Global Journal of Engineering and Technology Advances
eISSN: 2582-5003
Cross Ref DOI: 10.30574/gjeta
Journal homepage: https://gjeta.com/

(RESEARCH ARTICLE)

Check for updates

Factoring construction and demolition waste in the Zambian construction industry

Michael N Mulenga *

Department of Civil and Environmental Engineering, School of Engineering, University of Zambia, Zambia.

Global Journal of Engineering and Technology Advances, 2022, 11(02), 102–112

Publication history: Received on 22 April 2022; revised on 27 May 2022; accepted on 29 May 2022

Article DOI: https://doi.org/10.30574/gjeta.2022.11.2.0089

Abstract

The Zambian Construction Industry (ZCI) is one of the fastest growing sectors in Zambia arising from increased infrastructure development. The ZCI, like elsewhere, is composed of many players including designers, contractors, regulators, manufacturers and suppliers of construction materials. The country has seen an upsurge in Construction and Demolition Waste (CDW) generation due to increased construction activities. However, opportunities for utilizing CDW for sustainable construction and management have been minimal.

Most research in developing countries has focused on Municipal Waste Management (MWM) rather CDW. In Zambia, CDW is a challenge in the absence of legislation, guidelines and regulation. In the developed countries, guidelines, legislation and regulation, exist. Sustainable utilization of CDW in Zambia is limited due to inadequate policy guidelines and legislation.

The research aimed at estimating the levels of CDW waste generation and utilization, and proposing a framework for sustainable utilization and management of CDW. The research required both qualitative and quantitative data. Primary data was collected through questionnaires, interviews and site visits whilst secondary data was obtained through literature review. The research, conducted in four provinces of Zambia, established that CDW generation rates were mainly in the 1-10% levels and utilization was low, regardless of the type of project. The main cause for such generation levels was poor skills and workmanship. Further, there are no specific policies dealing with CDW in Zambia. A frame work for estimating and quantifying CDW generation over the whole life cycle of a construction project is also proposed.

Keywords: Zambian Construction Industry; Construction and Demolition Waste; Sustainable Construction and Management; Fastest growing sectors

1. Introduction

As per Zambia's aspiration of becoming a middle income country by 2030, through various strategies and objectives including but not limited to the National Industrial Policy [1], the 7th National Development Plan [2] and the Vision 2030 [3], Zambia has emphasised infrastructure development which has resulted in increased generation of CDW. The private sector in Zambia has spearheaded the construction of housing units for both rental and owner use. The Zambia real estate and construction sector grew by 9.5% and 9.1% in 2013 and 2014, respectively (www.zambiainvest.com, [4]) and the Building and Construction sector have been the largest industrial sector of Zambia comprising 27.5% of the GDP with a growth rate of 12% in 2014 (www.zambiainvest.com, [4]). With this upsurge in construction, there has been increased generation of CDW, however, opportunities for investing in utilization of CDW have not been utilized, despite the high levels of unemployment in the country, rising from levels of about 8% in 2012 to 13% in 2019 (Trading Economic.com/Central Statistical Office, [5]).

* Corresponding author: Michael N Mulenga
Department of Civil and Environmental Engineering, School of Engineering, University of Zambia, Zambia.

Aims and Objectives of the study

The research aimed at estimating the levels of CDW waste generation and utilization, and proposing a framework for sustainable utilization and management of CDW in Zambia.

The specific objectives were to:

- Estimate the generation and utilization of CDW from various construction projects
- To establish the causes for such levels of CDW generation and utilization of such waste
- To establish industry legislation, practices and guidelines that support sustainable construction
- To propose guidelines for estimating CDW waste generation and utilization

1.1. Literature Review

There are many definitions of construction and demolition waste (CDW). As highlighted by Osmani et al [6], the European Council Directive 91/156/EEC [7], defines waste as "any substance or object which the holder discards or intends or is required to discard" (Directive 91/156/EEC [2], Article 1, Letter a). This definition was further expanded as a material "which needed to be transported elsewhere from the construction site or used on the site itself other than the intended specific purpose of the project due to damage, excess or non-use or which cannot be used due to non-compliance with the specifications, or which is a by-product of the construction process".

The Environmental Protection Agency (EPA) [8]definition of CDW, as outlined in their annual National Waste Reports is: *"...all waste that arises from construction and demolition activities including excavated soil from contaminated sites. Those wastes are listed in Chapter 17 of the European Waste Catalogue (EWC)".* Osmani et al (2005) identified seven different types of waste: bricks, blocks and mortar (33%); timber (27%); packaging (18%), dry lining (10%); metals (3%); special waste (1%); and other waste 10%. According to Chen et al [9], CDW is one of the heaviest and most voluminous waste streams produced globally and accounts for approximately 35% of all global waste, as well as 70%, 50%, 44%, 36%, and 30% of the total waste in Spain, United Kingdom, Australia, Japan and Italy, respectively. Yakkaluru and Naik [10] categorized CDW as follows; *Process Waste*, such as steel off-cuts, masonry units, concrete and timber; *Demolition Waste* (*Natural Waste, Direct Waste* and Indirect *Waste*).

Several approaches have been taken in analysing CDW, such as those based on efficiency of manufacturing, sources or as a result of flaws in the design and/or procurement/project management, and materials handling. Other studies have focussed on assessing barriers to sustainable Waste Management and Mitigation (WMM).

