



ADDIS COLLEGE SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF CONSTRUCTION

TECHNOLOGY & MANAGEMENT

POSTGRADUATE PROGRAM

ASSESSMENT OF WASTAGE MATERIAL MINIMIZATION TECHNIQUES ON
BUILDING CONSTRUCTION PROJECTS: CASE STUDY ON ARADA SUB CITY
CONSTRUCTION BUILDING PROJECTS

BY

TEWODROS AYAYOU

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ADDIS ABABA, ETHIOPIA

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ID NO.008/2013

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DECLARATION

I, Tewodros Ayayou, declare that this research project entitles” Assessment wastage minimization techniques on building construction projects: case study on arada sub city construction building projects”. Is the outcome of my own effort and study also that all techniques of materials used for this study have been acknowledged I have produced it independently with the guidance and suggestion of my research advisor?

This research study has not been submitted for any degree in this university or any other university. It is submitted for the partial fulfillment of the degree of masters of construction technology and management.

By Tewodros Ayayou


Signature: -----

Date: -----

LITTER OF CERTIFICATION

This is to certify that Tewodros Ayayou has carried out this research work on the topic entitled” assessment wastage minimization techniques on building construction projects: case study on Arada sub city construction building projects”. This work is original in nature and suitable for submission in partial fulfillment of the requirement for the award of Master of degree in construction and technology management and the student has my permission to present it to for assessment.

Advisor Dr. Belachew Asteray

Signature-----

Date-----

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ABSTRACT

Construction waste has a detrimental impact on the environment, society, and economy in Ethiopia as a result of the construction industry's rapid rise. The ineffective waste management techniques used in construction projects are to blame. Consequently, a suitable waste management plan for materials is needed. The goal of this study was to pinpoint the essential methods that can reduce material waste during building construction projects. The necessary information was gathered using questionnaire surveys, literature evaluations of similar studies, and surveys of prior research. One hundred and twenty of the surveys that were given to clients, consultants, and contractors were returned. Using the relative relevance index method, these data were examined. Using prefabricated or off-site production of components, proper on-site waste management, and adopting a policy of material waste minimization plan were highlighted as critical ways to minimize building material wastes, according to the results. Every year, the construction sector produces wastes of building materials at construction sites. The cost of purchasing raw materials as well as the expense of cleaning up the garbage produced on site can both be decreased by reducing the amount of waste produced. By utilizing various techniques for data collecting and data analysis, our research determined the best way to lower those costs.

Keywords: Building construction; Construction material, Material wastes

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LIST OF ACRONYMS

AAHCPO - Addis Ababa Housing Construction Project Office

BC - Building Contractor

CWM - Construction Waste Management

DS - Disposal System

EPA - Environmental Protection Agency

KII- Key Informant Interview

RII - Relative Importance Index

SD - Standard Deviation

SPSS - Statistical Package for Social Science

WRAP - Waste and Resources Action Program

HPA-Hazardous Products Act

MSDSs -material safety data sheets

HRM –human resource management

RRFB-rectangular rapid flashing beacon

CCME-Canadian Council of Ministers of the Environment

GIS-Geographic Information System

WHMIS-Workplace Hazardous Materials Information System

WRE-waste recycling enterprises

BME-Building materials enterprises

VOCs-volatile organic compounds

POCs-persistent organic compounds

ANNs -artificial neural network

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CHAPTER ONE; INTRODUCTION

1.1. Background of the Study

Every nation's progress depends heavily on the construction industry. It is generally recognized for its support to economic growth and long-term national development, stressing its significance, especially for emerging countries (Ofori, 2015).

In most nations throughout the world, construction waste is becoming a significant environmental problem. Governments of the nation's encourage contractors to adopt alternate ways, such as recycling and reuse, to cut down on building waste. Submitted by (Dennis S. Mocozoma)

The cost of purchasing raw materials as well as the expense of cleaning up the garbage produced on site can both be decreased by reducing the amount of waste produced. It can also lessen waste brought on by inefficiencies on the job site, such as when waste is disposed of in a mixed bag. A home builder's waste stream is thought to be 80 percent or more recyclable. Garbage recovery for reuse and recycling can significantly reduce the amount of waste going for landfill disposal if it is planned. This may also create new building material secondary resource streams. The contractor will benefit from implementing waste management practices that lessen liability for jobsite waste because building construction is a business. (Phil Jones, Ph.D., and Rubina)

Recent years have seen a number of study initiatives conducted globally on waste in the building industry. Many of them have concentrated on the environmental harm caused by the squandering of building materials. On the other hand, other studies have focused on the financial implications of waste in the building sector (Girma, 2016).

The majority of prior analyses of waste quantification have concentrated on waste segregation for particular materials and the amount of trash produced rather than the effects of the sources that produced the garbage. Five construction sites in The Netherlands were the subject of a waste segregation study by Bossink and Brouwer. The study showed waste components as percentages of the total amount of waste generated, and it revealed that between 1% and 10% of each type of material delivered to the sites was wasted (O.O. Fadiya, 2013).

Gavilan and Bernold grouped sources of construction waste in the United States into six groups based on their functions: (1) design; (2) procurement; (3) material handling; (4) operations; (5) residuals; and (6) others. Ekanayake and Ofori supported this and similarly reorganized these six into four categories: design, operations, material handling, and procurement. According to Navon and Berkovich, an issue that frequently arises on major building projects is the absence of current information about on-site stockpiles. As a result, wasteful reordering of the same materials occurs. Additionally, trash can develop at any stage of development due to both internal causes like building activities and external factors like theft and vandalism (O.O. Fadiya, 2013).

Its contribution to national output is only one aspect of construction's function in socioeconomic growth (Lopes et al., 2011). According to Akadiri et al. (2012), the building sector is a crucial component of every economy. In Ethiopia, the sector has a crucial role to play. It boosts the economy of the nation, provides business chances for construction companies, and creates jobs for the local population (CSA, 2011). It also aids in a nation's development by providing for the construction of infrastructure (Papargyropoulou et al., 2011). Despite these contributions, the building industry's rapid growth has resulted in an increase in construction waste in developing nations (Muhammad et al., 2020). One of the major obstacles to the success of Ethiopia's construction industry is resource management (Tadesse Ayalew et al., 2016).

The majority of industries use more material resources than was initially estimated. Financial issues will result from improper handling and management of the material waste on the project site, which will eventually have a detrimental effect on the neighborhood and the environment. The construction industry generates enormous amounts of garbage, which pollutes the environment and emits CO₂ (Ajayi et al., 2015). During the various building stages, improper material management leads in waste, which harms the environment and costs money (Wahab and Lawal, 2011; Dajadian and Koch, 2014). For instance, Enshassi et al. (2006) asserted that it is one of the main reasons why businesses owned by stakeholders fail in developing nations. According to Olusanjo et al. (2014), building waste caused a 30 percent cost overrun overall. 8.5 to 16.6% of the materials, depending on the type, were recorded as waste (Adewuyi and Odesola, 2016).

Reducing material waste on a project is made easier by a firm commitment to environmentally friendly building practices (Adewuyi and Odesola, 2016). Reducing waste boosts overall net income and promotes economic stability (Husnain et al., 2017). Reducing and controlling waste at a building site lowers disposal and transportation costs, boosts revenue, saves time, safeguards the environment, and provides sanitary and safe work environments (Eze et al., 2016). Numerous studies and legislative proposals have been prompted by the need to stop and lessen the amount of trash produced by the sector (Ajayi et al., 2017). Research on waste management in construction is behind schedule in low- and middle-income nations. Therefore, many approaches to avoiding building wastes are thought to be crucial for doing so. There aren't many research available in emerging nations, especially in low-income nations.

Ethiopian journals have not yet published a lot of work in this field. Ethiopia has seen a surge in construction, however there are no efficient waste management systems in place to prevent waste (Endale Teferi, 2017), inhibiting the development of important waste management techniques (Asmara Seyoum, 2015). In this context, waste reduction techniques have not been effectively implemented by construction players. Various materials are left over at the site, dumped there, and used for things other than what they were designed for. In order to prevent and reduce material waste on construction project sites, the general goal of the current study was to identify the most crucial solutions. The study's objectives were to determine the most effective strategies for reducing construction waste, to examine stakeholders' perceptions of waste minimization approaches in building projects, and to validate the most effective methods for doing so on building construction sites. As a result, the study will help construction stakeholders and other specialists to comprehend crucial strategies needed to reduce material wastes produced by construction operations, preserve a cleaner environment, and ultimately reduce project costs. The design, execution, and evaluation (monitoring) of all forms of civil works are all done by the construction sector.

Physical infrastructures such as buildings, communication and energy related construction works, water supply and sewerage civil works are some of the major projects (program) in the construction industry. Currently construction projects are becoming

progressively larger and more complex in terms of physical size and cost. Due to this, the building industry is using a considerable amount of material resources. On the other hand, if the life cycle of the materials on site is closely examined, it is generally known that there is a relatively large portion of the materials being wasted because of different reasons at building sites (Getachew, 2009; Mulualem et al, 2012).

All estimators include wastage factors in estimating a bill of quantities since some levels of material waste are unavoidable during the construction process. However, experience over the years has demonstrated that absent the implementation of management mechanisms, wastage may regularly surpass frequently by a greater margin than the figure permitted in the tender document (Al-Moghany, 2006; Bossink and Brouwers, 1996).

1.2. Statement of the problem:

A sizable part of garbage entering the ground comes from the construction industry. According to estimates, 15 to 30 percent of all waste that is dumped in landfills worldwide is made up of building and demolition waste (Abukhader, 2015). Historically, the construction sector has been unfriendly to the environment. Trade contractors are paid for speed rather than their care for the environmental impact of their work, which is a construction cultural practice that contributes to waste (Kofoworola, 2009).

Construction trash has a detrimental environmental impact in Ethiopia since there is no efficient waste management system in place. Moreover, garbage levels are exceedingly high in the majority of Addis Ababa's condominiums and real estate. Particularly when it comes to government construction projects like 40/60 condominium (Getachew, 2009). The majority of earlier studies on the origin of construction waste have concentrated on waste minimization, waste generation volume, and waste segregation.

Today, construction site waste helps to contribute to the enormous amounts of waste construction materials produced by the construction sector each year. For a building company, the client, and the government, this is a severe issue. This issue also affects the sub-city of Arada. The amount of garbage from construction projects varies depending on where they are located. This study determines the reason for the waste and also establishes the appropriate ways to resolve this issue.

1.3. Research Questions

To help achieve the objectives, the following questions were asked

1. What are the main sources of building trash at construction sites in the Arada sub-city?
2. What are the main reasons for construction waste on the construction sites in the Arada sub-city?
- 3 How do the waste disposal practices at the site impact the well-being of health, the economy, and the environment?
4. How much do specific waste minimization strategies contribute to overall waste minimization techniques, and how effective are these techniques at the Arada sub city development site?

1.4. Objective of the study

1.4.1 General Objective

The main goal of this study is to assess construction material wastage minimization techniques and situation before, during, and after construction in the Arada sub city construction projects of sites by assessing the reasons behind it, its effects on project costs, and the level of participation and application of material wastage minimization strategies.

1.4.2. Specific Objectives

1. To Determine the primary source of building site garbage.
2. To Identify the primary reason for the site's waste of building materials.
3. To determine how disposal methods at the location affect economic, health, and environmental.
4. To waste minimization strategies.

1.4.3. Significance of the Study

This study is essential because it may show those working in the construction business how to manage and reduce waste of building materials when they are produced, transported, used, and stored on the job site. Due to the high cost of the homes, the

affordability of the condominiums is called into question. As a result, the project managers will learn about the office's cost control system and the effects of material waste, and they will implement corrective measures in the projects that follow. Additionally, this study aims to offer a framework for the creation of regulations and policies for the management of waste construction materials. Further to this

For researchers: This study provides a wealth of information on the application of the waste minimization technique to building construction. As a result, when an issue arises during building, a researcher can offer a remedy.

For other researchers: This research serves as a reference for other researchers to place greater emphasis based on upcoming new approaches so that researchers can do more work on the ground in the Arada sub-city.

If project growth begins in the future, this research will enable Addis Abeba's Arada sub-city make effective and economical use of its material resources.

1.5. Scope of the study:

The waste minimization and techniques methods used at construction sites in the town of ARADA SUB CITY are the main subject of this study. The purpose of the study is to: Identify the notion of waste.

To look at the kinds and proportion of construction trash. For instance, bricks, concrete, timber boards, and reinforcement bars.

Finally, look into ways to cut down on construction waste.

1.6. Limitation of the Study

This study's main objective was to assess the state of material waste management practices at building sites in the Arada sub-city. The existing practices of the project office in disposing of garbage at the project site are examined in this study, but additional research must be done at additional sites to track emerging practices among construction parties.

1.7. Organization of the paper

There were five chapters in the study. Following the introduction, chapter two provides a review of the literature on the definition, causes, classification, and impact of construction

material waste on the performance of construction projects, as well as on minimization strategies and practical advice for improving knowledge of managing and reducing construction material waste on Arada sub city construction project sites. The third chapter attempted to go over the procedures and techniques for gathering and analyzing data. The discussion of the study's findings and the analysis of the data are covered in chapter four. The study's result and recommendation are presented in Chapter 5 accordingly.

CHAPTER TWO: -LITERATURE REVIEW

2.1. Introduction

Construction Waste Defined Regarding what constitutes building waste, researchers and authors have offered a variety of definitions in pertinent literature. Construction waste, according to Cheung (1993), is a byproduct created and removed from locations where buildings and civil engineering projects are being built, renovated, or demolished. The difference between the value of materials that are delivered and accepted on site and those that are properly used as specified and accurately measured in the work, after deducting the cost savings of substituted materials transferred elsewhere, in which unnecessary cost and time may be incurred by material wastages, is what Shen et al. (2003) define as material waste.

2.1.1. Construction Waste

It is vital to make efforts to reduce the trash because it is common to find high-quality waste material used in the field throughout the construction process phase. According to Gavilan and Arnold (1994), the materials used in building can be divided into two main categories as follows:

Consumable material, the material that will become the part of building physical structures such as concrete, sand, gravel, stone, reinforced iron dam others. Non-consumable material, the supporting material used in the construction process, and not become the building physical part after the construction finish, such as scaffolding, formwork, whilst retaining walls, and others. The existence of waste materials will increase along with the construction process being implemented. The types of waste materials can be categorized into two parts as follows:

Demolition waste is waste derived from the demolition material of the renovation process or old building demolition. Waste produced during the building or renovation process is referred to as construction waste. The waste material cannot be utilized for the primary purpose. The trash includes cement, brick, plaster, wood, pipe, and other materials. Based on the type, construction waste may be divided into two categories as follows:

Waste produced during the building or renovation process is referred to as construction waste. The waste material cannot be utilized for the primary purpose. The trash includes cement, brick, plaster, wood, pipe, and other materials. Based on the type, construction waste may be divided into two categories as follows:

Direct waste is leftover material from a project that has been damaged, misplaced, or is otherwise no longer usable. Indirect waste is the waste product resulting from the project when the volume used exceeds the volume planned, but it does not result in the waste product physically in the field.

The concept of value is included in broader definitions of construction waste. Formoso et al, (2002) define waste as "the loss of any kind of resource—materials, time (labor and equipment), and capital—produced by activities that generate direct or indirect costs but add no value to the final product from the client's point of view."

Skoyles (1976) defines waste broadly as the difference between the value of materials delivered and accepted on site and those properly used as specified and accurately measured in the work after deducting the cost savings of substituted materials transferred elsewhere, where materials wastage may incur unnecessary cost and time. His definition includes indirect waste as a result of substitution or inefficiency, as well as monetary loss, such as waste caused by a concrete slab thickness that is greater than the structural designs specify.

2.1.2. Types of Waste

Waste in construction can be divided into two categories: material waste and time waste (Agyerum, 2012). However, the focus of this study is on material waste.

2.1.2.1. Construction Material Waste

According to Ekanayake and Ofori (2000), construction material waste is defined as any material other than earth materials that must be transported away from the construction site or used on the site itself for purposes other than the project's intended specific purpose due to damage, excess, or non-use. The above definition focuses on excess, damaged, or non-use materials used in the construction of building components that add no value to the building and must be transported from the site or used for another

purpose. Material waste, according to other researchers, is defined as "the difference between the value of materials delivered and accepted on site and those properly used on specified and accurately measured in the work."

after deducting the cost savings of substituted materials transferred elsewhere, where materials waste may incur unnecessary costs and time" (Enshansi, 1996; McDonald and Smithers, 1997; Pheng and Meng, 1997). Construction waste refers to materials from construction sites that are unsuitable for construction and must be discarded for whatever reason. Construction material waste is defined as any material, other than earth materials, that must be transported elsewhere from the construction site or used on the site itself for purposes other than the project's intended specific purpose, or that cannot be used due to non-compliance with specifications, or that is a byproduct of the construction process (Agyerum, 2012). As a result, the definition of construction materials waste used in this study is the excess of materials used over required quantities, as well as construction materials hauled away generated on the construction site that could not be useful for the intended construction. The amount of waste varies by location. Sites with high levels of waste typically have poor material control standards. Another factor influencing waste generation on construction sites is the site conditions. Waste levels are higher at muddy sites compared to clean and well-drained sites. Other factors such as project size, building design, and construction method all contribute to differences in waste levels. If the waste level of materials for a specific project is high in comparison to other sites, the performance level will be lower (Enshansi, 1996).

2.1.2.2. Time Waste

The second type of waste is time. Construction tasks are measured in terms of process (and reprocess or rework) time, inspection time, move time, and wait time. Only process time is regarded as a value-added activity. The value adding activity is defined as the activity that converts material and/or information into what the customer wants; the non-value adding activity (also known as waste) is defined as the activity that takes time, resources, or space but does not add value. However, not all process time is value adding; not all value adding time is process time. Wastes are also generated in processes as a

result of overproduction, incorrect construction methods, defects, and poor optimization in performance tasks (Al-Moghany, 2006).

2.1.3. Classification of Construction Materials Wastage

Construction waste can be classified based on its nature and losses, which are detailed and discussed below:

2.1.3.1. Based on Nature

According to Formoso et al. (1999), waste in construction projects can be classified as unavoidable or avoidable. Wastage costs more than what is saved if it can be avoided. There is a limit to how much waste of materials can be avoided. Beyond that point, any action taken to reduce waste will be ineffective because the cost of saving will outweigh the value of the materials saved. As a result, natural waste is permitted in the tenders. The amount of waste that can be generated is determined by the cost-effectiveness of the methods used to manage it (Formoso et al, 1999). When the cost of waste exceeds the cost of prevention, the waste is considered avoidable. This type of waste represents waste that exceeds the acceptable level at the site. As a result, these wastes could be reduced by implementing various waste minimization measures (Formoso et al, 1999).

Based on Loss Skoyles (1987) Construction materials waste was classified as direct and indirect waste. Direct waste is waste that can be avoided and involves the actual loss or removal and replacement of material. Direct waste is defined as the complete loss of materials as a result of irreparable damage or loss. In this case, the waste must usually be removed from the site. As a result, the cost of direct waste is followed by the cost of removal and disposal rather than the cost of material. Thus, by avoiding direct waste, direct financial benefits can be obtained. Direct waste can occur at any stage of the construction process, both before and after the materials are delivered to the site building (Formoso et al, 2002). Forms of direct waste (Skoyles and Skoyles, 1987).

- a. Delivery waste: -losses during material transportation to the site, unloading, and placement, in addition to initial storage. For example, bricks and glassing
- b. Cutting and traditional waste: cutting materials into different sizes and uneconomical shapes. For example, tiles and reinforcement bars.

- d. Use and waste: the hardening of excess materials in containers and cans. Paint, for example.
- e. Criminal waste: theft and vandalism, for example, tiles and cement bags
- f. Management waste: lack of supervision or poor management decisions. For example, throwing away excess material
- g. Waste as a result of incorrect usage: poor material selection. For example, inferior quality marbles and tiles are rejected. Indirect waste occurs when materials are not physically lost, but instead result in a monetary loss, such as waste caused by a concrete slab thickness greater than that specified by the structural design. Indirect waste is primarily caused by material substitution, the use of materials in excess of the quantities allowable under the contract, errors, waste caused by over allocation, where materials are applied in excess of those indicated or not clearly defined in contract documents, and waste caused by negligence, where materials are used in excess of the amount required by the contract due to the construction contractor's own negligence. A significant portion of these wastes have been hidden and it has not been perceived as actionable (Skoyles and Skoyles , 1987; Formoso et al, 2002).

