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# A post-contract project analysis of material waste and cost overrun on construction sites in Abuja, Nigeria

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## Abstract

Material waste and cost overrun have been identified as common problems in the construction industry. These problems occur at both pre- and post-contract stages of a construction project. As a result of a dearth of empirical research and low level of awareness, the majority of managers of construction projects in Nigeria pay hardly any attention to material waste issues that affect cost overrun. This article examines the material waste issues that affect cost overruns at the post-contract stage of building projects.

The study covers building construction projects in Abuja, Nigeria. In-depth interviews were conducted with professionals using purposive sampling technique. It is purposive, because only building professionals handling projects that are worth over eight million USD are consulted/interviewed. The professionals included 15 project managers, nine quantity surveyors, five site engineers and one senior technical officer of a waste management department/unit. The interviews were on issues relating to material waste and cost overruns at the post-contract stage of a project. The collected data were analysed manually, using the deductive approach. This involves constant comparative analysis of the data to generate common patterns on material waste and cost overrun.

The research found that poor quality-of-procurement management, construction management, and site management would cause material waste, which contributes to project cost overruns. A good-quality procurement management entails procuring the appropriate materials, at the right time and in accordance with specifications. Rework, site accidents, inadequate site security/fencing, poor site organisation and discipline,

construction-site disputes, lack of experience, and lack of co-ordination among the parties all contribute to material waste and cost overruns.

It can be concluded that proper attention to material waste issues has the potential to minimise the rate of cost overrun at the post-contract stage of a project. It is recommended that careful attention should be paid to the issues identified in this study, as they would help reduce the rate of material waste and cost overrun for projects.

**Keywords:** Cost overrun, construction industry, material waste, post-contract stage

## Abstrak

Materiaalafval en koste-oorskryding word geïdentifiseer as algemene probleme in die konstruksiebedryf. Hierdie probleme vind plaas in beide voor- en na-kontrakstadiums van 'n konstruksieprojek. As gevolg van 'n gebrek aan empiriese navorsing en lae vlak van bewustheid, gee die meeste bestuurders van konstruksieprojekte in Nigerië min aandag aan materiaalafvalkwessies wat koste-oorskryding beïnvloed. Hierdie artikel ondersoek die materiaalafvalkwessies wat koste-oorskryding in die na-kontrakstadium van bouprojekte beïnvloed.

Die studie dek boukonstruksieprojekte in Abuja, Nigerië. In-diepte onderhoude met professionele persone is gehou met behulp van doelgerigte steekproefnemingstegnieke. Dit is doelgerig omdat slegs professionele persone wat projekte hanteer wat meer as agt miljoen dollar werd is, geraadpleeg/ondervra is. Die professionele persone het 15 projekbestuurders, nege bourekenaars, vyf terreiningenieurs en een senior tegniese beampte van 'n afvalbestuursafdeling/-eenheid ingesluit. Die onderhoude het gegaan oor die kwessies wat verband hou met wesenlike afval en koste-oorskryding by die na-kontrakstadium van 'n projek. Die versamelde data is geanaliseer deur die deduktiewe benadering te gebruik. Dit behels konstante vergelykende analise van die data om algemene patrone op materiaalafval en koste-oorskryding te genereer.

Die navorsing het bevind dat swak gehalte-van-verkrygingsbestuur, konstruksiebestuur en terreinbestuur materiaalafval tot gevolg sal hê, wat bydra tot die koste van die projekkoste. Goeie gehalte-verkrygingsbestuur behels die verkryging van toepaslike materiale, op die regte tyd en in ooreenstemming met spesifikasies. Herstelwerk, terreinongelukke, onvoldoende terreinbeveiliging/heining, swak terreinorganisasie en dissipline, geskilpunte op die bouplek, gebrek aan ondervinding en gebrek aan koördinasie tussen partye dra alles by tot materiaalafval en koste-oorskryding.

Daar kan tot die gevolgtrekking gekom word dat behoorlike aandag aan materiaalafvalkwessies die potensiaal het om die koers van koste-oorskryding in die na-kontrakstadium van 'n projek te verminder. Daar word aanbeveel dat deeglik aandag gegee word aan die probleme wat in hierdie studie geïdentifiseer word, aangesien hulle sal help om die hoeveelheid afval en die koste-oorskryding vir projekte te verminder.

**Slutelwoorde:** Oorskryding van kostes, konstruksiebedryf, materiaalafval, na-kontrakstadium

## 1. Introduction

The construction industry, which plays a leading role in improving the quality of the built environment, is faced with the problems of waste, time overrun and cost overrun (Osmani, Glass & Price, 2008: 1147; Saidu & Shakantu, 2016a: 124). Material waste has become a serious problem and requires urgent attention in the construction industry (Adewuyi & Otali, 2013: 746). The majority of this waste has not been well managed, thus causing health and environmental problems (Imam, Mohammed, Wilson & Cheeseman, 2008: 469) and affecting the performance of many projects (Ameh & Itodo, 2013: 746; Saidu & Shakantu, 2016b: 555). Several authors reporting on the situation have disclosed the problem of material waste. For instance, 10%-15% of materials delivered to construction sites in the United Kingdom (UK) end up as waste (Osmani, 2011: 209; Saidu, 2016: 12). The United States (US) generates 164m tonnes of construction waste annually, representing 30%-40% of the country's municipal solid waste (Osmani, 2011: 209). In Malaysia, 28.34% of the total waste sent to landfills originates from construction activities (Begum, Siwar, Pereira & Jaafar, 2007: 190). For every 100 houses built in Nigeria, there is adequate waste material to build another 10 houses (Ameh & Itodo, 2013: 748).

