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DOI: <http://dx.doi.org/10.18820/24150487/as281.6>

ISSN: 1023-0564

e-ISSN: 2415-0487

Acta Structilia 2021 28(1): 142-167



Published by the UFS

<http://journals.ufs.ac.za/index.php/as>

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How to cite: Albert, I., Shakantu, W. & Ibrahim, S. 2021.

The effect of poor materials management in the construction industry:

A case study of Abuja, Nigeria. *Acta Structilia*, 28(1), pp. 142-167.

THE EFFECT OF POOR MATERIALS MANAGEMENT IN THE CONSTRUCTION INDUSTRY: A CASE STUDY OF ABUJA, NIGERIA

Received: September 2018

Peer reviewed and revised: February 2019

Published: June 2021

**The authors declared no conflict of interest for the article or title*

ABSTRACT

Effective materials management on construction sites is handled carelessly by construction practitioners. This may result in several challenges such as materials waste generation, poor quality of work, project delays, and poor materials flow. Construction practitioners in Abuja, Nigeria, do not understand the consequences of these challenges to construction projects. This article investigates the effect of poor materials management on materials waste, quality of work, and project profitability in construction projects in Nigeria. A qualitative research approach was adopted in the study which included collective case study investigations. The population for the study was ongoing building project sites (ten case studies purposefully selected) in Abuja. The research instrument was direct-covert observation by the researchers to observe and record the construction processes, people's behaviour, actions and interactions relating to materials management. The construction processes observed included materials usage onsite, loading/offloading of materials from procurement, storages,

as well as materials handling and movement on site. Recording sheets with checklists were pre-set with statements (Likert items) and responses to observe and document the effect of poor materials management. The statements were rated on an ordinal three-point Likert scale. The observed/collected data were analysed using descriptive methods to determine the modal values. The findings from the study revealed that poor materials management has a considerable effect on material waste generation on any construction project site; moderate effects on quality of building projects, and both considerable and moderate effects on profitability in the construction projects. Based on these findings, it can be concluded that effective management of materials in construction projects would reduce the amount of waste generation, increase the quality of construction work, and offer optimum profitability to construction contractors. It is, therefore, recommended that the construction industry in Nigeria should collaborate with government agencies to develop guidelines for preparing a waste management plan for the construction industry.

Keywords: Building materials, construction industry, materials management, poor materials management

ABSTRAK

Effektiewe materiaalbestuur op konstruksieterreine word onverskillig deur konstruksiepraktisyns hanteer. Dit kan lei tot verskeie uitdagings soos die opwekking van materiaalafval, swak gehalte werk, vertraging in die projek en swak vloei van materiaal. Die konstruksiepraktisyns in Abuja, Nigerië, verstaan nie die gevolge van hierdie uitdagings vir bouprojekte nie. Hierdie artikel ondersoek die effek van swak materiaalbestuur op materiaalafval, kwaliteit van die werk en projekwingsgewendheid in konstruksieprojekte in Nigerië. 'n Kwalitatiewe navorsingsbenadering is in die studie gebruik, wat kollektiewe gevallestudie-ondersoeke insluit. Die bevolking vir die studie was deurlopende bouprojekpersele (tien gevallestudies wat doelgerig gekies is) in Abuja. Die navorsingsinstrument was direkte-geheime waarneming deur die navorser om die konstruksieprosesse, mense se gedrag, optrede en interaksies wat met materiaalbestuur verband hou, waar te neem en op te teken. Die opgemerkte konstruksieprosesse sluit in die gebruik van materiaal op die terrein, laai/aflaai van materiaal vanaf verkryging, opbergings, en materiaalhantering en -beweging op die terrein. Opteekblaaië met kontrolelyste is vooraf opgestel met stellings (Likert-items) en antwoorde om die effek van swak materiaalbestuur waar te neem en te dokumenteer. Die stellings is op 'n gewone drie-punt Likert-skaal beoordeel. Die waargenome/versamelde data is geanaliseer met behulp van beskrywende metodes om die modale waardes te bepaal. Die bevindinge uit die studie het getoon dat swak materiaalbestuur 'n groot uitwerking het op die opwekking van materiaalafval op enige konstruksieprojek; matige effekte op die kwaliteit van bouprojekte; en beide 'n groot en matige uitwerking op wingsgewendheid in die bouprojekte. Op grond van hierdie bevindinge kan die gevolgtrekking gemaak word dat effektiewe bestuur van materiale in die konstruksieprojek sal lei tot die vermindering van die hoeveelheid afvalopwekking, verhoogde gehalte van konstruksiewerk en optimale wingsgewendheid vir konstruksie-kontraakteurs. Dit word dus aanbeveel dat die konstruksiebedryf in Nigerië saamwerk met regeringsinstansies om riglyne te ontwikkel vir die opstel van 'n afvalbestuursplan vir die konstruksiebedryf.