According to (Skoyles and Skoyles, 1987), indirect wastes have the following Forms:

- a. Substitution waste: material substitution at work that results in losses for either the contractor or the client. Use a 20cm HCB instead of a 10cm HCB, for example.
- b. Production and operational waste: when materials are used in excess of those specified in the contract document. For example, additional concrete in trenches or the use of excess plaster to correct an uneven surface.
- c. Negligence waste: site errors caused by the condemned work or the use of extra material. For example, foundation over-excavation may necessitate the use of additional concrete.

2.2. Theoretical Review

2.2.1. Construction Waste Material Types

Construction is a business that generates a wide range of waste. Given the wide variety of materials used in construction, this makes sense. There will be materials that must be disposed of by special environmental services, and others that can be dumped normally. In order to work toward a more sustainable industry, it is also necessary to understand which materials can be recycled. In this section, we will delve deeper into the various types of construction waste materials (Lee Chin, 2013).

Building Materials Building materials are among the most common materials used in construction. There are numerous types of construction projects. Building materials will always be used in projects, whether they are basic construction, demolition, restoration, or remodeling, and with that comes building material waste. Nails, wiring, insulation, rebar, wood, plaster, scrap metal, cement, and bricks are some of the most common examples of these materials. When these materials become waste, it is often because they have been damaged. However, in some cases, it is simply because they were unused. The good news is that many of these materials can be recycled. Wood is a material that can be reused in a variety of ways. When there is wood waste, it can be recovered and reused in new construction projects. Although the disposal of this type of waste is usually simple, it must still be done properly. Cement, plaster, and bricks are typically crushed and reused in future construction projects. A recycling or waste management company will come to collect the material as long as it is contained in a proper dumpster (Lee Chin, 2013).

Dredging Materials Dredging materials are those that are removed during the preparation of a demolition or construction site. Simply put, these are natural elements such as trees, tree stumps, rocks, dirt, and occasionally rubble. Although these are not generally considered hazardous materials, they should be collected by a waste management company that can provide proper waste disposal and trash removal for dredging materials. Specific materials from this waste that can be reused, such as wood from uprooted trees, can be taken to a recycling plant. Some of the most important aspects of dredging material disposal are proper recycling and disposal of natural resources (Assefa, 2021).

Hazardous Waste One of the most important types of construction waste materials to be able to identify and handle is hazardous waste. Not only can this type of waste be hazardous to those who work with it, but it can also endanger the general public if not properly managed. Construction, demolition, restoration, and remodeling sites can all generate hazardous waste. Much of the waste can come from common building materials. Lead, asbestos, plasterboard, paint thinners, strippers, mercury, fluorescent bulbs, and aerosol cans are some of the most visible examples of hazardous waste generated by construction. Environmental cleanup companies can help with the proper disposal of these hazardous materials. Hazardous material disposal is strictly governed by state and federal laws (Assefa, 2021).

Demolition Waste Materials There are specific waste types that are common in demolition projects. As a result, they are usually classified into a few sub-types. Asbestos and insulation are two of the most common types of demolition waste, and they are also extremely hazardous materials. Asbestos has been linked to an increased risk of lung disease and cancer. This is due to the fact that asbestos can produce very fine flakes that are easily inhaled. There is, however, insulation that is not entirely made of asbestos. The issue is that even if the insulation contains a trace amount of asbestos, it is still extremely dangerous. Non-asbestos materials such as concrete, bricks, tiles, and ceramics are another type of demolition waste. Reinforced concrete has a high recycling value because it can be reused to make new concrete. This type of material can be crushed on the construction site. Because there will be less need for vehicle use, transportation costs will be reduced. A third type of demolition waste material is wood, glass, and plastic. Wood from these sites can be disposed of in the same manner as previously mentioned. (2021, Assefa).

Ameh Oko John et al (2013) The research focuses on identifying the most wasteful materials in construction operations, as well as the top factors that contribute the most to material waste on construction sites.

Muhwezi (2012) investigated the characteristics of construction wastes on building projects in Uganda and proposed feasible measures to reduce their occurrence. A simple construction waste management system that can provide information on waste quantities,

identify areas of waste generation that are problematic, and analyze the causes of these wastes is proposed.

Ali Asghar Najafpoor et al (2011) identified the waste-generating activities in design, transportation, and storage. The most significant cause of waste generation was discovered through a questionnaire survey.

Jia-Yuan Wang et al (2008) Data from a questionnaire survey and structured interviews conducted in Shenzhen were used to analyze on-site production and sources of construction waste. The major causes of waste generation were identified, and recommendations for waste reduction were made.

Elizara B M et al (2005) presents a new concept that assists project managers on construction sites in improving project completion levels in terms of construction waste management practice. It is founded on the identification of construction waste management influencing factors that play a significant role in waste reduction. The factors were discovered through a review of the literature and an interview with a construction project practitioner..

Junli Yang et al (2005) studied a rigorous literature review in relation to waste generation and management systems, identifying future approaches to reduce, reuse, and recycle waste construction materials

Bon-Gang Hwang et al (2004) based on survey results; investigated how different project characteristics affect perception of benefits from construction waste management. A questionnaire was created to gather perceptions and opinions on project characteristics and the specific benefits of construction waste management.

Andrew R F Dainty et al (2004) investigated the effectiveness of waste-reduction measures used in high-profile UK construction projects. The case studies revealed a diverse range of waste strategies, the broader applicability of which was then investigated through a questionnaire survey conducted by waste minimization specialists. The most effective measures were those that promoted waste minimization collaboration throughout the supply chain.

Carlos T. Formoso et al (2003) focuses on the findings of two studies conducted in Brazil that investigated the appearance of material waste on construction sites, discusses the main causes of waste, and identifies some cost-effective preventive measures.

(Kumawat et al., 2022) Construction activities have increased in order to achieve extensive property development, better public transportation, and improved infrastructure for increasing urbanization, which results in more abstraction of natural raw materials and a significant increase in the production of building material waste.

(Kumawat et al., 2022) Building material waste accounts for at least 30% of total solid waste produced worldwide. Building material waste is caused by improperly organized supplies or the mishandling of materials by unskilled laborers.

Elizar(2015) The construction industry was confronted with a major problem: construction waste. Their significant impact on cost, time, productivity, and sustainability, among other things. It had a significant impact on practitioners and researchers all over the world. Construction waste management studies entail identifying, analyzing, and managing construction waste throughout the course of a construction project. By successfully completing the project, they are significantly reducing construction waste. In this study, effective waste management factors were identified, coded as critical success factors, and then ranked. This paper proposes a new concept for improving project performance and construction waste management practices. The three most important variables causing waste during the construction process are design changes, slow decision-making, and a lack of skilled labor. Based on this research, 5 variables and 22 indicators for improving waste construction management were identified.

(Raj & Eldhose, 2018) This study investigates the causes and magnitude of material waste on Jordanian construction sites. He had created a questionnaire form that includes questions about the causes of waste generated on construction sites as well as estimated percentages of waste for the ten most important materials used on construction sites. The study included a pilot survey. The questionnaire was distributed to 240 participants, the majority of whom were clients, contractors, and consultants. The primary goal of the study is to identify the major sources of material waste generated on construction sites. It was calculated using the opinions of 240 participants as well as the quantities of waste in

the main building materials used on the sites. Finally, a comparison with other countries is made. According to the findings of his research, the percentage of waste materials on Jordanian sites ranges between 15% and 21%.

(Raj & Eldhose, 2018) The construction industry is a major source of waste generation. To protect the environment, construction workers should dispose of construction solid waste from their work areas. Demolition waste is a major waste in some construction industries. The contractor is responsible for managing construction waste on the job site. This paper primarily addressed the issues of construction waste encountered in projects and how these waste can be reused on the job site. This study has improved ecological solid waste management.

Jiayuan Wang (2014) Construction waste is a global issue that affects all construction sites. It must result in a significant loss for the contractors or builders. They are ineffective for waste management during construction projects. Many contractors and builders are concerned about the best way to prevent or reduce waste. In this case, project managers should request additional research on waste management regulations, waste management systems, waste management awareness, low waste building technologies, fewer design changes, and waste management research and development. This type of research can improve project performance while also controlling or reducing unnecessary waste. In a construction project, project management must advise workers on their various studies of waste management programs, plans, and waste minimization methods. Such knowledge is put to use to improve the performance of construction waste management.

(Raj & Eldhose, 2018) In Malaysia, the construction industry is very important. Current developments have a number of negative and harmful environmental effects on the ecosystem. The primary goals of this research are to identify construction waste generation on site and to determine the construction waste management plan that was used in the same project. The study uses two methods of data collection: interviews and site observations. This study lasted two months and was conducted at three different locations. According to the study's findings, there are six types of waste produced in sites: wood, metal, concrete, mortar, packaging waste, and bricks. Finally, on-site waste

quantification. As a result, research construction waste management plans at job sites in order to reduce waste.

(Raj & Eldhose, 2018) Building material waste is divided into non-inert and inert waste, with non-inert waste being disposed of in landfills and inert waste being disposed of in urban fillings as reclamation products..

(Kumawat et al., 2022) Dumped building materials in forests, streams, and vacant lots cause erosion, pollute wells, water levels, and surface waters, attract pests, create fire hazards, and detract from the beauty of natural areas. Building material waste contaminated with toxic contaminants such as asbestos, heavy metals, persistent organic compounds (POCs), and volatile organic compounds (VOCs) is also more difficult to dispose of.

2.3. Empirical Review

2.3.1. Major source of construction materials waste at the site

Construction Material Waste Source Furthermore, in Singapore, Ekanayake and Ofori (2000) classified construction waste into four categories: design, operations, material handling, and procurement. Sasitharan Nagappan's previous research also revealed the most common causes of construction waste (2011). His research focused on the factors that contribute to construction waste in the field. The matrix of construction waste causes discovered 63 waste factors in construction activities. Design, Handling, Worker, Management, Site condition, Procurement, and External were the seven waste causes classified. Following a review of the literature, the sources of waste on-site were identified and classified into seven major categories in this study, Design, Procurement, Handling and storage, Operation, Weather, Vandalism and Others

(Pratap et al., 2015) Excess cement mix or leftover mortar after a building operation is the result of a rejection caused by a change in plan or poor workmanship, etc. Concrete is classified as waste in two types: reinforced (building structural elements) and non-reinforced (foundations).

Organic granules, cement, and water contain substances that make concrete an affordable and easy-to-manufacture material. Conventional concrete contains approximately 12%

cement, 80% bulk aggregates, and 8% water (Barbuta et al. 2015). Large quantities of bricks and brickwork mixed with cement, mortar, or lime are produced as trash during demolition. The stone is produced as waste material during the demolition of old buildings. Metal waste is generated by tubes, transmission lines, and light sheet material used in air vents, cords, and plumbing fixtures, as well as structural concrete. Plastic, glass, and paper are examples of waste materials (Ponnada and Kameswari 2015).

Briere et al. (2014) examined a subset of demolition waste and discovered that 52.8 percent of the most efficient waste was classified as

Design During the design stage, there are the most opportunities to improve material resource efficiency in construction projects. Inadequate design and specification, as well as a lack of standard manufactured sizes, are all waste contributory factors. Changes in design decisions while construction is underway can result in demolition, surplus and redundant materials, demoralization of the labor force, a reduction in product quality, and, in extreme cases, construction personnel turnover. (2012) (Sasitharan, Ismail, and Asmi).

Procurement of Construction Materials Ordering and shipping errors can result in material waste in building construction projects. Mistakes in procurement can lead to one of three material conditions: over-shipment, under-shipment, or miss-shipment. They are typically caused by a breakdown in communication within the builder's organization or between the builder and the vendor (GEREME, 2018).

Transportation, Handling and Storage In construction projects, improper material storage and handling are major contributors to physical waste generation. Improper handling can occur on the job site or before the material arrives. This means that the material could be harmed during fabrication, packaging, loading, or delivery. Construction materials may be damaged on the job site as a result of unnecessary handling or improper storage without adequate protection. Many construction materials, for example, are prone to deterioration and bio-degradation as a result of environmental factors. Furthermore, excess stocks are vulnerable to damage, deterioration, theft, and vandalism (GEREME, 2018).

Operation;-Many studies agree that one of the major causes of waste generation is improper operation procedures frequently result in excessive material waste. However, raw materials should be fully utilized to avoid waste. Rework, damage to other trades' work, poor workmanship, and using more materials than necessary are all the result of operatives' negligence, carelessness, or incapacity (Sasitharan, Ismail and Asmi, 2012).

Site Management Construction management is concerned with the planning, coordination, and control of all aspects of the construction project. Poor planning, as a result of management staff's lack of planning skills, results in the generation of physical waste in construction projects. Furthermore, improper planning and equipment selection cause the work to be halted. Thus, proper planning and controlling are critical functions that must be used effectively to eliminate material waste (Sasitharan, Ismail and Asmi, 2012).

Site Supervision Professional Construction supervision is a type of project management that is specifically designed to ensure the successful completion of a construction project. Comprehensive quality control services can be added to construction site supervision services. This ensures that the materials used, as well as the equipment and systems, are of high quality, function properly, and conform to the standard (GEREME, 2018).

Others these wastes can come from a variety of sources. This could be due to weather, theft, or an accident. To reduce material waste from such causes, avoid placing washable materials on the steep slope or near the drain, and provide a security guard at the construction site (Sasitharan, Ismail and Asmi, 2012).

Effect of Material Wastage on Construction Project Execution In addition to the waste management problem caused by the construction sector, construction site waste management and minimization has a great potential to contribute to construction industry performance improvement. Material waste in construction projects has an impact on work quality, project cost, working time, worker safety and health (GEREME, 2018).

Effect on Quality of Work Quality is an important factor in the success of construction projects. Quality issues are prevalent throughout the construction process. Achieving good waste minimization on construction projects contributes to a reduction in the

amount of construction waste sent to landfill. Because the majority of the causes of material waste are also the causes of quality issues in construction projects, reducing material waste can help to improve work quality. For example, labor issues such as a lack of skilled labor, worker error, rework, and so on are causes of material waste and poor work quality. As a result of resolving these causes of material waste, good work quality is achieved (GEREME, 2018).

Effect on Cost of Project Construction Material waste has a significant impact on the overall cost of a project. Direct and indirect costs comprise the true cost of material waste. The direct cost is the purchase price of the material that became waste, while the indirect cost is the cost of transporting the waste off-site and the missed opportunity to reclaim reusable and recyclable material. (iii) Loss of labor and management time. (iv) Loss of contracting ability due to a poor waste history By reducing the amount of waste that needs to be disposed of, a construction company can become more profitable. As a result, construction material waste has a significant impact on the overall project cost. GREME (2018).

Effect on Work Time Prior to the start of construction, the total time of the project is usually specified. However, construction projects are notorious for experiencing time delays for a variety of reasons. Material waste has a direct impact on project productivity and completion time, resulting in significant revenue loss (GEREME, 2018).

They went on to say that waste is generated not only by the application and use of materials on the construction site, but also by the processes preceding construction, such as material manufacturing, design, material supply, and planning. As a result, waste management should first consider the various sources of waste and the types of waste they generate, and then implement appropriate measures to reduce them from the source. Furthermore, waste is classified as direct waste, which is the loss of materials as a result of damage during handling or site application, or as lost during the construction process, and indirect waste, which does not result from direct waste (physical material loss), but has monetary consequences. Materials used for purposes other than those for which they were ordered are examples of indirect waste.

- Materials used for purposes other than those specified (substitution).

- Where materials are used in excess of those specified or not clearly defined in contract documents, such as additional concrete in trenches dug wider than intended due to a lack of an appropriately sized digger bucket.
- When materials are used for temporary site work for which no quantity or other allowances are made in the contract documentation, such as tower-crane bases, site paths, or temporary protection.
- When materials are used in excess of the contract amount due to the contractor's own negligence. (Sasitharan Nagapan et al. 2011)

2.4. Main Cause Of Construction Materials Waste At The Site

Construction Debris Unwanted products or materials are referred to as waste. Waste can also be defined as any material resulting from human or industrial activity that has no residual value. Construction waste is classified into two types: physical waste and nonphysical waste (Sasitharan Nagapan et al., 2011).

Physical Waste:-Physical construction waste is a mix of inert and non-inert materials generated during construction, excavation, renovation, demolition, roadwork, and other construction-related activities. Construction and demolition waste, as defined by Shen et al and Kofoworola and Gheewala, is waste generated by construction, renovation, and demolition activities such as land excavation or formation, civil and building construction, site clearance, demolition activities, roadwork, and building renovation. However, some people define solid waste as concrete debris, various types of bricks and blocks, various types of tiles, steel reinforcement, wood, plastic materials and paper, as well as gravel and soil. Physical construction waste has also been interpreted as waste origins in research and can be found in (Sasitharan Nagapan et al., 2011).

Non Physical Waste:-Waste, on the other hand, can be defined as non-value-added work. Non-value-added activity distinguishes between physical construction waste found on-site and other waste generated during the construction process. Other researchers refer to this type of waste as intangible waste, indirect waste, or non-physical waste. Waste, according to Womack and Jones, is any human activity that consumes resources but produces no value, such as mistakes that must be corrected, the production of items that no one wants,

unnecessary process steps, employee movement, and people waiting for the completion of upstream activities. Furthermore, Koskela defines waste as any inefficiency that results in the use of more equipment, materials, labor, or capital. In other words, waste in construction is related to several activities other than the quantity of waste materials on-site, such as overproduction, waiting time, material handling, processing, inventories, and worker movement. Similarly, an Indonesian researcher defined waste as not only waste of materials in the construction process, but also other non-value-added activities such as repair, waiting time, and delays (Sasitharan Nagapan et al., 2011).

An examination of some Brazilian construction sites

Overproduction: the production of more than is required or earlier than is required. This may result in material, man-hour, or equipment waste. In the case of deteriorating materials, it usually results in inventories of unfinished products or even their total loss. Overproduction of mortar that cannot be used on time is an example of this type of waste.

- Substitution: is monetary waste caused by the replacement of a less expensive material with a more expensive one (with unnecessary better performance); the execution of simple tasks by an over-qualified worker; or the use of highly sophisticated equipment when a much simpler one would suffice. Waiting time: refers to idle time caused by a lack of synchronization and leveling of material flows, as well as the pace of work by various groups or equipment. One example is idle time caused by a lack of material or a lack of available work space for a gang.

Transportation: the internal movement of materials on-site. This type of waste can be caused by excessive handling, the use of insufficient equipment, or poor pathway conditions. It is usually caused by poor layout and a lack of material flow planning. Its main consequences are: man-hour waste, energy waste, site space waste, and the possibility of material waste during transportation.

Processing: This refers to the nature of the processing (conversion) activity, which can only be avoided by changing the construction technology. When plastering a ceiling, for example, a portion of the mortar is typically wasted.

Inventories: excessive or unnecessary inventories lead to material waste (due to deterioration, losses due to insufficient stock conditions on site, robbery, vandalism), and monetary losses due to capital that is tied up. It could be due to a lack of resource planning or uncertainty in quantity estimation. **Movement:** is concerned with workers' unnecessary or inefficient movements while on the job. This could be due to insufficient equipment, ineffective work methods, or poor workplace organization.

Defective product production: occurs when the final or intermediate product does not meet quality specifications. This may necessitate rework or the incorporation of unnecessary materials into the building (indirect waste), such as excessive plastering thickness. It can be caused by a variety of factors, including poor design and specification, a lack of planning and control, a lack of teamwork qualification, a lack of integration between design and production, and so on.

Others: waste of any kind other than the previous ones, such as burglary, vandalism, inclement weather, accidents, and so on. The source of waste generation There could be a variety of causes for waste generation in various systems. However, some general causes of waste generation have been identified at various stages. The following is a check list of waste generation causes:- Lack of a material management system, Poor housekeeping and storage conditions, Poor quality control, Adhoc procurement, Contractor negligence, Unconcerned supervisory staff, Untrained labor ,Non-use of leftover materials, Theft and pilferage, Change in design and specification and Improper handling (Meghani, 2011).

Matrix of Causative Factors:-The purpose of factor mapping is to provide a preliminary idea of what previous researchers discovered about the factors that contributed to construction waste generation. Based on the frequency of the factors identified by previous researchers around the world, this matrix analysis can determine the severity of each factor. This study included 20 scholarly research papers and discovered 63 causative factors of construction waste generation. These factors are classified into seven categories. Table 1 depicts the mapping of the causative factors derived from research articles published worldwide. These can be used to develop a questionnaire to assess the relevance of these factors to the local environment (Sasitharan Nagapan et al., 2011).