Cost overrun is a global problem which makes it difficult for many construction projects to be completed within budget (Ameh & Itodo, 2013: 748; Memon, Abdul-Rahman, Zainun & Abd-Karim, 2013). Of construction project owners in the UK, 33.3% are faced with the problems of cost overrun (Abdul-Rahman, Memon & Abd. Karim 2013: 268). Flyvbjerg, Holm & Buhl (2004: 6) conducted a global study on cost overruns and concluded that cost overruns were found across 20 nations and five continents of the world, thus affecting 90% of completed projects in the world (Saidu & Shakantu, 2015: 95). The argument on how to totally remove cost overruns from projects has been on-going among the built environment professionals for the past seventy years (Apolot, Alinaitwe & Tindiwensi, 2013: 33).

Relating material waste to cost overrun, Ameh & Itodo (2013: 748) believe that building material wastage on construction sites accounts for cost overruns. For instance, material waste accounts for an additional 15% of project-cost overruns in the UK; 11% in Hong Kong, and between 20% and 30% in The Netherlands. The majority of these findings were survey based. However, Saidu & Shakantu (2016c: 99) investigated the contributions of material waste to cost overruns in Abuja, Nigeria, using field measurement of onsite material waste and determination of amount of cost overrun for each project.

The research concluded that building material waste contributes to approximately 4% of cost overrun.

The problems of material waste and cost overrun are occasioned by several causes at the pre- and post-contract stages of projects. The identification of these causes at these stages and the application of relevant control measures to minimise their occurrence is a step towards alleviating the consequences (Mou, 2008: 20; Oladiran, 2009: 2; Nagapan, Abdul-Rahman, Asmi & Hameed, 2012: 23; Saidu & Shakantu, 2015: 96).

This research addresses the problem of hardly any attention being paid by the majority of managers of construction projects to the effects of material waste on cost overruns. Many studies have been conducted in this field. For instance, Tam, Shen & Tam (2007: 1471) assessed the levels of material wastage affected by sub-contracting relationships and projects types with their correlations on construction site; Ameh & Itodo (2013: 748) assessed professionals' views of material wastage on construction sites and cost overruns. The study adopted a survey (questionnaire) research approach. Saidu & Shakantu (2015: 96) examined the relationship between quality of estimating, construction material waste generation and cost overruns in Abuja, Nigeria; Saidu & Shakantu (2016a: 124) examined the relationship between material waste and cost overrun in the construction industry using a thorough literature search and recommended further empirical investigations. Saidu & Shakantu (2016b: 555) developed a framework and an equation for managing construction-material waste and cost overruns but these are not empirically inclined. There is need for a research that provides an unprejudiced assessment of the material waste issues that have effects on cost overruns at the post-contract stage of a building project. Hence, this research examines the material waste issues that have effects on cost overruns at the post-contract stage of building projects by determining the material waste issues that relate to cost overruns at: a) the procurement stage of a project; (b) the site management stage of a project, and (c) the construction management stage of a project.

## **2. Literature review**

It is important to note that Figure 1 is not all about construction waste, but that it attempts to show the root cause of 'material waste' and 'cost overrun' from construction waste. Moreover, Tables 1, 2 and 3 contain information about material waste that relates to cost overrun and not only construction waste. Therefore, information about material waste dominated the entire literature review.

## 2.1 Material waste and cost overrun

Construction waste is a global challenge facing construction practitioners. It can have a significant impact on time, cost, quality and sustainability, as well as the success of projects (Nagapan *et al.*, 2012: 22). It is the difference between purchase and actual use (Al-Hajj & Hamani, 2011: 2). Construction waste has been described as any constituent generated, as a result of construction work, and abandoned, whether or not it has been processed or stocked up before being abandoned (Yuan, Lu & Hao, 2013: 484; Hussain, Abdul Rahman & Memon, 2013: 32).

Cost is considered one of the most significant issues and a driving force of project success. It has been regarded as a major concern throughout the project management life cycle. In spite of its recognised significance, it is common for a construction project to fail to achieve its goals within the budget. Cost overrun, according to Azhar, Farooqui & Ahmed (2008: 499), is simply an occurrence, where the final or actual cost of a project surpasses the original or initial estimates. Therefore, cost overrun is a very common issue that affects most of the projects in the construction industry (Azhar *et al.*, 2008: 499), while waste can have a significant effect on the success of a construction project, since it specifically has a major impact on the construction costs (Nagapan, Abdul-Rahman, Asmi & Hameed 2012: 22).

