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To cite this article: A Sholanke *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **331** 012016

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Noise Pollution and Waste Control Techniques in Building Construction in Nigeria: A Literature Review

Theme: Built Environment

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Abstract. The activities of the construction industry are often plagued with improper material control and operational measures that result in the production of noise and generation of waste in project sites. Waste and noise are generated in every step of the construction process, from the production of materials used, to the erection and finishing of structures. In this age of incorporating sustainability into the development of buildings and their environments, there is a need for the construction industry to substantially reduce the amount of noise and waste produced. This paper investigated various noise pollution and waste control techniques used in the construction industry in Nigeria, with a view to identify areas for further improvement. The paper is a systematic literature review which made use of document analysis to collect data and content analysis to analyse the data gathered. Descriptive approach was used to present the result. The paper examined the current state of waste and noise management and the recommendations provided. The study found that in Nigeria, the noise control technique employed is the use of noise barriers, while the waste control management strategies used are prefabricated elements, sorting waste generated, open dumping, open burning and composting disposal method. Some of the recommendations made include: discarding open dumping and open burning as waste control measures due to their negative environmental impact, developing and enforcing a legal framework for noise and construction waste. Furthermore, educating site workers on noise and waste control techniques and replacing machines that use combustion engines with those that use electrical motors. Students, educators, building industry practitioners and other construction industry stakeholders will find the study a useful material to work with, as well as build upon.

Keywords: Noise Pollution, Waste Control, Construction, Literature Review and Nigeria.

1. Introduction

The role of the construction industry is notably significant when it comes to a nation's economic development. The construction sector activities are considered the most important source of stimulus for development and the growth of the economy [1]. However, despite the benefits it provides, the impact on the society and the environment is tremendous when considering the relationship of the construction industry with other sectors such as the service sector and the various industries that deal



in material production, distribution, how resources are being used and the quantity that is required [2, 3]. Nigeria as a developing country has a lot to catch up on. The country can to achieve a sustainable environment by learning from the mistakes of others. The activities of the construction processes generate noise and waste which pose a severe threat to the environment. Their effects happen over time, from crude materials being processed, to their utilization in construction, to the maintenance and demolition of the structure [4]. Therefore, there is a need to control the amount of noise and waste generated in order to limit the effect they have on the environment. Also, most of the techniques available for noise pollution and waste control in Nigeria are used sparingly, while some of the control strategies that are being used have been dropped by developed countries due to their unsustainability, negative impact on the environment and having a damaging effect on the wellbeing of the public and workers on construction sites. The design of a building and the materials that are procured strongly influences how waste on a construction project is generated [4]. Therefore, this paper identified the sources of noise pollution and waste generation in building construction and the various techniques of controlling them in Nigeria, in order to identify areas for further improvement. The paper also suggested additional noise and waste control techniques that can effectively minimise waste and noise, reducing the impact of their activities on the environment and eliminate additional cost on projects in Nigeria. The study's scope is limited to the activities that occur during construction. Students, educators, building industry practitioners and other stakeholders will find the study a useful material to build upon and work with. The following part of the paper is divided into 4 sections namely: research methodology, results, conclusion and acknowledgements.

2. Research Methodology

The paper is a systematic literature review. Data was gathered from secondary sources by contextual analysis. The data were mainly collected from internet sources. The internet sources used include: research gate and science direct sites, as well as google search engine and google scholar. The data gathered were analysed by content analysis. The result was grouped in themes and presented using descriptive approach with the aid of a table and diagram for better understanding.

3. Results

3.1. Noise Pollution and Construction Waste

Pollution refers to changes that are undesirable. These changes occur in the air, land and water affecting their biological, physical or chemical composition and may harmfully affect our living conditions, raw material resources, human life and other species [5]. Pollution in building construction is mainly in the form of environmental pollution which also includes air, dust and noise pollution. According to Dixon [6], the estimate of the pollution of the world that can be attributed to buildings are: air quality in cities (23%), drinking water pollution (40%), climate change gases (50%), ozone depletion (50%) and landfill waste (50%). Environments around construction sites are usually disturbed by the noise pollution generated from construction activities. This negatively affects neighbours and construction workers [7].