Sleutelwoorde: Boumateriaal, konstruksiebedryf, materiaalbestuur, swak materiaalbestuur

1. INTRODUCTION

The Nigerian construction sector plays an important role in the economic development of the country, as it has contributed roughly half of the total stock of fixed capital investment in the Nigerian economy (Ugwu & Attah, 2016: 754; Wahab, 2010: 94). The cost of construction materials may be 50% to 70% of the total construction expenditure, depending on the type of construction project (Arijeloye & Akinradewo, 2016: 169; Albert, 2014: 2; Patel & Vyas, 2011: 1).

Construction waste has been identified as one of the major problems in the Nigerian construction industry that presents significant implications for the efficiency in the industry as well as the adverse impacts on the environment (Muleya & Kamalondo, 2017: 2). Sources of waste include unused materials, incorrect materials, surplus stencils or nails, packages of construction materials or components, surplus concrete materials resulting from fractures or deformations, due to improper storage or preservation of construction materials and components arriving at the construction site (Albert & Shakantu, 2017: 10). Others include poor materials handling, resulting in breakage; erroneous cuttings, increasing quantities of waste; improper or faulty equipment, delaying project completion; poor storage facilities, making it difficult to coordinate the storage requirements for the various subcontractors; poor workmanship, impacting negatively on the quality standard set up by management, and inaccurate measurements, leading to poor accounting for materials (Aziz & Hafez, 2013: 683).

Managing materials on construction sites is a serious issue among Nigerian subcontractors. Sometimes, materials on site need to be moved from one place to another, resulting in additional costs (Arijeloye & Akinradewo, 2016: 175). The difficulty in storing materials on site, due to limited space, is another problem in Nigerian construction material management. Sometimes, machinery cannot be adjusted on site, due to space or mismanagement of site activities. Many construction projects apply manual methods for tracking materials, and this involves paper-based techniques that can become problematic, due to many human errors (Kasim, Latiffi & Fathi, 2013: 7). Albert and Shakantu (2017: 9) posit that the construction process depends on having the right people with the appropriate skills who are able to deliver the project on time and on budget.

Therefore, the main goal of this study was to investigate the effect of poor materials management (PMM) in the Nigerian construction industry, with a view to enhancing site materials management and reducing waste. Without identifying the effect of PMM on materials waste, quality of work and project profitability, it may be difficult to enhance site materials management and reduce waste in the Nigerian construction industry.

2. LITERATURE REVIEW

2.1 Materials management in the construction industry

Materials management is defined as the process to provide the right material to the right place on time and in the right quantity, in order to minimize the cost of a project (Kulkarni, Sharma & Hote, 2017: 475). The main goal of materials management is to ensure a smooth flow of materials from the time the materials are ordered until they are used. In order to make materials management on site effective, a proper integrated materials handling process that includes the planning, identification, procuring, storage, receiving and distribution of material, should be in place (Dallasega & Rauch, 2017: 1888).

The construction industry involves the physical erection of structures using construction equipment, materials, supplies, supervision, and management that are necessary to accomplish the project (Clough, Sears & Sears, 2000). It involves many organisations such as clients or owners, architects, engineers, contractors, suppliers and vendors. It also includes the heterogeneous and often complex process of producing unique, large and immovable products with a supply of the resources (money, equipment, material, and labour). Unfortunately, the nature of the complexity, uncertainty and dynamics of most of the construction projects creates difficulties for even the best project managers (Duy, Ogunlana & Thi Xuan, 2004: 404). In addition, they are challenged by materials shortages, delays in supply, price fluctuations, damage and wastage, and lack of storage space (Asmara, 2015: 13; Kasim, 2011: 33; Ying, Tookey & Roberti, 2014: 263).

Construction materials management is defined as a reduction in the amount and environmental effect of material waste generated, by reducing the amount of materials used in a construction project (Adafin, Daramola & Ayodele, 2010: 62). Construction companies, which support an integrated material management process, practise the design and construction of new structures or the re-modelling of existing structures, in order to use materials more efficiently (Kulkarni *et al.*, 2017: 475; Muleya & Kamalondo, 2017: 5). This means that an excellent management system for handling materials from the design stage to the usage of the materials throughout the construction period contributes to the overall performance improvement of construction projects in terms of duration, budget, quality, productivity and material waste (Asmara, 2015: 13-14; Arijeloye & Akinradewo, 2016: 169; Kulkarni *et al.*, 2017: 475).

Construction companies that do not implement a proper materials control and management system often experience cost and time overruns, substandard work, disputes and abandonment (Adafin *et al.*, 2010: 63;

Adewuyi, 2012; Ameh & Itodo, 2013: 474). Improper materials control results in careless handling of materials, excessive expenditure on materials, profit loss for the contractor, and loss for the supplier when mishandled materials are rejected and returned (Omotosho, 2006).

2.2 Effect of poor materials management

PMM can have a negative impact on cost as a result of excessive waste, quality and time of work, which will affect project delivery and profitability.

