been on safety optimisation of the civil engineering design (Soltani & Corotis, 1988; Choi & Chang, 2009; Wang et al., 2011; Beck & Gomes, 2011). During this period, very little consideration was given to the impact on environmental sustainability and the life cycle of these structures.

Figure 2 indicates various social impacts and figure 3 Figure gave adaptation planning and implementation framework.

Figure 2: Social impacts of projects

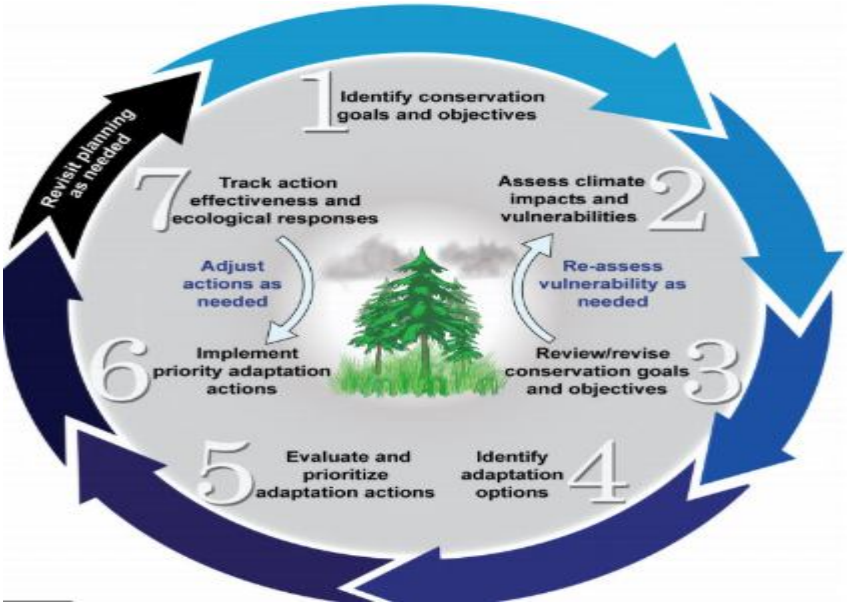

Figure 3: Adaptation planning and implementation framework

Stepwise approach for the management of corporate sustainability (Galeitzke et al. 2016)

At this point, an assessment of the cause-effect relationships can be implemented following a cross-factor impact assessment of all resource factors (Alwert et al. 2005). Identifying closed-loop interrelations is an attempt to address the system's theoretical discussion of the introduction, where weakening or strengthening dependencies are identified and expressed in relation to a specific analysis object (Galeitzke et al. 2015).

Enterprise modelling describes relevant processes and structures of a company or organisation and their mutual relationships. The applications are designed extend to the illustration of the

enterprise architecture, the root cause analysis of operational problems, strategy development, process optimisation or the management of business collaborations, among other topics (Sandkuhl et al. 2013).

Akinbode (2002) stated that the environment is the totality of the places and the surroundings, in which we live, work and interact with other people in our cultural, religious, political and socio-economic activities for self fulfillment and the advancement of our communities, societies and nations. In general, the environment is the most precious asset that we own, share and use together with other people for mutual benefits and enhanced welfare of the society at large.

Eco-effectivity strategies pursue absolute objectives in terms of reducing environmental pollution, as achieved through the use of renewable energy sources, recirculation of products, by-products and materials into product lifecycles or natural systems, as well as the limitation of environmental pollutants. Eco-effectivity thus refers to the degree of objective attainment, where the target is directly tied to the reduction of environmental or social burdens (Schaltegger, 2000).

Other civil engineering objectives that are not aligned with the objectives of EIA might be conflicting with the objectives of EIA. This creates the possibility of opposing interests, but it also creates the opportunity for EIA to contribute to the project by introducing aspects that would otherwise not even have been considered. In Figure 4, the alignment of objectives of EIA and civil engineers are schematically shown.

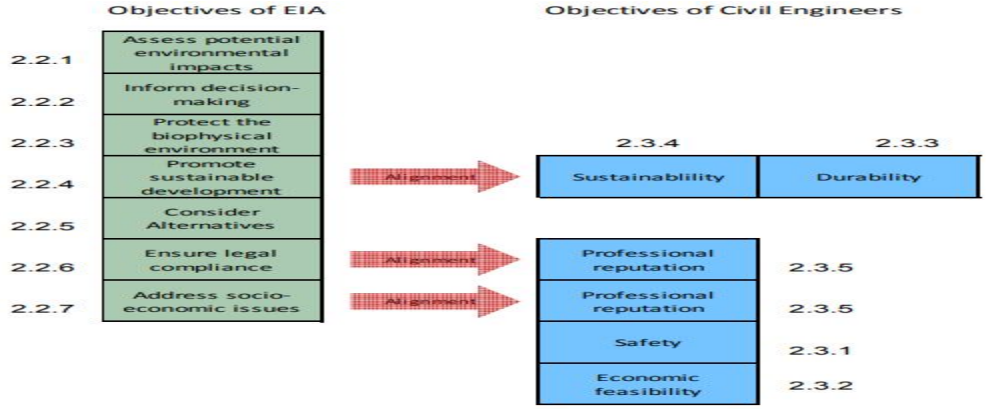

Figure 4: Alignment of objectives of EIA and Civil Engineers

3.0 METHODOLOGY

The research methodology for this study comprised both review of literature, interaction with professionals and an empirical study. For the empirical part of the study a questionnaire was developed based on the issues identified in the literature study. The outcome of the data was used to evaluate the merit of EIA for civil engineers.

