AN APPRAISAL ON THE MINIMIZATION OF WASTE IN CONSTRUCTION SITES IN MINNA METROPOLIS

BY

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2016/1/62190TI

DEPARTMENT OF INDSUTRIAL AND TECHNOLOGY EDUCATION, SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NIGER STATE

APRIL, 2023

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A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION,

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF TECHNOLOGY (B. TECH) DEGREE IN INDUSTRIAL AND TECHNOLOGY EDUCATION

APRIL, 2023

DECLARATION

I, ABDUL-HAMID Abubakar Ahmed with matriculation number 2016/1/62190TI, an undergraduate student of the department of Industrial and Technology Education, certify that the work embodied in this project is original and has not been submitted in parts or full for any other diploma or degree of this or any other University.

……………………………………. ……...……………………………

Name and Matric No. Sign and Date

CERTIFICATION

This project has been approved as meeting the requirement for the award of B. TECH. degree in Industrial and Technology Education, School of Science and Technology Education, Federal University of Technology, Minna.

Dr. A. B. Kagara ……………………………….

Project Supervisor Signature and Date

Dr. T. M. Saba ………………………………

Head of Department Signature and Date

……………………… ………………………………

External Examiner Signature and Date

DEDICATION

I dedicate this work to my father, mother and siblings.

ACKNOWLEDGEMENT

My profound gratitude goes to my supervisor, Dr. AB KAGARA, who remained patient with me, overlooked my shortcomings and supported me like his son whenever and wherever the support is needed. I'm also grateful to all the lecturers who had taught me either one thing or the other, for if not for the tremendous role they played in my life, I wouldn't have never thought about being who I am today and what I would become in the future.

My most special gratitude goes to my father, Alh. Hamidu Amadu Dikko and mother Hauwa'u Muhammad Jallo for all they've done for me; words can't quantify the magnanimity of the role they've played in my life. Also, I relay my most sincere appreciation to my siblings, cousins and friends for the tremendous contribution they've made to my life.

Finally, I thank the almighty Allah for seeing me through this journey from the inception to this point of delivery. Alhamdulillah!

ABSTRACT

This research work was designed to assess waste minimization in building construction sites. The main objectives of this work are: to identify the sort of construction waste often generated on site, to identify the importance of waste control in the construction industry, to identify the causes of waste on construction site, and lastly to identify the ways to be taken to reduce waste on construction sites. Literature reviews have been forwarded to examine the objectives and elaborate more on it. A survey research design was adopted for the study, were data was collected through questionnaires, in research, administered to companies, and professionals in the area of study, and the data gathered were carefully analysed and assessed, and presented by the use of tables. The target population for the study is 62 which consisted of 38 architects and 23 site engineers on the construction sites. The three hypotheses tested at 0.05 level of significance. The study finds out that there's no professional in the building construction industry that wants abundant waste on site; the study also found that waste is a common thing/phenomenon encountered in a construction site; it was also discovered that waste minimization is not highly important in building construction site to the professionals. After the study of the causes of construction waste, the following recommendations are made in order to minimize the accumulation of waste on construction site: contractors are advised to focus on quality in the construction activities so as to mitigate rework, which is identified as the major cause of material wastage on site. Contractors should secure safer smoother means of transporting materials to sites in order to reduce the wastage incurred through the difficulties in transportation. Clients should be enjoined to provide the necessary information to lessen last minute changes so that contractors can effectively manage their materials.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The majority of materials produced during the construction of new buildings and civil engineering structures, as well as when existing buildings and civil engineering structures are renovated or demolished via deconstruction activities, are known as construction and demolition waste (C&DW). Every public building project includes civil-engineering structures such as street drainage, roads or highways, bridges, utility plants, and dams. However, waste generation is a significant issue in construction projects, and the negative impact of waste has influenced C&DW management in many countries (Ademilade Aboginije, Clinton Aigbavboa & Wellington Thwala, 2021).

Waste is classified as foreign matter that has no immediate use at the point of creation. multitudinous waste generation conditioning including construction operations on one hand and poor waste operation methodologies on the other, lead to important waste being disposed of in authorized and unauthorized public spaces causing detriment to the terrain and the occupants as a result "(Chandrappa & Das, 2012)

Huge volumes of solid waste are produced every year from construction and demolition activities making construction a leading source of solid waste in many countries and cities (Tam et al., 2006). The same authors stated that increasing generation of these wastes has led to a significant impact on the environment and has since escalated to be a major public concern. As such, minimization of construction waste has become a pressing issue. Tam et al. (2006) identified six major reasons for excessive construction waste - cutting components on site; overordering; damage to material and components during transportation; loss during installation; poor workmanship and design or specification changes.

Nigeria generates approximately 32 million tonnes of waste per year, according to the Federal Ministry of Environment, one of the largest in Africa. Almost 70% of the waste produced end up in landfill, beaches, sewers and water bodies. According to Ajayi et al., Shen et al. stated that C&DW is the major contributor to nearly 15-30% of the total volume of waste disposed in several landfill sites in most countries, but this figure is bound to increase to approximately 40% when the amount of C&DW generated in construction per tonnes per day is taken into account. Therefore, reducing waste on construction sites is crucial for project planning and management, and it should receive enough attention. To complete a job safely and profitably is one of a contractor's main goals. Contractors live by the money they make through their expertise in order to exist. Additionally, poor material management during construction can lead to significant, needless costs. Due to insufficient quantities of material being used for manufacturing, this could lead to the contractor using insufficient materials and subsequently producing work that is nonconforming to specifications. Failure to minimize waste can have serious consequences. Poor waste management on building construction sites can lead to a lack of materials for on-site production, forcing contractors to produce non-conforming products.

For starters, using insufficient quantities of materials may cause a structure to partially or completely collapse. Weak spots on a structure are prone to collapsing due to insufficient strength to withstand both dead and imposed loads. Secondly, it may result in a contractor's lack of patronage, implying that the contractor is unable to secure contracts and, ultimately, liquidation. This means that both the contractor and his or her employees will be out of work. Thirdly, it is a measure of a contractor's ability. A collapsed building caused by insufficient strength of building components could be the result of the contractor's lack of construction knowledge or the contractor's use of fewer materials for production. Fourth, it reveals the level of competence of professionals in the industry in the event of a building collapse, and that the industry is not safe. It must be understood that a nation's infrastructure and development are heavily reliant on the construction industry, and particularly the building sector. As a result, it is critical that materials are well managed on site in order to reduce waste and its associated problems. Waste generated by construction operations must be taken seriously because the construction industry contributes a significant amount of waste to a country's overall waste volume. Today, its significance has a clear impact and has become critical in the pursuit of productivity goals.