Zou et al [11] through a research in Australia, identified six top barriers to re-use and recycle in construction waste: *Policy and governance, Quality*, *Cost: Information*, *Knowledge and education* and *Perception and culture*: He further established that CDW material is not considered as a potential resource, except metal.

In Zambia, the Environmental Management Act No 12 of 2011 [12] explicitly makes Environmental Impact Assessment (EIA) a requirement for all projects that may have an impact on the environment. The Environment Management Act No. 12 of 2011 and the EIA Regulations, Statutory Instrument No. 28 of 1997[13], make it mandatory to obtain environmental clearance for projects listed under the First and Second Schedules of the EIA Regulations. The EIA Regulations classify projects into two categories; Projects under the First Schedule require that an Environmental Project Brief (EPB) is prepared while projects under the Second Schedule require an Environmental Impact Statement (EIS).

The Zambia Environmental Management Agency (ZEMA) Environmental Guidelines for the Construction Sector in Zambia [14] provide information and guidance on EIA in general and specifically for construction related projects. They also act a resource for EIA practitioners. Further, the guidelines are meant to highlight the importance of consideration of alternatives in the preparation of EIAs in the construction sector and in the implementation of such projects, to ensure green construction or environmental sustainability. Section 6.10, in particular, addresses the issue of CDW, and it states that in choosing waste management strategies, minimization options such as; waste avoidance and/or reduction, reuse and recycling should be adopted. Other measures may include:

- Obtaining construction materials, paints, lubricants and other liquids in reusable packaging or containers
- Using overburden to construct temporary noise barriers
- Sending waste concrete from demolition activities to a concrete recycler instead of landfill
- Segregating and recycling solid wastes generated by construction activities

- Collecting lubricating oil from the construction vehicle fleet and sending it to a recycler

Muleya and Kamalondo [15] in their research concluded that the construction industry in Zambia had poor practice of waste management through waste disposal which is not environmentally friendly. The study further indicated feasibility to adopt a Site Waste Management Plan in the ZCI as an effective tool to address waste management challenges in the Zambian Construction.

The quantification of generated waste at every stage in the life cycle of a construction project is key to effective management of CDW. Although the ZEMA guidelines give some general direction in terms of new construction, there is no specific guidance in terms of maintenance, renovation and demolition. The estimation of CDW may be conducted at the construction and rehabilitation/maintenance/demotion stages. For renovation and demolition stages, there is need for pre-audit to ensure as much material is recovered for reuse. The quantification of the total CDW over the project cycle may thus be obtained.

2. Material and methods

2.1. Methods and techniques of the study

The methodology used a mixed approach. This approach required both qualitative and quantitative data. Primary data was collected through questionnaires, interview and site visits whilst secondary data was obtained through literature review.

The questionnaire survey was adopted for ease of administration especially because of the COVID 19 Pandemic which limited travel to sites and face to face interaction. The questionnaires were designed in such a way that the responses were open. Purposive sampling was used to develop the sample of the research under discussion. According to this method, which belongs to the category of non-probability sampling techniques, sample members were selected on the basis of their knowledge, relationships and expertise regarding a CDW (Freedman et al., 2007 [16] and Etikan et al [17]). In the study, the sample members who were selected had special relationship with CDW, sufficient and relevant work experience in the field of construction and were actively involved in several construction activities.

2.2. Population and Sample of the study

Because of limited resources, the survey was restricted to four (4) out of the ten (10) provinces of Zambia, but covered the two main provinces; Lusaka and Copper belt, where the majority of construction activities are taking place. One hundred and twenty questionnaires were purposively prepared and administered to stakeholders in five categories of the Zambian Construction Sector;

- Consultants
- Regulators
- Manufacturers of Construction Materials
- Contractors
- Professional Bodies

2.3. Data Processing and Statistical Tools used in the study

The data gathered were tabulated and processed using the Microsoft Excel Program. Results were presented generally in form of charts.

3. Results and discussion

3.1. Estimation of the generation and utilization of CDW from various construction projects

Figure 1 shows very low levels of CDW generation in Zambia, generally within the 0-10% level. The types of waste were mainly in form of structural steel, plumbing materials and Concrete bricks.

3.2. Levels of CDW generated from various types of projects

Figure 2 gives an indication of CDW production levels by type of works. Regardless of the type work, from New construction to Emergency works, the level of CDW generated was mainly within the 1-10%.