In Nigeria, the lowest average reported percentage of cost overrun on a project was 14% (Hussain *et al.*, 2013: 32; Ameh, Soyngbe & Odusanmi, 2010: 49). This problem, according to Ogunsemi & Jagboro (2006: 257), is attributed to a wrong cost-estimation method adopted at the early stage of building projects.

Ameh & Itodo (2013: 749) assert that material wastage on site leads to an increase in the final cost of the building project. As materials are wasted, more are procured, thus affecting the estimated cost (Teo, Abdelnaser & Abdul, 2009: 257). Ameh and Itodo (2013:754) highlighted that wastages from the following materials contribute to the total project cost: concrete 4%; blockwork 10%; waste from screeding and plastering 15%; packaging 5%, and formwork is based on the number of times it is re-used. Furthermore, research evidence has shown (see Tables 1, 2 and 3) that the main factors causing construction material waste are similar to those causing construction-cost overruns on site; hence, Nagapan, Abdul-Rahman & Asmi (2012: 2-3) (see Figure 1) categorised cost overruns and time overruns as part of non-physical waste, and other material waste as physical waste on a construction site. This shows that cost overruns, time overruns

and construction material waste are generally categorised as waste. This is supported by Ma (2011: 118) who defines waste as anything that does not add value. Therefore, cost overruns, material waste and material waste that may be lost to landfills do not add value to projects. Therefore, Nagapan, Abdul-Rahman & Asmi (2012: 2-3) assert that construction waste is not all about the quantities of materials that are wasted, but that it is also focused on factors such as overproduction, waiting time, material handling, inventories, and the unnecessary movement of workers that constitute a significant part of non-physical waste, to which the construction industry always pays the least attention.

It is clear from Figure 1 that, since construction waste entails both the physical and the non-physical waste, there is, therefore, a relationship between cost overrun emanating from the non-physical waste and material waste from the physical waste, as they both originate from the same waste family (Saidu & Shakantu, 2015: 97).

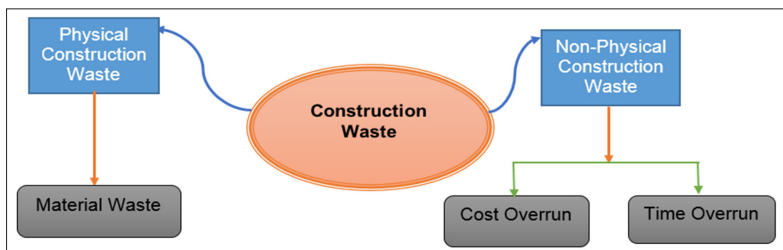


Figure 1: Classification of construction waste

Adapted from: Nagapan, Abdul-Rahman & Asmi, 2012: 2

Furthermore, the causes of material waste and those of cost overruns identified from the literature are similar. These causes occur as a result of one, or a combination of several causes at different stages of a project (the pre- and the post-contract stages), and they are crucial in identifying effective cost performance and sustainable construction (Saidu, 2016: 61).

## 2.2 Material waste and cost overrun at the post-contract stage of projects

The causes of material waste and cost overruns at the post-contract stage of projects are identified in three major phases, namely the quality-of-procurement management, the quality-of-construction management, and the quality-of-site management. Tables 1, 2 and 3 present the results of different studies on the causes of material

waste and those of cost overruns at these three phases of the post-contract stage. In all three tables, columns 2-3 are combined under the heading “material waste”, while columns 4-5 are combined under the heading “cost overrun”. These columns depict that each material waste cause listed in column 1 was identified and linked under a source and the location/country in columns 2-3 as well as in columns 4-5.

### 2.2.1 Procurement management phase

Table 1 lists the causes of material waste related to the causes of cost overruns with respect to the procurement management phase of a building construction project.

Table 1: The material waste causes that are similar to those of cost overruns with respect to quality-of-procurement management

<i>Causes of material waste related to the causes of cost overruns with respect to the procurement management phase of a project</i>	<i>Material waste</i>		<i>Cost overruns</i>	
	<i>Author and date</i>	<i>Location</i>	<i>Author and date</i>	<i>Location</i>
<i>Procurement and transportation</i>				
Errors/mistakes in material ordering/ procurement	Nagapan, Abdul-Rahman, Asmi & Hameed (2012: 23)	Malaysia	Allahaim & Liu (2012: 5-6)	Saudi Arabia
Procuring items not in compliance with specification	Adewuyi & Otali (2013: 748); Osmani <i>et al.</i> (2008: 23)	Rivers, Nigeria; UK	Allahaim & Liu (2012: 5-6)	Saudi Arabia
Errors in shipping/ supply	Osmani <i>et al.</i> (2008: 1149); Nagapan <i>et al.</i> (2012: 23)	UK; Malasia	Nega (2008: 48)	Ethiopia

