

Assessing the Major Factors for Construction Material Wastage and their Remedial measures on Building Construction Projects in SNNPR, Wolaita Sodo Town

Gizachew Markos Makebo

¹Lecturer, Department of Civil Engineering, Wolaita Sodo University, Wolaita Sodo, Ethiopia

Abstract - Waste includes both the construction material losses and the execution of unnecessary work, which generates additional cost but do not add value to the production. It is one of a serious problem in construction industry in the world. Similarly, it is a problem in Ethiopian construction industries, especially on public building construction projects. It is also a problem in Wolaita Sodo town in the same manner due to different reasons like poor workmanship, poor site management and so on. The main objective of the study is to assess the role of waste management and minimization on building construction projects in Wolaita Sodo town. The methods set to attain the objective of the study were literature review, questionnaire followed by interview for further clarification, site visits to take measurement, observation and web sites. The findings showed that HCB, reinforcement bars, cement, formwork, plastering, aggregate, sand, mortar and water have the highest level of wastage on the building sites and poor management, poor site condition, poor workmanship, wrong material handling, design changes and procurement. Depending on the result, there is 69.7% of building construction materials wastage and 64.2% of which caused by poor site management, poor site condition, poor workmanship, wrong handling of materials and design changes. To minimize such wastages of building construction materials like HCB, timber, steel bars, and others on the construction sites, it is advisable to take care when storing, managing, handling materials and supervising the site works.

Key Words: - Wastage, Construction materials, Cause and Effect and Minimization techniques

1. INTRODUCTION

Construction industry is an industry, which is involved in the planning, execution and evaluation (monitoring) of all types of civil works. Construction is not only one of the major sectors of an economy but it is also the largest and accounts from 12% to 25% of the GNP of both developed & developing countries [1]. For instance, the construction industry consumes 3 billion tons of raw materials annually while one quarter of the world timber is used in the construction industry [2].

In reality, some of these materials were eventually end up as construction and demolition waste. In the United States, 136 million tons of construction and demolition waste are sent into the landfill annually, which amounts to about 30% waste from the industry [3]. Construction material wastage has

adverse impact on construction cost, contractor's profit, construction duration and can be a possible source of dispute among parties to a project. Prevention of waste generation in the construction industry has been a great issue [4]

It also contributes additional cost to the overall construction because new purchases are usually made to replace wasted materials. Cost of rework and disposal also cause financial losses to the contractors [5]. Similarly, in Ethiopia construction materials wastage is becoming a serious problem, especially on public building construction projects and no attention was given to such problem [1]. It is also a problem in Wolaita Sodo town in the same manner due to different reasons like poor workmanship, poor site management and so on.

Measuring waste is an effective way to assess the performance of reduction systems because it usually allows areas of potential improvement to point out and the main causes of inefficiency to identify. The successful execution of construction projects within given cost, time and quality, good handling of construction materials on construction site requires systematic planning and controlling of the construction works. The cost reduction achieved by preventing the generation of construction waste is equally of direct benefit to all stakeholders of a construction project [4].

The study mainly focused on the parameters like forms, causes and factors to the construction waste and measures to control construction waste effectively. Therefore, this study aimed to determine the current situation with regard to managing and minimizing construction materials waste in Wolaita Sodo town and assess the effectiveness of the waste control measures to minimize construction materials waste in future construction projects.

2. Statement of the problem

Waste is one of the serious problems in construction industry. Many researchers and practitioners indicated that there are many wasteful activities during design and construction process. According A.B. Wahab and A.F. Lawal (2011) waste emanates from different stages of construction which are during planning, estimating and construction stage. Furthermore, Ekanayake and Ofori (2000) showed that waste occur during design, operational, procurement and material handling.

Rapid growth in construction activities increases construction waste problems around the world. Due to least priority given to appropriate waste minimization and management systems in Indian construction industries leads to generation of huge or large quantities of building construction material waste in every year (Thakur, 2017).

Similarly, in Ethiopia construction materials wastage is becoming a serious problem in Ethiopia, especially on public building construction projects and no attention was given to such problem (Asmare, 2015). It is also a problem in Wolaita Sodo town in the same manner due to different reasons like poor workmanship, poor site management and so on.

The study mainly focused on the parameters like forms, causes and factors to the construction waste and measures to control construction waste effectively. Therefore, this study aimed to determine the current situation with regard to managing and minimizing construction materials waste in Wolaita Sodo town and assess the effectiveness of the waste control measures to minimize construction materials waste in future construction projects.

