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Research Article

Assessment of Materials Management Strategies Used by Indigenous Contractors on Construction Projects in Abuja

Oni Olalere S[1*] https://orcid.org/0009-0005-7714-7697 Uzoma C[2] https://orcid.org/0009-0001-7790-5225 Jegede Veronica O[3] https://orcid.org/0000-0002-1880-1469 Bukar A[4] https://orcid.org/0009-0005-2537-6420

[1,2,3,4]Department of Building and Quantity Surveying, University of Abuja

Corresponding Author E-mail: olalere.oni@uniabuja.edu.ng

Abstract-Materials management in all ramifications cannot be overlooked, as wastage is a well-known issue plaguing the construction industry. Indigenous contractors hoping to compete with expatriates for construction projects are still facing the problem of wastage due to the absence of or low materials management strategies put in place. In view of this, the study assessed materials management strategies used by indigenous contractors on construction projects in Abuja. Data was gathered through a self-administered questionnaire, which was also acquired using a stratified random sampling technique of construction companies in Abuja. Two Hundred and Thirty-Nine (239) valid questionnaires were administered, out of which One Hundred and Eighty-Five (185), signifying 77.7% were sufficiently filled and returned. The data collected were further analyzed using the coefficient of standard deviation for causes of materials wastage and materials management strategies used by indigenous contractors. Multiple regression analysis was used for the effect of materials management on cost, time, and quality of construction projects. The findings pointed out that low usage of modern construction techniques and practices is the main cause of materials wastage, ICT-based technology to manage materials on fast-track systems from design phase to construction phase is obviously the method some indigenous contractors are using to manage materials on their projects and, inadequate materials management on construction sites is responsible for cost overruns. The findings provide succinct knowledge for indigenous contractors to make management decisions in their respective organizations for the engagement of modern construction estimating software, artificial intelligence (AI), and ICT procedures in curbing waste and managing construction materials.

Article Key Information

Keywords: Materials Management Strategies; Indigenous Contractors; Construction Projects; Abuja

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1. Introduction

Materials in the construction industry refer to resources used in the physical assembly and production of infrastructure. They are a mixture of refined or raw materials used in improving construction (Opara, 2013). In the views of Vatsal and Pitroda (2017), the high lookout for construction materials is so vital on project works simply because the quotation for materials spans from 60 – 80 % of the gross project cost. In light of this, improper material management

can lead to inevitable loss for a construction project. Material management is a crucial yet often overlooked and precarious factor in construction projects.

Okorocha (2013) pointed out that in these times of poor standard of living and sharp increment in materials value, worries for adequate maximization of existing resources seem to completely take over all conclusions about construction project execution in Nigeria. Only with the engagement of a professional project management team that doubts in the preparation and construction process be minimized to actualize great, valuable objectives of the construction project within the best time and price.

Navon and Berkovich (2006) opined that materials most time take a significant quota of the gross price in the construction of a project, necessitating the proper oversight of this resource, very vital. Despite their importance on construction projects, materials control and management are not properly attended to. Succinctly defined, material management is the effective control of the material segment in construction to guard against unwarranted waste (Omotosho, 2013).

Mezue (2016) explained further that material management strategy is a well-prepared activity or technique for the appropriate movement of material, and its sustainability is essential on a project to avoid guard against waste and save unnecessary delays. Bell and Stukhart (2010) undertook an overall theory for a Material Management System (MMS), which collated and incorporated the take-off, seller assessment, speedy procurement, and storing and distribution purposes of material. The organization birthed better labour productivity, lesser excess material, less material management, manpower, and cost savings. A1-Jibouri (2010) came up with a computer simulation model that helps in resolving the issue of request and supply of materials in live situations by possessing a well-programmed list of request and supply times of the various materials on site. The supply of individual variants of material is done spontaneously at a fixed time.

The large quantum of waste produced by construction projects poses a severe economic, environmental, and social issue (Sarhan *et al*., 2019). Construction waste emanates from construction events, like site arrangement, digging, fresh construction, building rehabilitation, deconstruction, and pulling down of the structure (Lu *et al*., 2021). Waste of materials constitutes a significant quota of construction value (Formoso *et al*., 2002; Li *et al*., 2005). This waste is as a result of poor overseeing on construction sites (Poon *et al*., 2004).

Proper supervision of materials over time has presented itself as a serious issue to a lot of organizations in the construction industry. During project executions, a high chance of mismanagement of materials by construction organizations always persists (Abdul-Rahman and Alidrisyi 2017). Adequate application of material management plans will certainly usher in cutting down of waste, project delay, conflicts, guarding against inferior works and abandonment with the prospects that works can be done and seen through within ample duration, cost and to the intended quality, resulting in value for money for the project's client (Donyavi and Flanagan 2009).

Monitoring materials is still a very herculean task on construction sites by indigenous contractors (Saidi *et al*., 2003). According to Navon and Berkovich (2006), proper materials management and overseeing are essential for a well-organized project management. Recent materials management and control approaches tend to be unacceptable, resulting in enormous materials wastage, a slow construction process, and escalated costs.

As pointed out by Vatsal and Pitroda (2017), material management is interwoven with other procedures and segments of construction and is reliant on several other influences, as it possesses tremendous risks. With the orientation of the construction project being in several segments, possessing uncoordinated communication, and with the absence of defined tasks amongst the participants, a rise in the issue of carrying out smooth material management is evident. Though material management issues greatly disturb construction professionals worldwide, their level of seriousness is more for these same professionals.

While carrying out a large volume of projects, most indigenous contractors' organizations usually fix their aim on delivering the work while totally forgetting the management of materials (Aibinu and Jagboro 2014). Total disregard for adequate materials management adds to numerous negative results like, broken materials, clients' disappointment,

reduced output of construction workers, materials wastage, and escalated project value and duration delay, which negatively impact the maximization of resources that are scarce, (Abdul-Rahman and Alidrisyi 2017). Most contractors' organizations have shown no seriousness in putting up a unit that takes charge of the management of their materials, leading to improper materials management (Omotosho, 2013).

Due to the problems highlighted above, the presented study aims to assess material management strategies used by indigenous contractors in Abuja. Several researchers have pointed out that material management strategies differ from contractor to contractor, some engaging the use of models (Jaselskis *et al*., 1995; Echeverry and Beltran, 1997; Navon and Berkovich, 2006). In determining the scope of this study and guiding the research process, three main questions have been posed:

Q1: What are the causes of materials wastage on construction projects of indigenous contractors?

Q2: What are the materials management strategies used by indigenous contractors in Abuja?

Q3: What are the effects of material management on cost, time, and quality of construction projects of indigenous contractors in Abuja?

In order to address these questions, quantitative-based research has been adopted. The paper will commence with a review of existing literature, followed by a description of the research method. With a well examined gathered data, the key findings will then be presented. Lastly, the outcomes of this examination will be addressed, answers will be arrived at for the study questions, and, conclusion will be drawn.