Causes of material waste related to the causes of cost overruns with respect to the procurement management phase of a project	Material waste		Cost overruns	
	Author and date	Location	Author and date	Location
Mistakes in quantity surveys: Poor estimate for procurement (over-procuring)	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Aziz (2013: 57); Allahaim & Liu (2012: 5-6)	Egypt; Saudi Arabia
Wrong material delivery procedures	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Aziz (2013: 57)	Egypt
Delivery of substandard materials	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Nega (2008: 48)	Ethiopia
Damage of material during transportation	Osmani <i>et al.</i> (2008: 1149)	UK	Nega (2008: 48)	Ethiopia
Late delivery/ Inadequate delivery schedule	Nguyen, Gupta & Faniran (nd: 6)	Geelong, Australia	Al-Najjar (2008: 51); Abdul Rahman, Memon & Abd. Karim (2013: 1965)	Gaza Strip; Malaysia
Poor material handling	Osmani <i>et al.</i> (2008: 1149); Nagapan <i>et al.</i> (2012: 23)	UK; Malaysia	Ameh, Soyngbe & Odusanmi (2010: 61-62)	Nigeria
Poor protection of materials and damage during transportation	Osmani <i>et al.</i> (2008: 1149); Aiyetan & Smallwood (2013: 1168)	UK; Lagos, Nigeria	Nega (2008)	Ethiopia
Over-allowance (difficulties in ordering less)	Osmani <i>et al.</i> (2008: 1149); Nagapan <i>et al.</i> (2012: 23)	UK; Malaysia	Allahaim & Liu (2012: 5-6)	Saudi Arabia



<i>Causes of material waste related to the causes of cost overruns with respect to the procurement management phase of a project</i>	<i>Material waste</i>		<i>Cost overruns</i>	
	<i>Author and date</i>	<i>Location</i>	<i>Author and date</i>	<i>Location</i>
Frequent variation orders	Nguyen <i>et al.</i> (nd: 6)	Geelong, Australia	Aziz (2013: 57); Baloyi & Bekker (2011: 55)	Egypt; South Africa
Poor product knowledge	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Jackson (2002: 4)	Reading
Difficulties of vehicles in accessing site	Osmani <i>et al.</i> (2008: 1149); Nagapan <i>et al.</i> (2012: 23)	UK; Batu, Malaysia	Allahaim & Liu (2012: 5-6); Zewdu & Aregaw (2015: 185)	Saudi Arabia; Ethiopia
<i>Manufacturers</i>				
Poor quality of materials	Adewuyi & Otali (2013: 748)	Nigeria	Ameh <i>et al.</i> (2010: 61-62)	Nigeria
Non-standard sizes of materials	Osmani (2011)	UK	Le-Hoai, Lee & Lee (2008: 370)	Vietnam
Poor product information	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Allahaim & Liu (2012: 5-6)	Saudi Arabia
Lack of awareness	Al-Hajj & Hamani (2011: 221)	UAE	Ameh <i>et al.</i> (2010: 61-62)	Nigeria
<i>Suppliers</i>				
Poor supply chain management	Al-Hajj & Hamani (2011: 221)	UAE	Ameh <i>et al.</i> (2010: 61-62)	Nigeria
Supplier errors	Odusami, Oladiran & Ibrahim (2012: 63)	Nigeria	Nega (2008: 48)	Ethiopia
Poor product incentive	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Allahaim & Liu (2012: 5-6)	Saudi Arabia

Causes of material waste related to the causes of cost overruns with respect to the procurement management phase of a project	Material waste		Cost overruns	
	Author and date	Location	Author and date	Location
Poor handling of supplied materials	Osmani <i>et al.</i> (2008: 1149); Ameh & Itodo (2013: 753)	UK; Nigeria	Ameh & Itodo (2013: 753)	Nigeria
Poor methods of unloading materials supplied in loose form	Adeyuyi & Otali (2013: 748)	Nigeria	Nega (2008: 48)	Ethiopia

### 2.2.2 Construction management phase

Table 2 lists the causes of material waste related to the causes of cost overruns with respect to the construction management phase of a building project.

Table 2: The relationship between the causes of material waste and cost overruns with respect to the quality of construction management

Causes of material waste related to the causes of cost overruns with respect to the construction management phase of a project	Material waste		Cost overruns	
	Author and date	Location	Author and date	Location
<b>Contractors</b>				
Incorrect scheduling and planning	Osmani <i>et al.</i> (2008: 1149)	UK	Abdul Rahman <i>et al.</i> (2013: 1965)	Malaysia;
Inappropriate contractor's policies	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Aziz (2013: 57)	Egypt
Lack of awareness	Al-Hajj & Hamani (2011: 221-228)	UAE	Aziz (2013: 57)	Egypt