3. OBJECTIVE

3.1 General Objective

The main objective of this study is to assess the major factors for construction material wastage and its management on building construction projects Sodo town.

3.2 Specific Objective

- ❖ To identify the building materials wastage in the construction sites
- ❖ To identify the causes and its effects on the building construction.
- ❖ To propose the best remedial methods to minimize construction material wastage.

4. LITERATURE REVIEW

Many researchers and practitioners indicated that there are many wasteful activities during design and construction process. According A.B. Wahab and A.F. Lawal (2011) waste emanates from different stages of construction which are during planning, estimating and construction stage. Furthermore, Ekanayake and Ofori (2000) showed that waste occur during design, operational, procurement and material handling. Rapid growth in construction activities increases construction waste problems around the world. Due to least priority given to appropriate waste minimization and management systems in Indian construction industries leads to generation of huge or large quantities of building construction material waste in every year [6].

4.1 Waste, Source of waste and Waste Management

Waste is any substance or object that you discard, intend to discard, or are required to discard and as such is subject to the number of regulatory requirements. Construction waste consists of unwanted material produced directly or incidentally by the construction or allied industries [7]. Construction waste can be defined as the by-product collected and removed from construction work places or sites and civil engineering structures (Shankari, D.Ambika, & Kavithra, 2017).

4.2 Sources of wastes in Construction

According to Ekanayake and Ofori (2000) design, operational, procurement, and material handling attributes contribute to waste on construction site. Construction wastes generally classified as process and demolition wastes and demolition wastes furtherly classified as natural, direct, indirect and consequential wastes [7]. According to [8] materials storage and handling, operational factors, design and documentation factors and procurement factors, errors by tradesmen, purchased products that do not comply with specification and lack of onsite materials control are the major sources of construction wastes. [9] Categorized source construction wastes as design and documentation, material and procurement, construction method and planning, and human resources.

4.3 Waste minimization

Minimizing what you need to buy and planning to use these materials efficiently and effectively is the first step to avoid waste in construction. Waste minimization is a shared responsibility between all parties of the supply chain, from the client down to the Contractor. This guidance focuses on the role of contractors and subcontractors, taking into account the fact that they cannot work in isolation to reduce and manage waste.

The most effective waste minimization strategies are those that developed throughout a project's design stages and agreed to by all parties involved. They decide on the materials used and the construction methods employed. According to Adjei-Kumi (2013) waste is an asset, and not a problem. Through informed design, alternative waste treatment and effective resource recovery, money can be saved at every stage of building development. Concept of reduce, reuses, recycle and replace (4R), particularly in the context of production and consumption is important minimization techniques.



Fig 1: Relation between 4R rules

5. METHODOLOGY

5.1 Description of the Study Area

Wolaita Sodo Town is one of the developing towns in the south nation nationalities and people’s regional state. The great Damota Mountain gives well attraction for the town with providing a good air-condition sand used as spiritual places for different religion disciplines. In geographical location a latitude and longitude of 6°54’N 37°45’E with an elevation between 1,600 and 2,100 meters (5,200 and 6,900 feet) above sea level. Now a day in Wolaita Sodo Town there is number of infrastructure constructions like private and public building constructions, the highway projects within the Wolaita Sodo Town are some of the construction projects that spends high amount of the zone budgets. The topography of Wolaita Sodo Town is somewhat mountainous, rolling and flat. It is not favorable for the building construction purpose because it requires additional cost when we compare it with flat topography.

5.2 Data collection

We used both qualitative and quantitative methods to analyse data collected based on the study requirements. Each method has its own essence and often used to address a data collected through an interview and questionnaire. Our study focused on both qualitative and quantitative data collection method.

5.3 Research design

With sources of construction waste as the independent variables, a survey questionnaire developed to measure the opinions of building contractors on the severity and frequencies of the contribution of these sources using a Likert scale, which is a multi-item measuring scale where response levels are anchored with consecutive integers and symmetrical about a neutral middle. The study used non-experimental descriptive research designs because it helps to describe the status of the wastage of construction materials in Wolaita Sodo Town. The study also used both qualitative and quantitative research approach because they help to conduct the study with quantitative and qualitative data.

5.4 Method of analysis and Discussions

Descriptive and frequency statistical analysis techniques used to analyse the data collected in the survey. MS Excel used for the analysis of data in a systematic way. Through qualitative and quantitative research approach, data collection method produced suitable amount of data. Depending on this, the study identified the data and interpreted them in the context of the collected data. Finally, the analysed data presented by means of tabulation, graphs, charts, percentage and other ranking systems.