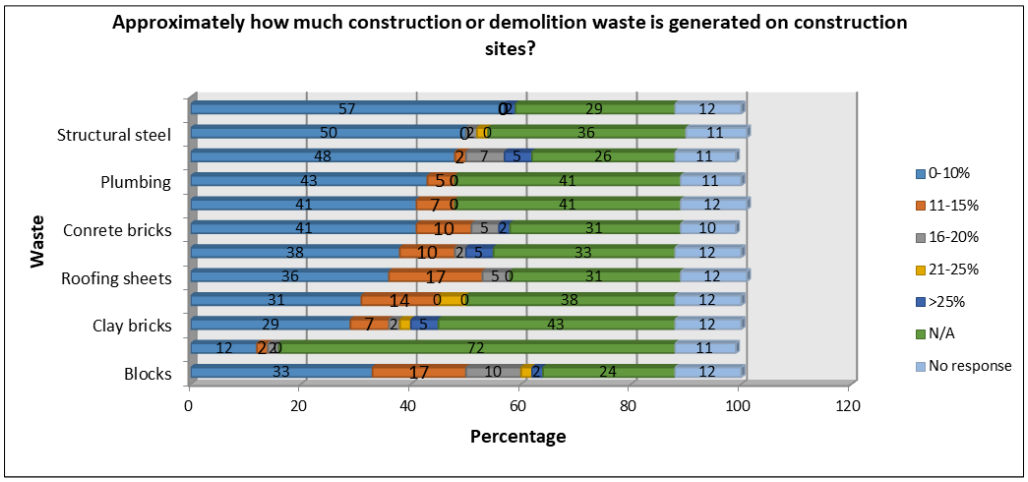

Figure 1 Approximation of CDW generated on construction sites

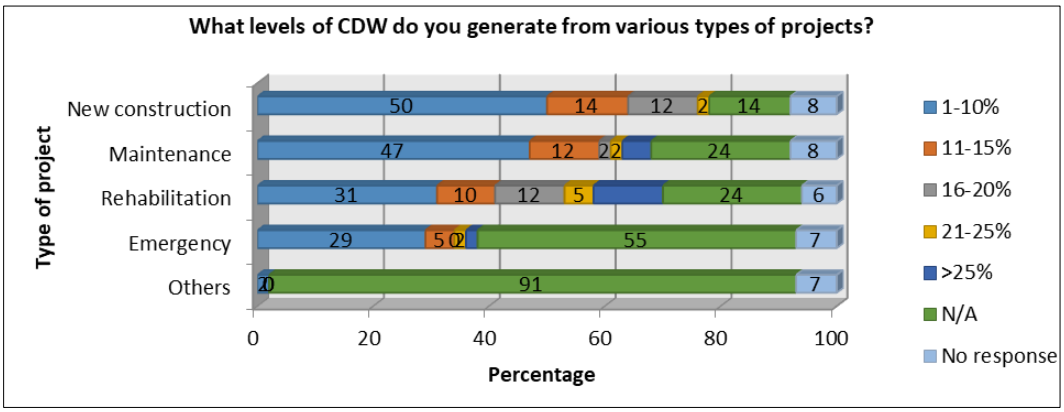

Figure 2 Levels of CDW generated from various types of projects

3.3. Causes for levels of CDW generation and utilization of such waste

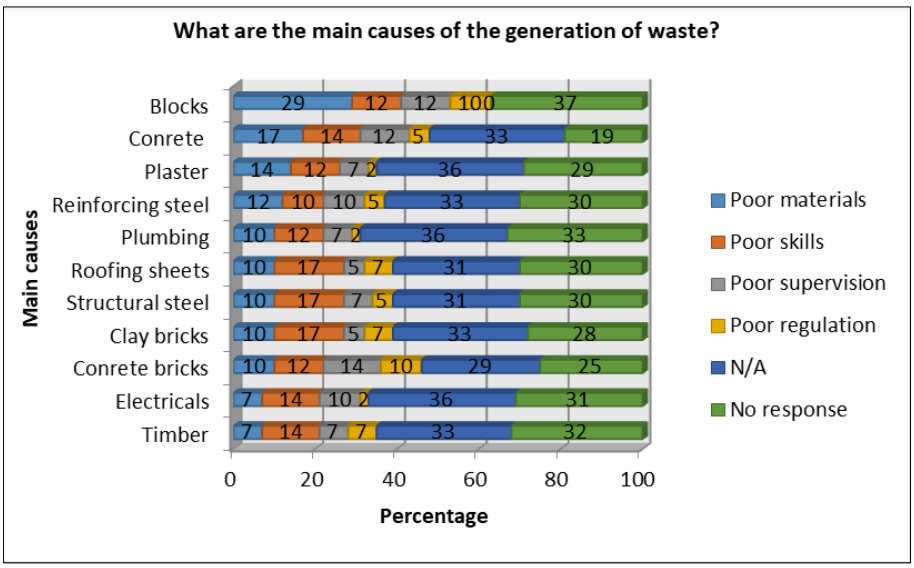

Figure 3 Main causes of CDW generation

Figures 3 shows that the main causes of waste generation were poor skills followed by poor materials and poor supervision. Poor regulation was also identified.

3.4. Frequency of utilization of CDW in Zambia

Figure 4 shows that 55% of respondents essentially utilized CDW whilst 36 % indicated that they either never or rarely utilized CDW.

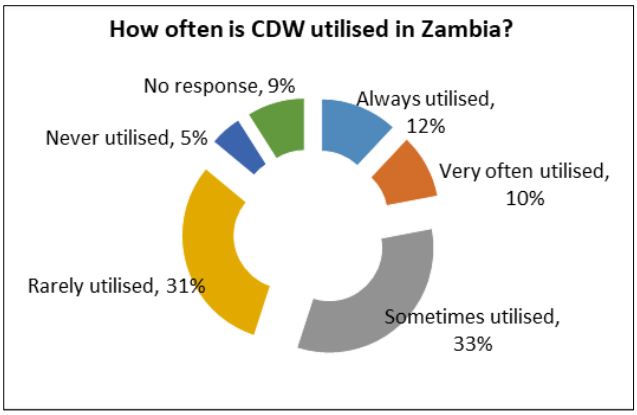

Figure 4 Frequency of CDW utilisation in Zambia

3.5. CDW utilisation in Zambia by province

Figure 5 shows that CDW is generally more frequently utilized on the Copper belt and Lusaka provinces, as expected, because of significant industrial activities.