<i>Causes of material waste related to the causes of cost overruns with respect to the construction management phase of a project</i>	<i>Material waste</i>		<i>Cost overruns</i>	
	<i>Author and date</i>	<i>Location</i>	<i>Author and date</i>	<i>Location</i>
Lack of experience	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Abdul Rahman <i>et al.</i> (2013: 1965); Ameh <i>et al.</i> (2010: 62)	Malaysia; Nigeria
Poor site management and supervision	Nagapan <i>et al.</i> (2012: 23); Ameh & Itodo (2013: 753)	Malaysia; Nigeria	Le-Hoai <i>et al.</i> (2008: 370); Allahaim & Liu (2012: 6)	Vietnam; Saudi Arabia
Poor building techniques	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Aziz (2013: 57)	Egypt
Incompetent subcontractor/supplier	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Ameh <i>et al.</i> (2010: 61-62)	Nigeria
Poor financial controls on site	Al-Hajj & Hamani (2011: 221)	UAE	Shanmugapriya & Subramanian (2013: 737-738)	India
Use of unskilled labour to replace skilled ones	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Memon <i>et al.</i> (2013: 10)	Malaysia
<i>Culture</i>				
Lack of incentive	Al-Hajj & Hamani (2011: 221)	UAE	Memon <i>et al.</i> (2013: 10)	Malaysia
Lack of training and development	Al-Hajj & Hamani (2011: 221); Adewuyi & Otdali (2013: 748)	UAE; Nigeria	Olawole & Sun (2010: 522)	UK
Lack of support from senior management	Al-Hajj & Hamani (2011: 221)	UAE	Aziz (2013: 57); Allahaim & Liu (2012: 5-6)	Egypt; Saudi Arabia
Lack of awareness among practitioners on waste management	Al-Hajj & Hamani (2011: 222)	UAE	Ameh <i>et al.</i> (2010: 62)	Nigeria

Causes of material waste related to the causes of cost overruns with respect to the construction management phase of a project	Material waste		Cost overruns	
	Author and date	Location	Author and date	Location
<b>Workers</b>				
Workers' mistakes or errors during construction	Al-Hajj & Hamani (2011: 226)	UAE	Shanmugapriya & Subramanian (2013: 737-738)	India
Incompetent workers	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Aziz (2013: 57); Olawole & Sun (2008: 522)	Egypt; UK
Poor workers' attitude	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Aziz (2013: 57)	Egypt
Lack of experienced workers	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Shanmugapriya & Subramanian (2013: 737); Love, Edward & Irani (2011)	India; UK
Shortage of skilled workers	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Abdul Rahman <i>et al.</i> (2013: 1965); Olawole & Sun (2010: 522)	Malaysia; India; UK
Inappropriate use of materials and equipment	Wahab & Lawal (2011: 252)	Nigeria	Allahaim & Liu (2012: 5-6)	Saudi Arabia
Poor workmanship	Odusami <i>et al.</i> (2012: 63) Aiyetan & Smallwood (2013: 1168)	Nigeria; Lagos, Nigeria	Nega (2008: 48)	Ethiopia
Damage caused by workers	Nagapan <i>et al.</i> (2012: 23); Al-Hajj & Hamani (2011: 221)	Malaysia; UAE	Allahaim & Liu (2012: 5-6)	Saudi Arabia

### 2.2.3 Site management phase

Table 3 lists the causes of material waste related to the causes of cost overruns with respect to the site management phase of a building construction project.

Table 3: The relationship between the causes of material waste and cost overruns with respect to quality of site management

Causes of material waste related to causes of cost overruns with respect to site management phase of a project	Material waste		Cost overruns	
	Author and date	Location	Author and date	Location
Wrong material/ equipment storage/stacking	Nagapan <i>et al.</i> (2013: 23)	Malaysia	Ubani, Okorochoa & Emeribe (2011: 76)	Nigeria
Transfer of materials from storage to application	Osmani <i>et al.</i> (2008: 1149)	UK	Ubani <i>et al.</i> (2011: 76)	Nigeria
Damage of materials by other trades	Aiyetan & Smallwood (2013: 1168)	Lagos, Nigeria	Jackson (2002: 4)	Reading
Poor site storage area	Osmani <i>et al.</i> (2008: 1149); Odusami <i>et al.</i> (2012: 63)	UK; Nigeria	Jackson (2002: 4)	Reading
Long distance from storage to application point	Osmani <i>et al.</i> (2008: 1149)	UK		
Damage by weather	Osmani <i>et al.</i> (2008: 1149); Wahab & Lawal (2011: 252)	UK; Nigeria	Allahaim & Liu (2012: 6); Memon <i>et al.</i> (2013: 10)	Saudi Arabia; Malaysia
<b>Security</b>				
Inadequate site security/Fencing	Nguyen <i>et al.</i> (nd)	Geelong, Australia	Allahaim & Liu (2012: 5-6)	Saudi Arabia
Theft	Osmani <i>et al.</i> (2013: 1149)	UK; Nigeria	Allahaim & Liu (2012: 5-6)	Saudi Arabia
Vandalism, sabotage pilferage, and material damage	Osman <i>et al.</i> (2008: 1149); Ameh & Itodo (2013: 753)	UK; Nigeria	Allahaim & Liu (2012: 5-6)	Saudi Arabia
Power and lighting problems on site	Nguye <i>et al.</i> (nd: 6)	Geelong, Australia	Allahaim & Liu (2012: 5-6)	Saudi Arabia

