

# An Assessment of the Approaches of Construction and Demolition Waste in Jos, Plateau State of Nigeria

Alice Bernard Benshak,

Plateau State Polytechnic Barkin Ladi, Jos Nigeria

Wetnwan Moris Dabuahat

Plateau State Polytechnic Barkin Ladi, Jos Nigeria

Nkup Joseph Tanko

Plateau State Polytechnic Barkin Ladi, Jos Nigeria

Veronica Yilret Nanle

Plateau State Polytechnic Barkin Ladi, Jos Nigeria

## Abstract

*The continuous rise in population, urbanization and expansion of cities has triggered a corresponding increase in construction and demolition activity. The frequent collapse of buildings attributed to poor structural design, building decay, and/or use of substandard materials has generated a substantial increase in construction refuse, also referred to as Construction and Demolition (C&D) Waste. This waste stream originates from residential, commercial, agricultural, institutional and industrial building projects for new builds, reconstruction, expansion, and refurbishments/rehabilitation. Most studies in Nigeria have generally focused on solid waste management without considering the uniqueness of C&D and giving it the attention needed, in order to achieve sustainable urban spaces that are highly functional, safe, convenient, and livable. This study seeks to investigate the different approaches and processes of C&D waste management in the City of Jos, in the Plateau State of Nigeria. The mix method was adopted for this research whereby quantitative and qualitative data was collected through a structured questionnaire for construction enterprises, as well as face-to-face interviews with the agencies responsible for waste management in the city. A total of 21 construction companies (representing about 10%) were randomly selected for questionnaire administration while interviews were conducted with the Plateau Environmental Protection and Sanitation Agency (PEPSA) and the Jos Metropolitan Development Board (JMDB) who are responsible for waste management. Investigations revealed that C&D waste consists of heavy and non-degradable materials such as: sheet metal roofing, sand, gravel, concrete, masonry, metal, and wood to mention only a few. The construction companies are solely responsible for: the collection, storage, transportation and disposal of wastes generated from their activities. Approximately 60-70% of the C&D waste materials are either reused, recycled or resold, while the remaining residual waste is indiscriminately disposed. Although the PEPSA and JMDB are responsible for waste management, their focus has been on establishing solid non-hazardous waste infrastructure systems, policies and plans. The absence of records of the quantity of C&D waste generated, the lack of financial data, and the omission of policies and plans for the C&D waste stream has resulted in a missed opportunity for a comprehensive and sustainable waste management strategy for the City and the state. To protect public health, valuable resources, and natural ecosystems, it is recommended that the C&D waste stream be included as part of the state's waste management program, in consideration of the growing construction and demolition activity, by including C&D policies and guidelines.*

### **Keywords**

*rubble, construction and demolition, disposal, sustainable, waste, reduce and reuse.*

### **1. Introduction**

Waste management has become an important issue confronting both developed and developing countries. The rate of waste generation has continued to increase due to population growth, lifestyle changes and choices, consumption and technological advancement, which has prompted the need to address this concern, (Ogunmakinde, Sher, & Maund, 2017). The construction and building activities contribute to approximately 30% of overall land fill volume, (Poon, 2007). In Nigeria for example, not all the material procured are utilized efficiently rather, there has been increasing over-consumption of material during construction, (Adeagbe, Achuen & Oyemogum 2016).

Construction by nature is not an eco-friendly activity. Construction, renovation, demolition activities lead to formation of waste which are heavy, high density, often bulky and occupy considerable space either on the roads or communal waste bin/container. Kumbar, Magdu, & Desai (2019). Construction industries produce large amount of C&D wastes throughout the year all over the world and these industries are faced with many challenges of which one is waste management from generation to disposal. However, C&D waste vary in terms of size, components and type/source. The quantity of material waste generated are not only diverse but may also depend on several factors, including construction method, attitudes of the construction workforce, materials employed, and site conditions. The huge amount of C&D waste streams in different countries has revealed the importance of local actions in order to manage, recycle and reuse of the wastes generated through the lifecycle of buildings. According to Wahab & Lawal (2015), in spite the huge amount of C&D waste generated in Nigeria, it was observed that little attention has been awarded to this stream of waste and argued that a low means of disposal and lack of awareness may be responsible. Karreem, Asa, & Lawa (2015) also supported this by explaining that the volume of waste is attributed to the availability of inexpensive disposal methods, suggesting that government should put in place regulatory policies and organizational policies in that regard.