2. Literature Review

This segment of the paper consists of four (4) main sections, including: overview of materials wastage; causes of materials wastage on construction projects; materials management strategies used by indigenous contractors, and the effect of materials management on cost, time, and quality of construction projects.

2.1 Overview of Material Wastage

Despite several academic works on waste management, construction projects still produce voluminous quantities of waste in several variants, such as wood, plastics, paper, metals, concrete, stone, rubber, and gypsum (Tam *et al*., 2018; Mahpour and Mortaheb, 2018)

According to Adewoyi (2007), a major challenge of many construction sites is the voluminous quantity of materials that are classified under the category of waste because of various circumstances. Almost all construction waste is used for landfilling, escalating the existing issues of landfill loading and operation. Ameh and Itodo (2013) observed that in every 100 houses constructed in Nigeria, enough material waste to build another 10 houses is generated. Construction waste can be segmented into three main areas, namely material, labour, and plant, but this review is on material wastage, as almost all the raw materials from construction involvement originate from non-renewable resources.

It is largely accepted that not all the materials supplied to construction sites are utilized for the purpose for which they were procured, and contractors apply more materials than what they have been paid for. A quick, easy way to ascertain the amount of waste is the difference between the volume of materials supplied to the site and that utilized as defined. (Skoyels, 2012).
Issues relating to material wastage on construction sites are not independent (Poon *et al*., 2004). Zighan and Abualqumboz (2021) opined that wastes are interrelated to every stage of the project's lifecycle, and as a result of this, management of waste throughout all stages of the project's lifespan is paramount. In the view of Poon *et al*., (2004), it is widely agreed that material supervision and guarding against waste on building sites pose certain issues as a result of the structure of the construction method and the engagement of a variants of construction workers. It is known that materials supplied to construction sites in most cases are not used for the essence they were procured, and also, reasonable volumes are either damaged or lost.

Sarhan *et al*. (2017) pointed out that the frequent variants of waste in the Kingdom of Saudi Arabia construction industry are delaying, making do, reworks, movement, over-processing, inventory, and excess production.

Some of the uncertainties and prices linked with overlapping and accelerating construction processes include high materials wastage (Fazio *et al*., 1988; Williams, 1995; Bogus *et al*., 2006).

Lam and Wong (2009) explained that a plan that well well-designed but void of coordinated data and proper consideration of construction challenges usually incurs more costs and duration to construct, while generating an excessive volume of waste owing to failed trials and causing accidents to site workers. Poon *et al*., (2004) further opined that there exist two foremost variants of building construction waste: structure waste and finishing waste. Concrete portions, cut iron bars, and abandoned timber pieces are classified as structural waste in the course of construction. Finishing waste, which also comprises several classifications of waste, is usually produced at the application of finishes to a building.

2.2 Causes of Materials Wastage on Construction Projects of Indigenous Contractors

Materials waste stems from construction activities such as site organization, excavation, fresh construction, renovation works, disassembling, and demolition works (Lu *et al.*, 2021). They are essentially composed of physical properties and mainly made up of fragmented concrete, bricks, metals, and other materials (Foo *et al.*, 2013).

Waste can also be surplus and damaged goods and components that stem from construction work or materials engaged briefly via the process of on-site activities (Poon, Ann and Ng, 2001). According to Osmani (2011), two key causes of waste during construction are futile communication processes among the project participants, inadequate data, and the complex nature of the plan.

In the views of Navon and Berkovich (2006), the issues common to materials waste and management can be broken down into two categories. Firstly, there are issues connecting with the procuring and supply of the materials – this aspect comprises coordinating the supply of materials to the site location, and discrepancies in the order placed and the materials brought to the site location. Secondly are logistical issues, which include strict observation of materials onsite, satisfactory movement of materials on and around the site, and materials haulage.

In research conducted by Zighan and Abualqumboz (2021), several issues were highlighted that cause materials wastage during construction.

Table 1. Identified causes of materials wastage during construction

Causes of waste during the construction phase	Detailed breakdown of causes
Low engagement with current construction techniques	• Methods of construction and approaches resulting in increased waste on projects. • Lack of know-how of current construction techniques and systems. • Poor disassembling skills and poor reusability practice. • Waste-efficient formworks. • Low usage of prefabricated components and off-site fabrication.
Unsatisfactory contractual relationships and obligations	• Lack of seriousness among contractors to accomplish projects with low waste. • Not going through designs and specifications before construction. • Absence of commendations about waste minimization from previous jobs. • Forgetting the construction sequence of work that provides for re-useable materials to be used.

	• Mismatched project delivery method to the agreed one.
Unsatisfactory site management techniques	• Absence of site planning to curtail waste of material. • Absence of logistic management and waste arrangement techniques.
Cultural obstacles	• Cultural obstructions preventing the achievement low low-waste projects. • Too many project interfaces culminating in to lack of understanding among stakeholders pertaining to requirements. • Communication lacuna amongst project team members.
Variation works	• Variation as a result of errors in project design. • Variation as a result of errors made during construction. • Variation due to peculiar clients' desires.

2.3 Materials Management Strategies used by Indigenous Contractors

Zairra and Narimah (2017) succinctly put material management as a well-organized process harmonizing identification, scheduling, procuring, transport, managing, storing, overseeing, and distributing with the aim of confirming the readiness of enough volumes, suitable quality, and realistic price of construction materials for the project's requirement. Materials management roles include forecasting and material take off, supplier assessment and picking, procuring, disbursement, transporting, material arrival, storing and recording, and material dissemination (Vatsal and Pitroda, 2017). In line with the results of several researchers, proper material management is among the relevant ingredients to the success of construction projects (Gulghane, 2015; Kayiranga *et al*., 2020). Without doubt, several studies clarified that appropriate material management could lead to a higher level of productivity in construction works and catalyze its greater performance (Pande & Sabihuddin, 2015; Kayiranga *et al*., 2020).

According to Poon *et al*., (2004), whose research focused on decreasing building waste through adequate materials control postulated that a lot of resources can be properly managed if better management of materials is carried out on building sites. The approach to managing materials embraces three key tasks: reduce, reuse, and recycle. Summarily, the study showed that the reduction in volume of material waste for public structures is a result of the engagement of low-waste technologies. The low observation in the volume of material waste for private residential structures was as a result of the engagement of several construction techniques including low-waste technologies as well as conventional methods. Low waste technologies have to do with waste avoidance and reduction. These methods aim at bringing down waste from the onset, which proves to be the best technique to manage waste. Through reducing waste at its beginning, the construction sector can greatly cut down the amount of building materials that need to be managed, reused, or discarded. One vital strategy of low waste technology is thorough designing and forecasting. Effective waste management in the construction sector requires implementing best techniques such as low waste technologies, which have shown effectiveness in cutting down waste as well as encouraging sustainability (Enobie *et. al*. 2024).