Causes of material waste related to causes of cost overruns with respect to site management phase of a project	Material waste		Cost overruns	
	Author and date	Location	Author and date	Location
<i>Site conditions</i>				
Poor site management	Odusami <i>et al.</i> (2012: 63)	Nigeria	Abdul Rahman <i>et al.</i> (2013: 288)	Malaysia
Poor site and unforeseen ground conditions	Wahab & Lawal (2011: 252); Aietan & Smallwood (2013: 1168)	Nigeria; Lagos, Nigeria	Aziz (2013: 57); Allahaim & Liu (2012: 5-6)	Egypt; Saudi Arabia
Leftover materials on site	Osmani (2011: 38)	UK	Ubani <i>et al.</i> (2011: 76)	Nigeria
Waste resulting from packaging	Osmani (2011: 38)	UK	Allahaim & Liu (2012: 5-6)	Saudi Arabia
Lack of environmental awareness	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Ubani <i>et al.</i> (2011: 76)	Nigeria
Difficulties in accessing construction site	Nagapan <i>et al.</i> (2012: 23)	Malaysia	Allahaim & Liu (2012: 5-6)	Saudi Arabia
Site congestion and Interference of other crews	Osmani (2011: 38)	UK	Le-Hoai <i>et al.</i> (2008: 370)	Vietnam
Inadequate site investigation	Osmani <i>et al.</i> (2008: 1149)	UK	Shanmugapriya & Subramanian (2013: 737-738)	India
Disputes on site	Adewuyi & Otali (2013: 748)	Nigeria	Allahaim & Liu (2012: 5-6)	Saudi Arabia
Extra materials ordered are discarded instead of carrying over to next site	Oladiran (2009: 2)	Nigeria	Allahaim & Liu (2012: 5-6)	Saudi Arabia
Equipment failure on site	Adewumi & Otali (2013: 748)	Nigeria	Shanmugapriya & Subramanian (2013: 737-738)	India

Causes of material waste related to causes of cost overruns with respect to site management phase of a project	Material waste		Cost overruns	
	Author and date	Location	Author and date	Location
Rework	Al-Hajj & Hamani (2011: 225); Adewuyi & Otali (2013: 748); Oladiran (2009: 2); Ameh & Itodo (2013: 753)	UAE; Rivers, Nigeria; Nigeria; Nigeria	Shanmugapriya & Subramanian (2013: 737-738); Le-Hoai <i>et al.</i> (2008: 370)	India; Vietnam
Site accidents	Odujami <i>et al.</i> (2012: 63)	Nigeria	Allahaim & Liu (2012: 5-6); Le-Hoai <i>et al.</i> (2008: 370)	Saudi Arabia; Vietnam
Lack of communication	Wahab & Lawal (2011: 252)	Nigeria	Abdul Rahman <i>et al.</i> (2013: 1965)	Malaysia

### 3. Research methodology

Although the research analysis was done using a deductive approach, the research method applied for this research was inductive reasoning. This is a reasoning strategy that intends to learn about the phenomena under investigation by applying a less structured methodology in order to obtain richer and more detailed information (Sutrisna, 2009: 9). To achieve this, a qualitative research method that is rooted in the phenomenological research paradigm was applied. This helped the researchers study the attitudes and behaviours of the research subjects within their natural settings (Babbie & Mouton, 2010: 51). This qualitative method involves analysing words; it refers to issues relating to people, objects and situations, and it focuses on naturally occurring, ordinary events in their natural settings (Farrell, 2011: 6). This enables the researchers to examine the material waste issues that affect cost overruns at the post-contract stage of a construction project. Based on the research problem advanced in this study, for instance, the majority of managers of construction projects pay hardly any attention to the effects of material waste on project cost overrun. This has prompted

the researchers to apply the qualitative method, in order to identify and examine these issues.

The study population consists of building construction projects in Abuja, the Federal Capital Territory of Nigeria. Abuja was selected because it is one of the metropolitan cities of Nigeria with the highest population of professionals in the built environment and with many ongoing construction projects.

### **3.1 Sampling method**

The sampling method was purposive/judgmental, because only building-construction professionals handling projects that are worth 1.6 billion Naira/eight million USD and above were consulted/interviewed. Unlike projects of lesser value, those worth eight million USD and above are categorised as big projects that are likely to be handled by more experienced professionals, who might be more familiar with the issues leading to material waste and cost overruns (Saidu & Shakantu, 2016c: 104). Through purposive sampling, the research targeted the most visible and experienced leaders.

### **3.2 Sample size**

Leedy & Ormrod (2014: 220) believe that the size of a purposive sampling technique for a phenomenological research ranges between five and 25 participants. For this research, semi-structured, in-depth interviews were conducted with 30 construction professionals, comprising 15 project managers, nine quantity surveyors, five site engineers and one senior technical officer of a waste-management department on the issues that relate to material waste and cost overruns at the post-contract stage of a construction project.

### **3.3 Data collection**

The research instrument (interview guide) enabled the researchers to be consistent with the questions posed to the respondents. It also enabled the collection of data based on the perception of the construction professionals in Abuja with regard to the issues that link material waste to cost overruns in the construction industry. Twelve questions based on the objectives of this research were generated. The interview guide was structured in three major groups, namely quality of procurement management, quality of construction management and quality of site management (see Appendix). Probing questions were asked during discussion with the interviewees, in order to obtain further information. An average of 35 minutes was spent in conducting each interview. The interviews



were conducted between December 2014 and March 2015. The approximate conversion rates as at November 2014 were Nigerian Naira to US dollar = ₦200 = 1USD. All 30 respondents identified in this research through the purposive sampling method responded to all the questions presented for discussion.