In construction, waste management is important: where the aim is to reduce and repurpose the quantity of waste generated, respectively, the intent is to achieve sustainable construction practices through social, environmental, and economic principles that contribute to sustainable development. The predominant stages in managing waste are generation, storage, collection, transfer, processing, and disposal, where several approaches may be adopted during each stage to ensure effective management. Although waste generation may be inevitable, reduction is possible and it may be achieved throughout all construction activities, from design to deconstruction. Ogunmakinde et.al. (2017)

It is obvious that the disposal of C&D waste is quite difficult because of its bulky and hazardous materials such as asbestos, heavy metals, persistent organic compounds etc. These wastes threaten human health and the natural/artificial environment with various effects. The overall impact of C&D waste is both on the environment and the economic sustainability of a community, the reason being that the construction sector as a base and crucial variable is related to all other sectors.

This study briefly focused on the approaches of C&D waste management from generation to disposal with the aims of identifying the current situation in construction and demolition waste management in Jos and demonstrating an understanding of the actual waste management strategy by the construction industry and the role of government in C&D waste management in Jos.

## *2. Literature Review*

C&D waste is defined by Begum, Siwara, Perira & Jaafar (2006) as the unwanted material generated during construction, including rejected structures and materials, materials which have been over-ordered or are surplus to requirement and materials which have been used and discarded. C&D waste stems from construction, refurbishment, and repairing work. Many wasteful activities can take place during both design and construction processes consuming both time and effort without adding value to the client. Such wastes are mostly generated during new construction and renovation as a result of site preparation, material use, material damage, material non-use, excess procurement and human error.

C&D waste is a growing problem all over the world. As reported by Stokoe et. al (1999), C&D wastes in Hongkong took up about 65% of the landfill space in 1994/95. Also, in the United Kingdom over 50% of waste in a typical landfill could be C&D waste. (Furgason et al. 1995). It was also reported by Craven et.al. (1994). Construction activities generates 20 to 30% of all wastes deposited in Australian landfill while in the United States C&D waste represents about one third of the volume of waste in landfill. (Serpell & Labra, 2003).

According to Obandan &Uga (1996), the construction industry contributes 3 to 6% of the gross development product (GDP) in developing countries and in Nigeria the construction industry contributes about 2% in the past 15years which account for 69% of the Nation's Fixed Capital formation, (Wahab and Lawal 2011)

In Nigeria, the C&D waste generation rate has been reported to be high and disposal methods less sustainable, (Ogunmakinde et.al 2019). Hence the need to dispose C&D waste in a more efficient and sustainable manner is of utmost importance. Despite the high levels of material waste in Nigeria, it was observed that by Wahab and Lawal (2019) that little attention is given to C&D waste management.

### *2.1 Construction and Demolition Waste - Sources and Types*

C&D waste according to Osami, (2008) refers to materials from construction sites that are unusable for the purpose of construction and have to be discarded for whatever reasons. This includes any material that needs to be removed from the site and transported elsewhere due to damage, excess, or by-product of the construction process, or non-use, or non-use due to non-compliance to the required specific standard. (Adeagban et.al. 2016). Poon (2007) also defined C&D waste as a mixture of inert and non-inert materials arising from construction, excavation, renovation, refurbishment, demolition, road work, and other construction related activities. Inert materials can be comprised of soft materials such as soil, earth and slurry or hard materials of rock and broken concrete. Non-inert materials include timber, plastics and packaging. Many wasteful activities can take place during both design and the construction processes, causing both time and effort wastage without adding value to the client