Frequent Design Changes :-Among other factors, 'frequent design changes' was discovered to be the most dominant cause of generating construction waste. These issues arise as a result of last-minute client changes during construction activities. This becomes a problem as a result of a lack of communication between contractors, designers, and clients during the design process. The client must sit together during the design stages to make the final decision before the contractor begins work on the construction projects. This is the most important stage after the drawing stage. When changes occur after the construction, rebuilding according to new drawings necessitates a significant amount of rework and time. To address this issue, more emphasis should be placed on waste reduction during the design phase. To avoid last-minute changes, all parties involved in construction projects should maintain open lines of communication with clients (Sasitharan Nagapan et al., 2011).

Wrong material storage:-The second leading cause of construction waste generation was improper material storage. It is also the leader in the Handling Group. This issue is always associated with improper storing methods as a result of handling activities. For example, improper handling of bricks during construction results in cracks. This material is brittle and must be handled with extreme caution. Human error is always to blame for problems. In addition, incorrect storage occurs as a result of an ineffective protection strategy. Cement, for example, must be stored in a shaded area to conserve space. However, workers incorrectly store it under bridges or in any open space. Finally, the materials are exposed to weather conditions such as direct sunlight and rain. Materials that are not properly protected end up as waste. Proper material storage is critical in order to avoid construction waste generation. Workers' storing methods must be monitored by storekeepers. This may reduce material damage on the job site. Aside from that, a very comprehensive and good storage technique should be used for better material protection on-site (Sasitharan Nagapan et al., 2011).

Effect of weather:-Materials that are not properly protected are discarded. Proper material storage is essential for avoiding construction waste generation. Storekeepers must monitor workers' storage methods. This could help to reduce material damage on the

job site. Aside from that, for better material protection on-site, a very comprehensive and good storage technique should be used (Sasitharan Nagapan et al., 2011).

Poor planning:-With a percentage of 7.4 percent, poor planning is the highest frequency score in the Management group. The management group is the most dominant in terms of construction waste generation. The act of management contributes significantly to waste generation. Workers receive less attention during material handling on site, resulting in waste. This issue arises as a result of the management site's poor planning skills. The project managers must assign a competent and dedicated supervisor to the job site. Workers' poor workmanship and improper material handling are the result of an incompetent supervisor and project manager. Furthermore, management's poor planning methods contribute to construction waste. Before planning, management must consider resources such as how many workers and supervisors are required for construction projects, as well as what type of equipment and how many tools are required for the specific works. Thus, proper planning is the key managerial function that should be used to be effective in eliminating these waste causes. All management leaders should devote more time to this cause (Sasitharan Nagapan et al., 2011).

Ordering errors:-In terms of procurement, ordering errors are the most common. During the ordering process, ordering errors such as over ordering and under ordering become major issues. Over ordering, for example, resulted in an excess of brick and concrete mixture on the construction site. On the other hand, if ordering is inadequate, fewer materials will be available on site during the construction process, resulting in a work stoppage. Another example is a lack of concrete premix during concreting activities, which can result in a delay and the need for material supply time. Aside from that, sometimes poor material ordering does not correspond to the actual works at site in terms of quality, type, and dimensions. This type of error occurs and ultimately results in material waste. Thus, proper material ordering is critical in reducing material losses and damage in construction projects (Sasitharan Nagapan et al., 2011).

Workers' mistakes:-Mistakes made by workers are a common source of construction waste. The cause is the most common among the other causes in the Worker group. Untrained laborers, a lack of skills, and a poor work attitude all contribute to worker

errors. Such employees frequently make mistakes at work. They consistently produced material waste such as bricks, light weight concrete, plaster, and tiles. By hiring a competent worker for site work, mistakes can be avoided. Furthermore, supervisors must always keep an eye on workers while they are on the job. This can make workers more alert and help them complete their tasks more efficiently. Workers must have a positive work culture and be accountable for their daily tasks. Waste generation can be reduced if workers take these steps positively.

Leftover materials on site:-Leftover materials on the job site are a major source of construction waste and can be seen with the naked eye after construction. This cause is near the top of the Site Condition list. This type of waste is also classified as physical waste on the job site. The leftover material on the job site is typically cut steel bar, used formwork, and broken bricks. This leftover scarp is always found at the conclusion of a construction project. The cause of this residual at the site is the project manager's and workers' poor attitude. Before they leave, they should clean up the area. The project manager should monitor and ensure that excess materials are stored in a storeroom or warehouse. They can also resell or recycle the remaining materials. This method will reduce the construction waste on site and also can save our environment (Sasitharan Nagapan et al., 2011).

The interdependence of several variables, into one called the factor, is used to reduce or sum the number of variables into smaller ones. As a result, the variables or factors that predominate will be studied further. Factor analysis is an extension of major component analysis in that it aims to obtain a small number of factors with properties, i.e., be able to explain as much data diversity as possible. These factors are mutually free, and each factor can be interpreted. On-site construction waste causes The material cutting process that results in the pieces resting, There is no material-cutting strategy. Materials of poor quality that are easily damaged Workers' behavior in utilizing the remaining material, Employee errors or carelessness while working in the field Materials that have been damaged/broken/scattered, In the absence of a waste management system in the project, The equipment is not functioning properly. Contractor incompetence in handling available materials, Inadequate working methods, Insufficient workforce ability to

operate the equipment, There is no material storage. Unskilled labor, inexperienced labor
Material mixing error Unintentional construction material damage Incompatibility
between the material and the method of storage, Poor material transfer from the
warehouse to the construction site, a lack of strict and regular supervision, Material size
difference prepared with required material size, Weather conditions that are unfavorable,
Arrival of uncoordinated materials, Warehouse moisture levels (Rai Widhiawati et al.,
2019).

2.5. Techniques of Disposal At The Site Affect Human, Economy And Environmental Health.

2.5.1. Disposal and Impact of Building Material Waste

Buildings are responsible for resource exploitation and pollutant emissions into the environment (Feng and Lam 2021).

As a result, the building sector has become a global target for reducing environmental impacts and limiting resource depletion (Hossain and Thomas 2019).

Construction companies are thriving in both urban and dynamically developing cities around the world (Hasan et al. 2021).

Rapid urbanization has resulted in unrestricted construction in both developed and developing countries. Building material waste has been produced in large quantities, resulting in catastrophic and tragic consequences for economic standards and environmental conservation on urban health and longevity (Aslam et al. 2020).

Improper waste management of building materials has a negative impact on our environment because of water, soil, and air pollution, which has a negative impact on our ecosystem's flora and fauna. It is also responsible for social and public health issues, which can cause health problems, improper working conditions, and human safety, as well as economic impacts due to the loss of raw materials, resources, and the use of fuel supply during waste transportation (Asgari et al. 2017).

Traditional Building Material Waste Disposal Methods: The traditional method of waste management has frequently been the dumping of waste construction materials in landfills, but this would be impractical in the future (Ginga et al. 2020).

The majority of construction waste is transported for disposal to landfills, which consume vast amounts of land and pose safety concerns due to the excessive accumulation. In the metropolitan lifestyle, the growth in construction and urbanization technology has led to a significant quantity of constructive wastes. The majority of constructive wastes are waste from reconstruction after demolition. Improper disposal of such solid wastes results in unsanitary and soil-depleted conditions, as well as environmental pollution (Luangcharoenrat et al. 2019).

It is critical to reduce the dumping of construction waste in landfills (Berge et al. 2018).

2.5.2. Sustainable Technologies for the Disposal of Building Material

Waste Sustainable construction is a holistic and integrative building process that seeks to restore harmony between the natural and built environments. Each country requires appropriate construction waste management, reduction, reuse, and recycling methods (Lei et al. 2019). The building waste management hierarchy is made up of five key groups (El-Haggar 2007). Reduce, Reuse, Recycle, Recover, and Disposal

The United Kingdom, North America, Europe, and various parts of Asia have all agreed to the 3R Principle, which states that waste should be reduced, reused, and reprocessed (Shen et al. 2002; Sakai et al. 2011; Allwood et al. 2011; Hasmori et al. 2020).

Coventry and Guthrie (1998) stated compelling reasons to prefer all such traditional approaches, such as reducing the risk of environmental pollution and human health uncertainty. This report was also found to be economically beneficial, as it can reduce project costs and expand business support (Shen et al. 2002; Dania et al. 2007).

Reduce, Reuse, Recycle, Recover {4R} Strategy In 4R approaches, waste reduction is the primary method related to reducing building material waste production at its local stage. The reduction could be accomplished by diminishing or withdrawing unspecified activities at running projects, or by preserving current buildings instead of constructing new ones. Though, it can also be managed by improving the dimension of modern construction or can build new construction with substantiality to prolong life. The reduction in building trash is recognized as the most effective and efficient method but several factors including design changes, poor material handling, lack of capability

among the laborers, weather, etc. arise the building material wastes. Besides, the reduction of building material wastes not only manages the generation of waste but also helps to reduce the running cost of disposal and recycling. Reducing construction waste saves landfill space and has a positive environmental impact (Kralj and Markic 2008; Osmani et al. 2008). Reduce, reuse, and recycle are three strategies for mitigating the effects of construction waste production (Yu et al. 2021). (Fig. 26.2).

Construction waste reuse and recycling reduces the demand for raw materials and resources, reducing pollution, aesthetic impacts, and disruption to natural habitats (Craighill and Powell 1997).

Reusing construction waste is also a sustainable approach to environmental management. If they meet certain criteria such as dimensions and quality, the reuse approach is a good option for managing and delaying final disposal or recycling of building material waste production. It is the straightforward repair, refurbishment, or easy recovery of used appliances from a building material waste manufacturer. As a result, reusable waste can be sold at the point of manufacture or at auction. Even a large amount of raw building material debris, such as gravel and aggregate products, concrete, clean wood, plastics, insulation materials, iron materials, and so on, can be recycled.

All used, re-used, or unused materials are considered waste in the Recycle strategy and are processed into valuable new products. Building materials enterprises (BMEs) and waste recycling enterprises (WREs) are the two primary players in the recycling of building waste, and their waste recycling decisions influence the waste recycling industry's development (He and Yuan 2020).

These building wastes are screened on-site or off-site before being transported to a processing center and re-manufactured into new or similar products. Waste screening relies on laboratory research or a scientific approach, as well as durability testing. Concrete and gravel, for example, can be recycled into aggregated concrete products; wood can be recycled into furniture.

Metals such as steel and copper can be recycled separately to create new valuable products. Tiles can be made from bricks and cement chips, sand, stone breaks, and so on.

As a result, a large amount of building material waste is left over after typical management and is dumped in landfills. It is known as waste disposal (Dania et al. 2008).

Glass waste from the construction industry is a major issue for effective waste treatment and reduction. The recycled glass has been developed for use in structural structures (Adekomaya and Majozi 2021).

Bakchan and Faust (2019) calculated the amount of construction waste (CW) generated by institutional building projects and quantified the benefits of CW recycling in terms of saving trees, water, energy, and reducing greenhouse gas pollution in the atmosphere.

2.5.3. Wastage Disposal impact on Environment

Historically, the construction industry has been environmentally unfriendly. Environmental effects of building material waste include SO₂ pollution, water contamination, and landscape erosion (Fadiya et al. 2014).

Because of the rapid increase in building construction activities, large amounts of waste have been generated, causing environmental change and pollution (Rani 2017).

The construction industry consumes 35% of generated energy and emits 40% of CO₂ into the atmosphere. This industry is the largest consumer of raw materials derived from natural resources, and its activities generate material waste that harms the environment (Luangcharoenrat et al. 2019).

Building material waste containing hazardous substances such as heavy metals and organic pollutants may leach if not properly treated before disposal, becoming toxic to the atmosphere and contaminating the water, soil, and air (Huang et al. 2017).

Building activities generate a large amount of waste, accounting for 20-30% of total solid waste, of which 70-80% is concrete and masonry, causing harm to both human life and the environment (Gupta 2018).

Due to the continuous increase in construction waste, there is a shortage of landfill space, which in turn causes pollution in the atmosphere due to illegal dumping around the world, including China, Malaysia, Hong Kong, and Israel (Yu et al. 2013).

Building material waste landfilling not only depletes landfilling resources but also contributes to increased energy consumption, greenhouse gas emissions, public health problems, and environmental contamination (Chen et al. 2017a, b; Mah et al. 2018; Zhang et al. 2019).

These wastes contribute to the global warming phenomenon, which causes an increase in temperature and weather extremes, resulting in heat waves and poor air quality (Marzouk and Azab 2014).

Building material waste contributes to air and water pollution, primarily from waste transportation, greenhouse gas emissions, and leachates released from wastes in landfill areas (Yahya and Halim Boussabaine 2006).

Sulfates found in gypsum drywall and building material debris are primarily responsible for environmental damage, and an excess of chemicals in water can have a cathartic effect on humans (Jang and Townsend 2001).

Improper disposal of building material waste limits any land reclamation work that could have been done on large surfaces, as well as contributing to the contamination of air with toxic gases such as CO₂ and CH₄, two of the main factors responsible for the greenhouse effect on a global scale (Iacoboaia et al. 2010).

Other chief pollutants in construction activities are mostly particulate matter 10 (PM 10) and 2.5 (PM 2.5), N₂ and SO₂, and volatile organic compounds (VOCs) which attributes to 23% of air pollution present in cities, 50% of climate change through greenhouse gas emission, 40% of pollution in drinking water, 50% of landfill pollution and 50% of Ozone depletion (Jain et al. 2016).

2.5.4. Wastage Disposal Impact on Public Health

Building material waste accounts for a significant portion of industrial waste. This waste is diverse and contains a wide range of building materials, as well as significant amounts of hazardous chemicals (Trankler et al. 1996).

The construction waste was disposed of in sanitary landfills. Heavy metals (HMs) such as Cd, As, Pb, Ni, Cr, Cu, and Zn are leached into water bodies as a result of improper waste disposal, posing a serious threat to the ecosystem and public health and can cause health

problems such as ulcers, liver damage, diarrhea, cancer, respiratory disorders, and cardiovascular disease through unintended utilization of the heavy metals (Yu et al. 2018).

Building materials' main constituents, such as calcite and gypsum, are responsible for causing respiratory tract infection and inflammation in the mucus membranes of the eyes, and their inhalation in the form of these ultra-fine particles, such as PM 2.5, could potentially lead to toxic respiratory effects (Oliveira et al. 2019).

Informal workers, such as recyclers, were also discovered to be suffering from body pain caused by lifting heavy loads, back pain caused by constant bending down, long working hours, and poor working conditions (Gutberlet and Baeder 2008).

Dust is the fourth highest percentage emission resulting from building activity, directly impacting the environment by contributing to the ecosystem's visual, image, and health, as well as public health (Estevez et al. 2003).

Some of the additional risks of handling building material waste include asbestos removal, which can cause cancer and other lung diseases when inhaled (Duan and Li 2016).

Improper waste management of building materials has a negative impact on community health and causes a variety of adverse health effects and disorders associated with pollution, such as respiratory illness, birth defects, cancer, and so on (Aboginijeetal.2020).

2.5.5. Disposal of wastage impact on economy

The built environment is at the heart of every economy, providing the infrastructure required to boost growth, but the way it consumes natural resources causes some of the most serious changes in the local and global environment (Dania et al. 2008).

Globally, the construction industry is recognized as an economic investment, and its link to economic development is well established, as many developing and developed nations have learned the importance of it at a socioeconomic level required for employment and long-term development of a country. It is vital to a country's progress because it provides

necessary infrastructure and materials for activities such as commerce, services, and utilities (Hasmori et al. 2020).

Building material waste is a major economic concern because the raw materials used in the construction elements are not recycled, which is both economically and environmentally inefficient (Marrero et al. 2017).

Proper recycling of building material waste can also benefit the economy by creating a variety of jobs in the field of recycling and salvaging of building material waste, which also benefits businesses by creating a strong social image, improving production efficiency and profits, and thus improving product quality and overall environmental performance (Jain 2012; Oyenuga and Bhamidimarri 2015).

2.6. Waste Minimization Techniques

Documentation and design: - are used to reduce waste materials generated as a result of design and documentation issues. Minimizing construction waste during the design stage is widely regarded as a critical strategy for effective waste reduction (Wang et al., 2014).

Material procurement: - The ability to prevent and reduce construction waste through the materials procurement process is critical and should be practiced. Procurement-related strategies are used to reduce material waste. Deliver the required quantity of material on time. Purchase materials that meet the specifications. An effective procurement management system, Find and choose the best suppliers. Make use of an experienced resource procurement team (Ajayi and Oyedele, 2018).

Material movement and storage:- Material management strategies for material storage and handling, as well as their overall ranking According to the analysis results, proper material storage was discovered to be the key strategy in preventing material breakage and deterioration due to improper storage. Store materials properly, Train workers on how to handle and install materials, maintain accurate inventory control, handle materials carefully during work, mechanically handle materials, and use appropriate tools and equipment (Tafesse, 2021).

Technology By technology:-we mean both the adoption of advanced construction systems and the direct incorporation of technological products in the establishment of construction

projects. Technology plays a significant role in completing the project within the estimated amount of construction materials by preventing issues that can lead to material waste. Different types of modern construction systems and technology products are used in building construction projects. Use prefabricated or off-site component production. Adopt recycling technology to recycle on-site waste materials. Adopt emerging technology products and services. Utilize modern plants and machinery (Tafesse, 2021).

Legal or policy:-considerations In Ethiopia, there is no specific policy governing construction waste management; however, constitutional provisions and national environmental policies address the issue indirectly. Legal or policy-related strategies identified during this study were ranked in order of importance. Recruit a material waste management officer. Incorporate a material waste minimization plan policy, and provide construction firms with scheduled training on material waste minimization strategies. Create strategies and guidelines for the use of recycled materials. Follow instructions and work in accordance with the agreement. Environmental regulation by the government and the implementation of a safety program (Endale Teferi, 2017).

Site management and planning: - Adequate planning and site management are critical in meeting various project requirements. On-site waste management that is appropriate, On-site accurate measurement of the size and quantity of material, Site supervision that is both effective and frequent, Provide incentives to motivate employees to reduce material waste. For material planning and scheduling, use software. Inspect and test the quality of materials used in the satire-use of leftover material on the job site. Employ skilled and experienced labor. Consider the economic, social, and environmental consequences of waste. Improve stakeholder coordination and record and measure various waste streams (Endale Teferi, 2017).

Construction Material Management: - The improper management of construction materials during the execution of construction activities is a critical factor that has a negative impact on the performance of construction projects. As a result, if the flow of construction materials is not properly managed, the project cost may vary significantly. By taking corrective measures in cost variance, the total cost of the project can be reduced to some extent. According to the Construction Industry Institute (CII), construction

materials and installed equipment can account for up to 50- 60% of the total project cost. The fundamental principles of construction site material management illuminate the factors that should be considered during construction site layout and planning for efficient material management (Singh, 2015).

Techniques for Managing Construction:- Materials Construction materials management is divided into five processes that are commonly used on construction sites: planning, procurement, logistics, handling, and waste control. Quantifying, ordering, and scheduling construction materials are all part of the planning process. Micro and macro planning levels are common in businesses. The purchase of construction materials and services from outside organizations is referred to as procurement (Singh, 2015)

Current Material Management Trends:- According to research, construction materials and equipment can account for more than 65 percent of the total cost of a typical construction project. Manual construction materials management practices are currently prevalent in Indian construction industries, and control procedures are unsatisfactory because they are labor intensive, inaccurate, and error prone (Singh, 2015).

Waste Management in Construction: - Construction waste is any unwanted material generated directly or indirectly by the construction or industrial processes. Construction and demolition waste is generated whenever there is a construction or demolition activity. Construction wastes in any project can take the form of building debris from demolition activities, rubble, earth material, concrete wastes, steel wastes, timber wastes, and construction site clearance construction materials, which result from various construction activities such as land excavation or formation on the construction site, civil and building construction materials, construction site clearance waste, demolition activities waste, roadwork waste, and build waste (Singh, 2015).

Construction Waste Management Waste reduction can be accomplished through a Zero Waste attitude, proper design decisions, construction site management, proper standardization of construction materials, and coding of the same. Construction waste can also be reduced by implementing a waste management system on the job site. The project activities must be planned at each stage by all construction personnel involved in order to reduce overall waste generation at the project (Singh, 2015).

The Current State of Construction Waste Due to the low priority given to appropriate construction site waste minimization and management systems in Indian construction industries, huge amounts of material waste are generated each year. Most countries currently lack awareness of resource-efficient construction practices. (Singh, 2015)

Municipal Policy and Law:- Municipalities can create their own waste management policies and bylaws, according to the Municipal Government Act (MGA, 1998, ss. 49, 81, 325-326). Municipal authorities can influence waste management in three ways: by enacting waste disposal by-laws, passing regulations through local health boards, particularly regarding hazardous wastes, and developing zoning by-laws for the citation of waste disposal and handling facilities (Meakin, 1992) Waste disposal bylaws vary greatly between municipalities. Although provincial regulations require C&D waste to be disposed of at approved facilities, municipalities may enact bylaws requiring diversion and recycling. HRM, for example, has enacted bylaws requiring C&D waste disposal facilities to recycle or divert 75 percent of C&D waste.