2.2.1 Effect on construction waste

Previous research on the causes of waste reveals that it may occur at any stage of the construction process from inception, through design, construction and operation of the built facility, due to one or a combination of many factors (Muhwezi, Chamuriho & Lema, 2012: 13). Ameh and Itodo (2013: 748) believe that building material wastage on construction sites accounts for cost overruns, because the vast majority of the managers of construction projects pay hardly any attention to the effects of the generated material waste on cost overruns. Meanwhile, Osmani, Glass and Price (2008: 1149) believe that construction waste is effectively generated throughout the construction project, from beginning to completion, with the pre-construction stage accounting for a considerable amount. Table 1 summarises the origin and causes of construction waste.

Table 1: Origin and causes of construction waste

<i>s/n</i>	<i>Origins of waste</i>	<i>Causes of waste</i>	<i>Sources in literature</i>
1	Contractual	Errors in contract documents Contract documents incomplete at commencement of construction	Osmani <i>et al.</i> , 2008; Ekanayake & Ofori, 2004; Zanelidin, 2006
2	Design	Design changes Design and detailing complexity Design and construction detail errors Unclear/unsuitable specification Poor coordination and communication (late information, last minute client requirements, slow drawing revision and distribution)	Lu & Yuan, 2011; Osmani <i>et al.</i> , 2008; Llatas, 2011; Faniran & Caban, 1998
3	Procurement	Ordering errors (<i>i.e.</i> , ordering items not in compliance with specification) Over-allowances (<i>i.e.</i> , difficulties in ordering small quantities) Supplier errors	Rajendran & Gomez, 2012; Muhwezi <i>et al.</i> , 2012; Ameh & Itodo, 2013; Kulkarni <i>et al.</i> , 2017

s/n	Origins of waste	Causes of waste	Sources in literature
4	Transportation	Damage during transportation Difficulties for delivery vehicles accessing construction sites Insufficient protection during unloading Inefficient methods of unloading	Muhwezi <i>et al.</i> , 2012; Osmani <i>et al.</i> , 2008; Faniran & Caban, 1998
5	On-site management and planning	Lack of on-site waste management plans Improper planning for required quantities Delays in passing information on types and sizes of materials and components to be used Lack of on-site material control Lack of supervision	Tam, 2008; Bossink & Brouwers, 1996; Faniran & Caban, 1998; Osmani <i>et al.</i> , 2008
6	Material storage	Inappropriate site storage space leading to damage or deterioration Improper storing methods Materials stored far away from point of application	Bossink & Brouwers, 1996; Osmani <i>et al.</i> , 2008; Arijeloye & Akinradewo, 2016
7	Material handling	Materials supplied in loose form On-site transportation methods from storage to the point of application Inadequate material handling	Arijeloye & Akinradewo, 2016; Asmara, 2015; Kasim, 2011
8	Site operation	Accidents due to negligence Unused materials and products Equipment malfunction Poor craftsmanship Use of wrong materials resulting in their disposal Time pressure Poor work ethics	Gürcanlı & Müngen, 2013; Dolo, Sawhney, Iyer & Rentala, 2012; Osmani <i>et al.</i> , 2008
9	Residual	Waste from application processes (<i>i.e.</i> , over-preparation of mortar) Off-cuts from cutting materials to length Waste from cutting uneconomical shapes Packaging	Rajendran & Gomez, 2012; Osmani <i>et al.</i> , 2008; Bossink & Brouwers, 1996

Table 2 summarises the origin and causes of construction waste that occurred on Brazilian building sites.

Table 2: Origin and causes of construction waste on Brazilian building sites

s/n	Origin	Causes	Sources in literature
1	Overproduction	This is the production of a quantity greater than required or earlier than necessary, resulting in waste of materials, man-hours or equipment usage. It usually produces inventories of unfinished products or even their total loss; in the case of materials that can deteriorate. An example of this type of waste is the overproduction of mortar that cannot be used on time.	Ugochukwu, Agugoesi, Mbakwe & Abazuonu, 2017; Pérez & Costa, 2018; Ali, Arun & Krishnamurthy, 2017
2	Substitution	This is monetary waste caused by the substitution of a material by a more expensive one with an unnecessary better performance, the execution of simple tasks by an over-qualified worker, or the use of highly sophisticated equipment where much simpler equipment would be adequate.	Butera, Christensen & Astrup, 2015; Alwan, Jones & Holgate, 2017; Bossink & Brouwers, 1996
3	Waiting time	This relates to the idle time caused by lack of synchronisation and levelling of material flows and pace of work by different groups or equipment. One example is the idle time caused by the lack of material or of work place available for a gang.	Ugochukwu <i>et al.</i> , 2017; Alwa, <i>et al.</i> , 2017; Formoso, Isatto & Hirota, 1999
4	Transportation	This has to do with the internal movement of materials on site. Excessive handling, the use of inadequate equipment, or bad conditions of pathways can cause this kind of waste. It is usually related to poor layout and lack of planning of material flows	Asmara, 2015; Rajendran & Gomez, 2012; Tam, 2008; Bossink & Brouwers, 1996
5	Processing	Related to the nature of the processing activity that could only be avoided by changing the construction technology. For example, a percentage of mortar is usually wasted when a ceiling is being plastered.	Arijeloye & Akinradewo, 2016; Faniran & Caban, 1998; Bossink & Brouwers, 1996
6	Inventories	Related to excessive or unnecessary inventories which lead to material waste by deterioration, losses due to inadequate stock conditions on site, robbery, vandalism and monetary losses, due to the capital that is tied up. It could be a result of lack of resource planning or uncertainty on the estimation of quantities.	Kasim, 2011; Osmani <i>et al.</i> , 2008; Tam, 2008
7	Movement	Concerned with unnecessary or inefficient movements made by workers during their job and this might be caused by inadequate equipment, ineffective work methods, or poor arrangement of the working place.	Formoso <i>et al.</i> , 1999; Asmara, 2015; Ugochukwu <i>et al.</i> , 2017