In addition to being a waste-aware society, it is critical to effectively communicate and develop adequate understanding of waste minimization. Wang etal. (2015) in their study to identify the stylish design strategies for construction waste minimization set up that the use of prefabricated factors exerts the largest influence on waste reduction, followed by many design variations during construction and investments on waste reduction. This sentiment was preliminarily stressed by Baldwin etal. (2008). Specifying operation of prefabricated factors in the design reduces waste generation during the construction stage. Zutshi and Creed (2015) emphasized that there's a need to incorporate perceptivity in design and wise application of accoutrements during construction to help gratuitous declination. Still, Baldwin et al. (2009) and Poon and Jaillon (2009) argue that standardization is a pre-requisite for operation of prefabricated factors else prefabricating alone cannot win the battle against waste generation on construction systems.

A design that completely considers ahead of time every detail of the factual construction process efficiently prevents gratuitous material waste (Wang etal., 2015). The same authors further stated that it's important to keep design changes during construction to a minimum while at the same time investing in waste reduction styles like enforcing training programmes to ameliorate pool mindfulness in order to reduce waste on construction spots. It would be intriguing to know the extent of any similar programmes in Gauteng.

Ding etal. (2016) stated that effective construction waste operation is of high significance for unborn sustainable development. Waste generated from construction conditioning can have numerous negative impacts on the terrain if not duly managed. These authors set up source reduction to be an effective waste reduction strategy and sorting construction waste to be vital in construction waste recycling and exercise. It has been mentioned that attention should be paid to source reduction styles similar as low waste technologies and on- point operation in order to achieve better environmental performance of the construction waste reduction strategies. It would be intriguing to identify the extent of waste sorting on construction spots in Gauteng and what happens to this waste. Ding et al. (2016) also stated that the most common and traditional result for construction waste in a lot of places worldwide is landfilling. Still, the authors admit grounded on previous studies, that the strategy of landfilling consumes a lot of land coffers and it has been delicate to meet the demands for landfilling in numerous countries and metropolises. Waste on tips causes dangerous goods on the terrain especially if not duly managed; therefore, waste operation has become a critical issue for the assiduity and the government. It has also been noted that a larger element of construction waste is solid matter thus if landfilling is the sole strategy employed to deal with waste, a huge quantum of land will be enthralled and soil will be defiled.

The construction assiduity has always been a major patron of material waste (Baldwin et al.; Poon 2007). Construction waste generation is dynamic; thus, prognosticating waste situations in advance isn't easy. The most effective system of reducing environmental impact of construction waste is by primarily precluding its generation or reducing it as much as possible. If waste generation couldn't be averted or only averted to a certain degree, the coming step should be to insure that construction waste is reused and reclaimed as much as possible (Esin and Cosgun, 2007; Poon 2005). Solid waste is a precious resource offering several social, profitable, environmental and technological benefits (Potdar etal., 2015). The growing sluice of waste requires a sustainable waste operation strategy (Jamas and Nepal, 2010). Yet, by reviewing the waste operation experience of some metropolises for the once many decades, it's perceived that radical changes are demanded to render the waste operation system more sustainable (Chung and Poon, 1998). It has been noted that proper waste operation generally yield some profitable, social and environmental benefits – precious coffers are recovered, health pitfalls lessened and environmental declination avoided. Hence the study is set to appraise on the minimization of waste in construction site in Minna metropolis.

1.2 Statement of the Problem

The environmental impact of construction waste is extensive. There are various methods demanded in the execution of mega projects in Minna, and with many commercial building and housing development projects planned, the construction sector generates a large amount of construction waste. Construction waste must be balanced justifiably with waste disposal because the large volume and diverse compositions have the potential to cause serious problems and have a negative impact on the environment. The procedure entails raising awareness, conserving cleanliness, and implementing an efficient waste management system. To maintain better construction waste monitoring, sustainable development must demonstrate benefits to the public rather than sacrifice.

The amount and type of waste products generated are determined by factors such as construction stage, type of construction work, and on-site disposal practices. Extra construction materials are typically planned as a result of a failure to consider waste reduction during the planning and design stages in order to minimize waste generation. Excessive waste of raw materials, poor waste management, and a lack of awareness about the need for waste reduction are all common on local construction sites. As a result, waste minimization is an important concern in waste management implementation. Construction activity growth generates construction waste, which is quickly becoming a serious environmental problem with lethal consequences. The majority of construction and demolition waste in our country is not recycled and instead ends up in landfills, taking up valuable land. not to mention the cost of land filling.

In line with this, the study was designed to assess the benefits of waste minimization, the materials that could be recycled, the methods used to dispose of waste materials, and the reasons why recycling is not popular.

1.3 Purpose of the Study

The purpose of this study is to assess waste on construction sites. So, in order to achieve this goal, the following objectives are listed below:

i. Identifying the causes construction site waste in Minna metropolis
ii. The Factors that affect the minimization of construction site waste in Minna metropolis.
iii. Strategies to be employed for minimizing construction site waste in Minna metropolis.

1.4 Significance of the Study

This study was conducted for a variety of reasons, the most important of which is that construction industry waste is one of the three major environmental problems. So we can reduce that through construction management and reap the benefits of waste reduction on the construction site. Some of the benefits of waste management are:

i. It helps to avoid accidents: the construction crew needs to make sure the trash and debris are thrown away appropriately to prevent any accidents. In case a fire starts or anything gets tossed into some equipment, make sure they are aware of what objects are dangerous.

ii. Maintains healthy working environment: keeping a variety of tools and materials on hand in order to maintain a safe building site, such as dump trucks for transporting dirt and pallets for storing bulky goods like bricks. Make sure there are consistently enough trash cans available so that your staff can dispose of their rubbish without any problems.

iii. Reduces cost: By using resources more efficiently, minimizing the waste you need to dispose of, and enhancing the productivity of your employees and contractors, you may reduce your expenditures. Then, you might be able to sell your services for less money in an effort to secure more bids.

    By becoming a "green" builder, you may set yourself apart from your rivals' businesses by actively decreasing the trash from your construction projects. Clients that are conscious of the negative impact trash may have on company budgets and reputation is looking for contractors who understand waste reduction and actively pursue it.

iv. Environmental friendly: waste management is crucial to ensuring that your project is environmentally sustainable. When waste is not disposed of in an environmentally sustainable manner, it can harm the local ecology and the places around it by contaminating the water supply or adding to air pollution.

v. Keeps track of materials: To prevent materials from being unintentionally thrown away, every piece of construction equipment must be tracked at all times. This contributes to time management as well as cost control. You wouldn't want to waste such a valuable resource if you are employing Reo mesh to keep your walls stable. This frequently occurs on construction sites and can be controlled with simple procedures. This can be as easy as designating unique colours for trash piles or maintaining a log. Never dispose of unnecessary materials until they are almost no longer functional on the site, or until there is nothing left that can be salvaged from them.