Contract administrators manage the movement of construction materials through the organization of detailed plans, which is conventional. The problem associated with this traditional method is that it is reliant on a paper arrangement and possesses key flaws such as taking too much time, being expensive, and actually conveying paperwork between site locations. In addition to that, it engages several people carrying out the management, being undependable, bringing in errors, and wanting more persons to administer and oversee administration (Ubani 2012; Echeme *et al*. 2022). As soon as businesses change to automated procurement and consequently embrace the materials management system (MMS) technique, these problems can be surmounted (Echeme 2021; Echeme *et al*. 2022). The successful engagement of MMS encompasses ascertaining sharing volumes for every assembly area, creating material stimulation ideas, picking stock stages for unprocessed materials, work to be delivered still under execution, processed materials, and propagating information all over the general manufacturing body (Allwin and Usha 2024).

Project lifecycle methodology is one technique engaged to manage waste on construction projects, and it delivers an organized method to project development (Association for Project Management, 2019). In spite of the interconnection

and great reliability among the project lifecycle segments, every stage of the project lifecycle has succinctly explained actions, inputs, and outputs (Zighan, 2020). Each stage of the project lifecycle produces different variants of waste for several reasons and from different causes (cf. Ding *et al*., 2018; Tam *et al*., 2007).

Osmani (2011) suggests that most research on materials wastage is responsive and geared in the direction of recycling and reusing waste as they are produced. These researchers examined waste assessment as well as on-site waste recycling so as to channel construction waste away from landfills. Echeme *et al*. (2022) opined that 'special security plans' is the most efficient materials management strategy, and also, 'observing of materials distributed' is the second most efficient strategy. The research conclusion showcases the fact that security plans are the most efficient management strategy to drastically reduce theft and vandalism, as it affects materials management.

McGrath (2001) suggested a waste reduction tool known as "SMART Waste." This tool was developed as a benchmark to appraise, reduce, and tackle waste in construction projects with the view of recovering materials.

Yuan (2013) made use of SWOT analysis to critically evaluate construction waste in Shenzhen, China, and came up with various techniques to manage waste, not forgetting internal and external features that add and/or hinder the operability of these strategies. Making use of technological methods, precisely BIM, Akinade *et al*. (2018) proffered numerous factors that participants anticipate from this technology to curtail construction waste. BIM, which is well known as an encompassing technology, can be utilized for 3D conceptualization, 4D organizing, 5D pricing, 6D sustainability, and 7D facilities management. 4D and 5D-BIM are generally accepted and put to use, however 6D and 7D-BIM are undergoing significant improvement (Wang and Liu 2020; Sood and Laishram 2024).

The novel attention of BIM is discovered at the preparation and designing stage, proposed for modeling the physical parts of structures. Gradually, BIM moved on from 3D to 4D and 5D modeling to accommodate the organizing and pricing of the construction procedure (Clark and Gray, 2014; Stanley and Thurnell, 2014; Yusof *et. al*., 2018). BIM engagement is not meant for fresh constructions, but can as well accommodate existing structures to remodel them to meet sustainability – engaging BIM as a device to accomplish thermal well-being, general comfort of building users, and to look into the concerns of carbon imprint as well as waste issues and management in existing structures (Backes *et al*., 2014; Yusof *et. al.* 2018). BIM was later on improved to 6D as well as 7D modeling for sustainable issues and operation-maintenance, correspondingly (Oo, 2014; Yusof *et. al.,* 2018).

Kasim *et al*. (2005) explained the development of a novel ICT-based methodology for managing materials on fast-track systems from the design phase to the construction phase with a view to improving the efficiency of the construction process. Adriaanse *et al*. (2010) postulated that several construction organizations are now accepting and engaging inter-organizational ICT as its use proposes a lot of advantages in advancing communication, teamwork, and management in carrying out construction works. The construction sector has been severely criticized for being slow in adopting novel management procedures and novel technologies over the past decades (Bowley, 1966; Latham, 1994; Egan, 1998; Fairclough, 2002; Woudhuysen and Abley, 2004; Hardie, 2016). According to Gamage (2021) absence of understanding, the absence of training, as well as the absence of assets form an obstacle in the digital revolution in the construction sector. Aside from that, organizational configuration and culture have an effect on a successful digital revolution.

In a case study conducted by Atkinson *et al*. (2021), it summarized various vital challenges faced in the implementation of ICT on construction projects under the headings of: Technology (IT backing, ICT structure, IT safety, and software), People (community characteristics, user proficiency, and protection), Technical Conformity (technical conformity proof) and Process (traditional procedure). In order to alleviate the issues put forward, subsequent projects could embrace the engagement of Mobile Information Communication Technology (M-ICT) by putting forward lines from the beginning.

As explained by Abdullah *et al*. (2024), complexity and uniqueness, value of information and incorporation, financial and cultural challenges, ethical and safety worries, scalability, as well as incorporation poise, as problems synonymous with cognitive computing when it comes to small construction organizations. These points show the vital problems that should be attended to when applying cognitive computing machineries, as it has realistic effects for construction sector transactions. These known challenges not only obstruct the acceptance of cognitive computing in small

construction works, but they also openly affect construction project expectations and can result in lengthy application durations and escalated costs, hampering construction timeframes and budgets.

The channel of energy is now geared towards web-based inter-organizational ICT, which integrates document organizing and workflow organizing traits. This variant of ICT is gaining popularity in usage in construction works to smooth data exchange among companies (Yeomans *et al*. 2005; Hjelt and Björk 2006; Adriaanse *et al*. 2010). According to field research, four groups impacting the engagement of ICT are spelt out: personal incentive; external incentive; information and expertise; and acting prospects (Adriaanse *et al*. 2010).

Among big building and construction organizations, the application of ICT to direct and organize core data patterns is currently at par with organizations in other sectors (Molnár *et al*., 2007; Jacobsson and Linderoth, *2010*). Contractors could engage ICTs as a means for incorporation, partnership, information organization, purchasing, site organization, and process development (Sarshar and Isikdag, 2004: 239; Acar *et al.,* 2005)

Gamage (2021) postulated that a construction entity could digitally allocate its project practices to actualize more profits as well as improved output and partnership. Implementation of the best procedure of engagement of technology can only shoot the construction sector up by 15% output improvement, including 6% price saving (McKinsey and Company 2017; Atkinson *et al*. 2021).

Cognitive computing, which has been termed a hopeful tool, has the prospective to transform the construction sector through improving decision-making, enhancing procedures, and increasing general project results (Abdullah *et al*. 2024).

Cross (2019) opined that establishments should automate their material management system to be in line with the acceptable trends to be able to follow the movement of materials from storage facilities, and also noted the need to educate staff in the expertise of material management to increase the knowledge of the task.

