A review of the causes of construction waste generation in Nigeria and recommendations

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ABSTRACT

The causes of construction waste (CW) in Nigeria have been a major topic for researchers over the last 15 years. However, no effort had been made to analyse these studies to understand the trends. A structured review of 30 research studies investigating the causes of CW in Nigeria from 2005 to 2019 was therefore undertaken. The findings indicated that the majority of the articles were published in journals. Questionnaire survey and descriptive statistics were the dominant data collection and analytical methods, respectively. Geographically, data collection focused on Abuja and Lagos. There was a significant focus on the causes of waste generation in the construction stage rather than the design and procurement stages. Late design changes, purchase of substandard materials and inadequate supervision were the underlying causes of waste in the design, procurement and construction stages, respectively. It is recommended that future studies should focus more on minimisation solutions from different perspectives due to the potential increase in construction activities in Nigeria. This study will guide researchers and practitioners to understand the trends of studies on the causes of CW in Nigeria.

Keywords: developing countries, sustainability, waste management & disposal

1. INTRODUCTION

The Nigerian construction industry contributes significantly to the economic development of the nation. The industry has outgrown most other local economy sectors over the last few years (Nigerian National Bureau of Statistics, 2019). Olusegun and Michael (2011) stress that construction investments account for over 50% of the gross fixed capital formation. According to the National Bureau of Statistics (2019), the sector's real growth rate in the third quarter of 2019 was 2.37% (year on year), from 0.67% in the second quarter; an increase of 1.71% points compared to the second quarter of the same year and higher by 1.83% from the rate recorded a year previously. Thus, the industry serves as one of the important sectors for reducing unemployment and providing necessary infrastructure and social amenities to meet the need of the increasing population. However, the industry is infamous for a high rate of waste generation in the country (Afolabi *et al.,* 2018). The poor performance of waste management within the industry results in frequent disposal (Ogunmakinde, 2019; Wahab and Lawal, 2011), thus constituting a significant environmental burden on municipalities with social and financial implications.

There is a significant absence of statistics on construction waste (CW) generation rate in Nigeria. Ola-Adisa *et al.* (2015) and Ugochukwu et al. (2017) observed that CW had become a serious issue requiring urgent attention. Currently, there is no government strategy, particularly for addressing the issue of CW in the country. Lack of waste minimisation policies (Adeagbo *et al.,* 2016) and the integration of sustainability in building construction are some of the key problems (Dania et al., 2013). According to Oko and Emmanuel (2013), up to 21–30% of a project cost overrun is attributed to materials waste.

As in many other parts of the world, the construction industry in Nigeria is the largest contributor to national waste. For instance, India generated between 112 and 431 million tonnes of CW in 2016 (Jain *et al.,* 2018), while in the UK, waste from the industry accounts for 61% of national waste generated (Defra, 2019). According to the UK Department for Environment, Food and Rural Affairs (Defra, 2012), England alone created about 77.4 million tonnes in 2010. Huang et al. (2018) show 30–40% of the total amount of waste produced in China emanates from the construction industry, with an average recovery rate as low as 5%. Approximately 40% of global solid waste originates from the construction industry (Esa *et al.,* 2017; Kulatunga et al., 2006; Tam et al., 2007), much of which could be salvaged through sustainable means (Aadal *et al.,* 2013).

Developing and implementing sustainable waste management is an integral part of sustainable construction. According to Sev (2009), waste management is one of the ways the construction industry can contribute to sustainable development. As a result, scholars have proposed varying waste management measures from different perspectives (Begum et al., 2006; Dainty and Brooke, 2004; Osmani et al., 2008). Understanding the causes of waste in the construction industry is the first step towards developing and implementing any management measures (Polat *et al.,* 2017). Several research studies have been conducted to assess the various causes of waste at different stages of the construction delivery process. Scholars often categorise the causes of CW to help practitioners identify their origins. Nagapan *et al.* (2012b) categorised the causes of waste into the design, handling, worker, management, site condition, procurement and external factors. According to Oladiran *et al.* (2019), CW origins include client, design, material handling, procurement and operation. While internal factors are the leading cause of waste generation in the construction industry, external factors like adverse weather (McGrath, 2001), and theft/vandalism (Eze *et al.,* 2017) could result in a waste of materials, particularly when a site is inadequately secured. According to Teo and Loosemore (2001), senior managers' low priority to waste minimisation is a root cause of waste in construction projects. Low priority can result in a lack of motivation among employees, which makes waste management in organisations a difficult task (Li and Du, 2015).