Other municipalities lack diversion requirements for C&D facilities in their bylaws, creating an uneven playing field for waste diversion goals across different regions (Bauld, 2008).

To address this issue, HRM has enacted a flow control bylaw. C&D waste disposal methods and facilities are defined by provincial legislation. The Nova Scotia Environment Department does not regulate C&D processing sites; however, processing may be included in approvals for disposal sites where C&D may be processed). Municipalities and individual waste management regions set their own C&D diversion targets. The RRFB provides an incentive to divert C&D waste from landfills by providing credits and funding to municipalities for C&D waste diverted from landfills (NSE, 2009; Walker et al., 2004).

Even if HRM is reducing waste disposal by requiring C&D waste diversion in their waste management plan, efforts may be hampered if waste is shipped outside the region to be processed. To help prevent this, HRM passed bylaw S602, which requires all C&D waste generated within the region to be processed at certified facilities within HRM's municipal

boundaries. This ensures that waste is diverted from landfill and that HRM receives the RRFB diversion credit (Walker et al., 2004).

Federal Law and Policy: - The policy environment that governs waste management in Nova Scotia is primarily influenced by provincial legislation and decisions made in relevant case law. Because most waste management falls under provincial jurisdiction and authority under the division of federal and provincial powers outlined in The Constitution Act, federal involvement in waste management efforts focuses on Tran's boundary waste (1867). The Canadian Environmental 22 Protection Act entails the federal government in the regulation and management of certain types of toxic substances, pollutants, and wastes (CEPA, 1999).

The Hazardous Products Act (HPA) also requires suppliers to provide WHMIS labels and material safety data sheets (MSDSs) for a controlled product at the time of (or prior to) sale or importation. By developing national goals, policies, and funding programs, the federal government can influence waste management in provincial jurisdictions. The media focused on municipal solid waste as a major problem in Canada in the late 1980s, and in 1989, the Canadian Council of Ministers of the Environment (CCME) adopted a national waste diversion goal of 50 percent by the year 2000, as well as a National Packing Protocol aimed at reducing packaging waste by 50 percent by the year 2000. (Wagner, 2007; Wagner & Arnold, 2008).

At the same time, waste management in Nova Scotia was becoming a growing public and media concern. The provincial government adopted the CCME waste diversion goal and chose to develop a waste management strategy that prioritized waste recovery and waste minimization over expanding and improving disposal options (Wagner, 2007).

Waste reduction through the following points: Aiming for Zero Waste, The design stage, Site administration, Codification, Standardization Identification (Codification), Stock control, Indenting, Transport receipt and inspection, Storage, Safety, security, and preservation, Issue and dispatch, Scrap/surplus disposal, Identification of obsolete/unserviceable and slow moving items and finally Stores records/accounting.

An overview of the paper The goal of this research is to determine the causes of material waste on multi-story construction sites and how it can be reduced. As a result, the overall project cost can be reduced while profit can be maximized. My research is limited to residence building work and is being conducted in the Anand district. In which five different buildings survey and compare their waste of building materials. Data on the estimated and actual consumption of major materials such as cement, reinforcement steel, bricks, sand, and coarse aggregate are gathered. Negative variance or waste was calculated for each project (Rai Widhiawati et al., 2019).

According to the Waste Hierarchy, the most effective environmental solution is often to reduce waste generation. Where further reduction is not possible, products and materials can sometimes be re-used, either for the same or a different purpose. If this is not possible, value should be recovered from waste through recycling, composting, or energy recovery from waste. Only if none of these solutions are feasible should waste be disposed of using the best environmentally feasible option. (Dania and colleagues, 2007)

Elizar(2015) The construction industry was confronted with a major problem: construction waste. Their significant impact on cost, time, productivity, and sustainability, among other things. It had a significant impact on practitioners and researchers all over the world. Construction waste management studies entail identifying, analyzing, and managing construction waste throughout the course of a construction project. By successfully completing the project, they are significantly reducing construction waste. In this study, effective waste management factors were identified, coded as critical success factors, and then ranked. This paper proposes a new concept for improving project performance and construction waste management practices. The three most important variables causing waste during the construction process are design changes, slow decision-making, and a lack of skilled labor. Based on this research, 5 variables and 22 indicators for improving waste construction management were identified.

GhanimA.Bekr (2014) investigates the causes and magnitude of material waste on Jordanian construction sites. He had created a questionnaire form that includes questions about the causes of waste generated on construction sites as well as estimated percentages of waste for the ten most important materials used on construction sites. The study

included a pilot survey. The questionnaire was distributed to 240 participants, the majority of whom were clients, contractors, and consultants. The primary goal of the study is to identify the major sources of material waste generated on construction sites. It was calculated using the opinions of 240 participants as well as the quantities of waste in the main building materials used on the sites. Finally, a comparison with other countries is made. According to the findings of his research, the percentage of waste materials on Jordanian sites ranges between 15% and 21%.

Wang Jiayuan (2014) Construction waste is a global issue that affects all construction sites. It must result in a significant loss for the contractors or builders. They are ineffective for waste management during construction projects. Many contractors and builders are concerned about the best way to prevent or reduce waste. In this case, project managers should request additional research on waste management regulations, waste management systems, waste management awareness, low waste building technologies, fewer design changes, and waste management research and development. This type of research can improve project performance while also controlling or reducing unnecessary waste. In a construction project, project management must advise workers on their various studies of waste management programs, plans, and waste minimization methods. Such knowledge is put to use to improve the performance of construction waste management.

Meghani, Mahesh D. (2011) 4-M (Material, Manpower, Money, and Machine) is an important factor in construction. Material waste has been identified as a major source of waste in the construction industry. The data will be collected from five different construction sites in India. Building materials account for 60 to 70% of the cost of a housing project. The function of waste management is to maximize resource utilization (Material) and reduce overall project costs. Waste encompasses both the occurrence of material losses and the execution of unnecessary work, which incurs additional costs but adds no value to the product (Koskela 1992), thereby affecting total project profit. This study compares material waste on different construction sites in Gujarat and makes recommendations to reduce waste on the job site.

Nagapan, Sasitharan (2013) In Malaysia, the construction industry is very important. Current developments have a number of negative and harmful environmental effects on the ecosystem. The primary goals of this research are to identify construction waste generation on site and to determine the construction waste management plan that was used in the same project. The study uses two methods of data collection: interviews and site observations. This study lasted two months and was conducted at three different locations. According to the study's findings, there are six types of waste produced in sites: wood, metal, concrete, mortar, packaging waste, and bricks. Finally, on-site waste quantification. As a result, research construction waste management plans at job sites in order to reduce waste.

Sapuay, S. E. (2016) The construction industry is a major producer of waste. To protect the environment by removing construction waste from their working area. Demolition waste is a significant waste in the construction industry. The contractor is responsible for managing construction waste on the job site. This paper primarily addressed the issues of construction waste encountered in projects and how this waste can be reused on the job site. This study has improved ecological solid waste management.

Methods for reducing construction waste Noraziah Wahia (2015) Construction waste from the construction site has a negative impact on the environment. Because of these negative consequences, construction waste production must be controlled and managed by stakeholders in the construction industry. The waste management systems in Hong Kong and Malaysia are depicted in this paper. It also demonstrates the differences and similarities between the two countries. These studies also deal with management systems in the future. This study is the keyword for waste reduction in Malaysia, as well as the precise source for waste management system reduction. To summarize, the Malaysian government can still make significant efforts to address the C&D waste issue by looking to Hong Kong as a model. The proper waste management system contributes to the popularity of these countries. This paper suggests that the waste management system be improved. Waste management facilities, particularly recycling facilities, require upgrading and improvement. The government's enforcement is critical to ensuring that the requirements and standards are met.

R. B. Surveillance (2013) The study's goal is to learn about the sources and causes of construction waste. It has been discovered that waste generated on construction sites causes financial losses, such as the cost of transporting and disposing of site waste and material storage costs. In this study, construction waste generation was studied at various types of construction sites such as commercial, residential, and industrial sites, and data on waste generation sources and average waste generation was collected. Route optimization for selected sites is also carried out in this project using a GIS application.

Ikau, Roseline (2016) The amount of material waste generated by construction activities is growing by the day. The primary goal of this paper was to identify the current various factors that contribute to construction waste generation on Malaysian construction sites. The study was followed by a structured questionnaire aimed at Malaysian contractors involved in various types of construction projects. Statistical Software Package was used to analyze the data. A questionnaire based on some important waste-generating factors was created. Further research will focus on sustainable waste management as it relates to construction waste minimization. The study's findings would raise awareness about the waste generated at the site and encourage the adoption of sustainable waste management practices.

Ruane Fernandes Magalhaes (2017) The construction industry is well-known for causing negative environmental impacts by emitting waste into the environment, and its effects have gotten worse as cities have grown in size. This research arose from the need to reduce the environmental and economic impacts of material waste in urban infrastructure projects. The study's main goal was to identify best practices to support the design stage and reduce waste. This research presents best practices for reducing waste in current projects and avoiding the role of decision-making in the design stage. The best practices were identified through a literature review, document analysis in 14 urban infrastructure projects, and a qualitative and quantitative survey of 18 experts.

Dachowski, Ryszard (2016) Contractors needed very important ways to avoid waste material because it will cause many environmental issues. They are generally reusing and recycling. They can use waste foam glass and high impact polystyrene to reduce sound and improve workability. The study's goal was to assess the efficacy of additives based on

the physical and mechanical quality microstructures of newly created materials. This research looked at the effects of additives on bulk density, flurry strength, compressive strength, and water absorption in modified cement mortar.

Banihashemi, Saeed (2017) During this time, special attention should be paid to the sustainable built environment. The goal of this research is to introduce an approach to construction waste optimization by increasing in a sustainable environment. Modular coordination is critical when deploying offsite construction.

Encourage parties involved in the building construction industry to use the method that leads to production in order to obtain an integrated design based on a basic element or component. Major benefits to facilitate productivity and reduce environmental impacts, such as project transfer via MC results algorithm, were developed based on Parametric design and modular coordination standards. That is, the facts are fabricated, and the facts cannot be applied to real-world situations, resulting in a hypothetical report. Furthermore, the algorithm developed will aid in reaching the lowest desktops in the interval to reduce the bandwidth limit. This causes further inquiries and validation.

Omar Saheed (2017) there is a massive amount of construction waste on construction sites. In this case, project management should include activities such as design, materials project, and construction phases of the Project delivery. This study includes physical storage and logistical means to reduce waste generated by construction activities, as well as methodology of explanatory research and research surveys in its methodological framework to understand the phenomenon of the construction industry's perspective.

Low waste management, low waste storage, effective material delivery management, waste quotas, and so on. The findings of this study will assist us in understanding a set of steps that should be taken during the procurement of objects. In the construction phase, it is important to try to waste the waste in other aspects of the project delivery process. Measures will be taken to waste more than half of the cost of premium purchase, purchase, and purchase process during the delivery process, as well as project costs. This can be accomplished by utilizing waste efficient purchase management, design compensation purchasing, and waste waste management services..

WeishengLu(2016) In this study, an S-curve model is developed and tested to indicate accumulative waste generation as a project progresses. This is used to forecast waste on the job site. The S-curve model is then linked to project characteristics using artificial neural networks (ANNs), allowing it to be used to forecast waste generation in future construction projects. The S-curve provides detailed forecasting and a recycling benchmark. The main contribution is waste management forecasting. S-curve modeling is a widely used tool. The S-curve provides scientific evidence for construction waste management as well.

Lai, Ying-Ying (2016) Taiwan construction waste management (CWM) practices and reuse status are discussed in this paper. Global warming is the cause of global climate change. Now that new and existing buildings are collapsing, waste is increasing. Some materials are renewable and will be used in the future. In recent years, Taiwan has generated 2 million tons of construction waste per year. Building waste must be transported to treatment facilities.

Review of Literature on Processing Construction Waste Management Modeling Construction and demolition (C&D) waste has received increased attention from construction practitioners and researchers, according to Hongping Yuan (2012). A model is necessary to reduce waste and strategies for C&D waste reduction. This research contains loops that use a dynamic approach to integrate major variables in C&D. These loops begin with a relationship in C&D, then a stock flow, and finally a case study for validation. The development of a dynamic model for evaluating C&D waste reduction strategies under various scenarios is a major contribution of this study. These projects seek to investigate the interdependence of variables. This study's contributions are primarily in three dimensions. First, consider the causal loop diagram, which depicts the interconnected relationships between major variables. Second, there is the established model in the stock-flow diagram. Finally, the case study results provide insights into the measures that could play a role in reducing the project's C&D waste. Grigor'eva, Larisa S (2016) Foreign and domestic experience show that avoiding the negative consequences of construction waste formation and accumulation can only be based on all processes of collection management, sorting, transport, and recycling, and proper waste management

system planning helps to predict stable system value. In the case of waste management, such calculations are critical for the easy management of the construction field. This system is divided into two major subsystems. The first subsystem is responsible for collecting, sorting, and transporting construction waste. The second subsystem is construction waste recycling, which provides a clear picture of the system's model and algorithm

Many jobsite waste issues are the result of avoidable practices. Material delivery care when loading, transporting and offloading materials is one of the key human interfaces that can reduce waste generation. Material storage, safe storage, covered storage when necessary, and storage away from jobsite activities (Dennis S. Macozoma).

Reducing construction site waste can save money on both raw material purchases and disposal of waste generated on the job site. It can also reduce waste caused by inefficiency on the job site.

Construction waste contributes to the massive amounts of construction waste generated by the construction industry each year. Construction waste is estimated to account for 15-30% of the total amount of waste that ends up in landfill sites in many countries. At the project level, the waste generated on site is estimated to be approximately 10% of the materials originally purchased. Because building construction is a business, the contractor will benefit from waste management methods that reduce liability for jobsite waste. Professor Phil Jones and Dr. Rubina

2.7. Summary of Research Gaps

This section will report on other related work in this area after introducing the concept of waste minimization in relation to environmental sustainability. Waste management/minimization research projects span multiple disciplines and sectors in the construction industry, employing a variety of strategies and concepts. As a result, this section discusses a number of issues that have been used in the construction industry to reduce waste.

While the list of previous works in the field of waste minimization strategies in this section is not exhaustive, it does show the wide range of research projects that should be

considered in determining a more sustainable course of action for the reduction or elimination of waste in construction projects. Achieving good waste minimization and management on construction projects will help reduce the amount of waste sent to landfills, making a significant contribution to overall sustainable development and environmental sustainability in particular (Wrap, 2007

CHAPTER THREE; MATERIALS AND METHODS (RESEARCH METHODOLOGY)

3.1. Introduction

The research methodology will provide the path and a completely appropriate sound method that is appropriate for the research project. A methodology provides a framework for achieving the project's goals and objectives while also making it more manageable, smooth, and effective. This chapter also includes information about the research population, sample size, and statistical tools used for data analysis, as well as the methodology used in this study and information about the research strategy, study site, sources of information, sampling techniques, sampling size, method of data collection and processing, method of data analysis and interpretation.

3.1.2. Research Design

The strategy used in this research began with problem identification, which was accomplished through an unstructured literature review, archival research, and informal discussions with colleagues and professionals in the sector, and then the research design was developed. Then, based on the research design, data and information sources were identified. The research instruments were chosen based on the data and information sources, and available documentary sources relevant to the research were reviewed. The thesis, books, and journal are all included in the review. Finally, following a thorough review of the literature, a questionnaire was created and distributed to client employees, contractors, and consultant employees to solicit feedback based on their experience. Data has been checked and sorted after obtaining the desired data. The data was then analyzed in order to extract the information obtained from the overall research work. This was followed by in-depth discussions in order to reach a conclusion and make recommendations based on the study's findings. In this study, a descriptive and exploratory survey design was used. It was attempted to collect data from the relevant population (client employees, consultant employees, and contractors) in order to assess their perceptions of material waste management systems in Arada sub-city building construction sites. The survey strategy was used to assess the construction material wastage in Addis Ababa Arada sub city building construction projects. As stated by

Naoum (2007), surveys are used to obtain data from a large number of samples within a short period of time. Thus, when data is collected from a defined sample, a generalized result can be obtained. The total number of the project sample for this study is 35.

3.1.3. Sources of Data

The information was gathered from both primary and secondary sources. The former has been used to collect information from project office employees, consultant firm employees, and contractors via questionnaire and direct observation. A questionnaire survey was chosen as the research instrument due to its suitability to the level of information required, cost and time constraints, and large number of participants. Secondary data was gathered from various organizational theses and documents such as material management manuals, purchasing manuals, construction manuals, property administration directives, and annual reports of the project office.

3.1.4. Sampling Techniques

Both probability and non-probability sampling techniques were used in this study. The sample size is determined using stratified probability sampling. The researcher employs the non-probability sampling method of judgmental sampling to obtain detailed information from experienced employees of the owner or client, consultant, and contractor of the project office. Non-probability sampling does not ensure that all elements of the population or study are represented in the sample units chosen at the researcher's discretion. The reasons for choosing such techniques were that they allow the researcher to freely select any respondent that he or she believes best fits the question

3.1.5. Study Population and Sample Size

Arada sub city construction site was chosen as the study's construction site. Some sites are currently completed, while others are not. Client/Owner, Consultant, and Contractor are among the study's participants.

Table 1-Study Populations Data

	Client		Consultants	Contractors	Total number of populations
Site	Construction department	Design department			
Arada sub city site	35	36	29	75	175
Total	35	36	29	75	175

Source Arada sub city office The sample size of project office was determined using the following formula: $n = \frac{N}{1+N(e)^2}$

3.1.6. Data Collection Tools

To collect data for the study, the researcher used both primary and secondary data collection methods. The researcher's personal observation and a questionnaire were used to collect primary data, both qualitative and quantitative. The open-ended and closed-ended format questions were designed to elicit information about the current state of construction waste management and disposal strategies in the study area, the AABC Arada sub city site. Secondary data were gathered from published and unpublished literature such as books, journals, and research materials, as well as statistical and legal documents relevant to the study's objective.

3.1.6.1. Questionnaire

To collect primary data from the sample population, a formal English questionnaire was designed. The questionnaire was structured to assess the situation and effectiveness of the waste management system and techniques of waste strategies at the Arada sub city site. The questionnaire was organized into four major sections to collect primary data about the types of waste from the study site, the waste monitoring system and the rate of waste generation, the time and manner of depositing waste, the storage system and facilities, the major causes of waste, the economic, human health, and environmental impact of waste

management, the awareness of professionals and staff of the Arada sub city and contractors on waste management issues and technology, and the awareness of professionals and staff of the Arada sub city and contractors on waste management issues and technology.

3.1.6.2. Non-Participant Observations

According to Tedlock (1991), the non-participant observation method entails the researcher physically viewing what is present and occurring at the site or geographical location of interest. The observable phenomena could be physical features at the study site or behaviors of the respondents the researcher plans to study. The observations can be made and visualized as photographs taken by cameras, or they can be described if they are behavioral and physically invisible. The researcher made multiple on-site visits and observations of the study site in order to assess the situation of construction waste management at the site, and he documented his observations and captured camera images.

3.1.6.3. Face to Face Interviews

The researcher established the other methods based on the researcher's objective. An in-depth interview questionnaire was created to gather information on the issues addressed by the questionnaire. The interview was intended to supplement the questionnaire and improve the reliability of the questionnaire data. The researcher conducted 15 interviews with AAA SUB CITY employees, contractors and consulting firms, MSEs, and members.

3.1.7 Method of Data Analysis

The data collected was analyzed and interpreted by using both qualitative and quantitative techniques. The data collected by closed ended questionnaires were analyzed quantitatively. The researcher used a descriptive statistics analysis to analyze quantitative data such as the percentage, frequency of the point by all respondents, and, weight for each point. The study method used to gather primary data is structured questions using analytical tools were used for data analysis. Descriptive statistics were used to describe the Assessment in Construction Waste Management Practice. The data were analyzed by Excel software and the results were presented with graphs, figures, and tables as well as in texts and Visio software used for the preparation process and flow chart design.

3.1.7.1. Data Reliability and Validity Test

A. Data Validity Test

Validity is different in type to test which comprises content, face internal and external validity ((Bell & Bryman, 2007). Content validity was ensured by formulating the questions in understandable words and meanings. Questionnaires included various questions that were prepared based on the knowledge of the civil work and Supply chain practice and performance in the telecom. The questionnaire was also initially evaluated by the civil work and Supply chain management professionals, managers, and employees and they ensured that the contents of the questionnaire were good and easy to understand; which indicated that the instrument fulfills the validity content. The questionnaire was also checked by the professionals, managers, and employees to see the contents such as its visibility and size and they suggested that it is acceptable; this implies that it fulfills face validity. The questionnaire included the entire civil work and Supply chain work participant (census) as a result fulfills the external validity or the study addressed the whole population.