Categories of waste material are; waste left over from new construction (i.e, new material, masonry, packaging etc); remodeling/demolition debris from older buildings (i.e, old material, concrete, wood, bricks, insulations, fixtures, etc,); and debris from large civil project works like high ways and bridges (ie. Concrete, asphalt, rubbles etc) (Junk King Report, 2020). These materials generally consist of debris that are heavy and bulky e.g concrete, asphalt, metal, bricks, wood, glass, plastics, rocks etc. The causes of material waste are diverse and may depend on several factors including construction methods, attitudes of the construction workforce, materials employed and site conditions. Other causes of C&D waste identified by Odusami, Oladiran & Ibrahim (2012) are; client related, management related, supply and storage related, design related, construction related and phenomenal occurrences. However, the consistent causes are design related, poor supervision and material handling which are human induced and may be minimized by adopting appropriate waste management strategies. Experience has shown over the years that, unless management control is tight wastage can frequently exceed often by a large margin the figure allowed in the tender document. (Enshassi 1999).

### *2.2 Construction and Waste Management Approaches*

C&D waste pose great danger to the environment hence construction industries need to find suitable sustainable methods of managing waste generated from their activities, Prevention and/or minimization should be considered throughout all stages of the project especially during the design stage (Vaidya, 2009). This stage offers the biggest opportunity to reduce waste by prioritizing waste prevention from the beginning of the project. When managing construction waste, it is important that practices reflect the waste hierarchy with waste prevention and minimization being the top priority followed by reuse and recycling. The primary aim is to prevent waste generation in the first place which minimizes the resources required to complete the job. Preventing waste is financially advantageous because it reduces the

amount of materials being purchased and removes the need to transport waste off site. On the site waste can be minimized by careful storage, handling and the setting up of a central cutting station for some trades. Trigunarysyah, Sofyan & Hendi (2006).

Landfill spaces are diminishing rapidly with the rise in development, urbanization, and population among other factors hence alternatives like reduce, reuse, and recycle are of pressing concern in waste management.

**Reduce:** source reduction prevents waste from being generated in the first place. Waste can be reduced through preservation of existing building rather than constructing new ones, optimizing the size of new buildings, using construction methods that allow disassembly and facilitate reuse of material and employing alternatives framing trends etc. (Laquatra & Pierce 2011). This can also conserve landfill space and reduce environmental impacts of producing new material and cutdown over all building project expenses.

**Divert and Reuse:** C&D debris like landscape and land clearing debris, asphalt pavements, gravel, concretes, masonry scrap and rubbles, woods, plastics etc can be diverted and reused as resources and significantly cut down waste, (Recycle Magazine, 2020)

**Recycle:** Concretes and rubbles are often recycled into aggregate and concrete products and woods into furniture products among others.

**Deconstruction:** Also, rather than demolition and dumping, the deconstruction of built infrastructure and conservation, reuse and recycling of the associated material resources, is identified as central to tackling the high level of waste generated the C&D sector. High quality assured, deconstruction is an effective means for reducing C&D waste, the demolition of a building produces enormous amount of debris and deconstruction is emerging as alternative to demolition as it seeks to maintain the highest possible value for material in existing building by dismantling building in manner that will allow the reuse as efficient recycling of material. (Chini, 2005). Deconstruction has the potential to ease future and dependency on further extraction of primary material from the natural environment. According to Zaman, Arnott, McIntyre & Hannon (2018) in a study estimated that a huge prospect in regard to materials recovery from deconstruction could possibly save around 502,158MJ of embodied energy and prevent carbon emissions of around 27,029kd (CO<sub>2</sub>). Deconstruction also in addition to emission reduction and resource recovery, has the prospect of employment, small business opportunities etc.

### 3. Materials and Methods:

This mix method was employed for the purpose of this study, data were collected through structured questionnaire survey and interviews. This research considered 10% of the total registered construction

companies in Jos giving a sample size of 21 selected registered construction companies with 2 interviews with Jos Metropolitan Development Board (JMDB) and Plateau Environmental Protection Agency (PEPSA). Out of the 21 questionnaires issued, about 17 were completed and returned representing 85% response.

The questionnaire was structured in 3 sections comprising;

- General information like size of the company, year of establishment, type of construction and work executed etc;
- Sources and type of C&D waste generated and;
- Approaches of waste management, preferred waste management approaches, challenges of waste management, among others.