Universally, materials management strategies consist of three vital constituents: designing to reduce materials wastage, material purchasing and management, and project site organization and practices. It was also advised that contractors provide their employers with the waste indices (in m^3/m^2 GFA) of executed projects carried out by them as part of the contract requirement. The employer can carry out regular checks and then publish the waste indices to interested persons on a regular basis. Furthermore, these waste indices can be used as a benchmark for projects to be done in future thereby advocating waste minimization (Poon *et al*., 2004).

In order to lessen some of the challenges of materials management, an automated model mainly for materials management and control was invented. The model handles procurement functions, monitors materials, as well as reports and gives notifications pertaining to the position of procurement instruction, materials getting to the project site, and their movement around the construction site, materials usage, among others. The model was implemented with the aid of Access© for the algorithms as well as the databases, and a PDA for the statistics gathering (Navon and Berkovich, 2006).

Lakshmi *et al*. (2015) appraised the engagement of Quality Function Deployment (QFD) as an administrative device to be of assistance to project managers. The project manager has the key task within the project execution, in making sure the design both meets the Client's desired expectations and is carried out appropriately, also ensuring that quality control/assurance methods are properly overseen. The study gave direction that there is a positive and vital bond between materials management issues and recurring faults of the equipment. The situation can be probable as the presence of materials management issues translates to the breakdown of the equipment.

Sayali and Raju (2016) noted that cost, quality & time are vital objectives of material management. In actualizing this, material management techniques have to be engaged. The ABC analysis, VED analysis, and SDE analysis are dissimilar procedures of material management. ABC analysis is centered on the inventory value of material. VED analysis allows for the importance of the usage of material, whereas SDE analysis provides accessibility of material in the construction market.

Antony and Navodaya (2017) clarified that techniques that are in place for properly handling materials are entirely reliant on human abilities. They additionally pointed out that the blending of Near Field Communication (NFC) and Global Positioning System (GPS) tools is now engaged, and they assist in less-cost, easy-to-execute results to recognize and monitor materials as well as other various components. This arrangement is completely automatic and allows for effective recognition and monitoring in all segments, such as assembling (offsite), in-transit (transportation), and project site (onsite). This technology assists in getting actual time and correct data pertaining to the construction project resources. The system also aids in showing the data to all stakeholders of the construction project in real time.

Kulkarni *et al.* (2017) concluded that big construction organizations are excellent and proficient enough in infusing material management procedures on construction sites. Medium-sized construction organizations possess some technical and periodic issues as they do not make use of any software. Small construction organizations fall behind when it comes to material management compared to medium & large organizations, largely as a result of the absence of information about material management.

Research conducted by Kayiranga *et al*. (2020) suggests the need to engage an inventory control system and information communication technology, principally Material Requirement Planning (MRP), for actualizing a greater level of achievement and improving the vital results of the construction site. There is an urge to provide service, exercise, and capacity development for the construction supervision of materials to have suitable sites during project construction.

2.4 Effect of Materials Management on Cost, Time, and Quality of Construction Projects

In the view of Okorocha (2013), enough materials requirements, organizing, and control are vital to well-organized materials management on construction sites and effective construction project delivery in Nigeria. According to Navon and Berkovich (2006), the key merits of engaging the automated model for materials management include: higher availability of materials on-site thereby ensuing improved productivity; availability of current and precise data pertaining the record of available materials on construction site; reduced excesses and waste of materials and immediate control data matching the proposed versus the actual consumption of construction materials – the latter is also engaged to bring up to date historical information records, which allow more precise preparation in the nearest future.

Considering the effects of materials management via environmental impact, economic impact, and performance impact, Albert *et al*. (2018) asserted that materials management functions develop the success pace of project preparation and accomplishment, thereby reducing the project cost. In addition, the total reduction of materials wastage in the process of construction is paramount so as to prevent loss of profits that could have been made by the stakeholders. As explained by Lenin *et al*. (2014), the main causes of cost escalations in line with poor materials management are: design problems, construction market situation, storage issues, contractor issues, external issues, client/owner-related issues, construction site issues, and labour and equipment-related issues.

In the views of Tait and Swaffield (2013), the commercial merits related to the materials management on construction project sites comprise: decreased damage to vital components, enhanced site appearance, decreased dual handling, enhanced site management, and decline in time wastage. The cost merit that could come up from materials management is coupled to the direct prices of both excess disposal and raw material procurement. The overview of their research highlighted that any financial advantage realized via materials management could improve the net turnover of the contractor, or be passed to the building owner, and add to savings in construction cost.

Ameh and Itodo (2013) believe that inadequate materials management on construction sites is responsible for cost overruns. This is because most construction supervisors pay minimal attention to the effects of created material waste on cost overruns at the planning phase of a project. Lenin *et al*. (2014) stated that emptiness is created by the non-engagement of proper materials management on construction project sites. Research has revealed that construction materials are responsible for 60-70% of the entire cost of projects. Material mismanagement minimizes the contractor's turnover, resulting in tremendous losses, and puts the project in serious trouble. Hence, the efficient

management of this particular major component can improve the output and cost efficiency of a project, also aiding in its timely completion.

Keitany *et al*. (2014) noted that Materials management is a mechanism to enhance performance in attaining building owners' service desires while also adding to cost-effectiveness by reducing costs and ensuring the best engagement of existing resources. In the summary of a research on material management carried out by Zairra and Narimah (2016), they thought that availability and adequacy of materials and equipment have an impact on duration, quality, output, and performance. Suitable quality material has an impact on time, cost, and quality performance. Practical changes have an impact on the duration outcome. Well-organized material monitoring has an impact on waste performance.

In the views of Michael *et al.* (2023), Poor Materials Management (PMM) escalates waste and has a regular effect on suboptimal recording for materials, thereby restricting the profitability of construction projects. This entails that there is a necessity to reduce waste of materials on building sites so as to accomplish tremendous profit and good accounts of all the materials obtained; material requests should be properly preserved, and scrutiny of all materials should be carried out. The serious impact of the absence of adequate keeping of materials leads to the theft of materials. This shows that, lack of proper storage of materials on a construction site results in loss, and should there is damage, extra material will be required to substitute the damaged materials, thereby leading to a lesser profit. Observation was also made on how PMM raises suboptimal materials quality, thereby resulting in the redoing of work and lessening the profit to be made. Redoing work could adversely affect time, productivity, and profit margin. These points confirm the notion that repetition of work in construction projects has the possibility to influence the overall project cost and lessen its profit margin.

According to Kayiranga *et al*. (2020), sufficient assurance when it comes to materials storage is sometimes not put into consideration, and this results in low quality of the materials or their gradual deterioration, which in the long run affects the quality and productivity of the project. Also, the control of material wastage is highly significant in monitoring the project construction cost.

In the views of Echeme *et al.* (2022), if not properly supervised, the voluminous quantity of financial means channeled to the procurement of materials can greatly add to project cost escalations and mar the project's successful execution and completion. This has stimulated project investors to be worried about well-organized material management, as this can assist in preventing unwanted cost escalations for project delivery. Furthermore, a lot of projects have been abandoned due to poor management of the materials assigned for the project application, resulting in cost overruns (Olayinka 2016; Echeme *et al.* 2022). The project's cost, duration, and quality are all affected by wrong supervision and management of resources on the construction project site (Fearson *et al.* 2010; Echeme *et al.* 2022).