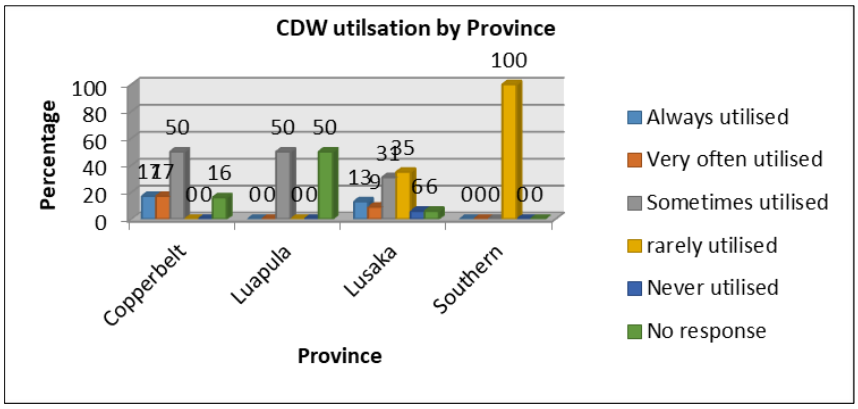

Figure 5 CDW utilisation by geographic location

3.6. Main barriers to utilization of CDW in Zambia

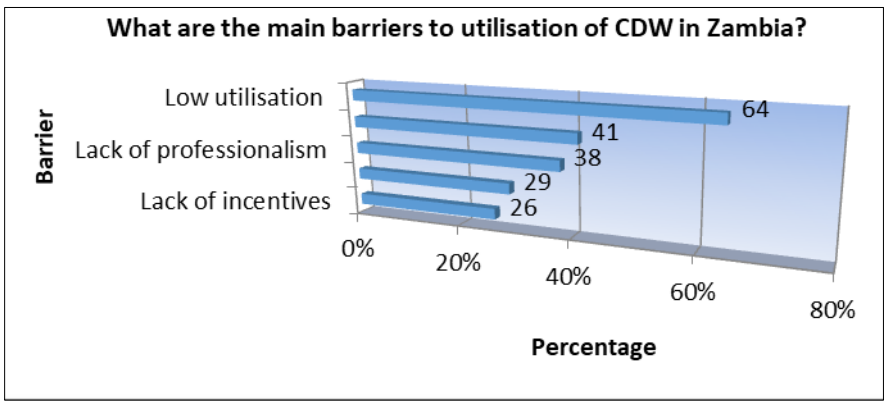

Figure 6 Main barriers to utilization of CDW in Zambia to CDW utilization by province

Figure 6 shows that the three mains barrier to CDW utilization were 'low utilization', 'poor regulation' and 'lack of professionalism'. This reinforces why CDW is less utilized in Zambia.

Figure 7 shows that 'lack of framework' was generally a main barrier to CDW utilization in all provinces sampled whilst Figure 8 shows that 'lack of professionalism' was generally a main barrier to CDW utilisation in Zambia.

