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Environmental Sustainability: Impact of Construction Acitivities

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Abstract. As a result of pollution, deforestation and other environmental challenges, construction process and activities has contributed in no small measure to environmental degradation. One of the fundamental tripod of sustainability is keeping the environment safe for the inhabitants. This study, therefore, examine the impact of construction activities on the environment with a view to highlighting mitigating approaches and their enforcement strategies. A quantitative research methodology was adopted, and convenient sampling technique was employed to gather information from primary sources. Questionnaires were administered on construction professionals which include architects, quantity surveyors, engineers, safety officers as well as construction and facility managers. Construction activities impact badly on the environment due to waste generation, resource consumption, noise pollution, air pollution due to dust from construction activities as well as bad odours from large diesel-powered vehicles/construction machinery. Although, some of these impacts cannot be completely eradicated, there are a number of approaches that could be used to mitigate them, these include Environmental Impact Assessment (EIA), green building (sustainable construction), Quantitative Risk Assessment (QRA), Environmental Management System (EMS), and Environmental Protection Agency (EPA). Therefore, an effort should be made by government and construction stakeholders to efficiently incorporate and enforce the available approaches/ initiatives through constant monitoring of construction process from start to completion and legislative laws that spell out punishment as response to violations. Awareness, learning and trainings of construction stakeholders on the impacts of building construction activities on the environment is also recommended.

Keywords: Construction activities, Construction Industry, Environment, Green building, Sustainable construction

1 Introduction

Construction activities involve the consumption of various form of resources including raw and finished materials that are derived from various sector of the environment. The impact of these activities on the environment cannot be over-emphasised. In this regard, ways of controlling, managing and reducing these environmental impacts have been

developed and implemented from time to time. Construction project performance and success has traditionally been measured in term of duration, cost, and quality. According to Gangolells, *et al.* [1], the environment has become the fourth variable. Fuertes *et al.* [2] stated that while economic development of a country can lead to an improvement in the quality of life of her citizens, the resulting environmental damages may affect human health and ultimately undermine the economic development and growth. Therefore, it is imperative for the construction industry to always take into account the environmental impacts of construction activities as an important factor of project success. According to Tam and Tsui [3], the construction industry plays an important role in meeting the needs of any society, as well as enhancing the quality of life of people. However, the responsibility for ensuring that activities of the industry and its products are consistent with environmental guidelines, standards and policies is an aspect that still needs to be defined.

One of the approaches that is widely used to reduce environmental impacts is the Environmental Impact Assessment (EIA). EIA is defined as a process that assesses and evaluate possible impacts of activities before the commencement of a project or development with a view to plan and mitigate the possible impacts [4]. This help managers and concerned stakeholders to make decisions on whether the project or development should proceed, and the required condition for the project to proceed. Over the years, a number of other approaches have been adopted in various sectors of the economy including the construction industry [2; 5; 6], these include; Environmental Protection Agency (EPA), Environmental Management Systems (EMS), and Life Cycle Assessment (LCA). All the approaches have different purpose, function, and procedure to implement them. However, one thing they all have in common is that they are all important tools for the conservation of the environment.

The Government plays an important role in this regard, in term of commitment towards the different approaches through appropriate legislation. According to Murombo [4], the South African government has put into practice environmental legislation for sustainable use of resources and conservation of natural resources, which addresses social, economic, and ecological issues. The implementation of laws and policies provided in this regard is of great importance, as it helps with the enforcement of the approaches. Wasserman [7] stated that the full implementation of these approaches does not entirely lie with the Government, public participation is also necessary for the proper actualisation. In this study, the common environmental impacts of building construction activities were identified and assessed, current approaches to encourage the minimisation of the impacts were evaluated and different means to enforce the initiatives were also discussed.

Literature Review

2.1 Construction activities

The construction industry plays a crucial role in the economy of South Africa by providing more than one million jobs and generating revenue of approximately R267bn annually [8]. However, it has been observed that construction activities impact on the

environment through the process of construction and life cycle of development. These impacts start from the initial work on site, through the actual construction, operational or usage period and to the final demolition or re-use [5; 9]. According to Li and Zhang [10], the construction industry is responsible for the use of high volume of natural resources and the generation of great amount of pollution. This is as a result of energy consumption during extraction, preparation, transportation, and usage of raw materials.

2.2 The Environment

According to Smull and Bourne [11] every human being responds to the environment they find themselves in different ways depending on their level of satisfaction by what surrounds them. Certain things must be present in the environment and others must cease to exist for human beings to be satisfied or content in any environment. When an environment is harmful or extremely unpleasant, it is what the environment allows or accommodates that causes people to have complaints about the environment. The typical emotional response to a harmful or unpleasant environment is either anger or depression. By paying special attention to people's behaviour and their reaction to certain conditions, issues that are dissatisfying about that particular environment, and what needs to change can be identified.