For instance, waste can be generated due to design errors (Love *et al.,* 2011), design changes that could lead to a potential rework onsite (Han *et al.,* 2013). About 33% of CW is due to design errors (Innes, 2004). The material procurement process could result in waste due to mistakes in a bill of quantity and an inefficient supply chain partnership (Dainty and Brooke, 2004). Also, waste can occur in a construction site due to inadequate site material management planning (Poon *et al.,* 2004). Nagapan *et al.* (2012a) identified poor site management and supervision, lack of experience, inadequate planning and scheduling and design errors as waste factors in projects. A similar study by AlHajj and Hamani (2011) identifies such factors as a lack of awareness, inadequate design information, rework and variations. According to Polat *et al.* (2017), frequent design changes, detail errors, plus cutting uneconomical shapes result in material waste in projects. There is a similarity in terms of factors causing waste in the industry; however, these factors usually vary in terms of significance based on a country's circumstances (Muhwezi *et al.,* 2012; Wan *et al.,* 2009). These

circumstances may include the level of technological advancement (Lu, 2019; Won and Cheng, 2017) and policy effectiveness (Lu and Tam, 2013).

The causes of CW have been a major topic among scholars interested in CW management in Nigeria. However, it is unclear how this topic has evolved in the last 15 years (2005–2019). There are varying findings on key causes of waste generation in many studies (Oladiran *et al.,* 2019; Saka *et al.,* 2019); hence, it remains unclear what practitioners should recognise as the waste generation factors frequently reported by earlier studies. Therefore, this research study aims to review studies investigating the causes of CW generation in Nigeria to evaluate their findings and consolidate the existing evidence on the topic. The findings are limited to the design, procurement and construction stages; hence, the demolition stage was excluded.

The remainder of this paper is structured as follows: Section 2 presents the method for articles searching and selection criteria. Section 3 presents the analysis and discussions of the findings. Finally, the conclusion and the recommendations are presented in Section 4.

2. METHOD

The method employed is a highly structured review of literature, involving detailed search and filtering of articles investigating the causes of CW in Nigeria, based on the available research outputs. Considering the above objective, a structured search using a time period of 2005–2019 was performed. The TITLE-ABS-KEY combination used in the search for articles was construction AND waste AND generation OR cause AND Nigeria. This is based on the titles and abstracts found in relevant publications on the topic.

Several scholars have employed Web of Science (WoS) and Scopus as the primary search engines for systematic reviews in CW management discipline (Wu et al., 2019a, 2019b). These two databases are essential in finding waste management publications (Chen *et al.,* 2018; Jin *et al.,* 2019). This is due to their wide range of publication indexes in engineering, natural and social science disciplines (Falagas et al., 2008). Therefore, the literature retrieval process was mainly carried out using WoS and Scopus.

An additional search was carried out in the Chartered Institute of Building (CIOB) and Taylor and Francis (T&F) databases. These databases were used to find academic articles that could be relevant for inclusion. Also, Google Scholar was used to locate grey literature for potential inclusion. Haddaway et al. (2015) explained that Google Scholar could complement other traditional search methods. The major challenge encountered in Google Scholar was a large number of publications showing up as results. A careful and extensive screening was carried out manually to filter out irrelevant articles. At the end of the search, the total number of eligible articles returned for potential screening was 3544. Several articles were found and selected for the review, while many were considered ineligible and were removed for various reasons (Figure 1).

2.1. Articles Selection Criteria

Only the studies identifying the causes of waste in the design, material procurement and construction stages in Nigerian building projects were eligible for inclusion. Therefore, all articles that did not fall within the above boundaries were removed. At the end of the selection process, 21 articles were identified as eligible for inclusion. The reference lists of these articles were manually scanned to detect any further articles for potential inclusion, and, in doing so, nine extra articles were found. This process increased the number of articles selected for the review to 30. Figure 1 shows the article selection process in preferred reporting items for systematic reviews (Prisma) (Page and Moher, 2017).