s/n	Origin	Causes	Sources in literature
8	Production of defective products	This also occurs when the final or intermediate product does not fit the quality specifications. It may lead to rework or to the incorporation of unnecessary materials to the building that is, indirect waste, such as the excessive thickness of plastering. It can also be caused by a wide range of reasons such as poor design and specification, lack of planning and control, poor qualification of the teamwork, lack of integration between design and production.	Ugochukwu <i>et al.</i> , 2017; Muhwezi <i>et al.</i> , 2012 Formoso <i>et al.</i> , 1999

The effect of PMM on materials waste is as follows:

- Increases quantities of waste.
- Negatively impacts on the waste management plan.
- Negatively impacts on the proposal for material waste recycling, recovering and disposal.
- Leads to mixing of waste.
- Makes it difficult to monitor the waste management plan.
- Makes it difficult to manage waste-related key performance indicators (KPIs).
- Makes it difficult to manage site waste management plan cost data.
- Negates the effort for minimizing materials utilisation.
- Impinges on the need to assess and identify materials waste streams.
- Makes it difficult to account for materials waste.
- Makes it difficult to implement a materials waste management policy.

2.2.2 Effect on quality of work

PMM has a negative impact on the quality of construction work (Ameh & Itodo, 2013: 474). Quality management in construction projects means maintaining the quality of construction works at the required standard to obtain customer's satisfaction that will bring long-term competitiveness and business survival for the companies (Khalek, Aziz & Sharabash, 2016: 391). Construction firms worldwide are actively engaged in achieving internationally accepted quality levels to ensure sustainability in the current competitive market (Abdul-Rahman, Wang & Yap, 2010: 3744; Khalek *et al.*, 2016: 391; Sinha, Garg & Dhall, 2016: 338). Construction

firms must, therefore, provide the tools, techniques and procedures for a proper total quality control plan (Khalek *et al.*, 2016: 391). Implementing the principles of Total Quality Management (TQM) in the construction industry is not an easy matter (Hoonakker, Carayon & Loushine, 2010: 955). Some reasons are 'the transient nature' of building and construction, the lack of standardisation, and the many parties involved. The conservative nature of the construction industry is another reason (Hoonakker *et al.*, 2010: 955).

To minimize the negative effect of PMM on the quality of work, construction firms should employ a quality control and management programme that focuses on the main principles of TQM (Forbes & Ahmed, 2011: 232). These principles focus, among others, on customers, processes, teamwork, employee participation and continuous overall improvement of the firm (Forbes & Ahmed, 2011: 232). According to Kuo and Kuo (2010: 623), construction firms that implement a TQM plan focus on:

- Leadership ability that refers to the extent to which top management embraces the concept of total quality management in construction business implementation.
- Human resources management, where top management supports quality improvement plans, systematically provides training courses, and creates an environment in which self-directedness in goal setting and implementation are facilitated.
- Process management, where the construction industry empowers its project leaders or other professionals to manage project execution during the project planning and design process.
- Cooperation of firms' management, where the firm emphasises the measurement of the cooperation relationship with external alliances, in terms of the responsibility of quality improvement, the communication channels, and providing clear instructions of quality requirements to the cooperating firms.
- Continuous quality improvement and information on the firm's strategies in continuous quality improvement, including obtaining customers' feedback, the efficiency of gathering feedback, encouraging employees' quality improvement ideas, and providing rewards for quality improvement innovations.

In practice, this means that construction firms with improved quality control plans are characterised by, for example, employee involvement, management commitment, a skilled workforce, communication between managers and employees, sufficient training and education, and subcontractors' involvement (Kuo & Kuo, 2010: 623). These firms also have well-defined roles and responsibilities, clearly defined goals and objectives, review/analysis used to improve performance, regular inspections and

audits, incentives for good performance, regular meetings, criteria used in pre-qualification in the bidding process, and written programmes or policies (Hoonakker *et al.*, 2010: 959).