Questionnaires were given to ten respondents; two managers and eight professionals, after fulfilling the above-stated validity measurement the reliability of the questionnaire has been checked during the pretest session with the above sample of respondents and ensured that their responses were almost similar. After performing the necessary modifications based on the feedback provided, the questionnaire was distributed to the respondents.

B. Data Reliability Test

However, the researcher believed the instrument is valid, the reliability or internal consistency of the data was measured using the measurement level ordinal (i.e., Likert scale), and the relative importance index (RII) is known as a good measure of reliability which values ranging from 0 to 1. The values between 0.8 and 1 indicate a high Importance level; values between 0.6 and 0.4 indicate a Medium Importance level while values below 0.4 are considered a low Importance level and have no impact on create construction waste materials in construction project activity. The relative importance index (RII) can be calculated using the below Equation. (Polat et al., 2017)

Where

$$RII = \frac{\sum_{i=1}^a w_i x(f_i/n)}{a}$$

i, is the point given to each factor by the respondent,
a, is the highest point of the scale, which is 5
w_i, is the weight for each point,

f_i, is the frequency of the point i by all respondents,

n, is the total number of responses. In this study,

In this study, the respondents are requested to express the importance levels of the waste causes on a 1-5 Likert scale. The RII values are transformed into five importance levels as shown in Table 3. (Polat et al., 2017)

Table 2:-The relationship between the RII values and importance levels

RII	Values Importance level
1.0 ≥ RII ≥ 0.8	High (H)
0.8 > RII ≥ 0.6	High-Medium (H-M)
0.6 > RII ≥ 0.4	Medium (M)
0.4 > RII ≥ 0.2	Medium-Low (M-L)
0.2 > RII ≥ 0.0	Low (L)

3.8. Ethical consideration

A research ethical issue is concerned with protecting respondents from any probable harm related to their responses. The respondents had to have informed consent, the right to privacy, and honesty with professional colleagues. Accordingly, the respondents in the study were selected with full consent and informed to respond to the questionnaire with confidence and understanding of the purpose of the study. The researcher assured the respondent that, the collected data will be used only for the intended purpose and the information will be kept confidential. Consequently, the researcher in this regard kept the responses of the respondents honestly and confidentially.

CHAPTER FOUR; ANALYSIS AND DISCUSSION OF THE STUDY

4.1. Introduction

The major goal of this study was to evaluate the existing state of controlling and minimizing material waste in the projects at the Arada Cub-City site by evaluating the sources, causes, influence on project performance, degree of participation, and solutions for material waste minimization. The respondents were tasked with ranking the primary causes and sources of building material waste in this section. The researcher chooses 130 total sample out of 175 total populations (47 client workers, 29 consultant employees, and 54 contractors' employees), and distributes the questionnaire for knowledgeable and more closely associated material management staff of the project office. The rationale behind choosing such procedures is that they provide the researcher the freedom to choose whichever responder they feel best fits the question.

4.2. Response Rate Analysis of the Study

85 of the 130 questionnaires that were distributed were returned. 37 contractors, 15 consulting firms, and 33 clients are participating in the questionnaire responses as a result. Following the completion of the questionnaire survey, the results were statistically analyzed using a variety of techniques detailed in the research methodology. Both primary and secondary data were used to conduct this study.

Table 3:-Response Rate of the Survey

O	Project stake holder	Questionnaire distributed		Questionnaire returned		Failed questionnaire		Analyzed questionnaire	
		No	%	No	%	No	%	No	%
1.	Client	42	32.307	33	25.38	0	0	33	25.38
2.	Consultant	35	26.923	15	11.538	0	0	15	11.538

3.	Contractor	53	40.769	37	28.46	0	0	37	28.46
Total		130	100	85	65.383	0	0	85	65.385

Source: Questionnaire Survey

4.2.1. Types of Organization (Respondent Designation)

The organizational grouping of the responses is shown in Table 4.2. Out of the 130 questionnaires overall 33 (38.82%) of the responders who were analyzed were clients. 37(43.529%) of them were contractors, compared to 15 (17.647%) who were employed as consultants. The management of materials and the minimization of waste involved all parties directly.

Table 4:-Respondent's organizational grouping

No	Organization group	No	%
1.	Client	33	38.82
2.	Consultant	15	17.647
3.	Contractor	37	43.529
Total		85	100

Source: Questionnaire Survey

4.3. Source of construction waste

The sources of construction trash that were discovered through questionnaire surveys and on-site observations are given and discussed in this section of the results. Surveys were created to determine the frequency and severity of the sources of building trash. As previously indicated, there are eight different sources of construction waste: design, procurement, storage and handling, operation, vandalism, weather, residual, and others.

There are numerous factors considered for the respondents to contribute to construction material waste (client, consultants and contractors). Construction waste might be caused by a single source or a multitude of others. Each source's influence differs from site to site. The sources of the identified design, procurement, storage and handling, operation, vandalism, weather, residual, and others were discussed in the literature review sections. The respondents anticipated ranking many of the sources inside each one.

4.4. Sources of Wastage

Major Sources of Waste On the construction site for the Arada sub city, respondents were asked to rank the various sources of waste that were listed. The respondents' evaluation of the relative relevance of each of the 8 sources of construction material waste (client, consultants and contractors,).

Table 5:-Analysis of Major Sources of Waste On the construction site

No.	Source of construction waste	Total	RII	%	Rank
1.	Design waste	85	0.8823	88.0	1
2.	Operational waste	85	0.8353	83.5	3
3.	Procurement waste	85	0.8588	85.88	2
4.	Material handling waste	85	0.81	80.9	4
5.	Weather waste	85	0.81	80.9	4
6.	Vandalism waste	85	00.43	42.6	5
7.	Residual waste	85	0.393	39.3	6
8.	Materials misplacement on site	85	0.3364	33.64	7

The table 3. Above demonstrates that the principal causes of the construction project Arada sub city site are, in order, design waste (0.8823), procurement waste (0.8588),

operational waste (0.8353), and material handling waste (0.8094). The outcome demonstrates that the design was severely lost due to issues during the pre-construction phase. Due to accurate measurement and irrational study. The planning and it classifies issues such an incorrect bill of quantities, a lack of a material plan, design modifications, and ambiguities, mistakes, and discrepancies in the drawings. The majority of the time, consultants' bill of quantities favored the contractor over the building's actual built usage, and the excess that was provided ended up being wasted. The second cause of procurement waste also has unequal competencies and ambiguous paperwork. Third, unlawful operations make up a portion of the sources of garbage at the Arada cub city project site, together with operational waste and material handling waste.

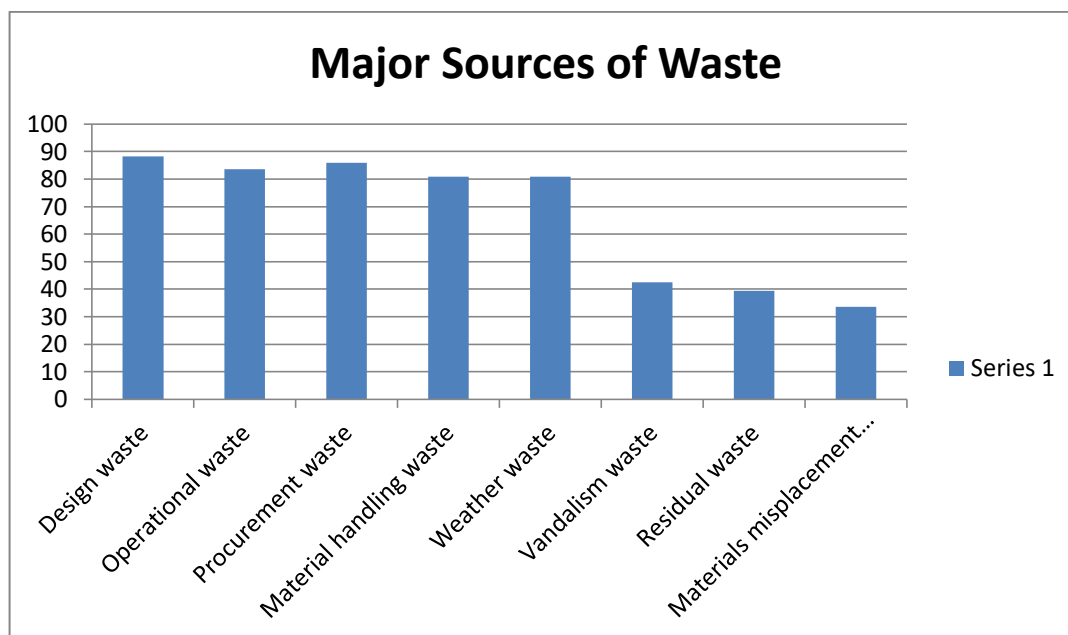


Figure 1: -Major Sources of Waste

4.5. Major Causes of Wastage on Project Site

The study's questionnaire looked at 26 factors that contribute to the waste of building materials, and the respondents ranked those factors according to how much waste they believe they are contributing in the following table.

Table 6:-Ranking of primary causes of construction material waste and their relative importance index.

No	Causes of waste	Total	RII	Rank	%
1.	Poor workmanship	85	0.86	2	86.8
2.	Poor communication between designer and builder or within the organization	85	0.6	19	60
3.	Inadequate supervision	85	0.83	6	83.29
4.	Damages caused by succeeding trades	85	0.51	21	51.53
5.	Required quantity unclear due to improper planning	85	0.89	1	89.4
6.	Bad weather condition	85	0.82	7	82.8
7.	Use of incorrect material, thus requiring replacement	85	0.64	18	64.49
8.	Dropping and spoiling of material during fixing	85	0.51	22	51.0
9.	functioning of equipment	85	0.49	23	49.65
10.	Site accidents	85	0.74	15	74.35
11.	Design changes during the construction period	85	0.86	3	86.12
12.	Lack of attention paid to dimensional coordination	85	0.44	24	44.2
13.	Lack of information in the drawings	85	0.77	11	77.4
14.	Incomplete and errors in contract documents	85	0.84	4	84.2
15.	Designers unfamiliarity with alternative products	85	0.76	12	76.47

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16.	Selection of inferior quality materials and products.	85	0.78	9	78.8
17.	Lack of attendance paid to standard sizes available in the market	85	0.53	20	53.6
18.	Complexity of the drawings	85	0.43	25	43
19	Inappropriate storage facilities.	85	0.67	17	67
20.	Damages during transportation	85	0.75	14	75
21.	Material supplied in loose forms	85	0.6	19	60
2	Unfriendly attitudes of project team and laborers	85	0.78	10	78.1
2	Mismatch of material purchased with specifications	85	0.75	13	75.5
2	Ordering errors	85	0.80	8	80.0
4.					7
2	Procurement waste	85	0.83	5	83.5
5.					
2	Lack of possibility to order small quantity	85	0.69	16	69.8
6.					8

According to the aforementioned table 4.5.1., the first five major causes of material waste on the Arada sub city building construction project site were, in order, Required quantity unclear due to improper planning (.894), Poor workmanship (.8612), Design changes during the construction period (.8612), Incomplete and errors in contract documents (.842), and Procurement waste (.8353). Lack of quality control systems for construction work and materials on the site is mostly to blame for material waste. There is no oversight organization for the application of the kaizen idea, which is crucial to reducing material waste and raising building quality. Many materials are wasted as a result of improper

storage at the contractor site. The contractor isn't accountable; though. Because the contractor is given preference while creating the bill of quantities. As built standard is higher than material standard. Therefore, the contractor showed no concern for material waste.

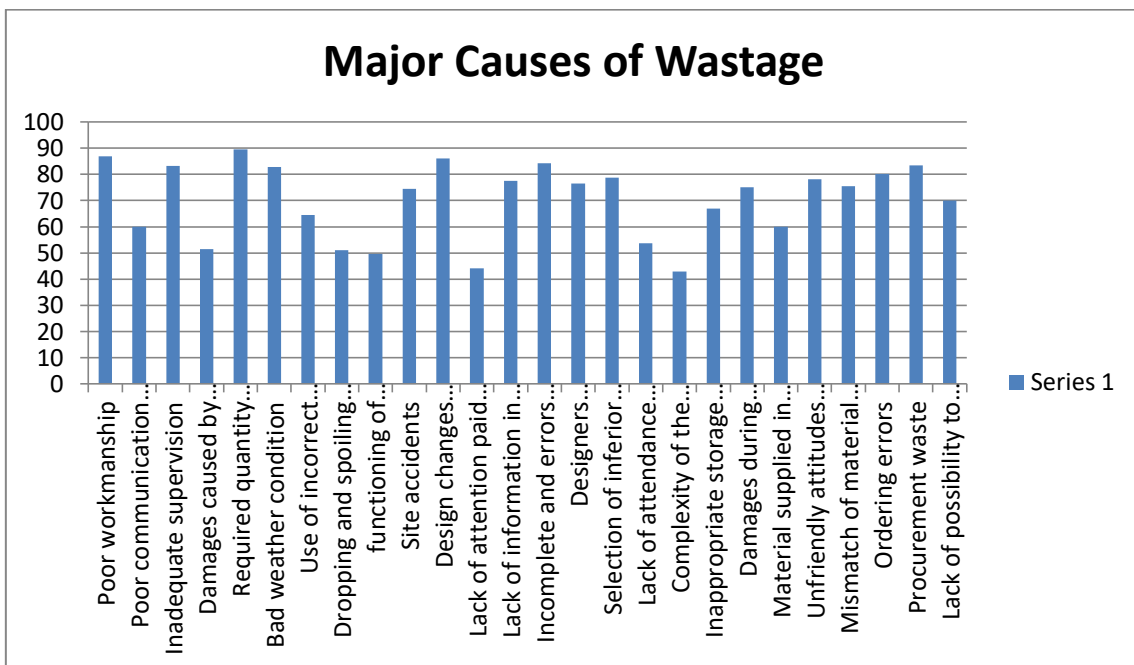


Figure 2: -Major Causes of Wastage

4.6 Wastage disposal techniques at the site.

The questionnaire for this study took into account six disposal methods that lead to the waste of construction materials, and the respondents ranked the severity of this waste according to the following table.

Table 7:-Ranking and Relative Importance Index of Major Construction Material Waste Disposal the minimization of negative effects on the environment, the economy, and human health.

No.	Methods of material dispose organization	Total	RII	Rank	%
1.	Re-use within the project office	85	0.727	1	72.7
2.	Transfer to another construction branches office	85	0.701	2	70.1
3.	Return back to the supplier	85	0.567	3	56.7
4.	Sales to another firm	85	0.546	4	54.6
5.	Donation to other charitable organization	85	0.466	6	46.6
6.	Doesn't apply any disposal action	85	0.473	5	47.3

The table 4.6.1 above demonstrates that the four main methods of material disposal of the construction project Arada sub city site are, in order, Re-use within the project office

(0.727), Transfer to another construction branches office (0.702), Return back to the supplier (0.567) and Sales to another firm (0.546) The outcome demonstrates that reusing materials within the project office was a key construction-phase strategy. the incorrect bill of quantities, the absence of a material plan, design revisions and alterations, and ambiguities, mistakes, and inconsistencies in the drawings. Most frequently covered disposal methods. The higher rank on the site reduced waste during the construction phase of Arada Cub City.

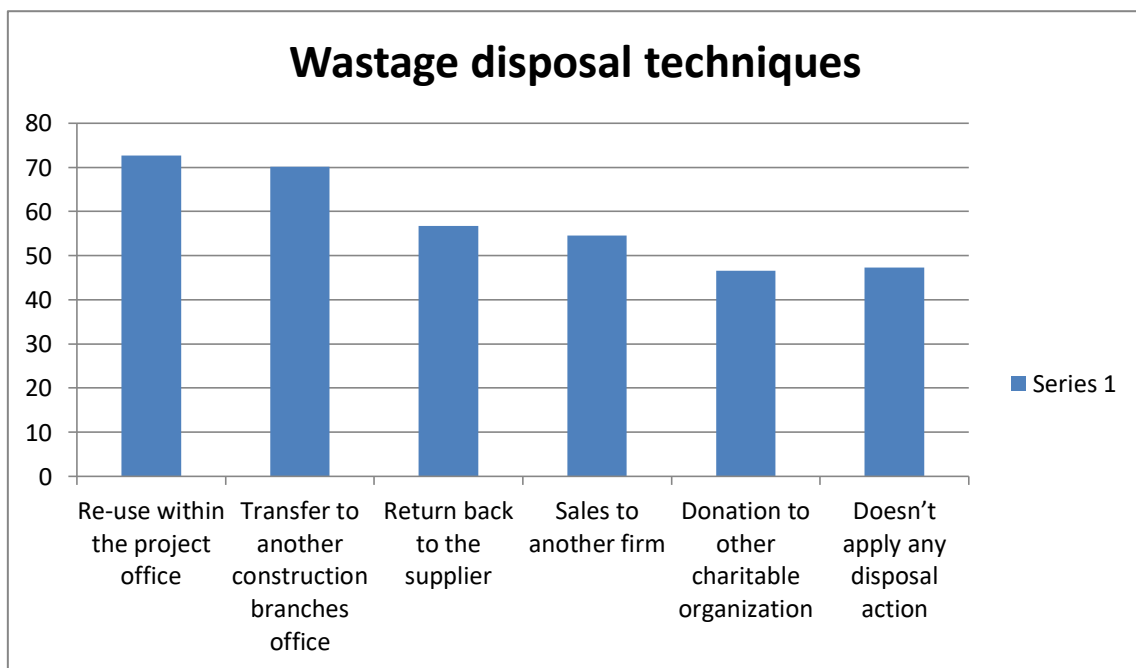


Figure 3: -Wastage disposal techniques

4.7. Assess Level of Construction of Waste Minimization Techniques To Waste Reduction And Levels Of Techniques Of Same Measures In The Arada Sub City Construction Sites

The construction sector is the largest waste generator to landfilling sites and at the same time the heavy consumer of resources.

The overall aim of the current study was to determine the most important strategies capable of preventing and reducing material wastage in construction project sites. The study was designed and executed to identify adequate strategies for construction waste reduction, to analyze the perception of building project stakeholders on waste

minimization techniques, and to confirm the key techniques to reduce construction wastes in building construction sites. Consequently, the study would assist construction stakeholders and other construction experts to understand key techniques that are required to minimize material wastes generated by construction activities, and maintain cleaner environment, and then minimize project costs.

4.7.1. Design and documentation

Design and documentation are utilized to lessen the production of waste materials, which have design and documentation problems as their root causes. A frequent technique for efficient waste minimization is to reduce construction waste during the design stage (Wang et al., 2014). This group included fifteen of them, as shown in the

Table 8:-Design- and documentation-related minimization methods for material waste are shown in Table.

No	Design and documentation related minimization techniques of material waste	Total	RII	Rank	%
1.	Design standardized material dimension	85	0.767	2	76.7
2.	Use experienced and sound design team	85	0.73	6	73.8
3.	Design adequate building component size, regular shape and spacing	85	0.69	9	69.88
4.	Avoid late design variation	85	0.67	10	67.06
5.	Design material optimization and sustainability	85	0.74	5	74.35
6.	Design off-site construction	85	0.75	4	75.76
7.	Have accurate contract document	85	0.76	3	76.0
8.	Accurate specification and quantity of materials	85	0.76	1	76.94
9.	Avoid designing for custom made size as much as possible	85	0.45	13	45.17
10.	Simplified and proper details of drawing	85	0.73	7	73.64
11.	Consider the availability of material during	85	0.66	11	66.6

	designing				
12.	Simple and repeatable design	85	0.72	8	72.94
13.	Reduce number of amenity areas	85	0.73	7	73.64
14.	Amalgamate services adjacent to each other	85	0.73	7	73.64
15.	Design renewable resources as much as possible	85	0.62	12	62.58

Accurate specification and material quantity were shown to be a very essential strategy to reduce construction wastes using the relative importance index (RII=0.7694). The amount of material that needs to be cut into pieces to meet the actual size of the building is reduced when this technique is taken into account during the design process. Research on crucial management strategies influencing on-site waste minimization in building projects provides evidence in support of this (Ajayi et al., 2017). By eliminating errors and omissions on the drawing brought on by the lack of knowledge of the designer, designing for the specified material dimension (RII=0.767) greatly reduced wastes. This action significantly contributes to lowering material waste (Adewuyi and Odesola, 2016). Having precise contract documentation (RII=0.76) was another crucial tactic for addressing the problem of material waste. For instance, according to Ajayi et al. (2015), standardized or optimized designs are essential strategies to attain waste-free construction sites. The three methods mentioned above are more akin to the construction site of the Arada subcity.