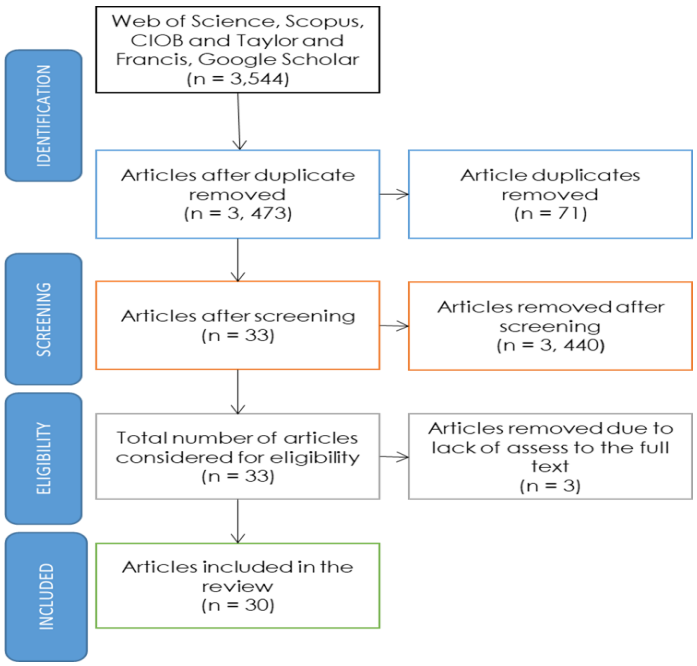


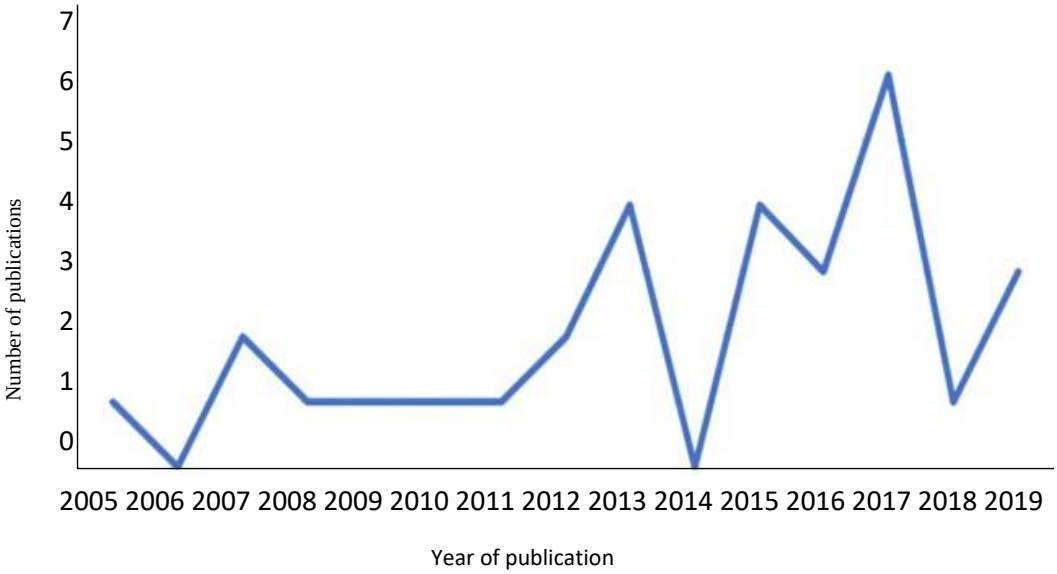
Figure 1: Article selection process

The articles were examined based on their contents such as titles, abstracts, findings, methods and conclusions to cross-examine their inclusion eligibility. All the articles were scanned to identify the design, procurement and CW generation factors. Frequency (number of studies that identified a particular cause of CW generation at each stage) is recorded in Table 2. Other contents of the articles shown in Table 1 were also identified for analysis. Document type was limited to journal papers, conference proceedings, PhD theses, government and professional body reports. No government or professional body reports were found for potential inclusion. The language of the publications was limited to English. The search was conducted from 21 August to 27 November 2019 and updated in May 2020. The update showed no relevant article had been published in 2020. The results were analysed in themes and presented using the descriptive technique.