3. Research Method

This research engaged the use of a field survey to ascertain materials management strategies used by indigenous contractors on construction projects in Abuja. Firstly, the causes of wastage, materials management strategies known as well as their cost, time, and quality effects on construction projects were identified in the literature. These were then used to design the questionnaire to achieve the objectives of the study. The option of a questionnaire survey was used to get responses from indigenous construction companies pertaining to materials management strategies. The main respondents were key management personnel (Project Managers and Quantity Surveyors) of indigenous companies through their professionals (Site Supervisors/Builders, Procurement officers, and Storekeepers) involved in the execution of small, medium, and large construction works in Abuja. The motive for these targeted respondents was basically because they possess firsthand knowledge of material procurement, application, and management. In order to show the generality and precision of the instrument, an experimental study was carried out before administering it to the respondents. The study employed a purposive sampling technique to determine a representative sample for questionnaire administration.

Purposive sampling is a non-probability technique that is based on the features of the study population. The sampling method adopted was chosen mainly because the target respondents are not just any kind of contracting firm but indigenous contractors located and executing projects in Abuja. The respondents were identified by drawing up a list

of contracting organizations of Nigerian nationals carrying out construction works in the country, especially in Abuja. The study engaged the use of Cochran's formula for infinite population developed in 1977, using equations 1 and 2 as follows:

$$n = \frac{pq\, z^2}{e^2} \quad \text{(equation 1)}$$

$$q = 1 - p \quad \text{(equation 2)}$$

Where n = sample size;

z = selected critical value of desired confidence level;

p = estimated proportion of the attribute present in the population;

e = desired level of precision.

The following values in sample size determination were adopted by the research:

p = 20% = 0.20;

q = 1 – 0.20 = 0.80; at confidence level of 90%, z = 1.93;

e = 0.05

Hence, $n = \frac{0.20 \times 0.80}{0.05^2}(1.93^2) = 239$

The significance of p = 20% is the estimate of the probable percentage of indigenous construction companies considered for the study. Going through the calculations, the sample size for the research with an infinite population using Cochran's formula is 239. A total of two hundred and thirty-nine (239) survey questionnaires were distributed, and a total of one hundred and eighty-five (185), representing 77% were sufficiently completed and returned. The questionnaire was segmented into two parts. The first part captured general information about the respondents. The second part addressed causes of waste, materials management strategies used by indigenous contractors and, effect of material management on cost, time and quality of construction projects and respondents were requested to rate these issues engaging a 5-point Likert scale where 1 = Strongly Agree, 2 = Agree, 3 = Undecided, 4 = Disagree and, 5 = Strongly Disagree. The information was gathered through a questionnaire method between April to October 2024. In analyzing the data acquired, this research engaged the use of frequency distribution, percentage, coefficient of standard deviation, and multiple regression analysis. Owing to the fact that multiple Likert scale questions were designed, it was tested using Cronbach's alpha test to ascertain its reliability. With the result of the test revealing a value of 0.913, showing a great degree of consistency, it was accepted as being reliable.

4. Results and Discussion

4.1 Results

This segment of the research showcased the background and other data of the respondents, as well as the results and analysis of materials management strategies used by indigenous contractors in Abuja.

4.1.1 Respondents' Background Information

Figure 1 showcased the background data of 185 participants as well as their designations and academic qualifications. Respondents who took part in the survey include Project Managers, Quantity Surveyors, Builders, Procurement

Officers, Store Keepers, and others (refer to Figure 1). According to Figure 1, going by the population survey, most of the respondents turned out to be Quantity Surveyors (37.8%), while other variants of disciplines happened to be the fewest respondents (2.2%). Pertaining to academic qualification, the respondents possess their first degrees of B.Sc./B.Tech. and HND with 40% and 28.1, respectively, meaning they have enough academic knowledge to understand the research topic being investigated.