The simple percentile and descriptive analytical tools were used to summarize and analyze the information collected. Due to the COVID19 pandemic, most data were collected through phone chats and/or other social media handles.

### *3.1 The Study Area:*

Jos covers the metropolis which also covers Jos-north and Jos-south L.G.As of Plateau State, Nigeria. The study area lies between the latitudes (9° 36'46.59"N and 10° 04' 08.79"N) and Longitudes (8° 41' 17.25"E and 9° 14' 32.80"E). Jos metropolis stands on the northern edge of the Jos Plateau. Its height is approximately 1,419m. above sea level and lies close to the geographical centre of Nigeria.

Tin mining and the extension of the rail line to Jos in 1972 are said to have paved the way for the development of commercial activities in Jos. The city has a population of about 900,000 people based on 2006 population census. The population has been projected to 2019 using an urban growth rate of 3.5%, hence the estimated population of Jos in 2020 is 1.5 million people.

During the British Colonial rule, Jos was a centre for tin mining and it is this activity that made Jos an important national administrative, commercial and tourist centre which led to an influx of migrants from different parts of the country and other parts of the world.

Jos town was chosen for this study because of the: accelerated pace of urbanization, high socio-economic activities, high population growth accompanied with the increasing and overwhelming municipal waste management problem suffered in most Nigerian cities.

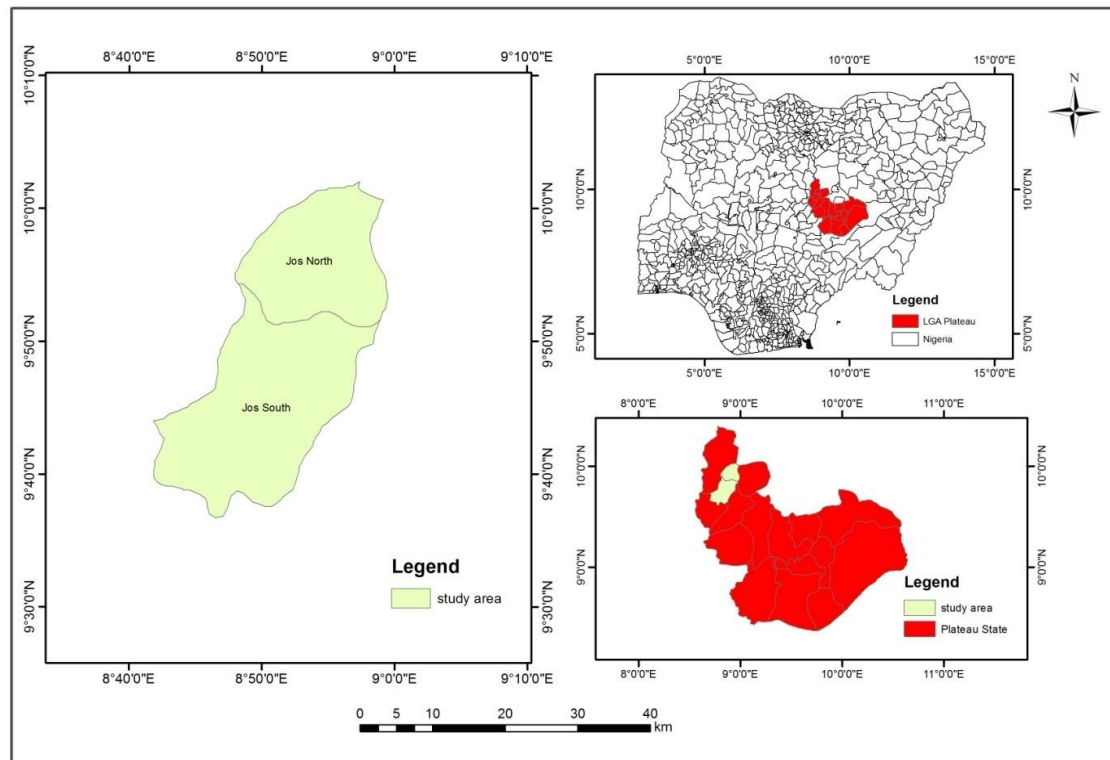


Fig 1: Study Area.