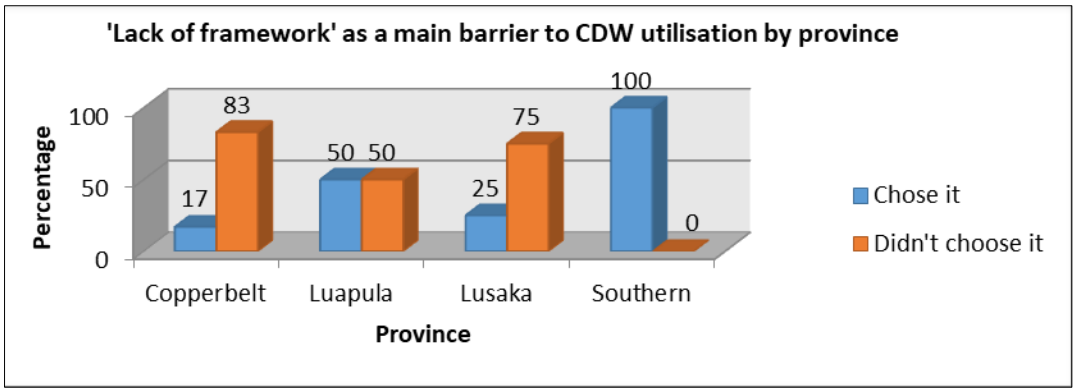

Figure 7 'Lack of framework' as a main barrier to CDW utilisation by province

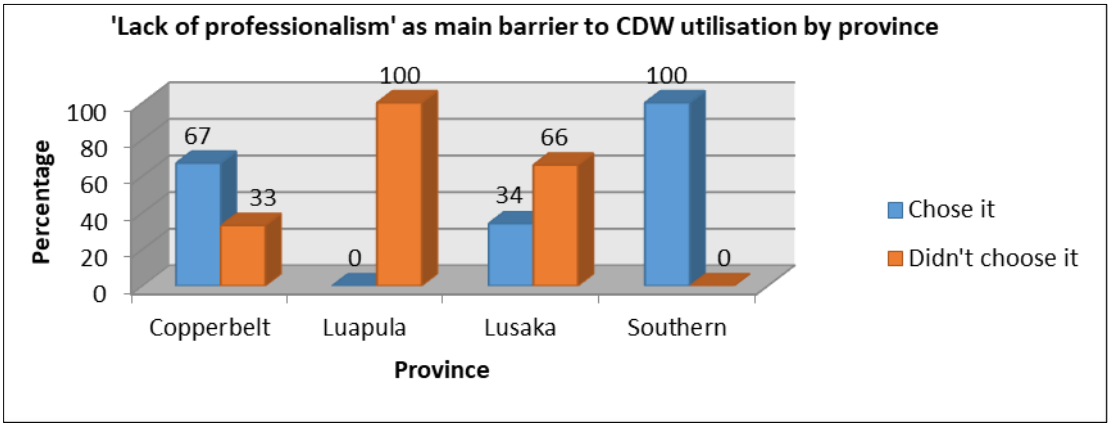

Figure 8 'lack of professionalism' as main barrier to CDW utilisation by geographic location

3.7. Availability of a policy and implementation plan to ensure awareness and practices on Sustainable/Green Construction

Most respondents indicated that their institution/company had a policy and implementation plan to retrain/update the skills and ensure awareness and practices on Sustainable/Green Construction.

3.8. Key Stakeholders' role in supporting sustainable utilization of CDW

Figure 9 shows that Government's role should be to conduct sensitizations on the use of CDW; provide a framework on utilization of CDW; regulate and enforce guidelines/implementation plans on the use of CDW whilst manufacturers (Figure 10) should 'produce quality materials to avoid wastage; promote reuse and recycling of materials; and buy CDW from companies for reuse and resell'.

Retailers (Figure 11) should collect materials for reuse and recycling; only sell materials in required quantities and specifications to avoid off-cuts; and should conduct sensitizations on the utilization of CDW. Contractors (Figure 12) should introduce sustainable waste management plans, recycle and reuse their own CDW and 'have authorized dumpsites for collection and sorting of waste'. They should also employ skilled workers to avoid unnecessary off-cuts.

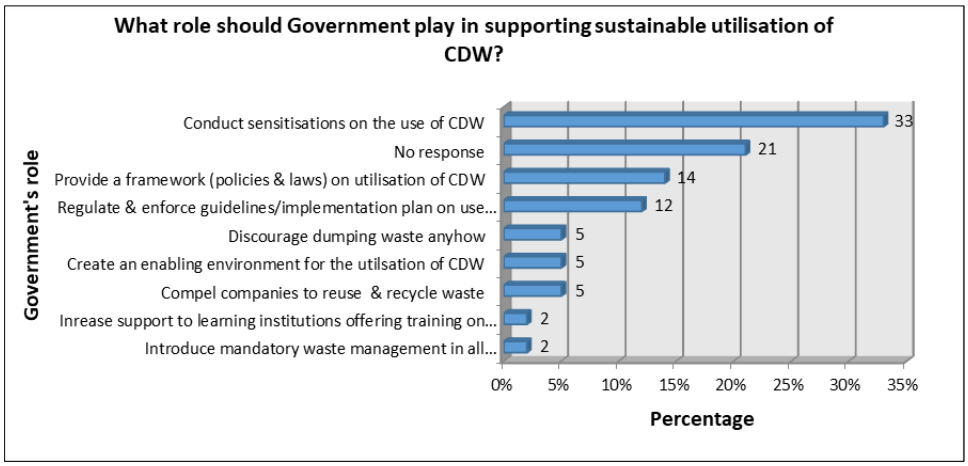

Figure 9 Government's role in supporting sustainable utilisation of CDW

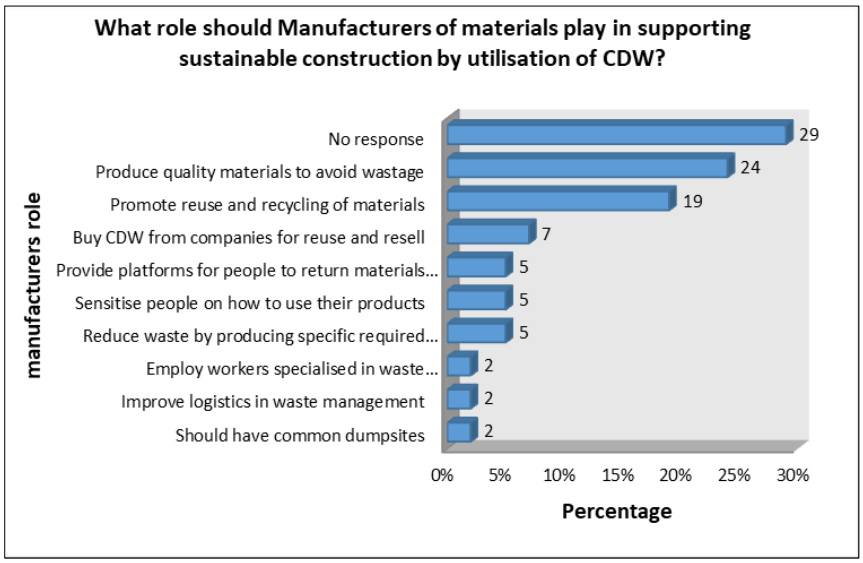

Figure 10 Manufacturer's role in supporting sustainable construction in CDW utilisation