6. Results and Discussions

Due to the increasing of the construction of building project there is great increase in wastage of construction materials now days.

Table1: Building Construction Materials and their Percentages

Construction materials	Rating of the construction materials		
	3(exist)	Sum	Percentages (%)
Cement	5	51	9.80
Sand	7	51	13.73
Aggregate	1	51	1.96
Water	4	51	7.84
Ceramic	3	51	5.88
HCB	7	51	13.73
Reinforcement bars	6	51	11.76
Timber	2	51	3.92
Brick	4	51	7.84
Mortar	3	51	5.88
Plastering	4	51	7.84
Formwork	5	51	9.80

In the study HCB (hollow concrete block) and sand are the highly wasting building construction materials in the building project leading cement and reinforcement bars, plastering and formwork, water and mortar, brick, timber etc.



Fig 2: Building construction materials vs their percentages

The graph indicates that the percentages of HCB and sand in the study were highest from the other construction materials.

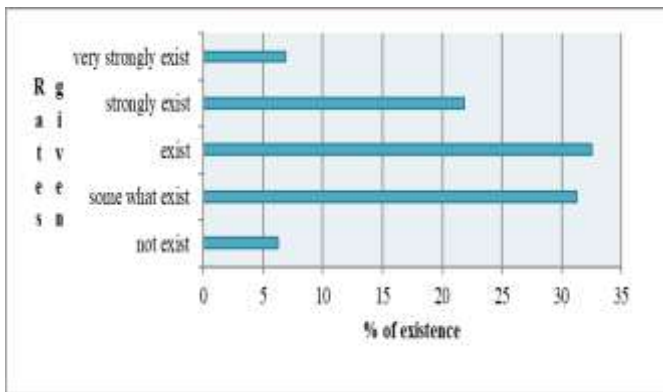


Fig 3: The existence of building construction materials vs their percentages.

Table 3: Causes of construction materials wastages and their percentages

Causes of construction wastes	Sum	Total	Percentage (%)
Design	17	161	10.56
Handling	24	161	14.91
Workmanship	28	161	17.39
Poor management	36	161	22.36
Poor site condition	31	161	19.25
Procurement	13	161	8.07
External	12	161	7.45

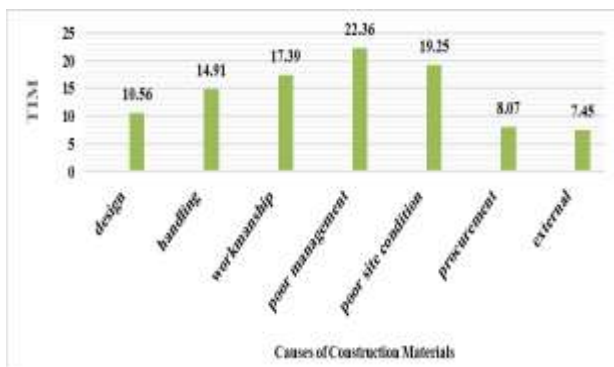


Fig 4: Causes of construction materials wastages and their percentages.

The chart shows that poor management, poor site condition and workman ship are top ranked causes of the construction material wastage.

6.1 Level of effectiveness of waste minimization techniques

Level of effectiveness	Percentages (%)
Very highly effective	44.6
Highly effective	23.9
Medium effective	19.2
Low effective	7.6
Very low effective	4.7

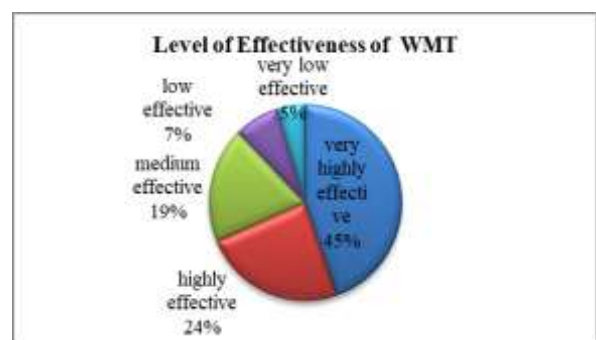


Fig 6: level of effectiveness of WMT

6.2 Material wastage in study area

6.2.1 HCB Blocks

The researcher identified different types of construction wastage in the study area such as HCB blocks, concrete, cement, aggregate, formwork, reinforcement and other types of wastes. The Construction material waste that identified are caused by disagreement between parties, poor handling of materials like HCB, poor planning, having week storage of construction materials and other related site problems.