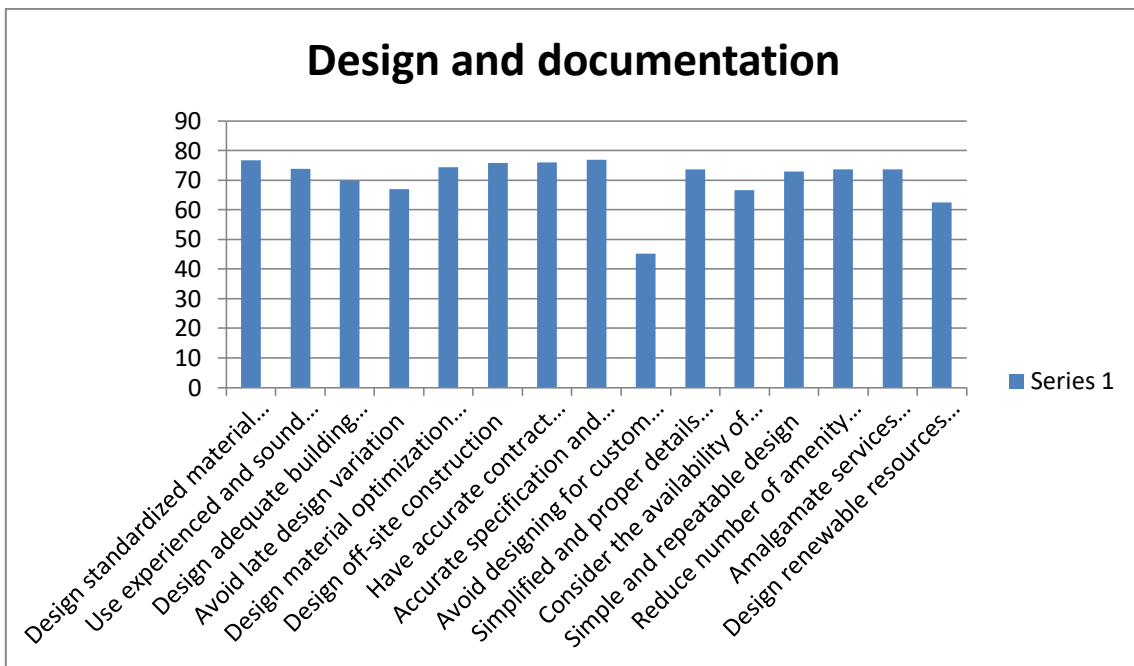


Figure 4: -Design and documentation

4.7.2. Material procurement

It is important to take advantage of the potential for preventing and decreasing construction waste during the materials procurement process (Ajayi and Oyedele, 2018).

The following

Table 9:-displays the procurement-related techniques used to reduce material waste..

No	Material procurement-related minimization techniques of material wastes	Total	RII	Rank	%
1	Deliver required quantity of material based on schedule	85	0.80	1	80.47
2	Purchase materials that comply with the specification	85	0.70	4	70.82
3	Proper procurement management system	85	0.76	3	76.23
4	Identify and select the right suppliers	85	0.78	2	78.82

5	Use experienced resources procurement team	85	0.6 4	5	64
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The study's findings showed that, with a RII value of 0.804, procuring material that complies with the specification and supplying the required quantity of material according to a schedule were the two extremely critical techniques. To avoid problems that can result in material waste, it is crucial to only order what is necessary (Assem and Karima, 2011; Sasidharani and Jayanthi, 2015). The most crucial tactic for dealing with material waste is to avoid placing excessive orders (Ajayi et al., 2017). Additionally, buying materials that meet specifications helps to limit the amount of trash produced by materials; otherwise, materials that don't meet specifications are unacceptable and may be deemed waste if they aren't sold or returned to the provider. While effective procurement management systems, with a RII value of 0.762, came in second in reducing building material wastes. This is recommended as a crucial tactic for managing building material wastes (Ajayi et al., 2017). The study's findings suggested that choosing the correct suppliers and identifying them are crucial steps in reducing construction wastes in the building industry (RII=0.788). Identification and selection of the appropriate material suppliers are methods developed for construction stakeholders to reduce construction wastes as it aids in obtaining quality supplies at the appropriate time in Arada sub city project construction.

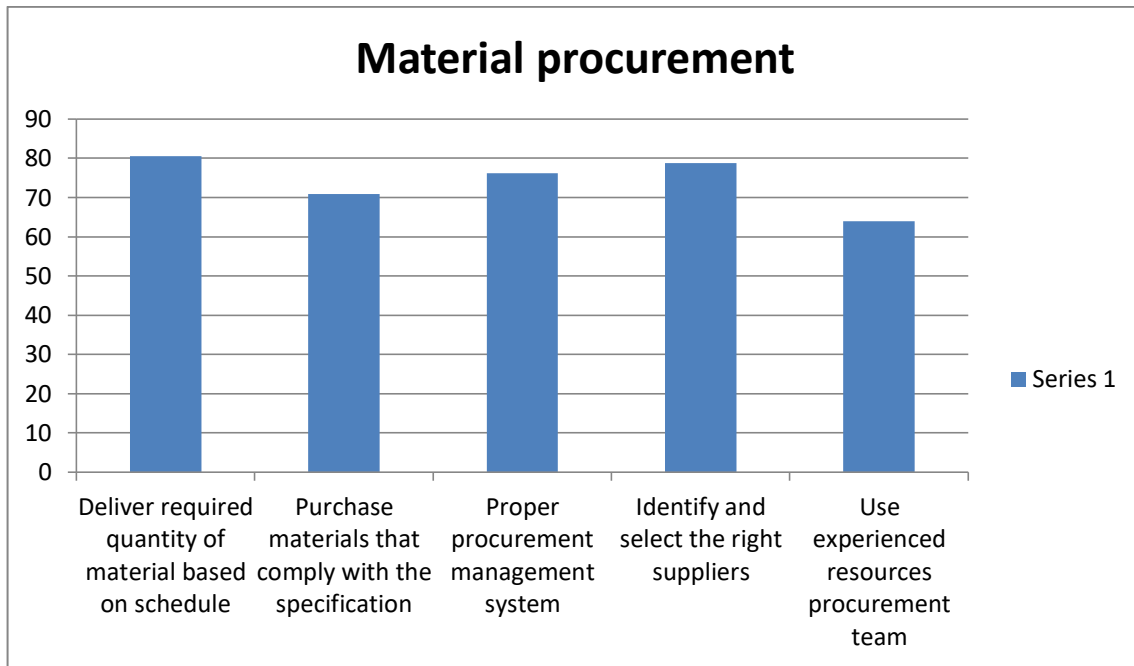


Figure 5: -Material procurement

4.7.3. Material handling and storage

The use of appropriate tools and equipment, training people in the handling and installation of materials, and mechanically managing materials are all material management strategies that are represented in Table 4 along with their overall ranking. According to the analysis's findings, (RII= 0.74, 0.572, and 0.569) correspondingly, was identified as the primary tactic in preventing material deterioration and breakage on the job site.

Table 10:-Material storage and handling related minimization techniques of material wastes

No	Material storage and handling related minimization techniques of material wastes	Total	RII	Rank	%
1	Properly store materials	85	0.454	6	45.4
2	Train workers about how to handle and install materials	85	0.5694	3	56.94
3	Accurate inventory control	85	0.468	5	46.8
4	Carefully handle materials during work	85	0.54588	4	54.6
5	Mechanically handle materials	85	0.7435	1	74.35
6	Use adequate tools and equipment	85	0.57176	2	57.2

Therefore, mechanical material handling should be used for each material at the project site (Assem and Karima , 2011). The most crucial method for minimizing construction waste is adequate material storage (Eze et al., 2016). With a RII value of 0.7435, training personnel in material management and installation is evaluated as the second crucial technique from those linked to material storage and handling. This is a calculated strategy for site employees to address waste issues (Adewuyi and Odesola, 2016; Endale Teferi, 2017). It serves to raise worker awareness, improve their understanding of the fundamentals of material waste, and improve the technological sophistication of their daily work. According to the analytical result of this work, accurate inventory control is evaluated as the third most significant approach with RII 0.569. It helps to prevent

building material from being wasted. Inventory management is the most important method for handling waste construction material, claims Aparna (2017).

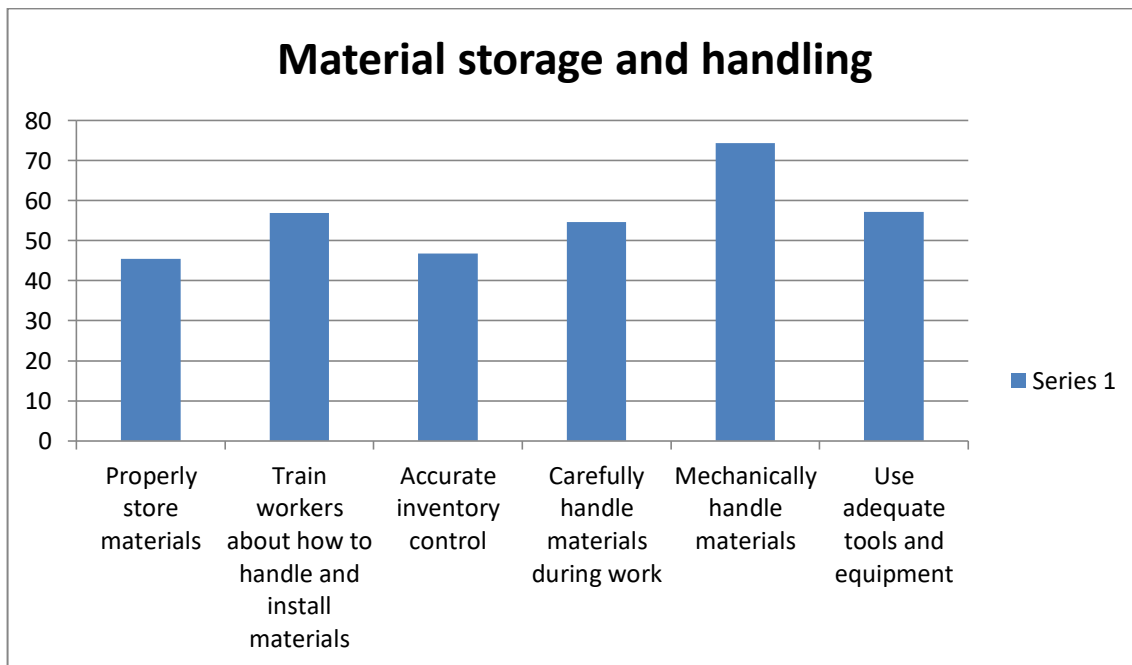


Figure 6: -Material storage and handling

4.7.4. Technology

By "technology" in this context, we refer to both the adoption of cutting-edge construction methods and the direct incorporation of technological innovations into the planning of construction projects. By preventing the problems that can result in material wastes, technology plays a significant part in completing the project within the allotted amount of construction materials. Different modern construction systems and technological goods are used in building construction projects. Modern construction techniques are effective ways to manage construction wastes, claim Ali et al. (2019). Table 4.7.4.1. lists various methods for reducing the production of material wastes during building construction projects along with their overall effectiveness.

Table 11:-Technology related minimization techniques of material wastes

No	Technology related minimization techniques of material wastes	Total	RII	Rank	%
1	Use prefabricated or off-site production of component	85	0.407	4	40.7
2	Adopt recycling technology to recycle waste materials left-over on site	85	0.505	1	50.6
3	Adopt emerging technology product	85	0.451	3	45.17
4	Use recent plants and machinery	85	0.473	2	47.3

According to the findings of the current study, adopting recycling technology to recycle leftover waste materials on site was the most crucial tactic to address the problems that cause the production of material wastes on construction sites. It was also ranked as the first major technique with a RII value of 0.51 in the study. Prefabricated and off-site construction components are an important technique to avoid the variables leading to material waste, according to a recent study by Eze et al. (2016). Utilize modern equipment and plants was evaluated as the second most significant method with a RII rating of 0.452. It was discovered to be the most effective method for reducing material waste at building sites (Sasidharani and Jayanthi, 2015). The third crucial approach had a relative relevance index value of 0.45 and involved the use of cutting-edge items (such as the fast wall system, lightweight construction technology, composite construction materials, and modular building components, etc.) in the construction project. Utilizing a modular design system and incorporating a new cutting-edge technology product can save waste, make installations simple, and help avoid on-site production wastes (Adewuyi and Odesola, 2016). Construction is expedited, quality is increased, and resource waste is minimized (Wang et al., 2014).

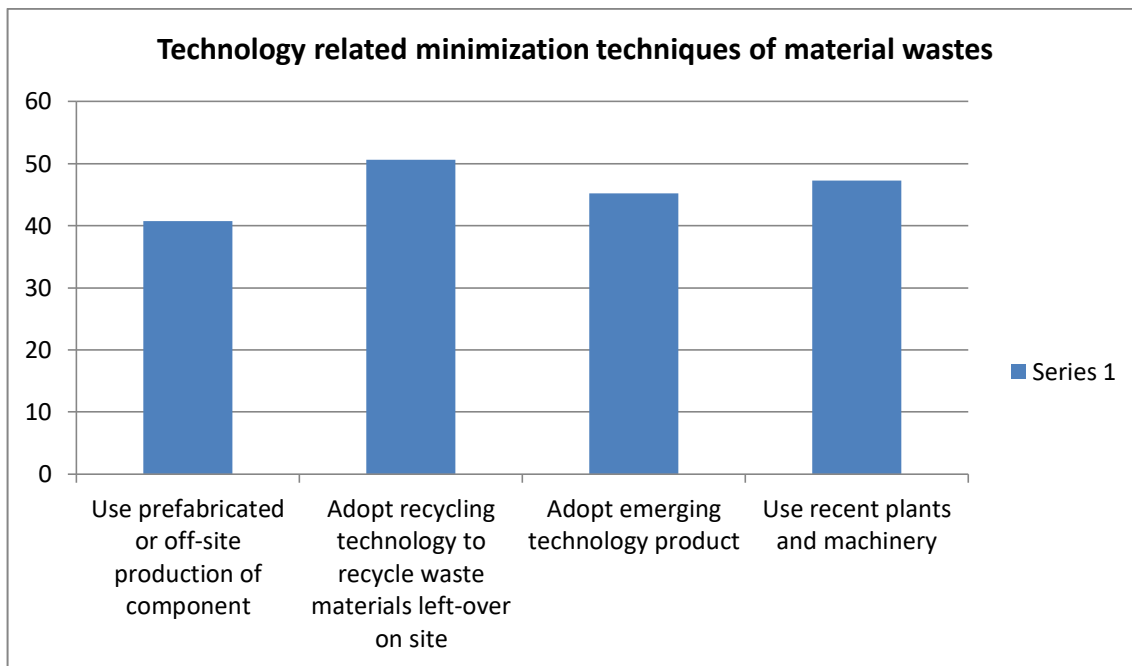


Figure 7: -Technology related minimization techniques of material wastes

4.7.5. Planning and site management

Getting different project requirements done requires careful planning and site management. Table 4.7.5.1. lists the various methods that fall within the headings of planning and site management, together with their RII rankings.

Table 12;-Planning and site management-related minimization techniques of material wastes

No.	Planning and site management-related minimization techniques of material	Total	RII	Ran k	%
1.	Appropriate waste management on site	85	0.74	2	74.35
2.	Accurate measurement of the size and quantity of material on site	85	0.50	10	50.35
3.	Effective and frequent site supervision	85	0.48	11	48.5
4.	Provide incentives to motivate	85	0.62	6	62.6

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	personnel to minimize material wastage				
5.	Use software for material planning and scheduling	85	0.59	8	59.5
6.	Properly inspect and check the quality of materials on site	85	0.74	1	74.8
7.	Re-use of leftover material on the site	85	0.70	3	70.8
8.	Employ experienced and skilled labor	85	0.67	5	67.3
9.	Keep in mind the economic, social, and environmental effect of wastage	85	0.61	7	61
10	Improve coordination among stakeholders	85	0.54	9	54.6
11	Record and measure different streams of waste	85	0.70	4	70.1

The top place in limiting the factors influencing the production of construction material wastes was held by properly inspecting and evaluating the quality of the materials on site (RII=0.748). It is essential for the achievement of building project objectives without material loss. It is recommended as the most effective method for reducing material waste (Ali et al., 2019). Additionally, it is acknowledged as the essential technique for getting the desired results in construction projects (Forster, 2014). The second-place finisher was appropriate trash management while working on site (RII=0.744). It guarantees effectiveness by preventing wasteful material usage and building mistakes. Adewuyi and Odesola (2016) assert that an essential method for accomplishing waste-free construction activities is accurate material measurement throughout operations. On-site reuse of scrap materials had a RII of 0.708. On the project site, it is crucial to reduce wastage and adopt the appropriate measures.

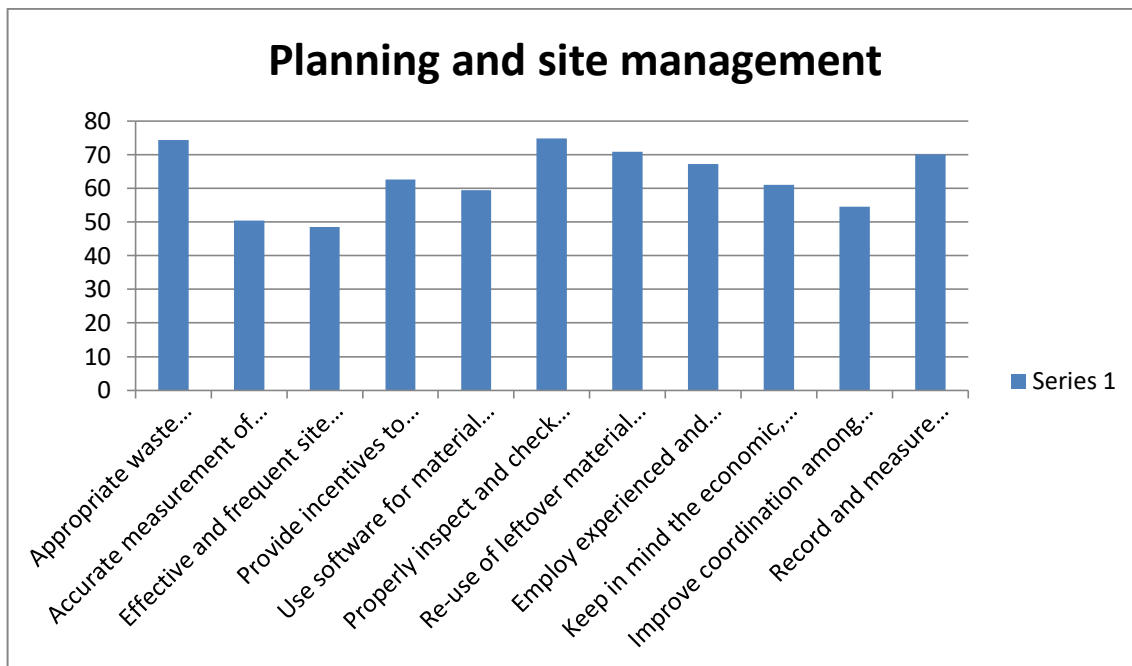


Figure 8: -Planning and site management

4.7.6. Legal or policy

In Ethiopia, there isn't a formal legislation that addresses how to manage building trash (Endale Teferi, 2017), however constitutional provisions and national environmental rules inadvertently address the problem. Strategies for law or policy discovered through this study were graded according to importance.

Table 13:-Legal or policy-related minimization techniques of material wastes

No .	Legal or policy to minimized waste techniques	Total	RII	Rank	%
1.	Incorporate policy of material waste minimization plan	85	0.53	5	53.6
2.	Provide scheduled training on material waste minimization strategies for construction firms	85	0.46	6	46.1

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3.	Establish strategies and guidelines for use of recycled material	85	0.55	4	55.0
4.	Establish strategies and guidelines for use of recycled material	85	0.68	2	68
5.	Obey instruction and work as per the agreement	85	0.76	1	76.9
6.	Government environmental regulation	85	0.42	7	42.58
7.	Implement a safety program	85	0.61	3	61.88

According to the study of the respondents, handling waste concerns at construction sites in the Arada sub-city had the greatest priority, with a RII of 0.769. The appointment of a waste officer or manager at the location aids in limiting the conditions that result in material wastes. The policy of construction material waste minimization plan (CMWMP), which outlines the acceptable level and methods of disposal as well as incentives and/or penalties for building enterprises, should be adopted by the government. The waste prevention techniques should be taken into account during the planning and construction stages of the project for the waste management strategy to be appropriately adapted at the policymaking level of the legislative approach. This strategy makes it possible to reduce trash on-site during a construction job (Muhammad et al., 2020). The third crucial approach, with a RII score of 0.680, established strategies and rules for the utilization of recycled material to prevent and decrease material wastes for building enterprises. By educating site workers on the preventative strategy and seriousness associated with material wastes, it helps to limit the amount of waste materials generated from building sites. The fundamental tactics for reducing material waste are staff training and raising awareness of waste management (Assem and Karima, 2011; Eze et al., 2016).