In addition, we would look into how to reduce the construction burden on the landfill and give more life to it. Another reason for this study is to determine how to prevent construction waste by which method and which way to minimize construction waste to notify those responsible or supervisor or contractor to the workers on site to work properly and how to prevent waste sources. Aside from that, this study hopes to persuade those in charge or anyone involved in the construction industry, such as builders, engineers, developers, construction site managers or supervisors, and contractors, that recycling is the best way to dispose of waste materials.

Recycling the materials reduces the burden on the landfill while also extending the life of the landfill. Instead of sending the materials to incinerators, the contractor can send the materials to a recycling centre or any recycling company. Recycling materials on site or sending them to a recycling centre will generate profit for the contractor or at the very least recoup his losses while also protecting the landfill and giving it new life. This is how builders and contractors in Minna building construction industry can reduce landfill waste and protect the environment.

1.5 Scope of the Study

The concentration of this study is to identify the causes of construction site waste and the factors that affect the minimization of such waste in construction sites. This study will also cover extensively the strategies to be employed in the minimization of the wastes in construction sites within Minna metropolis.

1.6 Research Question

1. What are the causes of construction site waste in Minna metropolis?
2. What are the factors that affect the minimization of construction site waste?
3. What are the strategies to be employed in reducing waste generation and accumulation in construction sites in Minna metropolis?

1.7 Hypothesis

The following null hypotheses, which will be tested at 0.05 levels of significance, are formulated to guide the study:

H01: There is no significance difference in the mean responses of architects and site engineers in the causes of construction site waste.

H02: There is no significance difference in the mean responses of architects and site engineers in the factors that affect the minimization of construction site waste.

H03: There is no significance difference in the mean responses of architects and site engineers in the strategies to be employed for the minimization of construction site waste.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The literature review of this study is done under the following sub-headings:

1. Theoretical framework

   1. The concept of waste
   2. Waste management

2. Conceptual framework

   1. Construction waste and waste management in building construction site
   2. Definition of Construction Waste
   3. Types of Construction Waste
   4. Construction Waste Management
   5. Construction waste management strategies
   6. Steps In Waste Management In Building Construction Sites
   7. Sources of construction waste and problems faced
   8. Benefits Of Waste Management In Building Construction Sites

3. Summary of the literature review

3.1 Theoretical Framework

3.1.1 The Concept of waste

Human interactions (human activities) with the environment have always contributed to waste production. However, according to Giusti (2009), waste generation and management were not major issues until humans began living together in communities. According to Vergara and Tchobanoglous (2012), as the population and purchasing power of people grow, more goods are manufactured to meet rising demand, resulting in increased waste production. According to Marchettini et al. (2007), these continuous flows of waste from human activities have overburdened the environment.

The sixteenth century saw a significant increase in waste generation as people began to migrate from rural to urban areas as a result of the industrial revolution (Wilson, 2007). This migration of individuals to cities resulted in a population explosion, which in turn resulted in an increase in the volume and variety of wastes generated in cities. Metals and glass started to appear in huge volumes in municipal waste streams around this time (Williams, 2005). The dense population of cities and communities resulted in the wanton disposal of waste hence polluting the environment. These dumps, in turn, became perfect breeding ground for rats and other vermin, posing serious public health risks. Unhealthy waste management methods caused a number of epidemic outbreaks with a high mortality rate (Tchobanoglous et al, 1993). As a result, public officials began to dispose of waste in a controlled manner in the nineteenth century in order to protect public health (Tchobanoglous et al, 1993).

3.1.2 Waste Management

Most developed countries went through a period of environmental development. But today, the majority of these nations have successfully dealt with most of the problems with environmental and health pollution brought on by the production of waste. In contrast, the growing rate of urbanization and development in developing countries is now causing a recurrence of the same problems that developed nations have had to deal with in the past (Wilson, 2007).

3.2 Conceptual framework

2.2.1 Construction Waste and Waste Management in Building Construction Sites

According to Ekanayake and Ofori, 2000, "construction waste can be divided into three principal categories namely: material, labour, and machinery waste. However, material wastage is given more concern because most of the raw materials used in construction industry come from non-renewable resources". Construction waste is defined as: the difference between the value of those materials delivered and accepted on site and those used properly as specified and accurately measured in the work, after deducting the cost saving of substituted materials and those transferred elsewhere (Peng and Tan, (1998).

Similarly, the Building Research Establishment (BRE) has defined building waste as the difference between materials ordered and those placed for fixing on building projects (Skoyles and Skoyles, 1987). Recently, for the purpose of evaluation of the construction material waste sources, Ekanayake and Offori (2000) have given a broader definition of the construction waste as: any material, apart from earth materials, which need to be transported elsewhere from the construction site or used within the construction site itself for the purpose of land filling, incineration, recycling, reusing or composting, other than the intended specific purpose of the project due to material damage, excess, non-use, or non-compliance with the specifications or being a by-product of the construction process. Construction waste is a major source of waste in many countries. They stated that the majority of the country's construction wastes contained both inert and non-inert materials. Further to that, Jaillon et al. (2009) stated that the large amount of solid waste produced by the Hong Kong construction industry is due to the country's limited land availability.

According to a study (Mcdonald & Smithers, 1998), Australia generates 15% or so of the country's annual solid waste landfills on average. According to Faniran & Caban (1998), Australia's strict regulations on landfills are a major contributing factor to the enormous amount of waste the country's construction industry generates. According to Faniran and Caban, the majority of construction waste is caused by design errors, design changes, packaging, and unused scrap materials, among other things.

Demirbas (2011) defines waste management as the process of gathering, transporting, and processing waste before disposing of any residual remains. Tchobanoglous et al. (1993) define solid waste management as the supervision and handling, storage, collection, conveyance, treatment, and disposal of waste in a manner that protects the surroundings and the public. Tchobanoglous et al. also stated that solid waste management employs skills and expertise from a variety of disciplines, including legal, financial, and administration, among others, in the day-to-day operation of waste management issues. According to Demirbas (2011), the primary reason for waste management is to ensure a safe environment.