3. FINDINGS, ANALYSIS AND DISCUSSIONS

3.1. Number of years of publications (2005–2019)

It is noticeable that the number of publications identifying the causes of CW in Nigeria has grown since 2013, following a constant trend from 2008 to 2011 (Figure 2). There is a drop in 2016, while 2017 has the highest number (n = 6) of publications. Thus, in 2017, researchers have made a reasonable effort in investigating the factors causing waste in the industry compared to other years under the review. It is anticipated that research on the topic will continue to grow across the country to inform practitioners on the issues that can result in a waste of materials in projects and a need to adopt effective waste management strategies for the environmental sustainability.



3.2. States/cities of data collection

From Table 1, in the state/city column, many studies have selected only one state/city for data collection, others combined two or more states/cities. However, two studies did not indicate their data collection field. Ten (*n* = 10) included Abuja, the Nigerian capital city as their research field between 2007 and 2018 and nine (*n* = 9) included Lagos between 2007 and 2019. The remaining studies were conducted in a range of different states/cities. Abuja is the fastest-growing city in Nigeria in terms of economic, infrastructure and urbanisation (Abubakar, 2014). Lagos is also known as Nigeria's economic hub, with a significant human population (Merem *et al.,* 2018). Population growth, urbanisation and industrialisation are significant factors of waste generation in urban areas (Vij, 2012). Perhaps, the reasons these two cities are leading in CW generation research compared to other states/cities.

3.3. Research method and article type

From Table 1, in the method column, findings show a range of different methods has been used to identify the causes of CW in Nigeria. Quantitative strategy (*n* = 23) through questionnaire survey appears as a dominant method. A few studies (*n* = 4) applied the mixed method (questionnaire and interviews). One study each applied case study/interviews, and questionnaire/ case study/interviews, respectively, while only two studies applied interviews.

Aderibigbe *et al.* (2017) used a questionnaire survey to identify waste compositions. They used the quantitative strategy to analyse participants' responses and presented the data in percentages. The result shows that sandcrete blocks (40%) have the highest waste composition, followed by ceiling board (20%), tiles (13%), timber and cement (10%) and steel reinforcement (7%). Ugochukwu et al. (2017) quantified material waste in a case study of five projects. The results show timber has the highest average percentage of waste, with 5.5%, tiles 3.47%; sandcrete block 1.6%; reinforcement bars 1.58% and concrete 1.55% in Anambra state. Further, findings suggest most studies applied descriptive statistics for data analysis. Based on the quantitative strategy, descriptive statistics are used in quantifying data by calculating the means, media, percentage and standard deviation. According to Lu and Yuan (2011) and Yuan and Shen (2011), the quantitative strategy is mostly used in data collection and analysis in CW management studies.

In the participant column (Table 1), based on observation, the participants in the previous studies are mostly quantity surveyors, engineers, architects, project managers and builders. This suggests the

named groups play active roles in the Nigerian construction industry. Five studies did not specify their sample size. The studies that adopted the questionnaire, interviews or mixed methods showed a smallest sample size of n= 30 and a largest of n = 743. Using the interviews of 30 construction professionals in Abuja, Saidu *et al.* (2017) revealed that projects cost overruns are a direct consequence of waste generation. The study suggests identifying the causes of waste and working towards their prevention can ensure cost efficiency of projects. Oladiran *et al.* (2019) found late design changes, delay in material delivery and inclement weather as primary causes of waste in the design, procurement and construction stages, respectively. Finally, in the article type column in Table 1, a significant number of articles (*n* = 23) was found in journals, a few articles (*n* = 6) appear in conference proceedings and one is a PhD thesis. Hence, more articles were published in journals in the last 15 years.