Construction firms that implement TQM principles in their quality control plans have the benefit of survival in an increasingly competitive world, better service to customers, and enhancement of the organisation's shareholder value (Forbes & Ahmed, 2011: 231-232). These firms improve the overall quality and safety of facilities, reduce project durations and costs, and utilize the talents of its people (Forbes & Ahmed, 2011: 231-232; Senaratne & Jayarathna, 2012: 103). All these activities will ensure that an organisation can provide a quality product at the right time, lowest cost and to the customer's specific specifications (Senaratne & Jayarathna, 2012: 103).

Focusing on TQM, the effect of PMM on quality of work can be summarised as follows:

- Quality of work is compromised, because PMM leaves some materials spoiled.
- Impacts negatively on the quality of some of the materials on site.
- Negates the quality standard set up by management.
- Negates materials quality control.
- Makes it difficult to conduct materials quality audits.

2.2.3 Effect on project profitability

Construction materials contribute significantly to the cost of any project. Material wastage thus has a negative impact on construction costs, contractor's profit margin, construction duration and can be a possible source of dispute among parties to a project (Adewuyi & Odesola, 2015: 83). The primary focus of a contractor is to deliver a project safely while maximising profit. Contractors need to survive, and this is based on the profit realised as a result of their expertise (Aiyetan & Smallwood, 2013: 1162).

Nguyen, Ogunlana and Lan (2004: 404) acknowledge that a construction project is successful when it is completed on time, within budget, in accordance with specifications, and to the stakeholders' satisfaction. Functionality, profitability to contractors, absence of claims and 'fitness for purpose' for occupiers have also been used as measures of project success.

The generation of wastes means loss of profits to contractors, due to extra overhead costs and delays in work execution, which lead to lower productivity (Muhwezi *et al.*, 2012: 12). Contractors and other stakeholders must, therefore, be educated and sensitized about the strategies and

benefits of waste minimization on construction projects and the cost-saving measures that can be followed in waste reduction, which can ultimately result in increased profit margins (Muhwezi *et al.*, 2012: 18).

Materials management on site should seek to reduce loss of profit, due to theft, damage and wastage, as well as running out of stock (Kasim, Anumba & Dainty, 2005: 795). In addition, management of construction materials in building projects can raise the project profit dramatically and save considerable time (Zeb, Malik, Nauman, Hanif & Amin, 2015: 170).

The effects of PMM on profitability are as follows:

- PMM increases waste, thus reducing profitability.
- Suboptimal accounting for materials affects profitability.
- Poor site storage of materials leads to theft of materials, resulting in low profitability.
- Poor site storage of materials leads to damage/destruction, thus reducing profitability.
- Suboptimal materials quality leads to rework and decreases profitability.
- PMM increases health and safety incidents, leading to claims/expenses and affecting profitability.

3. RESEARCH METHOD

This study investigates the effect of PMM in the construction industry in terms of materials waste, quality, and profitability in Abuja, Nigeria. The research adopted the qualitative method of research inquiry (Cresswell, 2006: 54). Although there are several types of qualitative methods such as, for instance, narrative analysis, ethnography, phenomenology, grounded theory, the collective case study approach was deemed appropriate for this research (Cresswell, 2006: 57). In this study, direct observation in the in-depth case studies provided an understanding of the PMM on construction sites (Taylor-Powell & Steele, 1996: 1). As a research method, observation enables researchers to obtain a detailed description of social settings or events to situate people's behaviour within their own sociocultural context (Hennink, Hutter & Bailey, 2011: 170). Observation provides the opportunity to document activities, behaviour and physical aspects without depending on peoples' willingness and ability to respond to questions (Taylor-Powell & Steele, 1996: 1).

3.1 Study area

The assessment was based on building construction project sites in the Federal Capital Territory (FCT) of Nigeria. Abuja is within the middle belt

region of Nigeria. The capital city Abuja is located within the wider Abuja Municipal Area Council. The territory is currently made up of six area councils, namely Abaji, Abuja Municipal Area Council (AMAC), Bwari, Gwagwalada, Kuje, and Kwali. AMAC is the area under study. This area consists of 11 wards, namely City Centre, Garki, Gwagwa, Gwarimpa, Jiwa, Karshi, Kabusa, Karu, Nyanya, Orozo, and Wuse. The study was carried out in the 11 wards under AMAC, but only 10 projects within the geographical area meet the purposive sampling requirement.

3.2 Population and sample

The population for this study is building construction sites in Abuja, the Federal Capital Territory of Nigeria, because it is one of Nigeria's metropolitan cities with the highest population of the built environment professionals in the country. It has many ongoing building construction projects, the proximity of the researcher's state of origin to the study area (FCT, Abuja), and the location of the construction projects in the same area makes the study more economical in terms of cost and time. From this population, a sample of ten building projects were selected, with a value of 100 million Naira and above, using purposive non-probability sampling techniques. The rationale for the purposive non-probability (typical case sampling selection) is that building construction projects of this value and above are typically likely to have PMM compared with projects of less value (Patton, 2002: 236).