2.2.2 Definition of Construction Waste

Construction waste is defined as anything generated during construction and then abandoned, regardless of whether it has been processed or stockpiled. Surplus materials from site clearance, excavation, construction, refurbishment, renovation, demolition, and road work are included.

Construction waste is classified into two types:

- Construction waste that is inert
- Construction waste that is non-inert

Non-inert construction waste accounts for approximately 20% of total waste and typically consists of bamboo, timber, vegetation, packaging waste, and other organic materials. Some of these can be recycled, while others end up in landfills.

In contrast, inert waste, also known as public fill, consists primarily of construction debris, rubble, earth, bitumen, and concrete that can be used to create new land. Concrete and asphalt can also be recycled for use in construction.

2.2.3 Types of Construction Waste

Construction waste can be broadly categorized into two types: direct and indirect**.**

Skoyles and Skoyles (1987) defined direct waste as the waste that can be prevented and involved the actual loss or removal and replacement of a material, while in-direct waste is not wasted physically; but the payment for the material can be wasted partially or totally. Gavilan and Bernold (1994) and Bossink and Brouwers (1996) grouped the causes of direct and indirect wastes into six categories, including design, procurement, material handling, operation, residual and others such as theft (Table I). Further, Faniran and Caban (1998) used this categorization for their study of identifying waste minimization strategies. They found that design changes contributed the highest waste (52 per cent) to the total construction waste.

2.2.4 Construction Waste Management

Waste minimization is a waste management strategy that aims to reduce the amount and toxicity of hazardous waste product. Aside from hazardous waste regulated under RCRA, the EPA promotes waste minimization techniques that focus on preventing waste from being created in the first place (source reduction) and recycling. Waste reduction can be accomplished in three ways: source reduction, recycling, and treatment.

2.2.5 Construction waste management strategies.

Four main construction waste management strategies were identified from the literature (Gavilan and Bernold, 1994; Faniran and Caban, 1998). They are:

1. Reuse;
2. Avoid or reduction;
3. Recycling; and
4. Disposal

Among these three strategies, avoiding waste, which refers to waste elimination or minimization, has been given the highest priority because it requires the fewest resources other than planning and design skills. Creating a waste minimization culture in the construction industry could be the first step in a waste reduction strategy (Teo and Loosemore, 2001; McDonald and Smithers, 1998). Reusing materials literally implies moving them from one application to another. The third option is recycling, which is the separation and recycling of recoverable waste materials generated during construction and remodeling. Composting, in which organic land-clearing debris is processed to produce humus for soil treatment, has also begun to emerge as a new application of an ancient technology (Ekanayake, 2000). Furthermore, incineration is another method of destroying waste by burning it, and while it was once considered a practical method of disposing of hazardous waste materials, it has recently become controversial for a variety of reasons, including the production of toxic gas and ash, which can harm local populations and pollute groundwater. The lowest level of the hierarchy is disposal or land filling.

Since reduction has been identified as the most effective waste management strategy, several construction techniques can be recommended as waste reduction initiatives.

The literature emphasized off-site construction technology (dry construction). For example, using pre-cast elements could reduce waste on building construction sites by 30% to 40%. (Poon et al., 2004b).

Furthermore, there are numerous advantages to pre-cast element manufacturing, such as reduced time and overall cost due to the ability to run multiple production lines concurrently; increased constructability and reduced site congestion due to the transition from an uncontrollable work environment on site to a controllable one in factories (Benjaoran and Dawood, 2004). As a result, the current paper seeks to determine how effective the use of pre-cast elements in building projects is in reducing construction waste.

2.2.6 Steps In Waste Management In Building Construction Sites:

- Reduce resource consumption by building smaller houses that are better suited to your needs. This is the most efficient way to save valuable resources for future generations while also reducing waste. It also saves money.

- Reuse existing buildings and materials to reduce resource demand, reduce waste volume, and save money. Don't demolish; instead, deconstruct and repurpose old structures.

- Recycle resources that have been discarded or have reached the end of their useful life. This will reduce the demand for new materials while also lowering the volume of waste sent to landfills. Sending construction materials to a landfill is equivalent to throwing money away.

- Use renewable resources, such as sustainably managed forests. This creates a sustainable economy and aids in the conservation of non-renewable resources. Use materials with a high recycled content to create a market for recycled resources. It will raise the price paid by recyclers for recovered resources, increasing the viability of recycling.

2.2.7 Sources of construction waste and problems faced

The building construction process consists of several activities. Each activity involves the possibility of failure or success. Failure leads to the waste of materials, time, and money.

Greenwood (2004) and Formoso et al. (2002) identify twenty-six (26) different types of construction waste. They are as follows: transit waste, stockpile waste, application waste, conversion waste, residual waste, cutting waste, design, ordering and non-delivery, materials handling and storage, inventory, damage to other trades' work, purchasing materials, substitution, waiting time, transportation, processing, movement, production of defective product, last-minute client requirements, construction method, familiarity with construction technology, rework/improve, site space.

1. Insufficient regulations

The importance of comprehensive government regulations in assisting with construction and demolition waste management has received considerable attention. Despite the fact that the Nigerian government has implemented various types of regulations to reduce construction and demolition waste production, Tam (2008) discovered that implementing a mandatory waste management plan for all construction projects would have a significant impact on company productivity. Clear municipal regulations and rules for allowing and persuading contractors to use recycled products made from construction and demolition waste are lacking, according to Kartam et al. (2004).

2. Landfill

Our current waste disposal method (landfill) is economically unviable. The costs to communities of operating and maintaining landfill sites are high, and suitable land is scarce. Due to potential health hazards, re-use options for landfill sites are extremely limited. Remediation is frequently prohibitively expensive.

Due to high concentrations of heavy metals and toxic chemicals, landfill emissions and leachate can be extremely toxic. These toxins end up in the water table and/or waterways, often with disastrous results.

We must reduce landfill waste volumes and remove toxic content from materials before disposal, using an alternative to landfilling.

3. Insufficient awareness about construction and demolition waste management

Although practitioners' awareness about construction and demolition waste management is vitally important to effective waste management, waste management is perceived as a low project priority (Teo *et al.*, 2001). Consequences caused by the weak awareness of major practitioners have been extensively investigated. Innes (2004) and Poon *et al*. (2004), for example, found that about one-third of construction waste could arise from design decisions because designers attached relatively little importance to the potential for waste reduction when choosing building materials. Lam (1997) found that very few contractors had spent efforts in considering the environment and developing the concept of recycling building materials. Because contractors ranked timing as their top priority, their effort was always focused on completing the project in the shortest time, rather than the environment (Poon *et al*., 2001). Therefore, changing practitioners' awareness of construction and demolition waste management can make a significant contribution to the implementation of construction and demolition waste management (Teo and Loosemore, 2001)

4. Poor skills of operatives

Skill is one of the main factors affecting the amounts of waste produced by operatives (Chen *et al*., 2002). Significant amount of construction and demolition waste caused by various construction activities, such as cut-corner of construction formwork, poor plastering work, deformation during transportation and delivering, could be largely reduced if skills of operatives can be improved (Wang *et al*., 2004). Clearly, poor skill of the operative is a significant contributor to the large amount of construction and demolition waste generation.