While there are some things existing within an environment that may prove to be toxic or dangerous, it does not necessarily mean that they will be toxic to everyone concerned, some things are toxic and dangerous to some people but not to others. Consequently, there are some factors that are toxic and injurious to all, and cannot be tolerated. When critical aspects of what is important to the public are absent, this will result in making the environment less healthy and less safe for the people.

2.3 Construction Activities and Environment

Most countries are faced with many environmental challenges due to the construction of different types of infrastructure. These include such things as soil alteration and excessive use of resources. Gangolells *et al.* [1] stated that one of the critical issues that involve the greatest level of uncertainty is in the identification and assessment of environmental impacts. It is important, to identify and assess these impacts. Dong and Ng [6] noted that due to the various challenges involved with the building of construction activities, including differences in locality, site, parties involved, as well as the tolerance levels, it is difficult to predict, manage and address environmental impacts. There are a number of approaches/initiatives that aid sustainable use and protection of the environment. These include EIA, EMS, EPA, LCA, Environmental Management Framework (EMF), and Green Building (Sustainable Construction).

It has been observed that some effective approaches relating to the assessment of environmental impacts have been largely overlooked [2]. In order for the approaches to be efficient and effective, Ametepey and Ansah [5] concluded that it does not end with just the implementation of the approaches but enforcement has to be taken into account. The enforcement of these approaches contains factors such as monitoring, controlling, maintenance, as well as mitigation. Furthermore, participation in the approaches should not be undertaken as a once-off event, but a sustained and continuous iterative process. An iterative process that begins with the identification of

the problem, through project conception/formulation, and final approval of the project [4].

Notable environmental issues include global warming, energy crisis, and ozone depletion. In order to control environmental pollution and sustain the development of infrastructure, sustainable development was proposed by the World Commission on Environment and Development [2]. This was explained as the development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs.

2 Research Methodology

A descriptive survey design was adopted for this study because it provides an adequate representation of the respondents' characteristics in term of behaviour, opinions, abilities, beliefs, and knowledge of a particular situation. This design was undertaken so as to meet the main objective of the study, which is to assess the environmental impacts of building construction activities. The study population include professionals in the South African construction industry. These include Quantity Surveyors, Construction Managers, Architects, Engineers and Safety Officers who have the required experience and are currently involved in at least one construction projects in Gauteng region of the country.

Questionnaires were adopted as a research instrument for the study and were distributed using convenient sampling method. It was designed such that the respondents can answer the questions with no hassles. Straight forward, clear and unambiguous language was used and close attention was paid to every question so as to make sure that bias questions would be avoided. A 5-point Likert scale was adopted for environmental impact of construction activities as well as enforcement of measures to mitigate the challenge. The scale ranges from extreme negative, through neutral value, to extreme positive. Mean Item Score (MIS) and Standard Deviation (SD) were calculated using SPSS 21 and the resulting values were used to rank the variables in descending order. For measures to combat the impact, respondents were asked to select as many factors as relevant and percentile was used to analyse this aspect and rank the factors accordingly.

3 Findings and Discussions

3.1 Background information

A total of 65 questionnaires were administered but due to non-responsiveness of some of the respondents and time constraints, 54 were retrieved. However, 50 of the completed instruments were adequately completed and certified fit for further analysis. Findings from the analysis of the research instrument indicate that 66% of the respondents are male and 34% are female with an average year of experience of about 7 years. 18% are Architects, 32% are Quantity Surveyors, 12% are Engineers, 8% are

Construction Managers, 4% are Facilities Managers, and the remaining 4% are site agents.

4.2 Environmental impacts of construction activities

The basic environmental impacts of construction activities as indicated in Table 1 are resource consumption (such as water, electricity and fuel consumption during the construction process) and waste generation. Others are air pollution due to dust from construction activities, noise pollution, destruction of the ecosystem and air pollution due to bad odour from large diesel-powered vehicles/construction machinery. The least impact is related to effects on biodiversity, soil alteration and generation of volatile organic compounds (VOCs) as a result of vehicle movements and machinery used in construction. The SD values also indicate there is agreement among respondents in the assessment of the factors.