Table 1: Characteristics of eligible articles

No	Author	Method			Article Type			Project Stage			State/City	Participants	Research sample size
		Questionnaire	Interviews	Case study	Journal	Conference	PhD thesis	Design	Procurement	Construction			
1	Ogunmakinde, 2019	✓	✓				✓	✓	✓	✓	Lagos	**Quest.** (UP; CEO; PM; Arch; Engr; QS; QM; Builders; technician); **Inter**. (Arch; Engr; PM; QS; MC; SC; FM)	243 65
2	Oladiran *et al.,* 2019	✓			✓			✓	✓	✓	Lagos; Ogun; Oyo Osun; Ondo; Ekiti	Civil Engr; QS; Arch; Builders	167
3	Saka *et al*., 2019	✓			✓					✓	Lagos	QS	52
4	Eze *et al.,* 2018	✓			✓					✓	Abuja	Builders; QS; Arch; Engr	195
5	Ugochukwu *et a*l., 2017		✓	✓	✓					✓	Anambra	Contractors, QS, PO; SK; Artisans Tradesmen	5 Building projects The human sample is unspecified
6	Haruna *et al*., 2017	✓	✓	✓	✓					✓	Adamawa	**Quest.** (Site managers; Artisans) **Inter.** (Artisans; Craftsmen)	20 Building projects 288
7	Eze *et al*., 2017	✓			✓			✓	✓	✓	Abuja	CO; artisans; tradesmen	125
8	Aderibigbe *et al*., 2017	✓			✓					✓	Abuja; Kogi	Builder; QS; Arch; Site supervisors; Foremen; SK	30
9	Aderibigbe *et al*., 2017		✓		✓				✓	✓	Abuja	PM; QS; STO; Engr	30
10	Saidu *et al*., 2017		✓		✓			✓	✓	✓	Abuja	PM; QS; STO; Engr	30
11	Adeagbo, *et al*., 2016	✓			✓					✓	Abuja	QS; Engr; Arch; and Builders	77
12	Arijeloye & Akinradewo, 2016	✓			✓					✓	Ondo	QS; Engr; Arch; and Builders	100
13	Garba *et al.,* 2016	✓			✓			✓	✓	✓	Kaduna; Abuja	QS; Arch; and Builders	53

14	Idris *et al.,* 2015	✓			✓					✓	Gombe	QS; Engr; Arch; and Builders	80
15	Ola-Adisa *et al*., 2015	✓			✓					✓	Bauchi	Arch, Engr; QS, Builders; Contractors	Unspecified
16	Adewuyi & Odesolay, 2015	✓			✓			✓	✓	✓	Bayelsa; Cross River; Delta; Edo; Rivers	Consultants; Contractors	743
17	Saidu & Shakantu, 2015	✓	✓			✓			✓		Abuja	PM; QS; Engr; STO	30
18	Aiyetan & Smallwood, 2013	✓				✓			✓	✓	Lagos	Arch; Builders; Engr; PM; QS	72
19	Adewuyi & Otali, 2013	✓			✓					✓	Rivers	Consultants; Contractors	74
20	Oko & Emmanuel, 2013	✓			✓					✓	Unspecified	Contractors; Client; PD	56
21	Ayegba 2013	✓			✓				✓	✓	Niger	Contractors	40
22	Odusami *et al*., 2012	✓			✓			✓	✓	✓	Lagos	Arch; Builders; Engr; QS	20
23	Babatunde, 2012	✓			✓				✓	✓	Abuja	Unspecified	51
24	Wahab & Lawal, 2011	✓	✓		✓					✓	Lagos	Arch; Builders; Engr; QS	75
25	Oyewobi & Ogunsemi, 2010	✓			✓					✓	Niger	Unspecified	Unspecified
26	Oladiran, 2009	✓				✓		✓	✓	✓	Unspecified	Unspecified	Unspecified
27	Oladiran, 2008	✓				✓		✓	✓	✓	Lagos	Contractors; Consultants; Client; PD	46
28	Dania *et al*., 2007	✓				✓				✓	Kaduna, Lagos; Abuja	Arch; Builders; Engr; QS	62
29	Wokekoro, 2007	✓				✓				✓	Rivers	ESA; Site mangers; Contractors; ESV; Arch, Civil Engineers	Unspecified
30	Akinkurolere & Franklin, 2005	✓			✓					✓	Ekiti; Lagos; Ogun; Ondo; Osun; Oyo	Arch; Builders; Engr; QS Contractors	71