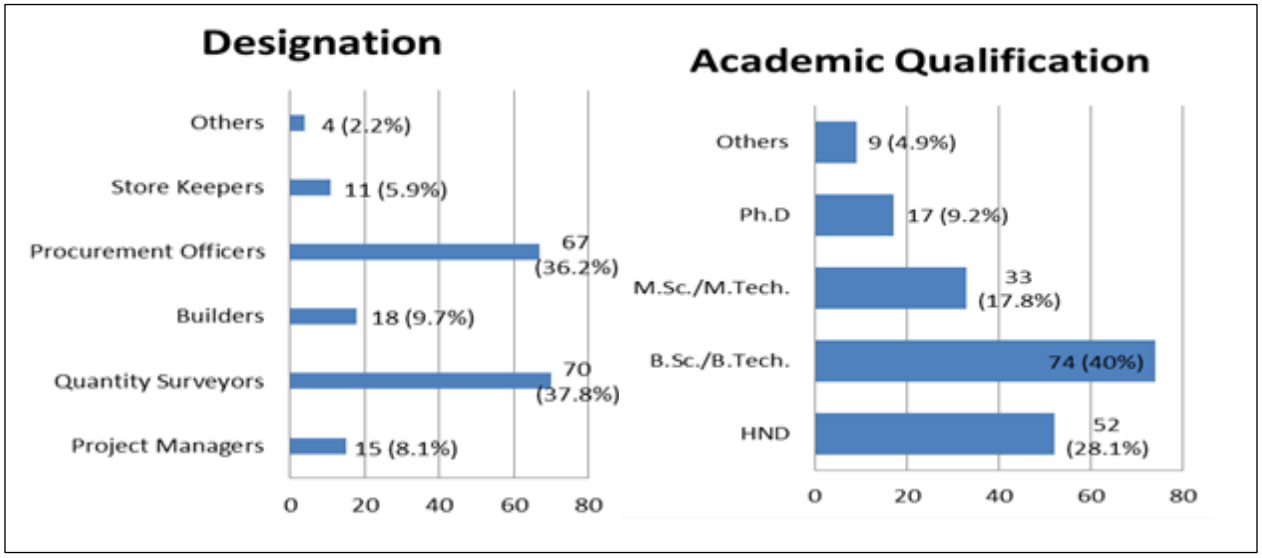

Figure 1: Respondent's background information

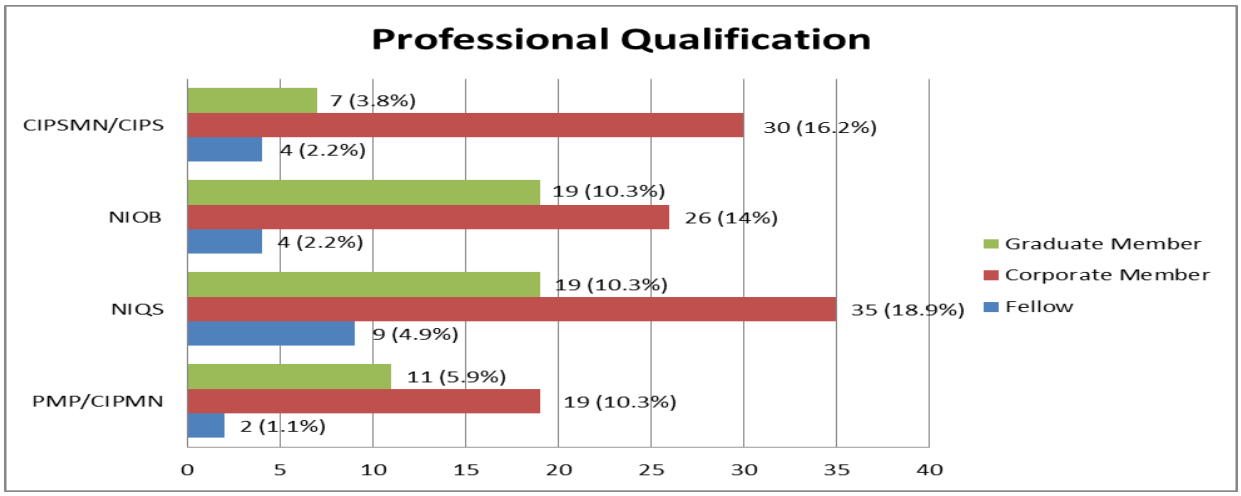

Figure 2: Respondent's professional qualification

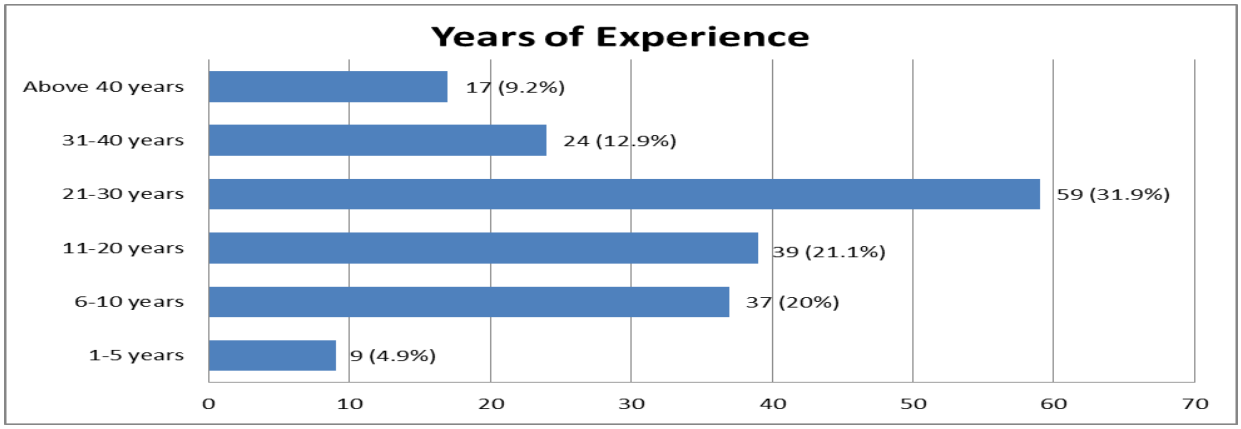

Figure 3: Respondent's years of experience

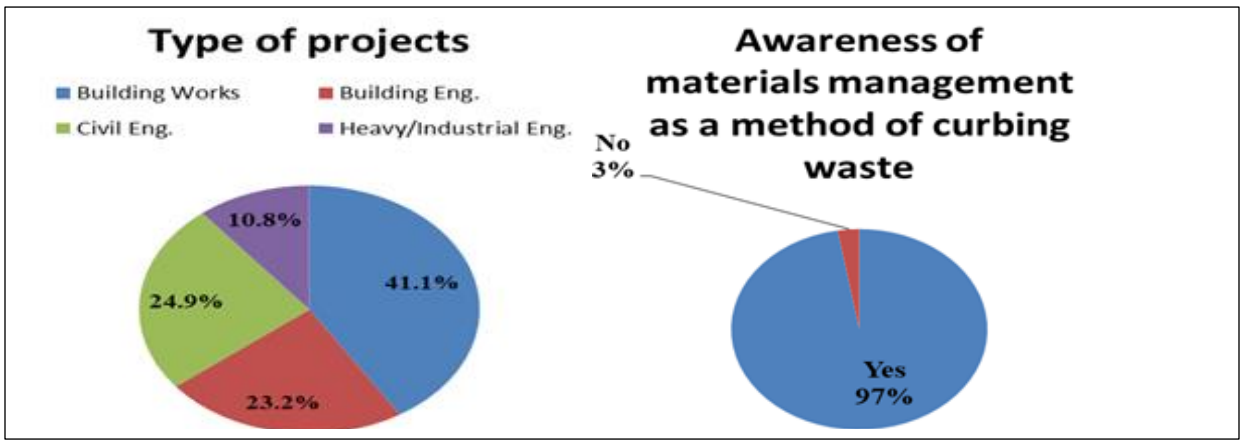

Figure 4: Types of projects engaged with and awareness of materials management

4.1.2 Respondents' Professional Qualifications

Based on the information shown in Figure 2, the categories of graduate, corporate, and fellow membership were being properly segmented for consideration. Corporate members of NIQS and CIPSMN/CIPS made up a considerable value of 18.9% and 16.2% respectively. This implies that the respondents are professionally qualified in their disciplines to give an adequate response to the research being undertaken.

4.1.3 Respondents' Years of Experience

Figure 3 showcases the respondents' years of experience, and concerning this, 95.1% of the respondents possess over five (5) years' experience in their various fields in the construction sector, making them capable of giving valuable information in line with the research being undertaken.

4.1.4 Awareness of Materials Management of Various Types of Projects

Figure 4 presents the awareness status of the respondents, including the type of projects they are involved in as well as knowledge of materials management as a method of curbing waste. According to the figure, the majority of the

respondents, with about 41.1% are involved in Building works, while the least respondents are involved in Heavy/Industrial Engineering works with 10.8%. Understudying their awareness of materials management, 97% of the respondents indicated full knowledge of materials management as a method of curbing waste, while 3% indicated otherwise.

4.1.5 Causes of Materials Wastage on Construction Projects

This segment presented the results of the data analysis of the causes of materials wastage on construction projects. As revealed in Table 2, "Low usage of modern construction techniques and practices" possessed the highest mean value of 3.19 and was ranked first. Following closely in second place is "Logistical issues relating to poor storage and supervision" with a mean value of 3.13. "Poor site management techniques" with a mean value of 3.08 ranked third, and, following immediately at fourth ranking with a mean value of 3.01, is "Procurement issues relating to purchase of materials and discrepancies". Coming from the bottom of the table, "Ineffective communication process among the project stakeholders", possessing a mean value of 2.76, was ranked lowest. The results of the mean values in Table 2 imply that materials wastage and its causes are very obvious among indigenous construction companies operating in Nigeria.