Fig 5: Poor handling HCB in building construction sites

6.2.2 Steel reinforcement

Steel reinforcement bars are common materials used in building construction projects. Wastage of construction materials that identified by researcher were due to demolition waste in Wolaita Sodo university techno campus as a result of cutting and poor storage in ETETE Project site

and left over on the site in the Wadu project site due to design error.



Fig 7: Wastage of steel reinforcement

6.2.3 Wastage of Sand through storage and handling

Sand is one of the ingredients of the concrete that used to the void space between the aggregate particles.



Fig 8: Poor handling/ management of sand on site

6.2.4 Demolition wastes

Demolition wastes occurred as a result of disagreement between the parties, some modification needed, design errors and the structure is no longer safe to use by the public. The materials that the demolition generates are large in proportion when compared with other types of wastes.



Fig 10: Wastage of during demolition

6.2.5 Wastage of cement through storage and handling

The effective storage of cement on building projects reduces wastes, project delay and helps to keep the quality of cement in good shape before usage. Analyzing the waste of cement is relatively complex because this material used as a component of mortar and cast-in-place concrete in several different processes, such as plastering and floor screed.

6.2.6 Wastage of ceramic and terrazzo tile in the building project

Ceramic and terrazzo tile is the most important building construction materials in the construction industries. They used in the finishing stage of the construction of the building project. Therefore, we have to take care when placing and using these building construction materials because they are easy to break.



Fig 9: Wrong storage of ceramic

6.2.7 Wastage of formwork in the building construction projects

Formwork is one of the important building construction materials in different construction projects in Wolaita Sodo town. By reducing the wastage of formwork in construction projects, we can get different benefits besides the cost saving like conservation of natural. This in turn helps to reduce the emission carbon dioxide to the air.



Fig 11: Wastages of formwork due to wrong fixing and dismantling

7. MATERIAL WASTAGE AND THEIR REMEDIAL MEASURES

Material Wastage and their Remedial Measures		
Material wastage	Sources	Remedial Measures
HCB wastage	<ul style="list-style-type: none"> ✓ disagreement between parties ✓ poor handling of materials ✓ poor planning ✓ having week storage of construction materials system 	<ul style="list-style-type: none"> ✓ The blocks should be stacked on level grounds ✓ It should be stored in a covered place ✓ The labor workers should take care when handling the HCB ✓ Semi broken HCB should be used in the area in the construction when needed ✓ If there is no probability to reuse HCB, it crushed well and used for stabilization of weak soil etc.
Steel reinforcement	<ul style="list-style-type: none"> ✓ Because of cutting, ✓ damages during storage, ✓ leftover on site, ✓ Rusting and design error /change/. 	<ul style="list-style-type: none"> ✓ use proper material storage system ✓ keeping the material from rusting ✓ use proper steel section
Sand	<ul style="list-style-type: none"> ✓ The loss of sand by erosion ✓ Miss use and left over on the site. ✓ Placing sand on the silt soil 	<ul style="list-style-type: none"> ✓ Sand should be placed on the silt free place ✓ It is advisable to lean concrete the soil before placing the sand ✓ Carefully loading the sand from the source ✓ Reducing amount of residual sand on the site ✓ Reducing the act of over ordering
Course aggregate	<ul style="list-style-type: none"> ✓ Segregation of aggregate ✓ Degradation of aggregate ✓ Contamination of materials by deleterious substances ✓ Incompatible or undesirable moisture content 	<ul style="list-style-type: none"> ✓ Store aggregates in separate place when many gradations and types of other aggregates are available. ✓ Otherwise, store aggregate in open place. ✓ Effective supervision when loading aggregate on site by labor workers ✓ Effective and efficient use of residual aggregate for other purpose ✓ Wastage arising from batching and measurement of concrete making materials that leads to materials wastage
Demolition wastes	<ul style="list-style-type: none"> ✓ disagreement between the parties, ✓ some modification needed, ✓ design errors and ✓ the structure is no longer safe to use by the public 	<ul style="list-style-type: none"> ✓ Reduce design change when the work is executing ✓ Forming good relation between the parties ✓ If reduction of the demolition wastage is impossible, demolish carefully in order to reuse the dismantled materials ✓ Reuse the concrete and other pieces of materials for other purposes like sub base course under the road pavement. ✓ If the concrete part is highly crushed, it reused for