Several authors have varying definitions of what constitute waste in construction. Material waste in construction can mostly be considered as a by-product that is produced as a result of activities relating to construction, renovation and demolition of structures [8]. Ayegba [9] referred to construction material wastes as those materials supplied to the site for construction, but were not used. Ameh *et al* [8] viewed it as wastefulness that occurs from the utilization of assets in larger amounts than necessary in the construction of building. Construction waste also include debris removed from construction sites and disposals in landfills. From the above narratives noise pollution that emanates from construction activities are a source of disturbance to both neighbours and construction workers. While construction wastes are not only hazardous to people but the environment as well. It is therefore important that these two construction by-products are effectively controlled in order to minimize their adverse effects.

3.2. Sources of Noise Pollution and Waste in Building Construction

The source of noise pollution in building construction comes from the activities that take place at the construction site and the equipment that are used, such as bulldozers, air compressors, pneumatic hammers, loaders, pavement breakers and dump trucks [10]. The source of construction waste during building construction comes from the materials used, which are by-products of construction processes [11]. These by-products are caused by some factors shown in table 1 and ranked in order of their significance.

Table 1. Causes of construction waste ^[12]

Causes of Construction Waste	Mean Rank Value	Rank
Poor site management and supervision	7.17	1
Lack of experience	7.71	2
Inadequate planning and scheduling	7.78	3
Mistakes and errors in design	8.00	4
Mistakes during construction	8.34	5
Incompetent subcontractors	8.76	6
Rework	9.02	7
Frequent design changes	9.24	8
Labour productivity	9.35	9
Inadequate monitoring and control	9.40	10
Inaccurate quantity take-off	9.74	11
Shortage of site workers	10.09	12
Lack of coordination between parties	10.21	13
Slow information flow between parties	10.61	14
Shortage of technical personnel (skilled labour)	10.91	15
Changes in material specification and type	10.93	16
Equipment availability and failure	11.83	17
Effect of weather	11.90	18

Table 1 shows that the highest ranked sources in descending order are poor site management and supervision, lack of experience, inadequate planning and scheduling, mistakes and errors in design and mistakes during construction. The lowest ranked sources in descending order are slow information flow between parties, shortage of technical personnel (skilled labour), changes in material specification and type, equipment availability and failure and effect of weather. Other sources in between include, incompetent subcontractors, rework, frequent design changes, labour productivity, inadequate monitoring and control, shortage of site workers, inaccurate quantity take-off and lack of coordination between parties [12].

Waste can likewise be delegated as physical and non-physical waste as shown in Figure 1.

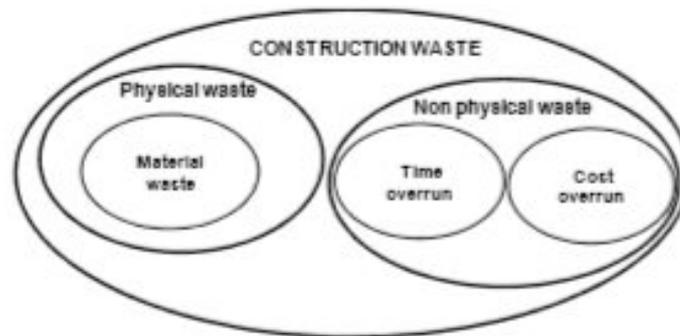


Figure 1. Categorization of waste types in construction ^[13]

Material waste falls under physical waste, while cost and time overrun are categorised under non-physical waste. Waste can also be grouped under six sources which include: residual, operation, handling, procurement, design and others [14]. According to the just-in-time concept, waste in construction can be grouped into seven categories as follows: waste from defects, delays, over-production, excess inventory, transportation, motion and unnecessary people processing [15].

Wahab *et al* [16] listed other sources of waste as: the design of building; material damage due to weather, inappropriate storage, mishandling or careless delivery; over consumption of resources; rework; vandalism; site office waste; lack of recording; materials supplied and their use on site. Construction waste are generally caused by slip-ups, working out of order, unnecessary repeated actions, untimely sources of information or not addressing issues on time.