Note: **PM**=Project manager; **QS**=Quantity surveyor; **STO**=Senior technical officer; **UP**=Urban planner; **CEO**=Chief executive officer; **PD**=Property developers; **CO**=Construction operatives; **ESA**=Environmental sanitation authority; **ESV**=Estate surveyors and valuers; **Arch**=Architects; **CE**=Civil Engineers; **SC**=Sub-Contractors; **FM**= Facility manager; **MC**= Main contractors; **SK**= Store keepers; **Quest**=Questionnaire; **Inter**=Interview

4. UNDERLYING CAUSES OF CW IN NIGERIA

4.1. Project stage

From Table 1, in the project stage column, previous studies have mainly focused on the causes of waste at the construction stage compared to the design and procurement stages. Sixteen articles investigated the causes of waste in the construction stage. Three articles integrated procurement and construction. One study investigated only procurement, while seven considered all three stages. The construction stage has drawn more research attention compared to the design and procurement stages. This finding is consistent with Lu and Yuan (2011), who reported that the construction stage had received significant attention among researchers. This could be as a result of tangible waste being generated at this stage, which can be quantified easily. According to Arijeloye and Akinradewo (2016), lack of proper work planning and scheduling, inadequate cash flow to contractors due to delayed payments, burglary, theft and vandalism are the key causes of waste generation in the construction stage in Ondo state.

4.2. Design stage

Table 2 shows that late design changes are the underlying factor of waste in the industry, with the highest frequency (12.0) of all the factors. Eze *et al.* (2017) demonstrated that late design changes, coupled with faulty design, tend to produce significant waste in Abuja. While the design stage offers the most significant opportunity for waste minimisation (Osmani et al., 2008), late design changes impede the achievement of zero waste in projects. This underlying cause resonates with many studies investigating the origin of waste in the design stage (Baldwin *et al.,* 2009; Han *et al.,* 2012; Wang *et al.,* 2014). Late design changes usually lead to reactive measures in the construction stage when waste occurs due to rework (Han *et al.,* 2013).

4.3. Procurement stage

Lack of prioritisation of a procurement process can lead to waste of materials in construction projects (Ajayi *et al.,* 2017). Table 2 shows that the underlying cause of waste generation in the procurement stage is the purchase of substandard materials, with a frequency of 5.0. The findings of Ogunmakinde (2019) suggest substandard materials are a leading factor of waste generation in Nigerian construction projects. Inferior materials could result in waste (Huang *et al.,* 2013; Low *et al.,* 2014) due to breakages during installation; in a worse scenario, they can result in structural failure during construction. For instance, load-bearing materials may have difficulties withstanding shear loads acting on structures with a potential risk of building failure. Additionally, the potential aftermath of inferior materials in buildings includes frequent renovation and maintenance.

4.4. Construction stage

While ineffective design and procurement processes can result in waste of materials in construction projects, waste becomes tangible in the construction stage. Table 2 shows that inadequate supervision is the leading waste factor in the construction stage, with a frequency of 9.0. This finding supports the studies by Durdyev and Mbachu (2011) and Nagapan *et al.* (2012a) that suggest inadequate supervision as a key contributory factor of waste in construction sites. According to Oko and Emmanuel (2013), Nigerian construction professionals believe poor supervision of site employees is a leading cause of waste generation in the industry. Waste can occur when site employees cannot work efficiently without adequate supervision due to lack of experience, training, negligence or poor incentive to support waste management (Teo and Loosemore, 2001). Ineffective supervision can

result in non-productivity of labour, thereby making waste generation inevitable in project sites. Adequate supervision requires the checking and approval of all works by a supervisor. Inadequate supervision is related to lack of top management support. According to Teo and Loosemore (2001) site employees do not prioritise waste minimisation where top managers show a lack of concern. Therefore, it is expected that top managers should pay more attention to issues of waste in projects, particularly in the area of supervision.