According to Bilitewski *et al*. (1994) and Gilpin (1996) waste management encompasses collection, transporting, storage, treatment, recovery and disposal of waste, and is defined as a comprehensive, integrated, and rational system approach towards achievement and maintenance of acceptable environmental quality and support of sustainable development. In addition, Minks (1994) regarded waste management as a tool for controlling disposal costs of construction waste, as well as facilitating examination of other alternative disposal methods such as recycling and reusing in order to reduce waste that finally results in landfills. The European Environment Information and Observation Network (EIONET) also defined waste management plan as a "strategic document drawn up for achieving the objectives of waste management and waste prevention and recovery", adding a limitation of the environmental impact of waste on human health and the environment (European Environment Information and Observation Network (EIONET), 2006).

5. Lack of a well-developed waste recycling market

One of the most important factors in the recycling of construction and demolition waste is the availability of markets for receiving the recycled product (Mills *et al*., 1999). Peng *et al*. (1997) also stated that recycling requires an aggressive marketing effort to locate markets and sell materials at the highest possible prices. A rather low level of market development indicates that considerable time and money must be invested in establishing relationships, keeping track of pricing changes and becoming a reliable supplier of materials, in order to ensure a continuous intake of construction materials. Therefore, lack of a well-developed waste recycling market will to a large extent hinder the effective implementation of waste recycling.

2.2.8 Benefits of waste management in building construction sites.

An effective material waste management system can realise benefits for a builder or contractor.

Previous studies by the Construction Industry Institute (CII) concluded that labour productivity could be improved by 6% and can produce 4-6% additional savings (Bernold and reseler,(1991). Tam and Tam (2006), Kartam *et al*. (2004), and Tam (2008) list a range of benefits from managing construction waste; they include reduction in the overall cost of materials, better handling of materials, reduction in duplicated orders, materials on site when needed and in the quantities required, improvement in labour productivity, improvement in project schedule performance, enhanced quality control, better field material control, better relations with Proceedings of the 4th International Conference on Engineering, Project, and Production Management (EPPM 2013) 11623 suppliers, reduction in materials surplus, reduction in storage of materials on site, labour savings, reduction in purchasing costs, and better cash flow management. Against these various benefits, the costs of acquiring and maintaining a materials management system has to be compared. However, based on the aforementioned advantages it can be concluded that investment in such systems can be quite beneficial.

Summary of the literature review

In numerous cities around the globe, construction waste is evolving into a serious environmental issue (Cheung et al., 1993). Construction and demolition debris (C & D) frequently accounts for 10-30% of waste received at many dumpsites (Tchobanoglous and Kreith, 2002). Therefore, reducing waste and managing waste sustainably is a major problem today.

Most of the solid waste produced by commercial construction is recyclable and amounts to 2 to 2.5 kilos per square foot on average. Creating a waste minimization culture in the construction industry could be the first step in a waste reduction strategy (Teo and Loosemore, 2001; McDonald and Smithers, 1998). Recycling and salvaging C&D waste can significantly reduce the need for virgin resources and the negative environmental effects that go along with them. Furthermore, effective building waste management, including managing of non-recyclables, can reduce pollution and prolong the life of existing landfills. Lowering initial generation of waste is therefore favourable to reuse or recycling whenever possible.

A construction waste management strategy should acknowledge project waste as an essential component of overall inventory control. The premise is that waste management is a component of materials management, and understanding that waste from one project is material available for yet another project facilitates effective and efficient waste management. In order to make sure that contractors and suitable sub - contractor are fully aware of the effects of these requirements on their work before and throughout construction, waste-management requirements should also be brought up both during the pre - construction phase and at on-going regular job meetings. A standard quality-assurance program should be integrated with waste management, and waste management requirements should be discussed frequently throughout the project. Regulations set forth by local and state governments must be followed when applying ground gypsum board as a soil amendment and processed clean wood waste to surfaces. When feasible, compliance with the plan would be made easier by associating the completion of recycling paperwork with one of the payments made to each trade contractor.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research Design

The study used a descriptive survey research design. Descriptive survey research design is a process of gathering from participants who are thought to be representative of the entire population (Nworgu, 2006). Furthermore, according to Gall, Gall, and Borg (2003), the survey research method employs a questionnaire or an interview to gather information from a sample that has been chosen to represent a population within which the results of the data analysis can be applied broadly. The design was considered suitable since this study solicited information from the project supervisors, architects, builders, engineers, project managers, and quantity surveyors within Minna through the use of structured questionnaire.

3.2 Area of the study

Minna is located at latitude 9.5836 degree north and longitude 6.5463 degree east, has an altitude of 251m. As of 2007, Minna has a population of approximately 304,113 people. Minna is the capital city of Niger State Nigeria.

Minna is experiencing a rapid population growth. As a result, it is also undergoing rapid infrastructural development, resulting in the construction of buildings of various shapes and sizes. As such, waste from each of these construction sites is increasing.

3.3 Population of the study

The population of the study consisted of the entire population of architects and site engineers located in 3 building construction companies within Minna.

3.4 Samples and Sampling Techniques

The entire population of architects and site engineers were used for the study. Therefore, no sampling was carried out.

3.5 Instrument for data collection

The questionnaire was the main instrument used by the researcher for the collection of data for the study. The questionnaire was structured sections (A-D).

Section A consisting of respondents personal data, while section B-D consisted of respondents view on items of questionnaire which are numbered from 1 to 36

Section B addressed the causes of construction site waste in Minna metropolis with 14 items.

Section C addressed the factors that affect the minimization of construction site waste in Minna metropolis with 12 items.

Section D addressed the strategies to be employed for the minimization of construction site waste within Minna metropolis.

Five point rating scale of Strongly Agreed (SA) -5 points, Agreed (A) -4 points, Neutral (N) -3 points, Disagree (D) -2 points, Strongly Disagree (AD) -1 point was used in the instrument.