3.3. Impact of Construction Waste on Cost

In construction projects, waste contributes up to 15% additional cost [14]. The cost implication of waste is due to the fact that materials become inadequate because of poor preparation, management and storage. The inadequate materials would then require replacement which increases the cost of the project [14]. Additional financial losses are incurred in a construction project due to purchases to replace squandered materials, delays on the project, revisions to address mistakes and managing produced waste, all of which can lead to heavy losses if not handled correctly [17]. Since materials represent around 30% to 70% of construction cost, material wastage results in the range of 20% to 30% of project cost overruns [17]. Materials are a significant component of a construction development venture. Therefore, poor management of materials in construction will lead to a variation in the cost of the project. Materials and installed equipment used in a construction project can account for 50% to 60% respectively, of the total project cost and affect 80% of its schedule [4]. This implies that unless the generation of waste is curtailed and effectively managed, the construction industry will continue to experience unnecessary financial losses. To this end, there is a need to find ways of improving the situation.

3.4. Impact of Noise Pollution and Construction Waste on the Environment

Exposure to noise pollution over time can lead to severe health risks to site workers and neighbours such as hearing impairment, stress, cardio vascular disease, hypertension, sleeping disturbance, loss of voice, loss of attention. It can also lead to lower productivity for site workers [7]. Therefore, the reduction of noise pollution is necessary to protect the health and wellbeing of site workers and neighbours.

Construction wastes that are not properly handled cause increasingly serious problems to the environment [18]. When there is no clear framework for waste control, they are disposed of illegally. This harms the environment and depletes landfills resources. Illegal practices include: illegal dumping in deserted and forested areas; dumping waste in waterways; mixing construction waste with domestic waste; burying waste in abandoned sites and illegal burning of waste [18]. Therefore, controlling

waste generation and noise pollution on construction sites is necessary in order to minimize the negative effect they have on the environment.

3.5. Noise Pollution and Waste Control Techniques in Building Construction

There are various methods of controlling and managing noise pollution and the generation of construction waste in a project site. Some of these control measures are examined in the following sections.

3.5.1. Noise Control Techniques. Noise control can be categorised into two main groups as follows: passive noise control and active noise control. These control measures aid in mitigating the transmission and emission of noise. Passive noise control focuses on reducing the transmission of noise, while active noise control involves reducing noise emission from its source [7].

Passive noise control includes the following: planning and organising the construction site layout of site in order to limit the exposure of workers to noise and to allow equipment and material move freely within the site without obstacles; organising construction activities in order to prevent unnecessary movement of equipment and materials around the site and organizing equipment to be able to move freely without obstacle. Others include: using noise isolation or sound proof barriers wherever possible; isolating noisy activities to noise zones where they would cause the least disturbance; marking noisy zones to prevent workers from entering unnecessarily; using hearing protection devices for site workers and adequately training personnel in order to avoid inadequate use of equipment and to appropriately protect themselves [7].

Active noise control techniques include: substituting equipment that use internal combustion engines with electric motors; use of power tools in place of traditional tools such as using nail guns instead of hammers; substituting noise generating activities with quieter methods and use of concrete mixers should be done at the construction plant preferably. Other control techniques are: substituting cranes with electric lifts if possible; use of damping to reduce impact noise; maintenance of machines periodically in order to reduce noise output and modifying machines to generate less noise. Also, the use of walkie-talkies for communicating instead of shouting commands and minimising the operating time for an equipment that generates noise, especially if it cannot be replaced by a less noisy alternative [7].

3.5.2. Waste Control Techniques. Reducing waste in construction can be achieved through the use of various techniques such as: site management, using standardized construction materials, adopting waste management systems, using waste rate estimation to improve the material handling, improve productivity and reduce the rate of waste. The use of alternative construction methods such as large panel systems, modularization, prefabricated components, off-site construction techniques and reducing the need for wet works can also be employed to reduce waste. Other methods include sorting construction waste as it is generated, stock control to minimize over ordering and educating site workers [4,14]. Waste management is necessary to deal with the already generated waste in an effective manner in order to reduce their effect on the environment. It involves using alternatives to waste disposal which are to: reduce, reuse, recycle and recover. These four techniques are known as the R's of construction waste management, while the fifth is disposal.