Table 2: Design, procurement and CW factors in Nigeria

No	Causes of Waste in the Design Stage	Reference (Refer to table 1)	Index
1	Late design changes	[2]; [7]; [13]; [16]; [19]; [1]; [21]; [22]; [26]; [27]; [20]; [10]	12.0
2	Error in material specification	[19]; [27]; [16]; [10]; [17]; [18]	6.0
3	Misinterpretation of drawings	[18]; [26]	2.0

	Causes of Waste in the Procurement Stage	Reference (Refer to table 1)	Index
1	Purchase of substandard materials	[1]; [13]; [25]; [26]; [27]	5.0
2	Poor storage of materials	[7]; [10]; [21]; [22]	4.0
3	Transportation	[13]; [18]; [23]; [26]	4.0
4	Delay in material delivery	[2]; [22]	2.0
5	Loading and unloading of materials	[13]; [26]	2.0
6	Ordering error	[21]; [22]	2.0
7	Lack of possibility to order small quantity	[13]	1.0
9	Packaging materials	[26]	1.0
10	Unfamiliarity with alternative materials	[26]	1.0
11	Inaccurate quantity take-off	[17]	1.0
12	Poor schedule of materials procurement	[16]	1.0

	Causes of Waste in the Construction Stage	Reference (Refer to table 1)	Index
1	Inadequate site supervision	[1]; [8]; [15]; [20]; [21]; [22]; [26]; [27]; [28]	9.0
2	Unawareness of waste management practices	[8]; [13]; [15]; [18]; [25]; [26]; [27]; [30]	8.0
3	Poor material handling	[5]; [13]; [14]; [18]; [20]; [21]	6.0
4	Theft/Vandalism	[7]; [8]; [10]; [12]; [21]; [26]	6.0
5	Uneconomical shape	[16]; [19]; [23]; [26]	4.0
6	Rework	[18]; [20]; [21]	3.0
7	Increment weather	[2]; [18]; [21]	3.0
8	Absence of policy	[11]; [28]	2.0
9	Inadequate reuse of materials	[24]; [26]	2.0
10	Inadequate recycling of materials	[24]; [26]	2.0
12	Inadequate planning	[10]; [24]	2.0
13	Faulty equipment	[18]	1.0
14	Lack of waste segregation	[24]	1.0
15	Poorly designed formwork	[6]	1.0
16	Poor site condition	[26]	1.0
17	Setting out errors	[26]	1.0
18	Under pressure for timely delivery of projects	[2]	1.0
19	Lack of proper work planning and scheduling	[12]	1.0
20	Building failure/defects	[26]	1.0
21	Lack of material waste documentation	[3]	1.0
22	Unclear instruction to workers	[4]	1.0

5. CONCLUSIONS

The causes of CW generation have attracted significant research attention and focus across the world. However, studies investigating the causes of CW in the Nigerian context are limited. Only 30 publications on the topic were found in various databases between 2005 and 2019. Numerous articles were published in 2017 compared to all the other years included in the review. A sizeable number of articles are published in journals. Abuja was found to be the city with the highest number of publications linked to the research field. While the mixed method can provide more robust research findings, the previous studies mostly ignore its application. Compared to many factors that can result in a waste of materials in construction projects, this study found that late design changes, purchase of

substandard materials and inadequate supervision are the underlying causes of waste in the design, procurement and construction stages. However, while some scholars have provided recommendations to improve waste management, there is minimal mention of how these recommendations can be put into practice.

This study contributes to the advancement of knowledge on waste generation in the construction industry, particularly in Nigeria and the neighbouring nations of sub-Saharan Africa. Despite the comprehensive approach used, the 30 publications analysed in this study may not contain every individual article investigating the causes of CW in Nigeria. The sample does, however, represent indicative trends in the discipline area. The findings of this study will be particularly useful for future research on the topic. Researchers will benefit from understanding the trends of studies investigating the causes of CW and hence pay greater attention to those areas unexplored or less covered in previous studies. Therefore, the following future research directions are recommended.

5.1. Recommendations

Future research studies should focus on the following.

- Investigating the causes of waste and its impacts using modelling and simulation techniques to understand the dynamic nature of waste generation and potential minimisation solutions.
- Investigating the causes of CW in the states/cities not found in the research sample.
- Providing supplementary physical quantification of CW is needed to record the quantities at the end of a project for potential prevention and statistics purposes.
- Paying considerable attention to the life-cycle concept of waste generation in the future for a more comprehensive understanding of waste generation in projects.
- Preventing the causes of material waste early in projects can improve the construction industry productivity.
- Finding minimisation measures to improve waste management practices of the Nigerian construction industry. Such measures should include a framework to prioritise waste minimisation strategies, a study on waste behaviour of site employees and policies for effective design, procurement and site operations.

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