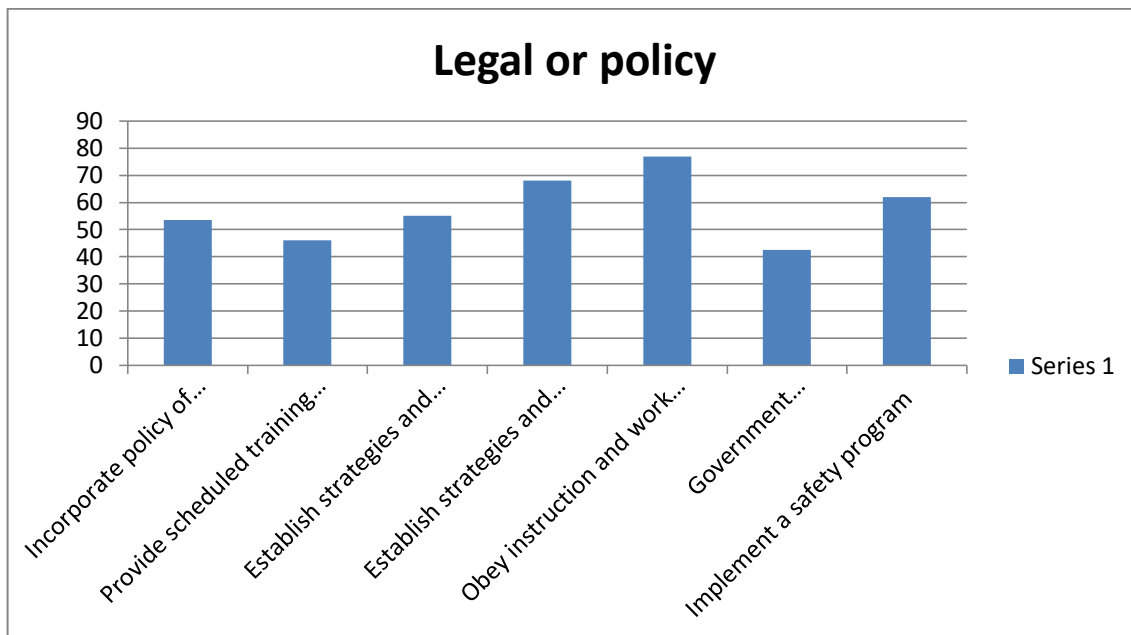


Figure 9: -Legal or policy

4.8. Face to Face Interview Results Concerning Construction Waste, Management and Disposal Strategy at Arada sub city

4.8.1. Types, Level, Waste Monitoring and Disposal

The project office purchases and supplies major construction materials like reinforcement bars, precast, blocks for slab and block work to the contractors in order to efficiently use and prevent waste of construction materials, according to interviews with the head, deputy head, and senior officers from the construction unit of the A. Materials like gravel, wood, wooden materials for forms and other works, nails, and wire rod are purchased and used by the contractors. The interviewees claimed that the sub-city branch office kept the supplies in its warehouses and provided them to the contractors.

The office specified a predetermined amount for each of the materials it delivers, which is the basis for the supply and distribution of the products to the contractors. Contractors are financially responsible for waste that arises from using materials beyond what is prescribed. Without the technique, the interviewees claim, there would have been waste, although they all concur that it has flaws. Poor craftsmanship, a lack of understanding, and a lack of storage facilities were issues noted by a few of them. Contractors are contractually required to dispose of excavated earth elements away from the site and into

landfills, according to Arada sub city design and construction project office respondents. Some of them are unsure about the locations and distances that contractors are required by contract to dispose of waste others argued that as long as waste is disposed of far from the site, contractors are under no obligation to care where or how far away waste should be put. Contractors must also clean up the area around buildings they are building up to a one-meter radius, according to Arada sub city design and construction project office respondents. Once more, some of the responses claim that contractors do not have any explicit obligations about where they should dispose of waste.

The findings of the questionnaire on the categories of trash and level as well as the waste monitoring system seem to agree with the results of the interviews with key personnel from the construction unit of the Arada sub city design and construction project office as well as the head. They all agreed that the location produces the wastes listed below. All of the responders stated that the bulk of the garbage produced at the site is made up of pieces of reinforcement bars. They all agreed that their claim is merely based on experience and actual observation rather than any kind of scientific analysis. All interviewers from the office stated, in a manner similar to questionnaire responses, that neither the study nor the other Arada sub city design and construction project office sites have a waste monitoring system. When asked to provide a precise estimate of the amount of waste produced by reinforcement bars or any other materials at the site, everyone stated that they did not know and added that no evaluation had been done. All of them gave negative answers when asked if they were familiar with site waste monitoring systems and techniques. However, interviews with some of them demonstrated that they have a marginally accurate understanding of its function in measuring waste. All of them concurred that its implementation at the site may be beneficial after hearing a definition of waste monitoring systems and a brief explanation of its functions.

Regarding the removal of garbage, according to the Arada sub city design and construction project office interviewees, everything including the metal scrap and reinforcement bars that are marketed primarily for reuse by MSEs is dumped into landfills. They added that their office is in charge of handling and getting rid of waste from supplies like cement and reinforcing bars that it gives to contractors. Their

comments indicate that the latter are in charge of getting rid of waste from the wood and other building supplies they buy. The main form of site trash identified in interview replies from Arada sub city design and construction project office consultants and contractors accord with questioner responses, which all stated that the site creates the items on the list. They claimed, like the Arada sub city design and construction project office interviewees, that the volume of waste from reinforcement bars is the biggest. They said that there is no system in place to keep track of the amount of waste at the site, thus their estimate is based only on observation. Interviewees from the consulting and contracting industries are more familiar with the idea of waste monitoring and its advantages than are those from the Arada sub city design and construction project office.

4.8.2. Respondents Opinion on the Causes of Waste

The majorities of Arada sub city design and construction project office, consultant and contractor interviewees agree that the items listed under Table 4.4.1 actually or potentially cause construction waste at the site. Asked on whether he considers lack of attention by management as a main cause one Arada sub city design and construction project office interviewee said it may be a potential cause but he views the challenge more relate to lack of capacity than lack of attention. He said there is a recognized and accepted management lack of capacity in terms of human resources, knowledge, skill, finance and material resources, which is more of a challenge than attention. He says the management pays sufficient attention to manage and dispose waste properly but it does not have adequate capacity to overcome the challenges.

Additionally, he believed that Arada sub city design and construction project office management's enhanced focus would not make a significant difference in overcoming the main obstacles. Additionally, he believed that Arada sub city design and construction project office management's enhanced focus would not make a significant difference in overcoming the main obstacles. He highlighted a lack of mandates, human resources, and waste management expertise as examples of what he considered to be a lack of capacity. When questioned about management in regards to the effective execution of contracts for trash and disposal, he responded that the issue is with the contractual provisions rather than a lack of managerial oversight. He claims that the office oversees waste disposal to

ensure it is done properly and that contractors are not paid unless rubbish is disposed of in accordance with the contract. If there are issues with how contractors dispose of waste, changing the standard contract may be the best course of action to ensure safer and more efficient disposal. The highest volume of waste (from reinforcement bars) is attributed by certain interviewees from the Arada sub city design and construction project office management to contractors. According to them, it happens because some contractors use more reinforcement bars than necessary and lack trained staff. The majority of them concur that the system and storage facilities lead to waste. Some of them claim that strengthening financial resources are necessary for upgrading storage facilities and systems which they do not.

Participants in the contractor and consultant interviews concur with the elements mentioned in Table 4.4.1 as waste causes. Corruption, according to one contractor, should be taken into account as one of the main causes of waste at the site. He claims that the Arada sub city design and construction project office has a well-known and documented corruption problem with the acquisition of building supplies for condominium sites. He claims that low-quality materials are supplied and used for building, which has a long-term detrimental effect on the economy. He cited the frequent media stories as proof that there was official corruption. He claims that despite knowing that the materials provided by Arada sub city design and construction project office fall short of the standards, contractors have no control over their quality and just use them. Another contractor who agreed with this viewpoint claimed that while there is a problem with the quality of the building materials that Arada sub city design and construction project office provides, the quality of the condominiums is immediately impacted. As he claims, contractors use the materials provided despite their quality, and there is no immediate, obvious material waste.

Another contractor expressed dissatisfaction with the MSEs' wasteful production of low-quality products. Regarding corruption, one Arada sub city design and construction project office interviewee indicated that items may be lost during transit from the store to the building site. According to what he says, dishonest transit participants like contractors and guards may work together to steal building materials and transport them to other

locations before they reach stores. He claimed that similar misconduct had occurred in the past at another location.

4.8.3. Construction Waste Disposal and its Impact on Human Health

In regards to the potential negative impacts of garbage disposal on human health, the interviewees' responses concur with those of the questionnaire respondents. While the majority of them acknowledged the potential, the majority also said it was important to evaluate and research the precise and immediate implications of the waste disposal system. The statements of the Arada sub city design and construction project office interviewees regarding the disposal of trash by contractors suggest the risk that the waste disposal system poses to human health. As they stated, contractors are not required by contract to dispose of waste safely. Their only responsibility is to remove building debris from the site. They wouldn't be held accountable, regardless of the materials' potential for harm and the way the dumping affected human health. The negative potential of the CWM & DS is supported by interview replies about policy and legislative awareness and enforcement. In light of the findings, the respondents indicated that other stakeholders also lack awareness and implementation of pertinent policies, rules, and regulations. This suggests that the Arada sub city design and construction project office itself or contractors may not properly dispose of waste because they are unaware of their obligations or because the applicable rules are not effectively enforced to prevent them from doing so. The Arada sub city design and construction project office interviewees conform with questionnaire responses regarding health effect assessment. They acknowledged that no evaluation of the site's waste management and disposal's effects on health had been done.

4.8.4. Responses of Waste Disposal negative impact on Economy, Environmental and Human Health

Key interviewees, including those from the important stakeholder Arada sub city design and construction project office, acknowledged that no environmental impact assessment was done on the effects of the waste disposal system on the environment. A lack of environmental assessment might be viewed as a sign of the waste disposal system's potential for harm given the low level of national economic and social development, the inadequate state of the building sector, and the body of literature. The interviewees are

aware of the connection between the environment and waste management and disposal, despite their lack of knowledge regarding the precise adverse impacts and how they occur. The results of the questionnaire are consistent with interview answers about the health effects of the waste disposal system. The majority of those surveyed concur that the waste disposal system may have negative effects on human health, but no assessment was made.

4.8.5. Site visits/observation

The researcher performed direct visits of construction sites involved in the systematic selection, observation, and recording of behaviors, events, and settings relevant to a problem under investigation. Observation of construction sites showed how construction companies handle their waste. This provided insight into the actual behavior of these organizations. The researcher spent time at construction sites and observed the flow activities of materials (delivery, transportation, handling, and storage) in addition to observation of conservation activities (rejection of material, labor mistakes, cutting). The observation of construction sites is not only focused on the causes and quality of waste of material. Other procedures monitored included the categories of waste and practicing the use of common work areas such as for block, steel reinforcement bars and woodcutting, plastering, concreting, etc. during the site visits some photos were taken to document the events and facts. The observation was made to determine if there was an attempt to prevent the different wastes.

CHAPTER FIVE; CONCLUSION AND RECOMMENDATION

5.1. Introduction

For a nation to develop sustainably, construction waste management is necessary. It aids in addressing economic, social, and environmental challenges. Once the reasons of waste production are known, they can be avoided or reduced to help the world and its inhabitants in the future. From this perspective, the goal of this study was to identify the source of construction waste by examining each party's participation and devising a management strategy. To build better techniques for the world, it is wise to determine where the construction debris comes from. Based on the study's findings, the following conclusions are offered.

- Prioritizing the sources will be made easier by the rate of construction and corresponding rating of the waste source. , design waste, procurement waste ,operational waste and material handling waste are the top four sources of construction waste, respectively, as shown in the analysis.

- Prioritizing the cause will be made easier by the rate of construction and corresponding rating of the waste cause. Required quantity unclear due to improper planning, Poor workmanship, Design changes during the construction period, Incomplete and errors in contract documents and Procurement waste are the top five causes of construction waste, respectively, as shown in the analysis.

- The survey's findings demonstrate how inadequate the building waste management strategy is in general use. According to this report, the majority of Arada sub city projects collect and dispose of their waste on Re-use within the project office, Sales to another firm, Transfer to another construction branches office, and Donation to other charitable organization. The outcome demonstrates that reusing materials within the project office was a key construction-phase strategy.

- The amount of material that needs to be cut into pieces to meet the actual size of the building is reduced when this technique is taken into account during the design process. Designing for the specified material dimension and having precise contract

documentation was another crucial tactic for addressing the problem of material waste. Standardized or optimized designs are essential strategies to attain waste-free construction sites. The three methods mentioned above are more akin to the construction site of the Arada subcity.

- The study's findings suggested that choosing the correct suppliers and identifying them are crucial steps in reducing construction wastes in the building industry (RII=0.788). Identification and selection of the appropriate material suppliers are methods developed for construction stakeholders to reduce construction techniques of wastes as it aids in obtaining quality supplies at the appropriate time in Arada sub city project construction..
- According to the findings of the current study, adopting recycling technology to recycle leftover waste materials on site was the most crucial tactic to address the problems that cause the production of material wastes on construction sites. It was also ranked as the first major technique with a RII value of 0.51 in the study.
- According to the study of the respondents, handling waste concerns at construction sites in the Arada sub-city had the greatest priority, with a RII of 0.769. The appointment of a waste officer or manager at the location aids in limiting the conditions that result in material wastes. The policy of construction material waste minimization plan, which outlines the acceptable level and methods of disposal as well as incentives and/or penalties for building enterprises, should be adopted by the government. The waste prevention techniques should be taken into account during the planning and construction stages of the project for the waste management strategy to be appropriately adapted at the policymaking level of the legislative approach.

5.2. RECOMMENDATIONS

For further research topics with its limitations, this study looked into the assessment of technique waste in building construction projects in Addis Arada sub city at the building project. However, the following problems are noted and recommended for more research.

- ❖ further research should be done on the other construction firms in order to find additional root causes of construction material waste as this study was only conducted in the building contracting companies of 1, 2, and 3. In addition, future research in this field should take consultants' and clients' perspectives into account.

- ❖ It is required study Practices of Construction Materials Management in Ethiopian Construction Industry. .

- ❖ It required the research of new technology of recycling waste and managing mechanism for applying to construction companies in Ethiopia, especially in Addis Ababa.

- By controlling operation, it is possible to reduce waste brought on by operational issues at Arada sub city construction site. Controlling operations are essential for preventing waste from the planning stage to the completion of the work. By utilizing the subsequent

1. Clearly identify roles and convey them: Make sure everyone working on the project is aware of their roles in relation to the waste management plan.

2. Educate and engage the workforce; be clear about how the different waste management plan components will be implemented.

3. Watch: To make sure the plan is being carried out.

- Site management and supervision should be performed on a frequent basis; failure to do so may lead to errors, reworks, and subpar workmanship; coordination between parties is essential for cutting down on waste.

- Before beginning construction, contractors should carefully review construction documents and drawings for any discrepancies and consult with the owner or designers to get advice or clarification. To reduce the need for rework, contractors should also try to understand the owner's and designers' intentions.

- In the construction industry, zero avoidable waste refers to preventing waste from being produced at every stage of a project's lifecycle..
- Professionals in the building business should take courses on sustainable construction in higher education institutions. Professional organizations should also hold conferences and workshops to train working professionals.
- There should be specific legislation governing the handling and disposal of construction wastes introduced by the Addis Abeba city government, followed by strict monitoring to ensure compliance; • Incentive programs should be established by the government to reward businesses that fully embrace construction waste management.
- Creating new jobs: The sorting and transportation of construction trash will become a crucial section of the building industry, providing many new jobs since waste may generate a large profit from salvaged building elements.
- The contractors need to be knowledgeable and skilled enough. Prior to the construction phase, they should earn experience so they can find the necessary materials. The quantity and caliber of the materials should be assessed, and they should be kept in the appropriate places;

5.3. FURTHER RESEARCH

The issues listed below are mentioned and recommendations for more research are made.

- Similar study will be conducted in other regions of the nation to gather information for a viable construction waste management system.
- Techniques for recycling building trash and locating valuable goods.
- Additional research on the material waste from other building projects, such as those for commercial, industrial, and educational facilities.

REFERENCES

Assefa, M. A. (2021). This thesis submitted to department of project management school of graduate student, st, marys university for partial fulfillment of the requirements for the degree of master of arts in project management .

GEREME, K. (2018). Evaluation of Construction Material Waste Management in Addis Ababa Housing Project Office : Lideta Project Branch Arabsa Site in Focus.

Sasitharan Nagapan, Ismail Abdul Rahman, & Ade Asmi. (2011). A Review of Construction Waste Cause Factors. Conference of Real Estate: Sustainable Growth Managing Challenges, Johor Bahru, Malaysia. <http://eprints.uthm.edu.my/2665/>

Meghani, M. D. (2011). A Study on Basic Material Waste in Building Industry : Main Causes and Prevention. National Conference on Recent Trends in Engineering& Technology, May, 1–4.

Rai Widhiawati, I. A., Yudha Astana, I. N., & Ayu Indrayani, N. L. (2019). An analysis of building construction waste in Badung, Bali. MATEC Web of Conferences, 276, 02010. <https://doi.org/10.1051/matecconf/201927602010>

Sasitharan Nagapan, Ismail Abdul Rahman, & Ade Asmi. (2011). A Review of Construction Waste Cause Factors. Conference of Real Estate: Sustainable Growth Managing Challenges, Johor Bahru, Malaysia. <http://eprints.uthm.edu.my/2665/>

Meghani, M. D. (2011). A Study on Basic Material Waste in Building Industry : Main Causes and Prevention. National Conference on Recent Trends in Engineering& Technology, May, 1–4.

Rai Widhiawati, I. A., Yudha Astana, I. N., & Ayu Indrayani, N. L. (2019). An analysis of building construction waste in Badung, Bali. MATEC Web of Conferences, 276, 02010. <https://doi.org/10.1051/matecconf/201927602010>

Sasitharan Nagapan, Ismail Abdul Rahman, & Ade Asmi. (2011). A Review of Construction Waste Cause Factors. Conference of Real Estate: Sustainable Growth Managing Challenges, Johor Bahru, Malaysia. <http://eprints.uthm.edu.my/2665/>

Meghani, M. D. (2011). A Study on Basic Material Waste in Building Industry : Main Causes and Prevention. National Conference on Recent Trends in Engineering& Technology, May, 1–4.

Rai Widhiawati, I. A., Yudha Astana, I. N., & Ayu Indrayani, N. L. (2019). An analysis of building construction waste in Badung, Bali. MATEC Web of Conferences, 276, 02010. <https://doi.org/10.1051/mateconf/201927602010>

Sasitharan Nagapan, Ismail Abdul Rahman, & Ade Asmi. (2011). A Review of Construction Waste Cause Factors. Conference of Real Estate: Sustainable Growth Managing Challenges, Johor Bahru, Malaysia. <http://eprints.uthm.edu.my/2665/>

Kumawat, T. K., Sharma, V., Kumawat, V., Biyani, M., Pandit, A., & Bhatt, A. (2022). Sustainable Techniques for Building Waste Disposal. Ecological and Health Effects of Building Materials, 489–503. https://doi.org/10.1007/978-3-030-76073-1_26

Pratap, V., Tomar, S., Dwivedi, D., & Gwalior, M. (2015). International Journal of Advance Engineering and Research Development. In Simulation of Field Oriented Control of Permanent Magnet Synchronous Motor (Vol. 2, Issue 4). <https://doi.org/10.21090/IJAERD.28000>

Raj, M., & Eldhose, S. (2018). Literature Review on Minimization of Construction Waste. 4(1), 2018. www.ijariie.com

Adnan Enshassi¹, Said El-Moghany, Peter E Mayer & Josef Zimmermann (2011), 'Material wastage on construction sites in the gaza strip', International Journal of Construction Project Management ISSN: 1944-1436 Vol.3, No. 2.