- i. **Reduce:** This is the first process in waste management. It involves reducing the amount of material that is produced for building construction. It can be achieved by reviewing how projects are designed in order to produce less waste, coordinating a project properly, avoiding material over-ordering, using standard quantities and sizes of materials and ensuring that stores are secure, safe and weatherproof.
- ii. **Reuse:** This method is effective for increasing cost savings on a construction project. This is achieved by reusing surplus materials in different projects, using cut-offs and selling off surplus materials. It helps to reduce the demand for new material and the impact of construction waste has on the environment.

- iii. **Recycle:** This method begins by sorting the waste generated into different categories. The reusable materials are separated from solid and unsafe ones, treated and returned back to the economy as a constituent of other products. The benefits of recycling include the reduced environmental impact of waste, improved cost effectiveness of waste handling and the conservation of natural resources.
- iv. **Recovery:** Recovery can be described as the removal of components or materials from the stream of waste such that it can be reused in the same form it was originally produced in. It reduces the volume of waste ending up in a landfill.
- v. **Disposal:** Disposal is the least sustainable waste management method out of the above options. It is difficult achieving sustainability because it involves dumping the waste generated into the environment and does not contribute towards reducing generated waste. However, construction waste is disposed of in landfills by many countries [14].

Figure 2 shows waste reduction hierarchy from the most favoured to the least favour in descending order which is reduce, reuse, recycle, recovery and landfill.

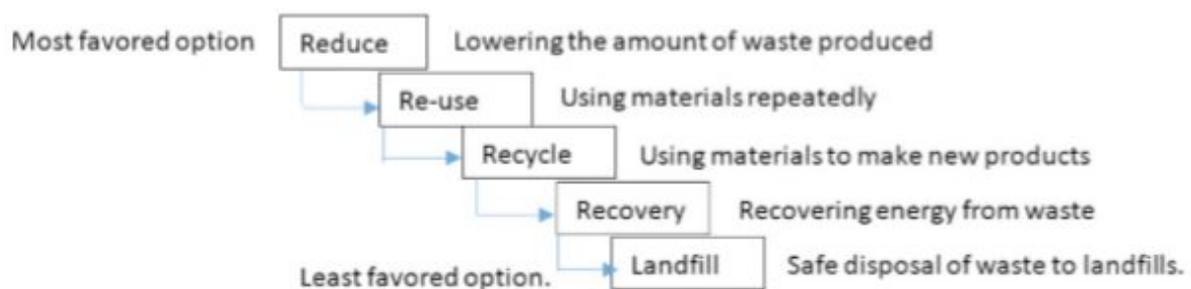


Figure 2. Waste Reduction Heirarchy^[14].

Some other methods that can be used to minimise the quantity of waste generated on construction projects are itemised as follows:

- i. Co-ordination between construction companies and designers;
- ii. Encourage effective communication among project stakeholders in order to keep relevant parties abreast on steps taken;
- iii. Planning the arrival of materials and products in order to stock them appropriately and in the order that they will be used;
- iv. Storing gravel, sand, soil and other comparable materials effectively to prevent them from spilling;
- v. Removing accident spills of materials before the day end;
- vi. Rejecting faulty materials when delivered in order to avoid disposal;
- vii. Materials delivered on site should be packed in order to reduce cracks during transportation and handling;
- viii. The number and amount of packaging materials should be reduced, especially those that are difficult to recycling or reuse;
- ix. Selecting products that leave the least amount of residue; and
- x. Storing materials appropriately in safe areas to protect them from deterioration;

The just-in-time (JIT) concept is another technique used to reduce waste and increase productivity. It is guided by six principles. The principles are: eliminating the categories of waste; uninterrupted workflow; Kanban or pull system; total quality control which ensures that completed works are free from defects before going on to the following step; employee participation by providing training and responsibilities in several areas and supplier relations which ensure the delivery of continuous high-quality materials and components [15].