#### 4. Research Results:

The quantitative phase of this research employed a representative sample size of 21 drawn from duly registered construction companies in the study area; representing 10% of the total number of construction companies in the study area. Questionnaires were issued to the 21 construction companies of which 10 were emailed and 11 were administered face to face. There was an 86% response rate to the questionnaire; (14%) did not respond.

For the qualitative phase, the following tables and chart present the demographic characteristics of respondent companies. In addition to the private company interviews, 2 interviews were conducted with the government agencies, Plateau Environmental Protection and Sanitation Agency (PEPSA) and the Jos Metropolitan Development Board (JMDB) which are responsible for waste management. The focus for these agencies has been on establishing solid non-hazardous waste infrastructure systems, policies and plans. Table 1 shows job description categories ranging from management to technicians were represented which gave a good cross-section of opinion from respondents. From Tables 2 and 3, it is clear that most of the companies are sole proprietorship representing 61% with 67% having more than 10 years of operating experience. 78% of the companies are engaged in new builds and new builds/renovation activities.



**Table 1: Job Description of Respondents**

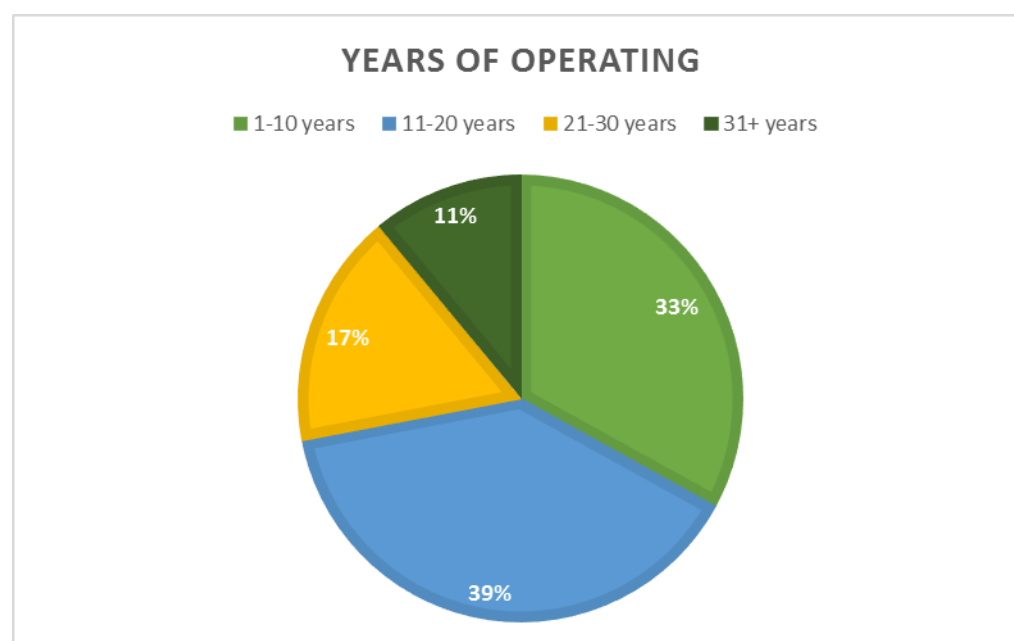
Job description	Frequency	Percentage %
CEO	1	6
Manager	2	11
Project Manager	5	28
Architect	1	6
Builder	2	11
Quantity Surveyor	1	6
Engineer	2	11
Technician	4	22

Source: Research Findings, 2020

**Table 2: Ownership of Construction Company Respondents**

Ownership	Frequency	Percentage %
Private Sole Proprietorship	11	61
Private Partnership	5	28
Government Agency	2	11

Source: Research Findings, 2020



Source: Research Findings, 2020



**Table 3: Type of Construction**

Activity Type	Frequency	Percentage %
New Build	5	28
New Build/Renovation	9	50
Maintenance/Repair	3	17
Demolition	1	6

Source: Research Findings, 2020

#### *4.1 Waste Management Approaches*

Although it is not possible to avoid waste generation during construction, it can however, be minimized at the initial stage of construction. Based on the study findings, C&D waste management in Nigeria is different from that of other parts of the world. For instance, waste management is not well structured in terms of sorting, hence waste streams are not well sorted in Nigeria.