3.3 Data collection

The data were sourced from ten both public and private construction project sites within Abuja, Nigeria, with a project value of up to 100 million Naira and above. Between November 2018 and February 2019, the researcher visited each of these project sites and used covert observation (no one knows that they are being observed and the observer is a concealed or embedded research) to observe and record people's behaviour, actions and interactions (McKechnie, 2008: 133). The observation was done for an average period of four hours for the four-month period.

The study considered the majority of the building materials such as blocks/bricks, timber, cement, reinforcement, mortar and aggregate (both fine and coarse) used in projects. These materials represent a significant percentage of the total cost of buildings in most of the traditionally built residential and commercial buildings in Nigeria. The construction processes observed included materials usage onsite, loading/offloading of materials from procurement, storages, as well as materials handling and movement on site. The site workers involved in each operation were observed.

For data collection, based on the literature review, recording sheets with checklists were pre-set with statements (Likert items) and responses to observe and document the effect of PMM related to material waste, quality, and profitability. Recording sheet 1 consists of 11 statements (Likert items) on the effect of PMM on materials waste. The observer rated quantities of waste, waste management plan, waste recycling and disposal, mixing, KPI, costs, utilisation, waste streams, account waste, and waste policy in terms of materials usage onsite, loading/offloading of materials from procurement, storages, as well as materials handling and movement on site. Recording sheet 2 consists of five statements (Likert items) on the effect of PMM on quality. The observer rated spoiled materials, onsite materials quality, standards, control, and audits in terms of the materials usage onsite, loading/offloading of materials from procurement, storages, as well as materials handling and movement on site. Recording sheet 3 consists of six statements (Likert items) on the effect of PMM on profitability. The observer rated increased waste, suboptimal accounting, theft, damaged materials, rework, health and safety claims in terms of the materials usage onsite, loading/offloading of materials from procurement, storages, as well as materials handling and movement on site. For the purpose of anonymity, the names of the project sites are not disclosed in this article. Instead, they are represented by case study (CS) numbers CS1-CS10.

3.4 Data analysis and interpretation

The Statistical Package for the Social Sciences (SPSS) version 23 was used to conduct descriptive analysis of the data computing the mode that describes the most frequently occurring effect of PMM in construction (Field, 2013).

To measure the central tendency of the effect of PMM on materials waste, quality and profitability, the statements (Likert items) were rated on an ordinal three-point Likert scale. Likert-type scales use fixed choice response formats and are designed to measure the strength of the researcher's perceived agreement or disagreement with statements (Likert items) (Schmee & Oppenlander, 2010: 14). The following scale measurement was used regarding modal value, where 1 = high effect; 2 = moderate effect, and 3 = low effect.

3.5 Limitation(s) of the study

This research focuses on the effect of PMM in building projects in Abuja, Federal Capital Territory of Nigeria. This article only focuses on knowing the level of effects of PMM on waste generation, quality and profitability. Subsequent research will address the mitigation strategies. This research uses observation of what was observed on site with the observation guide by the observer (researcher). No interviews were conducted. Thus, the voice of the contractor/consultants was not considered.

4. RESULTS AND DISCUSSION

4.1 Effect of poor materials management on materials waste

Table 3: Effect of poor materials management on materials waste

Statement	Case studies 3 = high effect; 2 = moderate effect; 1 = low effect										Mode
	CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8	CS9	CS10	
PMM increases quantities of waste	3	1	1	2	2	3	3	3	3	2	3
PMM negatively impacts on the waste management plan	3	1	1	1	1	3	3	2	3	2	1 & 3
PMM negatively impacts on the proposal for material waste recycling, recovering and disposal	2	2	2	2	2	2	3	3	3	2	2
PMM leads to mixing of waste	2	1	1	1	1	3	3	3	3	1	1
PMM makes it difficult to monitor the waste management plan	2	1	2	2	2	3	3	2	3	2	2
PMM makes it difficult to manage waste-related KPIs	2	1	1	3	2	3	2	3	3	2	2 & 3
PMM makes it difficult to manage site waste management plan cost data	3	1	1	1	3	3	2	3	2	2	3
PMM negates the effort for minimizing materials utilisation	2	2	2	2	2	2	2	2	2	2	2
PMM impinges on the need to assess and identify materials waste streams	3	1	1	1	1	3	3	2	2	1	1
PMM makes it difficult to account for materials waste	3	2	2	2	2	3	3	3	3	2	2 & 3
PMM makes it difficult to implement a materials waste management policy	3	2	1	3	2	3	3	3	3	2	3
Total											3

An overall model value of 3 (see Table 3) demonstrates that PMM has a high effect on material waste in the construction industry in Abuja, Nigeria.