4.0 IMPACT OF CIVIL ENGINEERING WORKS ON THE ENVIRONMENT

Sustainability is the prevention or reduction of the effect of environmental issues for humans to live a sustainable life and as part of the effort is to return human use of natural resources to a sustainable limit at which it can be replenished.

The impact of these projects on the environment range from cumulative to long term and short term impacts; and include impacts on human beings and manmade features, agriculture, effects on flora, fauna and geology, effects on land, effects on water, air and climate and the indirect and secondary impacts associated with the project. Environmental impact assessment may be said to be one of the vital steps required for careful planning and management of natural resources resulting from pressures placed on virtually all areas of the earth from the need to provide food, water, minerals, fuel, and other necessities for such increasing number of people.

Figure 5 shows the overview of Quest for sustainable cities.

Figure 5: Overview of Quest for sustainable cities

Civil engineering has always had a big impact on our society and environment. Decisions made by the government and private investors are generally money orientated but recently some of the planning and construction of projects has been halted due to the credit crisis. Currently, problems are now being resolved and debts are being paid off. The government and Investors are recently more worried about the environment and how to tackle occurring and future problems. Society is relying on them for plans, improvement and developments to stop civilization from suffering the further effects of global warming. With the help of construction projects from eco housing firms, public buildings and private funded structures, this will allow society to be aware of the problems caused by global warming and therefore respond by giving something back to the earth. This report will be based on what the world is doing about global warming, how it is put into action in the United Kingdom and how society can help. As a whole, civil engineering has

made changes in the past, present and will make changes for the future. With the help of governments, civil engineering gives a chance for society to independently help save the planet from global warming for the future generation. Sustainability for the future relies on the government to take further action to allow more eco developments and constructions to take place. With the society's knowledge growing about the rising threat, our chances to save the future is growing. Figure 6 highlights integration of sustainability into corporate strategy.

Figure 6: Integration of sustainability into corporate strategy

4.1 ANALYSIS AND DISCUSSION OF RESULTS

Ado Ekiti is selected as a case study, it is the administrative centre of Ekiti State, Nigeria. The land in Ado-Ekiti rises northwards and Westwards from 335 metres in Southeast and attains a maximum elevation of about 730 metres in the Southwest. Civil engineering works have eradicated issues related flooding, shelter and public health. The housing condition of a community has high level of correlation with the health status of residents. It is the embodiment of the shelter characteristics and that of the ambient environment, such conditions as crowdedness in house, poor drainages, building set back, etc. have implications on the relative ease with which communicable diseases are transmitted and hence health problems and cost to the community and government. Plate 1 indicated a typical Flood issue in Ekiti State.

Plate 1: Typical Flood issue in Ekiti State

Table 1: Types of Housing Units in Ado-Ekiti

TYPES OF HOUSING UNITS	FREQUENCY	PERCENTAGE (%)
Rooming houses	137	46.0
Flats	58	19.5
Bungalows	38	12.0
Compound	33	11.0
Duplex	13	4.5
Storey buildings	21	7.0
TOTAL	**300**	**100.0%**

Source: Field study (2019)

Table 1 indicated that 46.0% of the housing units were living were rooming houses, 19.5% lived in a flat, 12.0% lived in bungalows, 11.0% lives in compound buildings, 4.5% lives in duplex, while 7.0% lives in storey buildings. Thus, significant number of residents in the study area lives in rooming housing units with low income per month and as such was denied of the benefits of well furnished and quality buildings. This can be improved by civil engineering interventions.

5.0 CONCLUSIONS

The following are the conclusions made in this paper:

i. High cost of land is a major obstacle to the development of proper housing in urban areas like Ado-Ekiti in Nigeria.

ii. Civil engineering infrastructures need to be handled with sustainable development in view.

iii. Infrastructure elements such as buildings, roads, water, sewage and storm water can result in loss of critical ecosystems and biodiversity. It is clear that the engineering profession has a significant part to play in affecting the future of our planet.

iv. The rating of green buildings evaluates the environmental impacts of buildings but with little emphases on the environmental performance of civil engineering infrastructure. The concept of the green rating of green buildings and creates a decision toolkit that assesses the environmental impacts of infrastructure design decisions on development.

v. Environmental management plan, contingency plans and equipment that are to be used to carry out a specific work on all construction contracts should be specified, in order to have a friendly environment.

vi. A shift towards overall sustainability can be given great impetus, given the pervasiveness of engineering activities in all societies and their impacts on the environment, as well as the importance of engineering in economic development and living standards.

vii. The civil engineers are aware of projects where the EIA led to the adjustment of the initial design, construction materials or any other aspect of the project in order to improve the sustainability. EIA therefore creates the opportunity for the engineers to eliminate the most significant adverse environmental impacts in the design.

viii. Civil engineers needs to promote sustainable development and optimizes resource use and management opportunities. This will tackle flooding, bad roads and housing issues.

5.1 RECOMMENDATIONS

i. Government at all levels should regulate the price of land in the area to enable developers build adequate and modern housing facilities at affordable prices.

ii. There is a need to create an eco-sensitive infrastructure design rating system that encourages and promotes sustainable development.

iii. Engineers and allied professionals in construction industries are advised to implement standard and safe policies to ensure environmental protection.

iv. Mainstreaming environmental aspects and incorporating the eco-efficiency concept into various stages of infrastructure development have not been considered in most construction projects.

v. Guidelines should be developed for engineers on how environmental issues should be incorporated into the project EIAs and should also provide the framework for environmental practitioners to participate as team members during the planning and design phase of the development.

vi. Nigerian Society of Engineers and Council for the regulation of Engineering in Nigeria should enforce the issue of sustainability of the environment in every civil engineering projects. This will ameliorate negative effects in situations where it will be impossible.

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