Table 2. Causes of materials wastage on construction projects

Item no	Causes of materials wastage	STD	mean		STD. deviation	rank
			STATISTIC	STD. ERROR	STATISTICS	
1	Low usage of modern construction techniques and practices, such as Estimating Software and Artificial Intelligence (AI)	0.48	3.19	.09421	.96517	1
2	Logistical issues relating to poor storage and supervision during materials application	0.53	3.13	.09688	.99361	2
3	Poor site management techniques, such as the absence of site planning and waste arrangement procedure	0.91	3.08	.09213	.91844	3
4	Procurement issues relating to the purchase of materials and discrepancies	0.37	3.01	.07128	.71286	4
5	Variation works as a result of errors in project design, errors made during construction, and, due to the clients' selected desires	0.89	2.98	.08449	.90441	5
6	The contractor's lack of zeal to achieve zero wastage and forgetting the construction sequence of work	0.74	2.94	.06752	.66152	6
7	Inadequate information, as well as the complex nature of the plan	0.86	2.82	.07288	.52784	7
8	Ineffective communication process among the project stakeholders	1.43	2.76	.16539	1.19582	8
Cluster Mean		**0.78**	**2.99**			

4.1.6 Materials Management Strategies Used by Indigenous Contractors

This aspect of the study revealed the detailed information details of materials management strategies employed by indigenous contractors on their various construction projects. Succinctly shown in Table 3, "ICT-based technology to manage materials on fast-track systems from design phase to construction phase" took possession of the highest mean value of 4.69, thereby ranking first. Trailing immediately in second position is "Making use of Building Information

Modelling (BIM) technological method", carrying a mean value of 4.68. With a mean significance of 4.67, "Reduce, reuse, and recycle materials through the engagement of low-waste technologies and tools" was rated third. The fourth position, with a mean value of 4.66, is "Well-organized process of harmonizing, identification, scheduling, procuring, transport, managing, storing, overseeing, and distribution of materials". Analyzing results from the rear of the table, "Automated procurement and materials management system (MMS) technique", carrying a mean value of 4.49, was rated as the lowest. The outcomes of the mean values in Table 3 indicate that indigenous contractors doing business in Nigeria engage several materials management strategies in waste management.

Table 3. Materials management strategies used by indigenous contractors

Item no	**Materials management strategies used by indigenous contractors**	**STD**	**MEAN**		**STD. Deviation**	**RANK**
			STATISTIC	**STD. ERROR**	**STATISTICS**	
1	ICT-based technology to manage materials on fast-track systems from the design phase to the construction phase	0.73	4.69	.09952	.99101	1
2	Making use of the Building Information Modelling (BIM) technological method.	0.73	4.68	.09980	.99072	2
3	Reduce, reuse, and recycle materials through the engagement of low-waste technologies and tools.	0.73	4.67	.09857	.98842	3
4	Well-organized process of harmonizing, identification, scheduling, procuring, transport, managing, storing, overseeing, and distribution of materials.	0.74	4.66	.07718	.74285	4
5	Indigenous contractors are to provide their clients with the waste indices (in m^3/m^2 GFA) of previously executed projects to be used as a benchmark for proposed projects.	0.76	4.62	.08299	.95448	5
6	Engagement of Near Field Communication (NFC) and Global Positioning System (GPS) technology tools for monitoring materials.	0.85	4.59	.094278	.85563	6
7	Project lifecycle methodology technique (as each stage of the project lifecycle produces different variants of waste for several reasons and from different causes).	0.80	4.58	.07581	.79899	7
8	Proper arrangement and organization of detailed plans even though it is conventional.	0.83	4.54	.06867	.78527	8
9	Special security plans and also observing of materials distributed on site.	0.86	4.51	.08816	.85239	9
10	Automated procurement and materials management system (MMS) technique.	0.92	4.49	.09558	.89251	10
Cluster Mean		**0.80**	**4.60**			

4.1.7 Effects of Material Management on Cost, Time, and Quality of Construction Projects in Abuja

This segment showcases the results of the data examination of the effects of material management on cost, time, and quality of construction projects in Abuja. As seen in Table 4, respondents rated "Inadequate materials management on construction sites is responsible for cost overruns" highly, thereby ranking it first with a mean figure of 4.97. Following immediately is "Proper management of materials leads to enhanced site appearance and improved site management," which ranked second with a mean value of 4.94. Taking a mean data of 4.90, "Well-organized materials management on construction sites can lead to effective project delivery" was graded third. The results portrayed in Table 4 strongly reveal that there are varying degrees of effects of material management on cost, time, and quality of construction projects.

Table 4. Effects of material management on cost, time, and quality of projects

Item no	Effects of material management on cost, time, and quality of construction projects	Mean	Rank
1	Inadequate materials management on construction sites is responsible for cost overruns.	4.97	1
2	Proper management of materials leads to enhanced site appearance and improved site management.	4.94	2
3	Well-organized materials management on construction sites can lead to effective project delivery.	4.90	3
4	Materials management on construction project sites results to decreased damage to vital components.	4.88	4
5	Financial advantage realized via materials management could improve the net turnover of the contractor and, passed to the building owner.	4.85	5
6	Materials management engagement leads to a decrease in dual handling and; decline in time wastage.	4.81	6
7	Materials management techniques develop the success pace of project preparation and accomplishment, thereby reducing the project cost.	4.76	7
8	Materials management is a mechanism to enhance performance in attaining the building owner's service desires.	4.72	8
9	Efficient management of materials can improve the output and cost efficiency of a project, also aiding in its timely completion.	4.69	9
10	The cost merit that could come up from materials management is coupled to the direct prices of both excess disposal and raw material procurement.	4.66	10
Cluster Mean		**4.82**	

The result in Table 5 reveals that material management has a positive and significant correlation with cost, time, and quality, $\beta = .935$, t statistic of 10.314, and computed p-value of 0.000, which is below the level of significance (0.05) adopted for this study. The Table shows that a unit change in cost, time, and quality leads to an increase in material management in Abuja by 0.977 units ($\beta = .977$). Moreover, the Table shows that material management 9.35% ($R_2 = 0.935$) variance in cost, time, and quality. Based on this result, the null hypothesis is rejected, which affirms that there is no significant relationship between material management on cost, time, and quality of construction projects in Abuja is hereby rejected.