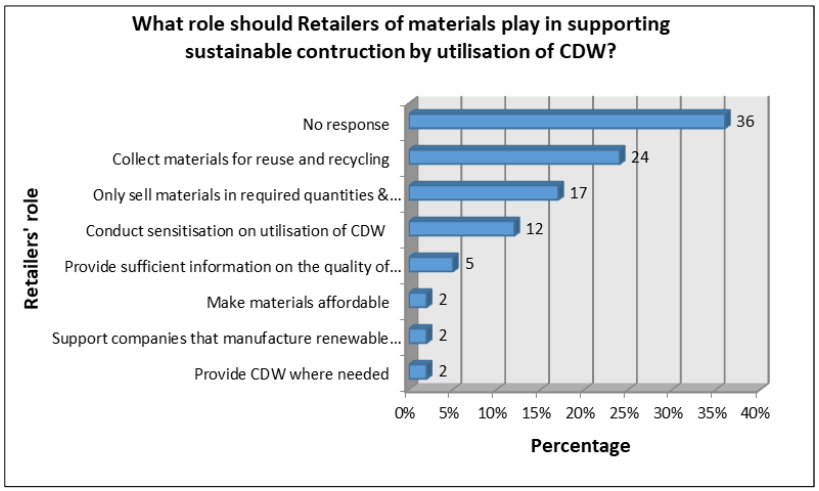

Figure 11 Retailer's role in supporting sustainable construction in utilisation of CDW

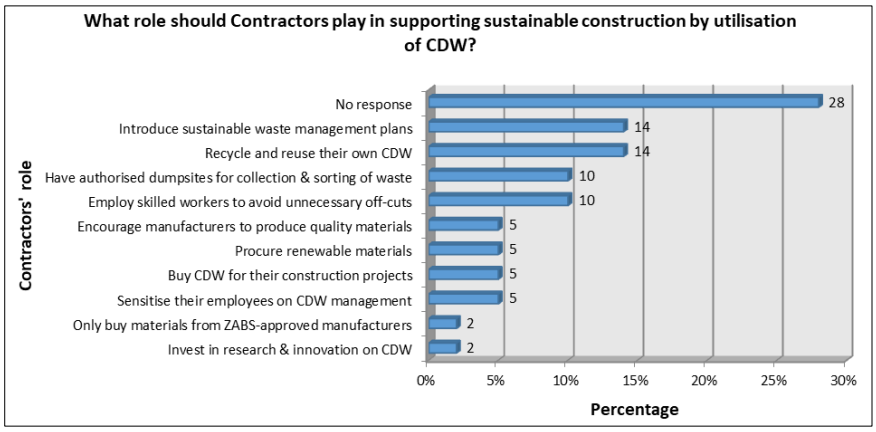

Figure 12 Contractor's role in supporting sustainable construction in CDW utilisation

Figure 13 indicates that Consultants should be sensitizing on the importance of CDW utilization, ensure that Contractors manage waste properly and have a CDW plan; and should, enforce guidelines on disposal, collection and use of CDW.

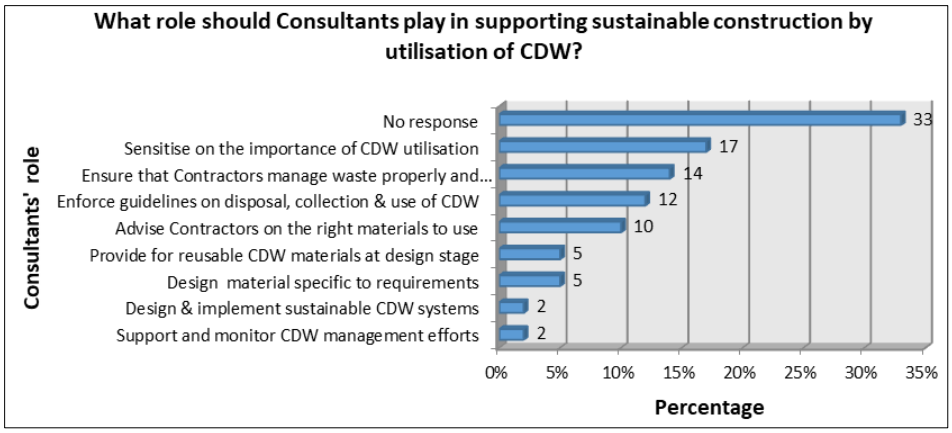

Figure 13 Consultant's role in supporting sustainable construction in CDW utilisation

Regulators (Figure 14), must provide policy framework and implementation plan for CDW management, ensure compliance with waste management plans; and build capacity/promote training on CDW utilization. Additionally, they should ensure that companies and manufacturers provide quality materials and regulate the use and reuse of CDW, respectively.