3.6 Validation of the instrument

Three lectures from the Department of Industrial and Technology Education (Building Option), Federal University of Technology, Minna, validated the instrument, and their suggestions were incorporated in the final draft of the instrument, so as to ensure that the instrument was capable of eliciting necessary information that is needed for the study.

3.7 Administration of the instrument

The questionnaire were administered to the respondents by the researcher and the completed questionnaire were collected by the researcher at the instant where possible; otherwise respondents were given a week to return the questionnaire, which was done in order to have high rate of return of questionnaire.

3.8 Method of Data Analysis

Mean and standard deviation was used to answer the research question while the t-test was used to test the hypothesis at 0.05 level of significance. In order to take decision, a mean score of 3.00 was used. Therefore any item with a mean of 3.00 and above was regarded as agreed and any item with a mean of 2.99 and below was regarded as not agreed. Also to the test of hypotheses where the calculated t-value of the item was not significantly greater or less than the critical or table value the null hypotheses was accepted if otherwise was rejected.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

In this research, data collected for the purpose of answering the research question are presented and analysed. The findings presented, are i-line with the research question and hypothesis.

4.1 Research question 1

What are the causes of construction site waste in Minna metropolis?

Table 1;

Mean response and standard deviation of Architects and site Engineers on the causes of construction site waste in Minna

S/N	FACTORS	X1	SD1	X2	SD2	Xt	REMARK
1	Poor supervision	4.59	0.72	4.26	0.81	4.43	AGREED
2	Poor workmanship	4.34	0.70	4.39	0.84	4.37	AGREED
3	Poor facilities	3.76	1.08	4.04	0.88	3.90	AGREED
4	Improper handlings	4.29	0.76	4.09	1.04	4.19	AGREED
5	Improper storage	4.11	0.76	4.22	0.67	4.17	AGREED
6	Design error	4.05	0.77	4.26	0.86	4.16	AGREED
7	Human error	4.32	0.84	4.39	0.78	4.36	AGREED
8	Design change	3.24	0.85	3.78	0.80	3.51	AGREED
9	Material deterioration	3.45	1.08	3.65	1.07	3.55	AGREED
10	No waste minimization Personnel	4.11	0.76	4.22	0.67	4.17	AGREED

N1 = number of architects; 38, **N2** = site engineers; 23, **X1** = mean response of architects, **X2** = mean response of site engineers, **Xt** = average mean of both architects and site engineers. **SD1** = standard deviation for architects; **SD2** = standard deviation for site engineers.

Table 1 above shows that both the architects and site engineers agree on items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and disagree on none of the items above.

4.2 Research Questions 2

What are the factors that affect the minimization of construction site waste in Minna metropolis?

Table 2;

Mean response and standard deviation of architects and site engineers on the factors that affect minimization of construction site waste in Minna.

S/N	FACTORS	X1	SD1	X2	SD2	Xt	REMARK
1	Support of waste minimization	3.74	1.17	4.39	0.87	4.07	AGREED
2	Staff knowledge of waste minimization	4.11	0.22	4.00	0.78	4.06	AGREED
3	Waste minimization motivation	3.32	1.23	4.26	1.04	3.79	AGREED
4	Material storage practice	3.87	0.08	4.04	1.07	3.96	AGREED
5	Estimating/ordering practice	3.92	1.25	4.39	0.87	4.16	AGREED
6	The high cost of recycling infrastructure	4.50	1.27	4.26	0.98	4.38	AGREED
7	Design issues	3.71	0.91	4.23	0.73	3.97	AGREED
8	Sustainable development awareness	3.21	1.03	4.23	0.73	3.97	AGREED

9	Material supply issues	2.95	0.61	3.65	0.90	3.30	AGREED
10	Cost of a new materials against recycled	3.87	0.12	3.78	0.13	3.83	AGREED

N1 = number of architects; 38, **N2** = site engineers; 23, **X1** = mean response of architects, **X2** = mean response of site engineers, **Xt** = average mean of both architects and site engineers. **SD1** = standard deviation for architects; **SD2** = standard deviation for site engineers.

Table 1 above shows that both the architects and site engineers agree on items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and disagree on none of the items above.

4.3 Research question 3

What are the strategies to be employed for the minimization of construction site waste within Minna metropolis?

Table 3;

Mean response and standard deviation of architects and site engineers

S/N	FACTORS	X1	SD1	X2	SD2	Xt	REMARK
1	Early project planning	4.05	0.23	4.09	0.75	4.07	AGREED
2	Having a prudent project design to avoid any changes in the future	4.29	0.12	3.39	0.43	3.84	AGREED
3	Using materials that can be easily recycled	3.76	0.91	3.61	0.61	3.69	AGREED
4	The staff should be educated on the waste minimization and how important it is in reducing cost and keeping the environment healthy.	3.95	1.08	4.39	1.11	4.17	AGREED

5	There should be assured uninterrupted supply of materials.	3.95	1.10	4.17	1.15	4.06	AGREED
6	There should proper material storage strategy.	3.21	0.19	4.09	1.11	3.65	AGREED
7	There should expert on site to supervise the project	3.00	0.33	3.83	0.41	3.42	AGREED
8	Securing quality materials for the project to avoid deterioration.	3.32	0.78	3.78	0.27	3.55	AGREED
9	Workers should be motivated to always minimize waste on site	4.32	0.67	4.13	0.98	4.23	AGREED
10	Work should be done only when there's conducive weather favourable for such work.	3.53	0.88	4.04	1.39	3.79	AGREED

N1 = number of architects; 38, **N2** = site engineers; 23, **X1** = mean response of architects, **X2** = mean response of site engineers, **Xt** = average mean of both architects and site engineers. **SD1** = standard deviation for architects; **SD2** = standard deviation for site engineers.

Table 1 above shows that both the architects and site engineers agree on items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and disagree on none of the items above.

4.4 Hypothesis 1

There is no significant difference between the mean rating of architects and site engineers on the causes of construction site waste in Minna metropolis

Table 4;

T-test analysis of mean response of architects and site engineers on the causes of construction site waste in Minna metropolis

RESPONDENTS	N	X	SD	df	T-cal	Sig(2 tail)
Architects	38	4.026	0.839			
				59	3.303	2.00
Site engineers	23	4.134	0.856			

SD1 = standard deviation of architects; **SD2** = standard deviation for site engineers,

T-cal = test value; **S** = significant; **NS** = Not significant

Table 4; this indicates that t-cal value weighted 3.303 above the 2.00 level of significant differences. It shows that there's significant difference between the mean responses of the respondents on these items at 0.05 percent level of significance. A null hypothesis is rejected.

4.5 Hypothesis 2

There is no significant difference between the mean rating of architects and site engineers on the factors that affect waste minimization on constructions sites in Minna metropolis.