The size and type of construction company can be associated with particular kinds of waste generated, for example, companies that engage in new development generate waste such as packing material, masonry, and sand; while those companies that engage in maintenance and repair generate waste such as broken bricks, wood with nails and screws, broken concrete etc. See Table 4 for a breakdown of the types of waste generated.

Findings shows that C&D waste management vary widely among construction industries in Jos Nigeria depending on the construction activity and waste generated, financial capacity of a company, available technology, etc. While some companies (mostly the small ones) adopt reuse practices of waste material for backfilling or burning in order to cut the overrun cost and maximize profit, other companies (namely the larger companies) prefer on-site dig-and-bury or burning of wood waste, plastic and packaging. Overall, approximately 60-70% of the C&D waste materials are either reused, recycled or resold, while the remaining residual waste is indiscriminately disposed by open dumping, landfilling, burning and reuse in the study area. The government agencies responsible for waste disposal in the study area confirmed that all construction companies are each responsible for the waste generated by their activities.

The agencies also confirmed the lack of information on the quantity of C&D waste generated in the area, and that burning is still practiced by some construction firms in spite of some level of awareness of the environmental impact of such practices and going against the local by-laws Awareness may not necessarily translate into action therefore appropriate methods of waste disposal should be enforced by the relevant authority.

#### *4.2 Plateau State Waste Management*

The Nigerian government through the have established various authorities and agencies that would ensure efficient and effective mode of waste management in the country. ELRI (2004). Plateau Environmental Protection and Sanitation Agency was established in 2000 by the state parliament (Gwom, & Ayuba, 2014). It is saddled with the responsibilities of solid waste management (remove, transport and dispose); clear and maintain public drainage facilities; register private waste collection companies; approve and monitor all disposal systems in the city; assess recycling as a waste management option and recommend basic standards for solid, liquid, gaseous or toxic waste management in line with Federal Environmental Protection Agency (FEPA), establish safe and recommend acceptable safe methods of collection and disposal of hazardous products, educate the public on various disposal method, initiate environmental legislation and constant reviews of the existing ones, Eche, et, al. (2004). Other agencies responsible for the collection, transportation and disposal of waste in the state include the Jos Metropolitan Development Board (JMDB) and the state Ministry of Housing and Urban Development.

C&D waste has not been treated separately from other wastes in the study area and by the agency responsible for waste management therefore these wastes are jointly collected manually by the use of push carts, wheel barrows, and pedal tricycles which is mostly by the informal sector while they are transported using tippers, trucks, vans, by the agencies saddled with that responsibilities etc.

Result from interview with PEPSA and JMDB revealed that; some challenges of the agencies in discharging their responsibilities include slow and/or non-implementation of the policies due to lack of political will, existing policies on waste does not spell out specific methods for handling different types of waste, non-continuity of programs by successive government, bureaucratic bottle neck etc. Other problems faced by the agencies include poor and/or inaccessibility of some areas, poor funding/manpower/evacuation trucks, non-payments of bills by residents, companies, industries among others hence waste is not efficiently and effectively managed.

This study provides a reference point for industries and government agencies to improve on sustainable waste management and disposal methods in Jos, Nigeria and waste management policies. There is also room for improvement to waste minimization practices that could be gained through additional opportunities to reduce, reuse and recycle.