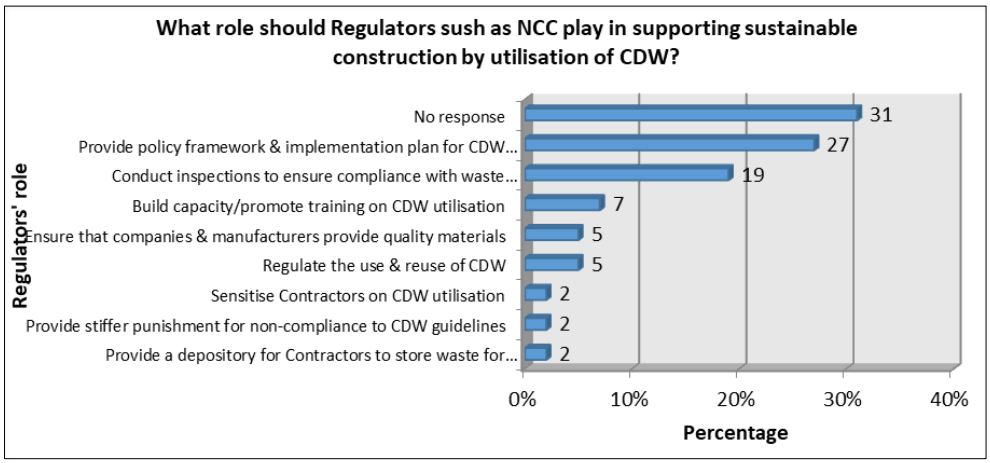

Figure 14 Role of Regulators in supporting sustainable construction in utilisation of CDW

3.9. Framework for estimating CDW waste generation and utilization

Figure 15 is a proposed framework for estimating CDW over the project life cycle. For renovation and demolition stages, pre-audits could ensure as much material is recovered for reuse.

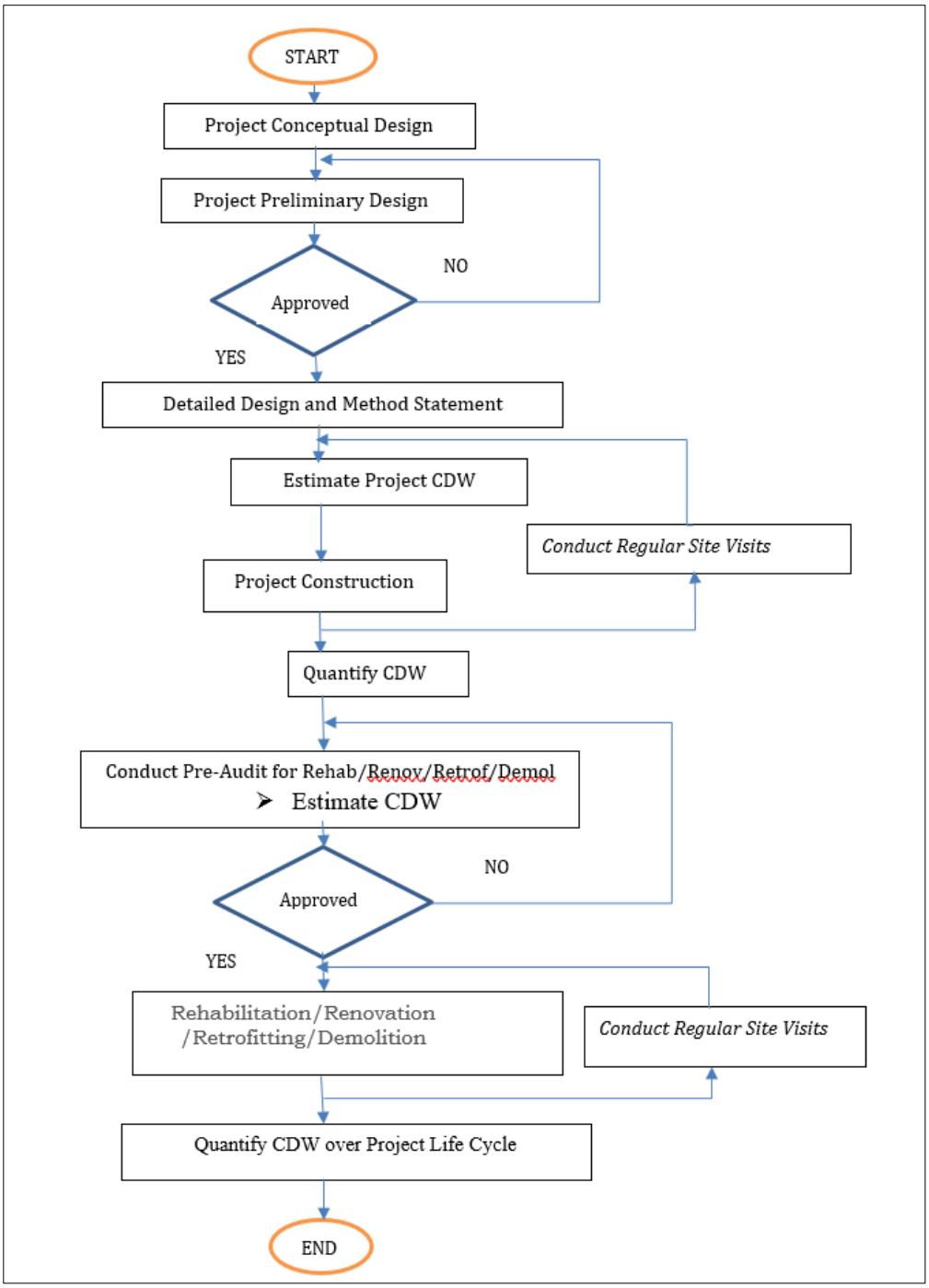

Figure 15 Proposed Framework for Estimating and Quantifying Project CDW

4. Conclusion

The objectives of this study were to (a) estimate the generation and utilization of CDW from various construction projects, (b) establish the causes for such levels of CDW generation and utilization of such waste, (c) establish gaps in industry legislation, practices and guidelines that support sustainable construction, and (d) propose a framework for estimating CDW waste generation and utilization for sustainable construction in Zambia.