Table 5;

T-test analysis of mean responses of architects and site engineers on the factors that affect the minimization of construction site waste in Minna metropolis

RESPONDENTS	N	X	SD	Df	T-cal	Sig(2 tail)
Architects	38	4.005	0.801			
				59	3.526	2.00
Site engineers	23	4.225	0.875			

SD1 = standard deviation of architects; **SD2** = standard deviation for site engineers,

T-cal = test value; **S** = significant; **NS** = Not significant

Table 5; this indicates that t-cal value weighted 3.303 above the 2.00 level of significant differences. It shows that there's significant difference between the mean responses of the respondents on these items at 0.05 percent level of significance. A null hypothesis is rejected.

4.6 Hypothesis 3

There is no significant difference between the mean of rating of architects and site engineers on the strategies to be employed for the minimization of construction site waste within Minna metropolis

Table 6;

T-test analysis of mean responses of architects and site engineers the strategies to be employed for the minimization of construction site waste within Minna metropolis

RESPONDENTS	N	X	SD	Df	T-cal	Sig(2 tail)
Architects	38	4.005	0.771			
				59	0.649	2.00
Site engineers	23	3.762	0.939			

SD1 = standard deviation of architects; **SD2** = standard deviation for site engineers,

T-cal = test value; **S** = significant; **NS** = Not significant

Table 6; this indicates that t-cal value weighted 3.303 above the 2.00 level of significant differences. It shows that there's significant difference between the mean responses of the respondents on these items at 0.05 percent level of significance. A null hypothesis is rejected.

4.7 Findings

The major findings of the research are listed below based on the research question

Findings revealed the following on the causes of construction site waste in Minna

1. Poor workmanship
2. Lack of minimization personnel
3. Design change
4. Improper handlings
5. Poor facilities

Finding revealed the following on the factors that affect minimization of construction site waste in Minna

1. Staff knowledge of waste minimization
2. The high cost of recycling infrastructure
3. Material storage practice
4. Sustainable development awareness

Finding revealed the following

1. early project planning
2. Using materials that can be easily recycled

3. There should expert on site to supervise the project

4. Securing quality materials for the project to avoid deterioration

5. There should be assured uninterrupted supply of materials

4.8 Discussion of findings

Many of the respondents showed a poor adoption of different methods of managing construction wastes. The most widely adopted methods were reusing and sale as scrap, largely due to the high use of timber in construction and its high scrap value for uses such a firewood. This was buttressed by the observation that only 42.6% were satisfied with the methods of waste minimization on their sites. Roughly 20% were neutral while 32.8% expressed that they were satisfied with their methods.

The low level of adoption may be explained by the fact that respondents showed a poor understanding of the benefits of an effective construction waste minimization scheme. Majority felt lower project costs (69.4%) and cleaner environment (66.1%) were the principal benefits of construction waste minimization. Other factors such as increased business patronage and longer lifespan of non-renewable sources of materials were not widely thought to be important.

Another general observation from the results of the analysis was that the practice of waste minimization by construction firms in Nigeria is poor, 62% claimed they were not aware of any legislation on policies on construction waste minimization 32% claimed to be in apposition to influence policy making in their organizations but only 8% of them attested to have formulated one.

With respect to the cause of waste on site, several factors were obtained from the work of Tam et al, (2003) and the respondents were requested to rank from 1 through to 5 (i.e. from strongly disagree to strongly agree as shown in the legend below the table). The means for each of the factors were computed and used to rank the factors with respect to their significant contribution to waste generation. From the results which are shown in Table 7 below, poor supervision, workmanship and storage facilities were regarded as the most common causes of waste on site, while equipment malfunction, weather and force majoure were the least common.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

This study was carried out to examine how waste management can help in the control of waste sourced from building materials in construction sites and to find out the extent professional in the building construction industry carries out effective measures to manage waste in sites. The chapter one of the study discussed extensively on the issues concerning the construction site waste management, the causes and ways of minimization, the background of the study, the statement of the problem was well itemized. The purpose of the study, significance of the study, the research questions and hypotheses were all formulated to guide the study.

The review of related literature treated the waste maintenance culture in some of the construction companies in Minna, and looked into construction waste and waste management in building construction site, definition of construction waste, types of construction waste, construction waste management, construction waste management strategies, steps in waste management in building construction sites, sources of construction waste and problems faced, benefits of waste management in building construction sites within Minna metropolis. There are sub-headings that discussed extensively about what is, causes and maintenance practices, and different views concerning the topic were harmonized in a comprehensive literature review.

A survey research design was used whereby a questionnaire was used as source for opinions from respondents on needed waste management strategies to be adopted for effective practice in industries in Niger State. The target population for this study was 61 respondents which are architects and site engineers in building construction companies within Minna. The instrument was validated by three lecturers from the department of Industrial and Technology

Education, Federal University of Technology, Minna. The data collected was analysed using mean standard deviation and T-test. A mean response of 3.00 was used as cut-off point. T-test, however, was employed to test the null hypotheses at 0.05 level of significance.

5.2 Implication of the Study

The finding of the study has implications on site labourers, architects and engineers. The finding of the study reveals that site operators should have the basic understanding of the causes of waste and management strategies. The implication is that when the site operators acquire the basic knowledge of waste management, there would be great improvement in the amount of waste accumulated in the construction industry. The study reveals the implication of the roles of the site operators, architects, engineers and government in making sure that construction waste accumulation is reduced to the barest minimum. With organization of seminars and workshops, all the parties involved will have the basic needed knowledge of construction waste management, thereby putting the management strategies in practice.

5.3 Contribution to Knowledge

The essence of the study is to identify the construction waste minimization strategies to be adopted by the construction site in Minna metropolis. The study, specifically, emphasizes and contributes to knowledge by identifying the following:

1. What is known by construction waste
2. Site practices that cause construction waste
3. Construction waste minimization strategies

5.4 Conclusion

Information gathered in secondary data and the result that will be found from analyses of the questionnaire will be combined in order to make a conclusion. An investigation into the waste construction site was carried out to understand the disadvantages, and to find the problems and control that are facing the waste construction in building sites in Minna.

The selection of sub-contractors needs to consider their wastage reduction plan as part of assessment criteria. Provision of waste reduction training to on-site staff is also considered important in raising environmental awareness and helping site staff generating a better working procedure to reduce generation of wastage. The construction site shall be clearly signposted with information relating to waste management including directions to waste containers and the recycling centre, waste collection intervals, waste management targets and progress on site, acceptable and unacceptable site waste practice and outstanding performers among others.