**Table 4: Type of Waste Generated**

Waste	New Devt.	%	New/Renovation	%	Maintenance	%	Demolition	%
Masonry	18	100	18	100	9	50	-	-
Debris	18	100	18	100	18	100	18	100
Sand	18	100	18	100	16	89	11	61
Concrete	18	100	18	100	18	100	18	100
Wood	18	100	18	100	14	78	7	39
Plastic	18	100	18	100	8	44	2	11
Rocks	13	72	18	100	4	22	8	44
Broken bricks	18	100	18	100	13	72	18	100
Insulation	18	100	18	100	7	39	5	26
Asphalt	2	11	2	11	2	11	2	11
Gravels	11	61	15	83	16	86	6	33
Packaging	9	50	13	72	8	44	1	6
Others	7	39	7	39	7	39	3	17

Source: Research Findings, 2020

**Table 5: Source of Waste**

Source/Activity	Frequency	Percentage %
Excessive Purchase	3	17
Inappropriate storage	9	50
Mishandling	9	50
Careless delivery	11	61
Packaging	18	100
Construction Debris	18	100
Loading/offloading	15	83
Vandalism	5	26

Source: Research Findings, 2020



Table 6: C&D Waste Disposal Methods

Method	Frequency	Percentage %
Open Dumping	7	39
Landfilling	14	78
Incineration	5	26
On-site dig and bury	6	33
Burning	13	72
Reuse for backfilling	9	50
Recycle	3	17
Resell	11	61
Give away	5	26
Others	7	39

Source: Research Findings, 2020

### 5. Conclusion and Recommendations:

The study examined the approaches and processes of C&D waste management in Jos, Nigeria. Using the mixed methods of research, the study revealed that C&D waste management includes: landfilling, reuse, burning, open dumping, incineration, and on-site dig-and-bury. The size and type of construction activity determines the waste material generated and the disposal strategies employed by the companies.

Although JMDB and PEPSA are responsible for waste management in the study area, it was determined that in actuality, the construction companies are responsible for waste generated from their activities.

Burning, open dumping and burying are still practiced by the construction companies in the study area despite the environmental legislation prohibiting such practices;

Construction companies are aware of the danger of indiscriminate waste disposal and the environmental effects yet still practice waste disposal methods that are environmentally unfriendly, hence enforcement should be included as part of the waste management strategy by the government agencies responsible for waste management in the state.

It is recommended that government agencies should devise a means of formulating and enforcing regulatory policies and enhancing by-law compliance which should also include a mandatory waste management plan by companies to be submitted to JMDB as an arm of government responsible for approval of all development plans among other things. The waste management plan should include proposed waste disposal methods and a final submission detailing the total waste managed on-site and tonnage of each method, while government representatives monitors adherence.



Construction companies need to work together to collectively develop a more holistic waste disposal framework from construction design to completion, keeping track of the quantity of wastes generated by their activities and employing the use of environmentally-friendly waste disposal methods. Reduce, recycle, reuse when adopted can save excessive use of resources and minimize waste generation, and increase profits.

To protect valuable Nigerian resources, public health and natural ecosystems, it is recommended that the C&D waste stream be included as part of the state's waste management program, in consideration of the growing construction and demolition activities in Jos, by including C&D policies and guidelines that enable communities in Plateau State, Nigeria to attain waste management approaches and processes that are more sustainable and environmentally-friendly.

### References

- Adeagbo, D.O; Achuenue, E. & Oyemogun, I.M. (2016): Construction Material Waste Management Practices in Selected Construction Site in Abuja, Nig. Journal of Management and Technology Vol. 1 No. 2 December, 2016
- Begum, R.A., Siwara, C., Pereira, J.J., & Jaafar, A.H., (2006). Journal of Resources conservation and recycling. 48 (1): 86–98.
- Asase, M.; Yanful, E.K.; Mensah, M.; Stanford, J.; Amponsah, S. Comparison of municipal solid waste management systems in Canada and Ghana: A case study of the cities of London, Ontario, and Kumasi, Ghana. Waste Manag. 2009, 29, 2779–2786.
- Arslan, H.; Cosgun, N. & Salgin, B.: Construction and Demolition Management in Turkey
- Chini, R (ED,); Deconstruction and Material Reuse – an International Overview; Final Report of Task Group 39 on Deconstruction, International Council for Research and Innovation in Building Construction. Gainesville, FL US. 2005
- Ekanayake, L.L.; Ofori, G. Construction material waste source evaluation. In Proceedings of the Second Southern African Conference on Sustainable Development in the Built Environment: Strategies for a Sustainable Built Environment, Pretoria, South Africa, 23–25 August 2000.
- Ekanayake, L.L.; Ofori, G. Building Waste Assessments Score: Design based tool. Build. Environ. 2004, 39, 851–8
- Ekanayake, L.L., & Ofori, G. (2004). Building waste assessments score: design based tool. Building and the Environment, 39(7): 851-861. Available at: <http://www.engineeringvillage2.org/controller/servlet/Controller?CID>
- Enshassi A (1996). Materials control and waste on building sites. Building Res. Info., 24(1): 31-34.
- Ferguson J, Kermode N, Nash CL, Sketch WAJ, Huxford RP (1995). Managing and minimizing construction waste, A Practical Guide, Institution of Civil Engineers, London.
- Federal Office of Statistics (1997). Review of Nigeria Economy, FOS, Abuja, Nigeria.