This means that PMM exacerbates the problem of wastage of materials on sites.

The results show that PMM increases the quantity of materials waste. This finding was supported by Saidu and Shakantu (2016: 106) that imprudent materials management does increase material waste on construction sites, with an additional result of a corresponding increase in the amount of cost overrun for a project. In addition, material waste has a significant impact on the cost of a project as well as an adverse impact on the environment (Nagapan, Rahman, Asmi, Memon & Latif, 2012: 325). The study found that a waste management plan has a high effect on construction site materials wastage. This finding corroborates studies by Tam (2008: 1074), Bossink & Brouwers (1996: 57), Faniran & Caban (1998: 183), and Osmani *et al.* (2008: 1149), as highlighted in Table 1.

It is important to understand what wastes are likely to be generated and then focus on how the generation of those wastes can be avoided or minimized. Regarding monitoring of the waste management plan, it was observed that PMM negatively impacts on the waste management plan. This corroborates the findings of Dania, Kehinde and Bala (2007: 128) that site materials waste management is very poor and has much room for improvement. A waste management plan, therefore, provides an idea about different kinds of waste and how they can be managed to ensure minimal to no negative effect on the construction project. Effective waste management approaches could reduce the negative impact of the construction industry on the environment.

Mixing of waste also had a negative effect on the construction sites. This corroborates the report of Cox (2018) that mixing waste for disposal makes it almost impossible to meet the organisation's waste management targets. The mixing of waste on sites should be avoided, as it is difficult to separate the waste at a later stage. Efforts at minimising materials utilisation, site waste management plan cost data and a waste management policy had a moderate to high effect on the control of materials wastage. It is imperative to determine the waste-related KPIs that are best for construction projects, because it is evident from the results in Table 3 that waste-related KPIs have a high effect on materials waste on construction sites. This means that the management teams selected the right KPI for the construction companies. This finding supports a study by Chan and Chan (2004: 203), which established that, in order to identify the 'real' success factors of construction projects, it is important to identify parameters (KPIs) for benchmarking projects at the project selection phase, in order to achieve good project performance.

PMM has a low effect on materials waste streams, because waste is not sorted into specific streams, from its source through to recovery, recycling

or disposal process on construction projects. This implies that PMM has a negative effect on construction projects. This contradicts a report by Towing (1998) that recycling and controlled management of construction waste streams would save land and create better opportunities for handling other kinds of waste.

In this context, managing materials waste means eliminating waste, where possible, minimising waste, where feasible, and reusing materials that might otherwise become waste. Therefore, producing a site waste management plan before the start of a construction project would help achieve good practice waste management.

4.2 Effect of poor materials management on quality

Table 4: Effect of poor materials management on quality

Statement	Case studies										Mode
	3 = high effect; 2 = moderate effect; 1 = low effect										
	CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8	CS9	CS10	
Quality of work is compromised, because PMM leaves some materials spoiled	3	1	1	1	2	3	3	2	2	1	1
PMM impacts negatively on the quality of some of the materials on site	3	1	1	2	3	2	2	2	2	1	2
PMM negates the quality standard set up by management	2	2	2	2	2	2	2	2	2	2	2
PMM negates materials quality control	2	2	2	3	3	3	3	3	3	2	3
PMM makes it difficult to conduct materials quality audits	2	2	2	3	2	3	3	3	2	2	2
Total											2

An overall modal value of 2 (see Table 4) demonstrates that PMM has a moderate effect on quality in the construction industry in Abuja, Nigeria.

It is clear from Table 4 that the statement “poor materials management negates materials quality control” was considered to have a high effect on quality, since it has a modal value of 3. This is in tandem with the findings of Khalek *et al.* (2016: 394) on achieving quality in materials management in construction projects. Quality control is that part of quality management that ensures that products and services comply with requirements and standards. One way of controlling quality is based on the inspection or verification of products.

The statements with moderate effects on quality were: PMM impacts negatively on the quality of some of the materials on site; PMM negates

the quality standard set up by management, and PMM makes it difficult to conduct materials quality audits. These were considered to have moderate effects on quality, because they all have modal values of 2. These results corroborate the findings of Khalek *et al.* (2016: 394), who highlighted that onsite delivery of substandard materials and products is one of the major problems impacting negatively on the quality of materials on site.

A quality audit is a review of how well the key areas of the project quality plan are being followed. The purpose of the audit is to determine whether the quality plan is working as intended. To achieve a successful materials quality audit, first, the correct procedures specified in the quality plan should be followed and, secondly, they should be followed consistently (Oakland, 2014; Dale, Van Der Wiele & Van Iwaarden, 2007; Juran, 1999).

It is the responsibility of the contractor to assure the client of continuous conformity with the appropriate standards and regulations, and to conduct quality control through self-inspection, quality assurance, quality directing, and quality auditing.