		simple residential buildings after checking its compressive strength
Cement	<ul style="list-style-type: none"> ✓ Storage and handling problem 	<ul style="list-style-type: none"> ✓ A warehouse or shed used to store cement should be as air-dry as possible, ✓ All cracks and openings should be closed, ✓ Cement bags should not be stored on damp floors, ✓ Bags should be stacked close together to reduce air circulation, but they should not be stacked against outside walls, ✓ Bags to be stored for long periods should be covered with other waterproof covering ✓ Standard strength tests or loss on ignition tests should be made whenever the quality of the cement is doubtful, ✓ Bulk cement is usually stored in waterproof bins. Ordinarily, it does not remain in storage very long but it can be stored for a relatively long time without deterioration.
Wastage of ceramic and terrazzo tile	<ul style="list-style-type: none"> ✓ Poor placing system 	<ul style="list-style-type: none"> ✓ Proper handling ✓ Taking care when loading, unloading and placing ✓ Properly cutting in the time of application ✓ Using the residuals for practical purpose for the students in this campus
Wastage of formwork	<ul style="list-style-type: none"> ✓ Lack of proper storage place ✓ wrong fixing and dismantling ✓ Effect of weather ✓ Ordering errors, and Workers mistakes 	<ul style="list-style-type: none"> ✓ Proper storage of ply woods in the site ✓ Selecting the best types of ply woods before starting the construction, ✓ Safely dismantling ✓ Taking care when fixing the formwork ✓ Properly placing after the use ✓ Use other alternative method if so like steel panel/steel formwork

8. CONCLUSIONS

The study concluded that there is an existence of building construction material wastage in building construction site. Some building construction materials that frequently results in wastage ranked in their level of existence are:- HCB, cement and reinforcement, formwork and plastering, sand, water and mortar, timber, aggregate and brick.

The causes for this construction materials wastage in Wolaita Sodo are classified into five broad groups and presented as follows,

- ✓ Poor site management (22.36%)—with in poor site management there are number sub groups such as weak planning, poor site management, weak site supervision, rework, lack of wastage management activities and scarcity of equipment's.
- ✓ Poor site condition (19.25%):-leftover materials on site, poor site layout, congestion on site etc.
- ✓ Workmanship (17.39%):-workers mistake, poor attitude of workers, poor workmanship and too much over time for workers.

- ✓ Wrong material handling (14.91%): wrong material storage, poor material handling, damage during transportation etc.
- ✓ Design changes (10.56%):-frequent design changes, design errors, poor design quality and complicated design.
- ✓ Procurement and other external factors (15.52%):- Ordering error, mistakes in quality survey, ignorance of specification, effects of weather, accidents and crimes,

The findings of the study helped us to set out the remedial measures to minimize the wastage of building construction materials. These remedial measures are highly effective in minimizing wastage of building construction materials in the public building in Wolaita Sodo town.

9. REFERENCES

- [1] A. S. Joro, "managing and minimizing wastage of construction materials on selected public building projects in Addis ababa," Addis Ababa university, Addis Ababa, 2015.
- [2] G. A. Bekr, "Study of the Causes and Magnitude of Wastage of Materials on Construction sites in Jordan," *Journal of Construction Engineering*, p. 102, 2014.
- [3] M.Vyas, K. V.patel and Chetna, "Construction materials management in project sites," *Master in Engineering and management*, 2011.
- [4] M. Raj and S. eldhose, "literature review on minimization of construction waste," *IJARIE*, pp. 693-697, 2018.
- [5] Ekanayake and Ofori, "Malaysian Construction Research Journal," *waste management and minimization*, p. 45, 2000.
- [6] A. Thakur, "construction material wastage minimization and management," *International Research Journal of Engineering and Technology (IRJET)*, p. 88, 2017.
- [7] Y. Peddavenkatesu and B. Naik, "Waste Minimisation in Construction Industry," *International Journal of Innovative Research in Science, Engineering and Technology*, vol. 5, no. 10, 2016.
- [8] K. Agyekum, J. Ayarkwa and T. Adjei-Kumi, "Minimizing Materials Wastage in Construction- A Lean Construction Approach," *Journal of Engineering and Applied Science*, pp. 125-146, 2013.
- [9] C. Luangcharoenrat, S. Intrachotoo, V. Peansupap and W. Sutthinarakorn, "Factors Influencing Construction Waste Generation in Building Construction: Thailand's Perspective," www.mdpi.com/journal/sustainability, vol. 11, pp. 1-17, 2019.