### **3.4 Data analysis**

The recorded, transcribed and interpreted interview data were analysed, using the 'deductive approach'. The application of the 'deductive analysis' of data in qualitative research enabled the researchers to extensively condense raw data into a brief and summary format, and to establish clear links between the research purpose and the summary findings derived from the raw data (Dey, 2005: 55).

The data in this analysis was done manually after each respondent's views were coded and similar views were brought together under a theme/heading. This method involves constant comparative analysis of the data after it has been sorted and coded to generate knowledge about any common pattern in the interviewees' evidence on material waste and cost overrun. The analysis began by comparing the opinions of the first two interviewees. The process continued with a comparison of the data from the comments and inputs from each new interviewee, until all the responses had been compared with each other. The similarities and differences between the interviewees' responses were used to develop a conceptualisation of the possible association between the various data items. The results are presented under subthemes under the following headings: quality of procurement management, quality of construction management, and quality of site management.

## **4. Results and discussion**

The results are the summary of the interviews conducted with the 30 respondents after linking the similarities together. These are the key issues realised from the interviews. They are not literatures, but qualitative results. For presentation and discussion purposes, a summary of the interview results is presented under the following headings/themes, which are in line with the set objectives of the research, namely quality of procurement management; quality of construction management, and quality of site management.

## **4.1 Quality of procurement management**

### **4.1.1 The quality of procurement management in the respondents' organisations**

The majority of organisations/firms procure materials strictly in accordance with project specifications; with an efficient and well-organised procurement management; they have the know-how of what to procure, what quantity to procure, at what cost to procure, and where to procure. Some companies have the knowledge of current material prices, both locally and internationally, while few lack such knowledge. Some have a network of procurement departments, both locally and internationally, in case the projects require foreign materials.

### **4.1.2 Contribution of materials procurement to waste-generation and cost overruns**

Procuring the appropriate materials, at the right time, in accordance with the specifications, and proper material handling and good product knowledge would reduce material waste and cost overruns. This result corroborates the findings of *Osmani et al.* (2008: 1147) and *Nagapan et al.* (2012: 22) who highlighted poor material handling as a cause of material waste, and *Ameh et al.* (2010: 49) who also noted the same issue as a cause of cost overrun.

### **4.1.3 Contributions of quality of firms' procurement management to material-waste generation and cost overruns**

A good quality-procurement management team should envisage better transportation of materials, order the appropriate quantity of materials, and provide easy access roads. Where these cannot be envisaged, waste would inevitably occur and contribute to cost overruns.

In the absence of a competent and experienced procurement management, a job would probably be given to an incompetent contractor, who might end up wasting materials, thus leading to cost overruns. Moreover, lack of quality control in procurement and adequate estimation for procurement, as stated in project specifications, may result in wastage of materials and contribute to cost overrun. This finding also supports the literature identified in section 2 of this study.

#### **4.1.4 Material waste causes on project cost-overrun with respect to quality of procurement management**

The following material-waste causes resulted in cost overruns at this stage: procuring items not in compliance with the specifications; engaging inexperienced personnel in estimation and procurement; procuring wrong quantity of materials; errors in shipping; damage of material during transportation, and lack of awareness. These results are in line with the causes of material waste that are similar to the causes of cost overrun identified in section 2 of this research study.

## **4.2 Quality of construction management**

### **4.2.1 Quality of construction management based on the respondent's experience**

Quality of construction management entails managing the entire construction process from inception to completion with all the necessary management tools. Some respondents believe that it is the practical way of achieving design reality through co-ordinating, controlling, organising, communicating, scheduling, motivating, proper building techniques, and good workmanship. Some respondents view construction management as the pillar of every construction work, which has to do with the management of people, plant, materials, equipment, money, time, and the entire construction process.

### **4.2.2 Relationship between the interviewee firms' construction management, material-waste generation and cost overruns**

The respondents were not fully satisfied with their organisations' approach to construction management. Some disclosed that their firms/organisations were operating far below the average level in terms of construction management; some at the average level, while some still have a very long way to go. The reason for this is that there are situations where projects are not delivered on time, and sometimes within the budgeted cost. However, very few were doing above average. These are experienced and always plan ahead; hence, they generate less waste and cost overruns.

### **4.2.3 Contribution of subcontractors and suppliers to material-waste generation and cost overruns**

Both the subcontractors and the suppliers contribute to material-waste generation and cost overruns. Subcontractors are profit-oriented individuals and the waste they generate directly affects

their profits. Most of the contract agreements require subcontractors to generate waste at their own risk, which makes them more careful about the amount of waste they generate.

For the suppliers, the quality control department evaluates the supplied product to ensure that they conform with the project's specification.