4.3 Effect of poor materials management on profitability

Table 5: Effect of poor materials management on profitability

Statement	Case studies										Mode
	3 = high effect; 2 = moderate effect; 1 = low effect										
	CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8	CS9	CS10	
PMM increases waste, thus reducing profitability	2	1	1	2	2	3	3	3	3	2	2 & 3
PMM leads to suboptimal accounting for materials, thus affecting profitability	2	2	1	2	2	3	3	3	3	1	2 & 3
Poor site storage of materials leads to theft of materials, thus leading to low profitability	3	3	1	3	3	3	2	2	1	2	3
Poor site storage of materials leads to damage/ destruction, thus reducing profitability	2	2	1	2	2	3	3	3	3	2	2
PMM increases suboptimal materials quality, thus leading to rework and decreasing profitability	3	2	1	2	2	2	2	2	2	1	2
PMM increases health and safety incidents, thus leading to claims/expenses and affecting profitability	3	3	2	1	1	3	3	2	3	2	3
Total											2 & 3

Overall modal values of 2 and 3 (see Table 5) demonstrate that PMM has a moderate to high effect on profitability in the construction industry in Abuja, Nigeria.

The reason why contractors fail to achieve their desired profitability after winning a contract is that the materials required to complete the project are not managed properly during the construction period (Kerzner, 2002).

It was found that PMM increases waste, thus reducing profitability of construction projects. This means that materials waste on site reduces the contractors' profits. This corroborates the submission that prevention and managing the causes of wastage may help reduce the impact on the project and increase profits (Ahankoob, Khoshnava, Rostami & Preece 2012: 196). There is a need to reduce materials waste on site, in order to achieve profitability.

The research also found that PMM has a moderate to high effect on suboptimal accounting for materials, thus affecting profitability. This supports Wahab and Lawal's (2011: 252) finding that there is a lack of record-keeping of materials supplied and used on site, thus affecting profitability. Therefore, proper records of materials receiving, and materials requisition should be kept, and materials monitoring should be done.

Another high effect of PMM is on-site storage of materials, which leads to theft of materials and reduced profitability. Missing materials due to theft need to be replaced by new materials, thus reducing profitability.

Another high effect of PMM was on poor site storage of materials, which leads to damage/destruction and reduces the profitability of construction projects. This finding agrees with Kasim *et al.* (2005: 795), as highlighted in section 2.2.3 of this study. This means that, if adequate storage of materials is not put in place and if there is damage/destruction, more material is needed to replace the damaged/destroyed materials, thus decreasing profitability.

There is a moderate effect in terms of how PMM increases suboptimal materials quality, which leads to rework and decreases profitability. Rework could adversely affect time and productivity and, ultimately, also profitability. These results are in line with the findings of Sun and Meng (2009: 560), Aiyetan (2013: 2), as well as Hughes and Thorpe (2014: 223), that the direct impacts of rework on construction projects would likely include additional time for rework; additional costs for covering rework occurrences; additional materials for rework and subsequent wastage handling, and additional labour for rework and related extensions of supervision manpower. All these studies agree that rework in construction projects has the potential to make at least a moderate contribution to the total project cost and to decrease profitability.

In addition, the study found that PMM has a high effect on the occurrence of health and safety incidents, leading to claims/expenses and affecting profitability. This finding agrees with Muhwezi *et al.*'s (2012: 11) assertion that materials waste on building projects caused not only financial setbacks to contractors, but also significant health incidents. During this study, it was observed that construction workers on sites lacked appropriate protective equipment. For example, workers were observed carrying out activities such as painting, excavations and concreting without the right protective gear such as helmets, masks, ear muffs, goggles, and overalls. There are always claims/expenses for health and safety incidents on site whenever they occur.

5. CONCLUSION AND RECOMMENDATIONS

This article investigated the effect of PMM on materials waste, quality of work and project profitability in the Nigerian construction industry.

The study's findings revealed that PMM has a high effect on material waste generation on any construction project site, with the following statements: PMM makes it difficult to implement materials waste management policy; to account for materials waste; to manage site waste management plan cost data; to manage waste-related KPIs; negatively impacts the waste management plan and increases quantities of waste.

The study also found that PMM has a moderate effect on the quality of building projects in Abuja, with the following statements: PMM impacts negatively on the quality of some of the materials on site; negates the quality standard set up by management and makes it difficult to conduct materials quality audits.

In terms of profitability, it was found that PMM has both high and moderate effects on profitability in the construction industry in Abuja, Nigeria. The statements were: PMM increases waste, thus reducing profitability, and PMM leads to suboptimal accounting for materials, thus affecting profitability.

Based on these findings, it can be concluded that effective management of materials in construction projects would reduce the amount of waste generation, increase the quality of construction work, and result in optimum profitability to construction contractors.

It is, therefore, recommended that the construction industry in Nigeria should collaborate with government agencies to develop guidelines for preparing a waste management plan for the construction industry and ensure that top management adopts the culture of training and developing their staff about new managerial tools and techniques for site materials management.

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