Table 5. Multiple regression analysis results on the relationship between material management on cost, time, and quality of construction projects in Abuja

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-1.072	.230		-4.654	.000
	Cost	-1.087	.150	-.562	-7.254	.000
	Time	.696	.067	.499	10.452	.000
	Quality	1.604	.155	.977	10.314	.000

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.935[a]	.874	.873	.26078

a. Predictors: (Constant), Quality, Time, Cost

From Table 5, the regression model equation using the unstandardized coefficient is:

$Y = B + B_1x_1$

$Y = 0.1072 + 0.935x_1$ ---------- Equation 1

Where: Y = Materials Management

x_1 = cost, time, and quality

4.2 Discussion

There is rapid awareness of materials management strategies among indigenous contractors in Abuja, necessitating the need to properly understand the strategies being used by these indigenous contractors as well as the effects of these strategies on construction projects. This research thoroughly examined the effects of materials management on cost, time, and quality of construction projects in Abuja. Firstly, several causes of materials wastage in construction were investigated. The result revealed that "Low usage of modern construction techniques and practices" is considered the paramount cause of materials wastage. This finding aligns with the studies conducted by Zighan and Abualqumboz (2021), which asserted that low engagement of current construction techniques, such as methods of construction approaches and lack of know-how of current construction techniques and systems, will result in increased waste on projects. This particular finding can be of vital importance to indigenous contractors in upgrading their engagement of construction techniques to meet modern methods. Going forward, the usage of modern construction estimating software and artificial intelligence (AI) will assist construction stakeholders, especially indigenous contractors, in curbing waste, thereby leading to optimum management of construction materials.

Next in line being investigation are the various materials management strategies used by indigenous contractors. The study showcased that "ICT-based technology to manage materials on fast-track systems from design phase to construction phase" is obviously one method some indigenous contractors are using to manage materials on their projects. This corroborates the research carried out by Kasim *et al*. (2005), which discussed that the usage of ICT-based methodology in supervising materials on fast-track systems from the design phase to the construction phase can conveniently improve the efficiency of construction development. With this finding, indigenous contractors can make management decisions in their respective organizations to make use of ICT procedures in managing construction materials. The ripple effect of this decision as a form of materials management strategy will obviously be felt by other project participants during construction, as budgeted resources can be greatly utilized.

At this point, it should be noted that even though some respondents replied that low usage of modern construction techniques is the chief cause of materials wastage on construction sites, which is in line with Zighan and Abualqumboz (2021), others are of the notion that they are already using ICT based technology to carry out works on their projects and by implication, managing the materials used which tallies with the findings of Adriaanse *et al*. (2010). In one way or the other, the results point to the fact that modern techniques and technology is the way forward in managing

materials. Furthermore, with this engagement of ICT based technologies, it is hoped that there will be health competition amongst indigenous contractors at regional or global platforms for efficient management of materials leading to optimal project delivery as highlighted by Yeomans *et al*. 2005; Hjelt and Björk 2006; Adriaanse *et al*. 2010.

Last to be examined are the effects of material management on cost, time and quality of construction projects. The result shows that "inadequate materials management on construction sites is responsible for cost overruns". Following immediately as regards quality is that "proper management of materials leads to enhanced site appearance and improved site management". These findings go in line with the studies undertaken by Ameh and Itodo (2013) who believed that inadequate materials management on construction sites is responsible for cost overruns because managers pay minimal attention to the effects of created material waste at planning phase of a project and; Tait and Swaffield (2013) who explained that the commercial merits related with the materials management on construction project sites comprise: decreased damage to vital components, enhanced site appearance, decrease in dual handling, enhanced site management. This discovery can be useful to construction managers in proper cost and quality management at several stages of executing construction works. By extension, indigenous contractors and their various site engineers will find these results more beneficial as cost and quality planning from the conceptual stage down to execution will be properly monitored for efficient project delivery.

Based on the information analyzed, the survey participants (mainly Project Managers, Quantity Surveyors, Builders, Procurement Officers, and Store Keepers) understand the causes of materials wastage, materials management strategies to be used, and the effects of these strategies on cost, time, and quality of construction projects. This research has been able to provide succinct details of materials management strategies as well as their cost, time, and quality effects in order to assist construction stakeholders, especially indigenous contractors, in knowing the appropriate materials management strategies to engage for efficient execution and delivery of construction projects.

5. Conclusion and Recommendations

Various materials management strategies are employed for usage by indigenous contractors in Abuja, and as such, their effects on construction projects via cost, time, and quality ought to be properly understood. The current research aimed to assess material management strategies used by indigenous contractors on construction projects in Abuja. A questionnaire survey of 185 respondents, basically comprising Project Managers, Quantity Surveyors, Builders, Procurement Officers, and Store Keepers engaged with indigenous contractors in Abuja, was carried out to assess materials management strategies. The research has revealed that low usage of modern construction techniques and practices is the paramount cause of materials wastage; ICT-based technology to manage materials on fast-track systems from the design phase to the construction phase is greatly being used, and inadequate materials management on construction sites is responsible for cost overruns. The revelations of this study showcase key methods used in materials management by indigenous contractors in Abuja.

In line with the analyzed data, it is obvious that ICT-based technology to fast-track systems from design to the construction phase is the most engaged materials management strategy being used, and cost and quality greatly suffer the most if insufficient materials management practices are put in place on construction sites. The outcomes point out the fact that it is necessary for indigenous contractors, subcontractors, and virtually all construction stakeholders to embrace and seriously engage the use of convenient ICT-based technologies in their various companies in managing construction materials to achieve significant value. They should also understand that to guard against cost escalation and poor quality on construction projects being executed, sound materials management practices from the conception stage to the execution stage need to be put in place. It is hoped and recommended that the Federal Ministry of Works and Housing through regulatory bodies such as Council for Registered Builders (CORBON) and Quantity Surveyors Registration Board of Nigeria (QSRBN) spell out guiding procedures for the adoption of advanced materials management strategies such as ICT-based technologies by indigenous contractors for cost efficiency and optimal quality of construction works. It should be noted that even though the study was conducted in Abuja, the findings could prove to be very resourceful to indigenous contractors in several states in Nigeria. Future research should focus on: identifying factors that hinder the adoption of ICT-based technologies on materials management for sustainability;

the economic feasibility of engaging ICT-based technologies on materials management for sustainability and; the impact of materials management training programs and policies on project delivery. This will further enlighten indigenous construction stakeholders on best practices in handling materials management on their various construction projects.

Declarations

Ethical Approval and Consent to Participate:

Informed consent, both verbal and written, was obtained from all participants before data collection. The study was conducted with full transparency.

Consent for Publication:

All authors consent to the publication of this manuscript and confirm that the work is original, has not been published elsewhere, and is not under consideration for publication elsewhere.

Competing Interests:

The authors declare no competing interests related to this study.

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Data Availability:

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Authors' Contributions:

Write each author's contribution. See the example below.

Oni Olalere S: Conceptualization, methodology, and manuscript drafting. Oni Olalere S, Uzoma C: Data collection, analysis, and figure preparation. Oni Olalere S, Jegede Veronica O, Burkar A: Literature review and critical manuscript revision. All authors read and approved the final manuscript.

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