#### **4.2.4 Impact of rework and mistake/error on material-waste and cost overruns**

Inexperienced professionals/personnel or working contrary to project specification/contract lead to rework and mistakes/errors. An abortive work is already a waste, and it would require the same type of materials, the same labour, and the same costs to re-build. This result corroborates the findings of Aziz (2013: 52) who concluded that abortive works contribute to cost overruns.

#### **4.2.5 Material-waste causes that affect cost overruns with respect to quality-of-construction management**

The following material-waste causes affect project-cost overrun with respect to quality-of-construction management: engaging incompetent workers; rework; incorrect scheduling and planning; shortage of skilled workers; lack of experience; poor financial controls on site; poor staff workers' relationship; lack of awareness of waste management; lack of incentive, and the use of unskilled labour to replace skilled ones. These results corroborate the findings outlined in section 2 of this research.

### **4.3 Quality of site management**

#### **4.3.1 Respondents' understanding of site management and its contributions to material waste and cost overrun**

Site management is an aspect of construction management that deals with the planning, controlling, co-ordinating, communicating, motivating, scheduling, and organising of the entire activities on the site, including the 5Ms (men, machines, money, materials, and management) to achieve the desired project objectives; it involves site security, access road, minimisation of wasteful time, timely provision of materials, and site safety; it has to do with the management of the routine activities on site, and it includes a certain group of people that administer the day-to-day running of a site from inception to completion of a project. Therefore, site management contributes to material waste and cost overruns when

the management of the site issues is poor or not properly managed or addressed.

#### **4.3.2 Contributions of site security, site accident, and site disputes to material-waste generation and cost overruns**

Inadequate site security would lead to pilfering/thefts and damage/sabotage of materials on site. When the site is not properly organised and disciplined, accidents are bound to occur, and these might affect the workers, the structure, or even both.

#### **4.3.3 Material waste causes that affect cost overruns with respect to quality-of-site management**

The following material-waste causes affect cost overruns with respect to quality of site management stage: inadequate site security/fencing; poor site organisation and discipline; construction-site disputes; poor site management and the 5Ms; lack of experience; poor construction planning and control; lack of co-ordination among the parties; poor site storage area; communication problems and poor site supervision; problems relating to on-site health and safety; wrong location of cranes on site; inappropriate records of materials, and lack of environmental awareness. These results support the findings highlighted in section 2 of this study.

## **5. Conclusion and recommendations**

Material waste and cost overrun are common problems in the construction industry at both the pre- and post-contract stages of a construction project. As a result of a dearth of empirical research and a low level of awareness, the majority of managers of construction projects in Nigeria pay hardly any attention to material waste issues that affect cost overrun. This article examined the material waste issues that affect cost overruns at the post-contract stage of building projects.

The research concludes that both the literature and the empirical findings from the study have established a link between the issues on material waste and cost overruns at the post-contract stage of a project (procurement, construction management, and site management stages).

It is concluded that proper management of procurement, construction-management and site-management processes, as well as their related material waste causes would reduce the rate of cost overruns for projects.

Based on these, it is recommended that proper attention to material waste issues at the post-contract stage of any project has the potential to minimise the rate of cost overrun. Therefore, careful attention should be paid to the issues identified in this study, as they would assist in reducing the rate of material waste and cost overrun for a project. Construction professionals should be well informed of these issues at an early stage of a project, to enable them (professionals) to evaluate the extent to which their consequences could be minimised.

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**Appendix**

**AN INTERVIEW GUIDE**

**on**

**“A post-contract stage analysis of material waste and cost overrun on construction sites in Abuja, Nigeria”**

**SECTION A: (Preliminary questions)**

Name of the person being interviewed \_\_\_\_\_

Position \_\_\_\_\_

Name of the firm/organisation \_\_\_\_\_

Name of the project \_\_\_\_\_

Project location \_\_\_\_\_

Project value (₦) \_\_\_\_\_

Years of experience in the industry \_\_\_\_\_

Highest educational qualification \_\_\_\_\_

Please describe your role in the organisation \_\_\_\_\_

**SECTION B: (Main research objectives)**

**a) Quality of procurement management**

1. Can you tell me about the quality of procurement management in your organisation/industry?
2. Does the quality of materials procurement contribute to material waste-generation? What about cost overruns?
3. Does the quality of your firm's procurement management contribute to material-waste generation and cost overruns?
4. Based on your experience, what are the material waste causes that affect cost-overrun with respect to quality of procurement management?

**b) Quality of construction management**

1. Based on your experience, what is the quality of construction management?
2. How can you relate the quality of your firm/organisation's construction management to material waste generation and cost overrun
3. Do sub-contractors and suppliers in any way affect the material waste generation and cost overrun?
4. Does rework have any impact on the material waste generation and cost overrun? What about mistakes/errors?
5. What are the material waste causes that affect cost overruns with respect to the quality of construction management?

**c) Quality of site management**

1. What is your understanding of 'site management'? How does site management contribute to material waste and cost overrun?
2. How do the site security, site accident and site dispute affect material waste generation and cost overrun?
3. What are the material waste causes that affect cost overruns with respect to the quality of site management?