Ameh Oko John, Daniel Emmanuel Itodo (2013), 'Professionals views of material wastage on construction sites and cost overrun' ,research paper.

Andrew R J Dainty & Richard J Brooke (2004), 'Towards improved construction waste minimisation: a need for improved supply chain integration', Structural Survey, Vol. 22, No 1, pp. 20 - 29.

Bon-Gang Hwang & Zong Bao Yeo (2011), 'Perception on benefits of construction waste management in the Singapore construction industry', *Engineering, Construction and Architectural Management*, Vol. 18, No 4, pp. 394 - 40.

Carlous T F Ormosco ,Lucio Soibelman & Claudia de cesare (2002), 'Material Waste Management in Building Industry '.

Elgizaw S M, El-Haggarb S M & Nassara K (2011), 'Slum development using zero waste concepts: construction waste case study, ' *International Conference on Sustainable Design, Engineering and Construction Procedia Engineering* .

Elizara M, Agung Wibowoa & Pinardi Koestalama (2005), 'Identification and analyze of influence level on waste construction management of performance' , *The 5th International Conference of Euro Asia Civil Engineering Forum (EACEF-5)*.

Graham J Treloar, Hani Gupta, Peter E D & Love Binh Nguyen (2003), 'An analysis of factors influencing waste minimisation and use of recycled materials for the construction of residential buildings', *Management of Environmental Quality: An International Journal*, Vol. 14, No 1, pp. 134 - 145.

Hongping Yuan Liyin & Shen Jiayuan Wang (2011), 'Major obstacles to improving the performance of waste management in China's construction industry', *Facilities*, Vol. 29, No 5/6, pp. 224 - 242.

Jia-Yuan Wang (2008), 'An investigation of construction wastes: an empirical study in Shenzhen', *Journal of Engineering, Design and Technology*, Vol. 6, No 3, pp. 227 – 236.

Mohammed Arif & Deepthi Bendil (2012), 'Construction waste management in India: an exploratory study', *Construction Innovation*, Vol. 12, No 2, pp. 133 – 155.

Muhwezi L M, Chamuritho N M & Lema (2012) , 'An investigation into Materials Wastes on building construction projects in Uganda' , *journal of Engineering research* Vol.1(1), pp 11-18.

Nayanthara De Silva S B & Vithana K H (2008), 'Use of PC elements for waste minimization in the Sri Lankan construction industry', *Structural Survey*, Vol. 26, No 3, pp. 188 – 19

Nigel Lawson, Ian Douglas Stephen, Garvin Clodagh ,McGrath David & Manning Jonathan Vetterlein (2001),'Recycling construction and demolition wastes – a UK perspective', Environmental Management and Health, Vol. 12, No 2, pp. 146 - 157.

Oladiran & Olatunji Joseph (2008),'Causes And Minimization Techniques Of Material Waste In Nigerian Construction Process' Fifth international conference (CITC).

Ruichang Ma (2015), 'Characterizing the generation and management of a new construction waste in China' The Tenth International Conference on Waste Management and Technology(ICWM

APPENDICES APPENDIX A: LETTER

Dear participant,

I am currently working on a research on Wastage minimization Techniques on Building Construction Projects: Case Study on Arada Sub City Construction Building Projects, as a partial fulfillment for my MSC study in Construction technology and management at the Addis College. This research is aimed to assesses and investigate the Wastage minimization Techniques on Building Construction Projects specifically Wastage minimization on Building construction projects in Arada Sub City and their challenges.

To successfully conduct this research, it is mandatory to look into the issues from different perspectives by involving different stakeholders and professionals. In this respect, you are the one who can give the correct information; hence I kindly request you to respond to the questions.

I would like to confirm you that your response will be kept strictly confidential and it will be used exclusively for the purpose of this research. Besides, your quick response is vitally important in order to finalize the research timely and I would appreciate if you complete and return it within one week of your receipt of same.

Thank you very much for your time and cooperation, and looking forward to receiving your response. Yours faithfully,

Lji Tewodros Ayayou

Addis College University, School of Graduate Studies

School of Construction Technology and Management

My Address

Tel: 0911006638

E-mail: ljitewodros123@gmail.com

APPENDEX B: QUESTIONNAIRE

PART ONE - GENERAL

You are not obliged to answer any of the questions which you do not want to.

If you have any query on this survey, you are kindly requested to contact me directly on tel. 09-11-00-66-38.

Since this survey is required for academic research; your prompt response is highly appreciable.

Specific Objectives

The following are the specific objectives of the study,

assessing the Wastage minimization Techniques on Building Construction on huge Building project network expansion plan and improvement of maintenance needs

Assess the operational Wastage minimization Techniques on Building Construction and how they will improve the existing weak local construction performance.

Comment the strategies and put forward recommendations on Wastage minimization and Techniques of the local Building Construction Projects on cost efficiency, quality Building, and employment with respect to Labor base approach to Building construction,

Part One: General Information

Instruction: The questions below are related to your personal Information. Please indicate your response by marking (√) in the boxes provided in front of each question, and fill the blank spaces as appropriate

Type of Organization (Respondents designation)

Client /Own Consultant Contractor

Gender: (1) Male (2) Female

Age (in yrs.) (1)20-35 (2) 36-45 (3)46-65

(4) Above 65

4. Education Background: (1) TVET (2) Diploma (3) First Degree (4)
Master's (5) Degree Ph.D.

5. Year(s) of experience in port construction:

1- 4-7 more than 7 year

6. Years of experience in the Arada sub city construction site

(1) <1 (2) 1-3 (3) 3-7 (4) above 7

7. Among the project performance measuring parameters, which one greatly affected by
construction material wastage in your site?

Quality of the house time cost of the house environment

PART TWO – ABOUT THE FIRM

Survey question for Contractors, Consultants/designer, Administrations/

Dear respondents,

The purpose of this research is to collect information on construction waste management and disposal system at Arada sub city construction project site in order to identify problems and provide alternative solutions of waste disposal to local management as a requirement for the completion of MSC in construction Technology and management from Addis college construction and Technology University. Your volunteer participation in providing accurate information is vital for the successful completion of this research. The information provided will be used for academic purpose only and will be kept confidential.

Thank You for your participation

Tewodros Ayayou

Tel: 0911006638

E-mail: ljitewodros123@gmail.com

Part Two

1. To what extent do you agree the following constraints are source of construction waste, how would you rate economic and environmental problems as regard to the following aspects? By ticking“√ “the appropriate boxes.

1. Strongly disagree 2. Disagree
3. Neutral/Not sure 4. Agree
5. Strongly agree

Source of construction waste	1	2	3	4	5
Design waste					
Operational waste					
Procurement waste					
Material handling waste					
Weather waste					
Vandalism waste					
Residual waste					
Materials misplacement on site					

2. Which one is the cause of material construction Waste in Arada sub city construction sites?

The given below are possible causes of construction material waste. Please Rank on a scale of 1-5 which of these waste sources and causes contributes highly to the generation of waste on the Arada sub city projects site by ticking“√ “the appropriate boxes.

- 1 not a waste cause 2 insignificant waste cause
3 Quite a waste cause 4 significant waste cause and 5 Major waste cause

ASSESSMENT OF WASTAGE MATERIAL MINIMIZATION TECHNIQUES ON BUILDING
CONSTRUCTION PROJECTS: CASE STUDY ON ARADA SUB CITY CONSTRUCTION BUILDING
PROJECTS

Causes of waste	1	2	3	4	5
Poor workmanship					
Poor communication between designer and builder or within the organization					
Inadequate supervision					
Damages caused by succeeding trades					
Required quantity unclear due to improper planning					
Bad weather condition					
Use of incorrect material, thus requiring replacement					
Dropping and spoiling of material during fixing					
Malfunctioning of equipment					
Site accidents					
Design changes during the construction period					
Lack of attention paid to dimensional coordination					
Lack of information in the drawings					
Incomplete and errors in contract					

ASSESSMENT OF WASTAGE MATERIAL MINIMIZATION TECHNIQUES ON BUILDING
CONSTRUCTION PROJECTS: CASE STUDY ON ARADA SUB CITY CONSTRUCTION BUILDING
PROJECTS

documents					
Designers unfamiliarity with alternative products					
Selection of inferior quality materials and products.					
Lack of attendance paid to standard sizes available in the market					
Complexity of the drawings					
Inappropriate storage facilities.					
Damages during transportation					
Material supplied in loose forms					
Unfriendly attitudes of project team and laborers					
Mismatch of material purchased with specifications					
Ordering errors					
Procurement waste					
Lack of possibility to order small quantity					

3. How does the waste techniques disposal at the site affect human, economy and environmental health? The disposal of waste material affects human, economic and environmental health. Rank below the box from 1-3 the waste of material techniques of Arada sub city projects site by ticking“√ “the appropriate boxes

very low=1,low=2,medium=3,high=4,very high=5

ASSESSMENT OF WASTAGE MATERIAL MINIMIZATION TECHNIQUES ON BUILDING
CONSTRUCTION PROJECTS: CASE STUDY ON ARADA SUB CITY CONSTRUCTION BUILDING
PROJECTS

Methods of material dispose organization	1	2	3	4	5
Re-use within the project office					
Transfer to another construction branches office					
Return back to the supplier					
Sales to another firm					
Donation to other charitable organization					
Doesn't apply any disposal action					

Design and documentation related minimization techniques of material waste	Design standardized material dimension					
	Use experienced and sound design team					
	Design adequate building component size, regular shape and spacing					
	Avoid late design variation					
	Design material optimization and sustainability					
	Design off-site construction					
	Have accurate contract document					
	Accurate specification and quantity of materials					
	Avoid designing for custom made size as much as possible					
	Simplified and proper details of drawing					
	Consider the availability of material during designing					
Simple and repeatable design						

ASSESSMENT OF WASTAGE MATERIAL MINIMIZATION TECHNIQUES ON BUILDING
CONSTRUCTION PROJECTS: CASE STUDY ON ARADA SUB CITY CONSTRUCTION BUILDING
PROJECTS

Design and documentation related minimization techniques of material waste	Design standardized material dimension					
	Use experienced and sound design team					
	Design adequate building component size, regular shape and spacing					
	Avoid late design variation					
	Design material optimization and sustainability					
	Design off-site construction					
	Have accurate contract document					
	Accurate specification and quantity of materials					
	Avoid designing for custom made size as much as possible					
	Simplified and proper details of drawing					
	Consider the availability of material during designing					
	Simple and repeatable design					

ASSESSMENT OF WASTAGE MATERIAL MINIMIZATION TECHNIQUES ON BUILDING
CONSTRUCTION PROJECTS: CASE STUDY ON ARADA SUB CITY CONSTRUCTION BUILDING
PROJECTS

	Reduce number of amenity areas					
	Amalgamate services adjacent to each other					
	Design renewable resources as much as possible					
Material procurement-related minimization techniques of material wastes	Deliver required quantity of material based on schedule					
	Purchase materials that comply with the specification					
	Proper procurement management system					
	Identify and select the right suppliers					
	Use experienced resources procurement team					
Material storage and handling related minimization techniques of material	Properly store materials					
	Train workers about how to handle and install materials					
	Accurate inventory control					
	Carefully handle materials					

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wastes	during work					
	Mechanically handle materials					
Technology related minimization techniques of material wastes	Use adequate tools and equipment					
	Use prefabricated or off-site production of components					
	Adopt recycling technology to recycle waste					
	materials left-over on site					
	Adopt emerging technology product					
	Use recent plants and machinery					
Planning and site management-related minimization techniques of material	Appropriate waste management on site					
	Accurate measurement of the size and quantity of material on site					
	Effective and frequent site supervision					
	Provide incentives to motivate personnel to minimize material wastage					
	Use software for material planning and scheduling					

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	Properly inspect and check the quality of materials on site					
	Re-use of leftover material on the site					
	Employ experienced and skilled labor					
	Keep in mind the economic, social, and environmental effect of wastage					
	Improve coordination among stakeholders					
	Record and measure different streams of waste					
Legal or policy to minimized waste techniques	Employ material waste management officer					
	Incorporate policy of material waste minimization plan					
	Provide scheduled training on material waste minimization strategies for construction firms					
	Establish strategies and					

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	guidelines for use of recycled material					
	Establish strategies and guidelines for use of recycled material					
	Obey instruction and work as per the agreement					
	Government environmental regulation					
	Implement a safety program					

APPENDICES APPENDIX A: LETTER Dear participant,

I am currently working on a research on Wastage minimization Techniques on Building Construction Projects: Case Study on Arada Sub City Construction Building Projects, as a partial fulfillment for my MSC study in Construction technology and management at the Addis College. This research is aimed to assesses and investigate the Wastage minimization Techniques on Building Construction Projects specifically Wastage minimization on Building construction projects in Arada Sub City and their challenges.

To successfully conduct this research, it is mandatory to look into the issues from different perspectives by involving different stakeholders and professionals. In this respect, you are the one who can give the correct information; hence I kindly request you to respond to the questions.

I would like to confirm you that your response will be kept strictly confidential and it will be used exclusively for the purpose of this research. Besides, your quick response is vitally important in order to finalize the research timely and I would appreciate if you complete and return it within one week of your receipt of same.

Thank you very much for your time and cooperation, and looking forward to receiving your response. Yours faithfully,

Lji Tewodros Ayayou

Addis College University, School of Graduate Studies

School of Construction Technology and Management

My Address

Tel: 0911006638

E-mail: ljitewodros123@gmail.com

APPENDEX B: QUESTIONNAIRE

PART ONE - GENERAL

You are not obliged to answer any of the questions which you do not want to.

If you have any query on this survey, you are kindly requested to contact me directly on tel. 09-11-00-66-38.

Since this survey is required for academic research; your prompt response is highly appreciable.

Specific Objectives

The following are the specific objectives of the study,

assessing the Wastage minimization Techniques on Building Construction on huge Building project network expansion plan and improvement of maintenance needs

Assess the operational Wastage minimization Techniques on Building Construction and how they will improve the existing weak local construction performance.

Comment the strategies and put forward recommendations on Wastage minimization and Techniques of the local Building Construction Projects on cost efficiency, quality Building, and employment with respect to Labor base approach to Building construction,

Part One: General Information

Instruction: The questions below are related to your personal Information. Please indicate your response by marking (✓) in the boxes provided in front of each question, and fill the blank spaces as appropriate

Type of Organization (Respondents designation)

Client /Owner Consultant Contractor

Gender: (1) Male (2) Female

Age (in yrs.) (1)20-35 (2) 36-45 (3)46-65

(4) Above 65

4. Education Background: (1) TVET (2) Diploma (3) First Degree (4) Master's (5) Degree Ph.D.

5. Year(s) of experience in port construction:

1- 4-7 more than 7 years

6. Years of experience in the Arada sub city construction site

(1) <1 (2) 1-3 (3) 3-7 (4) above 7

7. Among the project performance measuring parameters, which one greatly affected by construction material wastage in your site?

Quality of the house time cost of the house environment

PART TWO – ABOUT THE FIRM

Survey question for Contractors, Consultants/designer, Administrations/

Dear respondents,

The purpose of this research is to collect information on construction waste management and disposal system at Arada sub city construction project site in order to identify problems and provide alternative solutions of waste disposal to local management as a requirement for the completion of MSC in construction Technology and management from Addis college construction and Technology University. Your volunteer participation in providing accurate information is vital for the successful completion of this research. The information provided will be used for academic purpose only and will be kept confidential.

Thank You for your participation

Tewodros Ayayou

Tel: 0911006638

E-mail: ljitewodros123@gmail.com

Part Two

1. To what extent do you agree the following constraints are source of construction waste, how would you rate economic and environmental problems as regard to the following aspects? By ticking“√ “the appropriate boxes.

1. Strongly disagree 2. Disagree
3. Neutral/Not sure 4. Agree
5. Strongly agree

Source of construction waste	1	2	3	4	5
Design waste					
Operational waste					
Procurement waste					
Material handling waste					
Weather waste					
Vandalism waste					
Residual waste					
Materials misplacement on site					

2. Which one is the cause of material construction Waste in Arada sub city construction sites?

The given below are possible causes of construction material waste. Please Rank on a scale of 1-5 which of these waste sources and causes contributes highly to the generation of waste on the Arada sub city projects site by ticking“√ “the appropriate boxes.

- 1 not a waste cause 2 insignificant waste cause

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3 Quite a waste cause 4 significant waste cause and 5 Major waste cause

Causes of waste	1	2	3	4	5
Poor workmanship					
Poor communication between designer and builder or within the organization					
Inadequate supervision					
Damages caused by succeeding trades					
Required quantity unclear due to improper planning					
Bad weather condition					
Use of incorrect material, thus requiring replacement					
Dropping and spoiling of material during fixing					
Malfunctioning of equipment					
Site accidents					
Design changes during the construction period					
Lack of attention paid to dimensional coordination					

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Lack of information in the drawings					
Incomplete and errors in contract documents					
Designers unfamiliarity with alternative products					
Selection of inferior quality materials and products.					
Lack of attendance paid to standard sizes available in the market					
Complexity of the drawings					
Inappropriate storage facilities.					
Damages during transportation					
Material supplied in loose forms					
Unfriendly attitudes of project team and laborers					
Mismatch of material purchased with specifications					
Ordering errors					
Procurement waste					
Lack of possibility to order small quantity					

3. How does the waste techniques disposal at the site affect human, economy and environmental health? The disposal of waste material affects human, economic and environmental health. Rank below the box from 1-3 the waste of material techniques of Arada sub city projects site by ticking“√ “the appropriate boxes

very low=1,low=2,medium=3,high=4,very high=5

ethods of material dispose organization	1	2	3	4	5
Re-use within the project office					
Transfer to another construction branches office					
Return back to the supplier					
Sales to another firm					
Donation to other charitable organization					
Doesn't apply any disposal action					

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Design and documentation related minimization techniques of material waste	Design standardized material dimension					
	Use experienced and sound design team					
	Design adequate building component size, regular shape and spacing					
	Avoid late design variation					
	Design material optimization and sustainability					
	Design off-site construction					
	Have accurate contract document					
	Accurate specification and quantity of materials					
	Avoid designing for custom made size as much as possible					
	Simplified and proper details of					

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	drawing					
	Consider the availability of material during designing					
	Simple and repeatable design					
	Reduce number of amenity areas					
	Amalgamate services adjacent to each other					
	Design renewable resources as much as possible					
Material procurement-related minimization techniques of material wastes	Deliver required quantity of material based on schedule					
	Purchase materials that comply with the specification					
	Proper procurement management					

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	system					
	Identify and select the right suppliers					
	Use experienced resources procurement team					
Material storage and handling related minimization techniques of material wastes	Properly store materials					
	Train workers about how to handle and install materials					
	Accurate inventory control					
	Carefully handle materials during work					
	Mechanically handle materials					
Technology related minimization techniques of material wastes	Use adequate tools and equipment					
	Use prefabricated or off-site production of components					
	Adopt recycling technology to recycle waste					

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	materials left-over on site				
	Adopt emerging technology product				
	Use recent plants and machinery				
Planning and site management-related minimization techniques of material	Appropriate waste management on site				
	Accurate measurement of the size and quantity of material on site				
	Effective and frequent site supervision				
	Provide incentives to motivate personnel to minimize material wastage				
	Use software for material planning and scheduling				
	Properly inspect and check the				

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	quality of materials on site					
	Re-use of leftover material on the site					
	Employ experienced and skilled labor					
	Keep in mind the economic, social, and environmental effect of wastage					
	Improve coordination among stakeholders					
	Record and measure different streams of waste					
	Employ material waste management officer					

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Legal or policy to minimized waste techniques	Incorporate policy of material waste minimization plan					
	Provide scheduled training on material waste minimization strategies for construction firms					
	Establish strategies and guidelines for use of recycled material					
	Establish strategies and guidelines for use of recycled material					
	Obey instruction and work as per the agreement					
	Government environmental regulation					
	Implement a safety program					

4. Waste Minimization techniques below are possible strategies that contribute to the minimization of material wastes in building construction projects. Rank on a scale of 1-5 first the level of contribution of these strategies for Minimization of material wastage in Arada sub city sites. by ticking“√ “the appropriate boxes.

- 1= Very low contribution** **2= Low contribution,**
3= Medium contribution, **4= High contribution,**
5= Very high contribution

5. What is the major source and causes of construction material waste in your project branch office? Please specify it? -----

Please suggest the ways of waste minimization? -----

6. How does the waste techniques disposal at the site affect human, economy and environmental health?

7. Do you believe the waste disposal system practiced may have negative impacts to the Environment?

Yes No I don't know

8. Please state some of the human and environmental impacts of the waste disposal system you believe are harmful -----