5.5 Recommendations

In view of the conclusions, the following recommendations were made:

1. Contractors should focus on quality in their construction activities in order to mitigate rework improvement, which is the major cause of material wastage.
2. Contractors should also adopt appropriate materials handling and storage methods to mitigate material wastage.
3. Contractors should plan and organise site layouts to avoid experiencing difficulty in movement of materials on site that causes wastage.
4. Clients should be briefed and are enjoined to provide the requisite information to mitigate last minute changes so that contractors can manage their materials effectively.
5. Contractors should make use of various measures of control that can minimize wastage.

5.6 Suggestion for Further Study

1. Poor workmanship as a major source of construction waste.
2. How the usage of quality materials could help in minimizing construction waste accumulation in Minna.
3. The high cost of recycling infrastructure as one of the major sources of site construction waste accumulation.

REFERENCES

Alwi, S., Hampson, K. and Mohammed, S., (2002), Waste in the Indonesian Construction Projects, Proceedings of the CIB W107 1st International Conference: Creating a Sustainable Construction Industry in Developing Countries, 11-13 November, Stellenbosch, South Africa.

CIB Publication 237 (2001) Agenda 21 for Sustainable Construction in Developing Countries, First Discussion Document, and Version 2 California Integrated Waste Minimization Board, (2003), Rebuilding Green, http//:www.ciwmb.ca.gov/greenbuilding/pg2 (accessed 21-06-2006) Coventry, S. and Guthrie, P. (1998) Waste Minimization and Recycling in construction – Design manual CIRIA London.

Department of the Environment, Transport and Regions, (2000), Building a Better Quality of Life: A Strategy for more Sustainable Construction, DETR, and London

Elias- Ozkan S.R. and Duzgunnes, A. (2002) Recycling of Construction Materials and the Reuse of Building Components: An Overview Proceedings of the CIB W107 1st International Conference: Creating a Sustainable Construction Industry in Developing Countries, 11-13 November, Stellenbosch, South Africa.

Horsley A., France C. and Quarter mass B., 92003), 'Delivering Energy Efficient Buildings: a Design.

Lingard, H, Graham, P. and Smithers, G. (2000) 'Employee Perceptions of the Solid Waste Minimization System Operating in a Large Australian Contraction Organization: Implications for Company Policy Implementation', Construction Minimization and Economics, vol. 18, pp 384.

Procedure to Demonstrate Environmental and Economic Benefits', Journal of Construction Minimization and Economics, vol. 21, pg 345.

Poon C.S., Ann T.W. and Jaillon L., (2004), Reducing Building Waste at Construction Sites in Hong Kong' Construction Minimization and Economics, vol. 22, issue 5, pp 461-470.

Ademilade Aboginije, Clinton Aigbavboa and Wellington Thwala (2021): A Holistic Assessment of Construction and Demolition Waste Management in the Nigerian Construction Projects, pp 1.

Poon C. S. Yu A. T. W. and Jaillon L. (2004): Reducing Building Waste at Construction Sites in Hong Kong. Construction Management and Economics, 22 pp 461-471.

Poon C.S., Wan Yu, A. T., Wong S. W. and Cheung E.(2004) Minimization of Construction Waste in Public Housing Projects in Hong Kong', Journal of Construction Minimization and Economics, vol. 22, issue 5, pp 461-470.

Shen, L.Y., Tam, V.W., Tam, C.M., and Drew, D., (2004), 'Mapping Approach for Examining Waste Minimization Waste on Construction Sites', Journal of Construction Engineering and Minimization , vol. 130, no. 4, July/August 2004, pp. 472-481

Shen, L.Y., Tam, V.W., Tam, C.M., and, C.M., (2002), Materials Wastage in Construction Activities – a Hong Kong Survey, Proceedings of the CIB W107 1st International Conference: Creating a Sustainable Construction Industry in Developing Countries, 11 -13 November, Stellenbosch, South Africa.

Watuka, J., and Aligula, E.M., (2002), Sustainable Construction Practices in the Kenyan Construction Industry: The Need for a Facilitative Regulatory Environment, Proceedings of the CIB W107 1st International Conference: Creating a Sustainable Construction Industry in Developing Countries, 11 -13 November, Stellenbosch, South Africa.

APENDIX A

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION

QUESTIONNAIRE ON

AN APPRAISAL ON THE MINIMIZATION OF CONSTRUCTION SITE WASTE IN MINNA.

SECTION A

INTRODUCTION: please complete this questionnaire faithfully as possible and sincerely tick [✓] the column that best represent your perception about the above topic. The questionnaire is specifically for research purpose and your view will be treated confidentially.

PERSONAL DATA

Respondents

Architects [ ]   Site Engineers [ ]

INTRODUCTION: A five point rating scale is used to indicate your opinion, tick [✓] the word or phrase which best describe your agreement as shown below.

1. STRONGLY AGREE (SA) = 5 points
2. AGREE (A) = 4 points
3. DISAGREE (DA) = 3 points
4. STRONGLY DISAGREE (SD) = 2 points
5. NEUTRAL (N) = 1 point

SECTION B

What are the causes of construction site waste in Minna metropolis?

S/NO	Factors	SA	A	N	D	SD
1	Poor supervision					
2	Poor workmanship					
3	Poor facilities					
4	Improper handlings					
5	Improper storage					
6	Design error					
7	Human error					
8	Design change					
9	Material deterioration					
10	No waste minimization Personnel					

SECTION C

What are the factors that affect the minimization of construction site waste in Minna metropolis?

S/NO	Factors	SA	A	N	D	SD
1	Support of waste minimization					
2	Staff knowledge of waste minimization					
3	Waste minimization motivation					
4	Material storage practice					
5	Estimating/ordering practice					
6	The high cost of recycling infrastructure					
7	Design issues					
8	Sustainable development awareness					
9	Material supply issues					
10	Cost of a new materials against recycled					

SECTION D

What are the strategies to be employed for the minimization of construction site waste within Minna metropolis?

S/NO	Factors	SA	A	N	D	SD
1	Early project planning					
2	Having a prudent project design to avoid any changes in the future					
3	Using materials that can be easily recycled					
4	The staff should be educated on the waste minimization and how important it is in reducing cost and keeping the environment healthy.					
5	There should be assured uninterrupted supply of materials.					
6	There should proper material storage strategy.					
7	There should expert on site to supervise the project					
8	Securing quality materials for the project to avoid deterioration.					
9	Workers should be motivated to always minimize waste on site					
10	Work should be done only when there's conducive weather favourable for such work.					