3.6. Noise Pollution and Waste Control Techniques in Nigeria

3.6.1. Noise Control Techniques. There are a number of ways by which noise pollution on construction sites are controlled in Nigeria. They include: modifying existing equipment; using quieter equipment; using barrier protection; maintenance of equipment and using partial enclosures. Others techniques are: total enclosures; work activity scheduling; noise perimeter zones; proper maintenance; modified operating procedures. Similarly, the relocation of noisy vents away from workers; replacement of equipment with a quieter version; modified room treatment to reduce noise transmitted; relocation of equipment; and running equipment at lower speed or less than its full power are other control techniques in Nigeria [19-21].

Reducing noise pollution by dampening at the source is one of the best methods used for noise reduction. Personal Protective Equipment (PPE) is necessary when noise exceed 85 dB(A). Using shock mounting assemblies, noise mapping, and smoothing the transport route to site are also noise reducing techniques employed [22].

3.6.2. Waste Control Techniques. Construction companies in Nigeria have used a number of techniques in order to minimize and manage the generation of waste on their sites, some of which include: use of prefabricated elements; sorting of generated waste; open dumping; open burning; and composting disposal method [16]. Although, the study carried out by Wahab *et al* [16] indicated that the percentage of respondents that used waste control techniques are as follows: use of prefabricated elements (9.10%); sorting of generated waste (14.29%); open dumping (70.5%); open burning (16%); composting disposal method (13.5%). Their study also indicated that: site space as a factor is highly ranked in affecting the choice of on-site sorting; during construction process most sites did not sort out waste generated; there were unplanned deposition of waste on sites and a 100% of the respondents had never calculated the volume of waste that could be generated per surface area using waste indices [16]. All of which has led to indiscriminate dumping of refuse in landfills without considering the negative impact their activities and materials have on the environmental and the public. Dania *et al* [23] showed that the reuse of materials and sale as scrap such as timber for firewood were methods that are widely adopted. Other methods are recycling, reducing the amount of materials used, controlled dumps and waste packaging. To effectively implement site waste management practices, a government legislative framework is required to make waste management a focus [11,24].

Some other important strategies used to reduce waste in descending order include: adequate site supervision and control; proper storage handling and usage of materials; effectual material planning and policy control; ensuring the comprehensive design detailing and specifications are correct; site security; education and training of site personnel; avoiding late changes at critical stages of the development and recycling of materials where economical [15].

4. Conclusion

The study set out to identify the noise pollution and waste control techniques in Nigeria. The result shows the sources of waste construction and noise pollution are from the equipment used and the activities employed on the construction site in addition to mistakes and unnecessary movements. The results also showed the negative impact construction waste has on cost and the damaging effects of construction waste and noise pollution on the environment and other control techniques. It is observed that though professionals in the construction industry are mindful of some of these waste control measures, they do not implement their control techniques adequately. There is a poor practice of waste management concepts and noise pollution techniques. Generally, awareness is needed for construction professionals to know the impact of noise pollution and construction waste on the environment and the public's wellbeing, as well as the benefits of using sustainable control strategies in their projects. The study recommends that outdated waste management practices such as open dumping and burning should be stopped because of their negative impact on the environment. Also, a legal framework for noise and construction waste should be developed and enforced. Furthermore, site workers should be

educated on noise and waste control techniques and machines that use combustion engines should be replaced with those that use electrical motors. The authors recognise that the sources and the scope used for the paper are a limitation to the study. Hence, further studies could explore the use of more internet search engines to gather data. In addition, suggested areas for further research include: comparative analysis of noise control and waste management techniques employed before and after construction projects; noise pollution and waste management strategies used in construction projects in other countries; and to carry out similar studies using primary sources to collect data.

Acknowledgements

The authors are grateful to Covenant university for providing the funds, facilities and an enabling environment to carry out and publish this paper. The authors are also appreciative of researchers whose work were used and duly acknowledged in the study.

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