- Laquatra, J. & Pierce, M. (2011): Waste Management at the Construction Site. <http://www.researchgate.net/publication/221914788>
- Kareem, W.A.; Asa, O.A.; Lawal, M.D: Resources Construction and Waste Management Practices in Construction Industry, (Oman Chapter) 201,4,20
- Kumbra, S.A.; Magdum, J.J.; & Desai, D.B.: Recycling and Refuse of Construction and Demolition Waste for Sustainable Development. <http://www.ssm.com/link/OIDA-Intl-Journal-sustainable-devhtml>
- Obadan MI, Uga EO (1996). National planning and construction in Nigeria. 17th biennial Conference of the Nigerian Institute of Quantity Surveyors, 10(25): 8-13.
- Odusami, K.T.; Oladiran, O.J.; Ibrahim, S.A. Evaluation of Materials Wastage and Control in some selected Building sites in Nigeria. Emir. J. Eng. Res. 2012, 17, 53–65.
- Ogunmakinde, O.E.; Sher, W. & Maund K. (2014): An Assessment of Material Waste Disposal Methods in the Nigerian Construction Industry. MDPI [www.mdpi.com/journal/recycling](http://www.mdpi.com/journal/recycling).
- Osmani, M., Glass, J., & Price, A.D.F. (2008). Architects' perspectives on construction waste reduction by design. Waste Management, 28(7): 1147-1158
- Poon, C.S., (2007). Reducing construction waste. Waste Management, 27: 1715-1716.
- Poon, C.S.; Yu, A.T.W.; Ng, L.H. A Guide for Managing and Minimizing Building and Demolition Waste; The Hong Kong Polytechnic University: Hong Kong, 2001.
- Poon, C. S., Yu, A. T. W., & Jaillon, L. (2004). Reducing building waste at construction sites in Hong Kong. Journal of Construction Management and Economics, 22, 240-248 FUTA Journal of Management and Technology Construction Material Waste Management Vol.1, No. 2 December 2016
- Poon CS, Yu ATW, Ng IH (2001). On-site sorting of construction and demolition waste in Hong Kong . Resources, Construction and Recycling. 32(1): 157-172
- [Recycling Magazine.com/2020/03/30/best-practices-for-waste-management](http://Recycling Magazine.com/2020/03/30/best-practices-for-waste-management).
- Serpell A, Labra M (2003). A study on construction waste in Chile. In : Ofori G, Ling FY, editors. Proceedings, Joint Symposium of CIB W55, W65 and W107 on Knowledge. Construction 2. October, pp.102-111.
- Stokoe MJ, Kwong PW, Lau MM (1999). Waste reduction: A tool for sustainable waste Management for Hong Kong. In: Barrage A, Edelman Y, editors. Proceedings of R'99 World Congress, Geneva: EMPA, 5: 165-170.
- Wahab A.B. & Lawal A. F. (2011). An evaluation of waste control measure in construction industry in Nigeria. African Journal of Environmental Science & Technology, 3: 246-254
- Zaman, A.U; Arnott, J.; McIntyre, K. & Hannon, J. (2018): Resource Harvesting Through a Systematic Deconstruction Residential House. A Case Study of the 'Whole House Reuse' Project in Christchurch, New Zealand.