Table 1. Environmental impacts due to construction activities

Environmental impacts	MIS	SD	Rank
Resource consumption (such as water, electricity and fuel consumption during the construction process)	4.02	0.829	1
Waste generation	3.92	0.709	2
Air pollution due to dust from construction activities	3.72	0.663	3
Noise pollution	3.60	0.551	4
Destruction of the ecosystem	3.46	0.289	5
Air pollution due to odour from large diesel-powered vehicles/construction machinery	3.44	0.755	6
Generation of greenhouse gas emissions as a result of vehicle movements and machinery used in construction	3.41	0.597	7
Vibrations due to heavy construction machinery	3.35	0.330	8
Generation of chlorofluorocarbon (CFC's) as a result of vehicle movements and machinery used in construction	3.26	0.608	9
Effects on biodiversity	3.10	0.618	10
Soil alteration	3.08	0.472	11
Generation of volatile organic compounds (VOC's) as a result of vehicle movements and machinery used in construction	2.96	0.995	12

4.3 Combating environmental impact of construction activities

Construction experts were asked about the approaches that are in place to mitigate the environmental impacts of construction activities. Provision was also made for the respondents to write other approaches that were not listed. Using their frequency of selection and percentage calculated in Table 2, Environmental Impact Assessment (EIA) and Green Building (Sustainable Construction strategy) are the two important

initiatives. Others are Environmental Management System (EMS), Life Cycle Assessment (LCA), Environmental Management Framework (EMF) and Strategic Environmental Assessment. No other approach was specified by any of the respondents indicating that the selected list of initiatives is expansive.

Table 2. Approaches to combat environmental impacts

Approaches/initiatives	Percentage	Rank
Environmental Impact Assessment (EIA)	21.4	1
Green Building (Sustainable Construction)	20.9	2
Quantitative Risk Assessment (QRA)	12.3	3
Environmental Management System (EMS	11.2	4
Environmental Protection Agency (EPA)	10.7	5
Life Cycle Assessment (LCA)	9.6	6
Environmental Management Framework (EMF)	7.5	7
Strategic Environmental Assessment (SEA)	6.4	8

Furthermore, steps to be taken to enforce the approaches/initiatives for the minimisation of environmental impacts of construction activities are indicated in Table 3. These include constant monitoring of construction process from start to completion, enforceability and audit ability of the strategy, linking mitigation commitments to monitoring and legislative laws that spell out punishment as a response to violations. Others are transparency and accountability in contract administration, checking company profiles and confirming qualifications, a delegation of tasks and continuous professional development. On the lower end are giving the public and government access to commitment documents and making follow up actions.

Table 3. Enforcement strategies for environmental control measures

Mitigation method	MIS	SD	Rank
Constantly monitoring the construction process from start to completion	4.46	1.150	1
Enforceability and audit ability of the strategy	4.22	1.137	2
Linking mitigation commitments to monitoring	4.18	1.008	3
Legislative laws that spell out punishment as a response to violations	4.15	0.829	4
Strict disciplinary measures from professional bodies	4.12	0.957	5
Organisations to have programs of awareness	3.98	0.656	6
Transparency and accountability in contract administration	3.94	1.026	7
Continuous professional development	3.84	1.025	8
Delegation of tasks	3.71	0.638	9
Appointment of highly experienced construction professionals	3.70	0.812	10
Devising contingency plans	3.70	1.139	11
Checking company profiles and confirming qualifications	3.44	0.718	12

Giving the public and government access to commitment documents	1.08	0.453	13
Making follow up actions	0.46	0.968	14

4.4 Discussion

In support of Zolfgharian [12], some impacts of construction activities on the environment are so minor that they may be considered as acceptable, whereas some are highly significant that they cannot be ignored. However, there are certain environmental impacts of construction activities that are significant, such as air pollution, noise pollution, resource consumption, destruction of the ecosystem and waste generation. This is in agreement with Gangolells *et al*. [1] and Ametepey and Ansah [5]. Previous studies from Ruckelshaus [13], Rendell and McGinty [14], Fischer [15], Jay *et al.* [16] and Murombo [4] revealed that there are a number of approaches/ initiatives that are available in combating environmental impacts, both nationally and internationally. Some of these are regulations that should be adhered to so as to protect the environment. In agreement with these authors, the findings from this study indicate that EIA and Sustainable Construction are the most widely used approaches to combat environmental impacts.

4 Conclusion and Recommendation

Construction activities impact badly on the environment. Although some of these impacts cannot be completely extinguished, there are a number of approaches/ initiatives that have been put in place in order to minimise and control these adverse environmental impacts. However, enforcing these approaches has been a major challenge. The impacts of construction activities include waste generation, resource consumption, noise pollution, air pollution destruction of the ecosystem and generation of greenhouse gas emissions as a result of vehicle movements and machinery used in construction.

The approaches/ initiatives currently used to mitigate these impacts are Environmental Impact Assessment (EIA) and Sustainable Construction. However, to ensure the enforcement of the mitigating approaches, construction process need to be monitored from start to completion, legislative laws that spell out punishment as response to violations must be put in place, strict disciplinary measures of members by various professional bodies, there should be transparency and accountability in contract administration, and continuous professional development should be encouraged. An effort should be made to efficiently incorporate the above-mentioned approaches/ initiatives into construction projects right from the inception stage. Careful consideration should also be taken to ensure that these approaches are used efficiently and according to standard.

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