With regard to objectives (a) and (b), the study established that:

- Very low levels of construction and demolition waste is generated on construction sites in the four provinces of Zambia covered in the study. The CDW generated from all the different types of waste is mainly within the 0-10% level followed by the 11-15% level;
- Regardless of the type of project, whether new construction, maintenance, or rehabilitation, the level of CDW generated was mainly within the 1-10% margin followed by the 11-15% levels;
- The main causes of waste generation are 'poor skills' followed by poor materials and then poor supervision, and;
- CDW is less utilised in Zambia.

With regard to objective (c), there are no specific policies to address sustainable construction Zambia. However, The Zambia Green Jobs Programme (ZGJP)-2013 to 2018 [18], supported the creation of green jobs among micro, small and medium enterprises (MSMEs) in the Zambian building construction industry, while at the same time generating systemic change and contributing to the broader discussion on inclusive green growth and job creation in Zambia.

Recommendations

Estimation of the CDW at the various stages of the whole life cycle of a project should be included as part of the ZEMA approval process, and complete design reporting. Estimation of CDW can guide investment in the management and sustainable utilization of CDW.

Construction-industry specific policies and guidelines that address sustainability in the construction industry are urgently required. National Council for Construction (NCC) and professional Associations such as Zambia Institute of Architects and the Engineering Institution of Zambia (EIZ) could lead the process.

Introduction of the pre-demolition audits can offer useful support to CDW management.

More detailed research is required to enable estimation of CDW throughout the whole life cycle of projects, which can encourage and guide investment in CDW, and help create the so much needed jobs for the youth.

Compliance with ethical standards

Acknowledgments

The author would like to express special thanks and gratitude to the Directorate of Research and Graduate Studies, University of Zambia, for providing Seed funding for the research. The author also thanks all those who participated in this study, as well as Research Assistants.

References

[1] Republic of Zambia, Ministry of Commerce, Trade and Industry, National Industrial Policy. March 2018.

[2] Republic of Zambia, Ministry of National Development Planning, 7th National Development Plan (2017-2021), June 2017.

[3] Republic of Zambia, Vision 2030, A Prosperous Middle Income Nation by 2030, December 2006.

[4] www.zambiainvest.com, accessed 7th June 2021.

[5] Trading Economic.com/Central Statistical Office. Accessed 7th June 2021.

[6] M. Osmani, A. D. F. Price & J. Glass, Potential for Construction Waste Minimisation through Design, Sustainable Development and Planning II, WIT Transactions on Ecology and the Environment, Vol 84, 2005, WIT Press, 575-584

[7] European Council Directive 91/156/EEC, Official Journal of the European Communities, No L 78/33.

[8] Environmental Protection Agency, Design Out Waste A-design team guide to waste reduction in construction and demolition projects, EPA-funded project under the STRIVE Programme carried out by the Department of Building and Civil Engineering in GMIT2 in collaboration with Scott Tallon Walker Architects and John Sisk and Son Building Contractors, accessed at www.epa.ie.

[9] Jianguo Chen, Yangyue Su, Hongyun Si, Jindao Chen. Managerial Areas of Construction and Demolition Waste: A Scientometric Review, International Journal of Environmental Research and Public Health. 2018; 15: 2350.

[10] Yakkaluru, Naik. Waste Minimisation in Construction Industry, International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization). 2016; 5(10).

[11] Zou P, Hardy R, Yang R. Barriers to building and construction waste reduction, reuse and recycling: A case study of the Australian capital region. In M. Panko and L. Kestle (Eds.). Building Today - Saving Tomorrow: Sustainability In Construction And Deconstruction Conference Proceedings. (pp. 27-35). Auckland, New Zealand: Unitec Institute of Technology. Retrieved from: www.unitec.ac.nz/epress/. 2015.

[12] Republic of Zambia, The Environment Management Act No. 12 of 2011, Government Printer, Lusaka, Zambia.

[13] Government of Zambia, Statutory Instrument No. 28 of 1997, The Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997

[14] Zambia Environmental Management Agency (ZEMA), Environmental Impact Assessment Guidelines for the Construction Sector in Zambia. 2016.

[15] Muleya F, Kamalondo H. An Investigation of Waste Management Practices in the Zambian Construction Industry, Journal of Building Construction and Planning Research. 2017; 5: 1-13.

[16] David A. Freedman. On types of scientific inquiry: The role of qualitative reasoning, Statistics Department, UC Berkeley, CA 94720-3860. 2007.

[17] Ilker Etikan, Sulaiman Abubakar Musa, Rukayya Sunusi Alkassim. Comparison of Convenience Sampling and Purposive Sampling. American Journal of Theoretical and Applied Statistics. 2016; 5(1): 1-4.

[18] International Labour Organization, Zambia Green Jobs Programme, Building Construction Sector, 2013-2018.