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Contemporary Assessment of Effect of Construction Material Waste Management on Final Costs of Projects in Nigeria: An Empirical Approach

F. Onyia[1]., C.I. Anyanwu (Ph.D)[1]., G.C. Enyinna (Ph.D)[1]., O. A. Amuda (Ph.D)[2] ., P.P.C. Njoku[1].
Affiliation: [1]Department of Project Management Technology
Federal University of Technology Owerri
[2]Department of Quantity Surveying
Imo State University Owerri
gregory.enyinna@futo.edu.ng

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ABSTRACT

This paper presents an evaluation of the extent to which materials waste management in construction project sites affect final project cost. Nigeria is the largest African country with potentials for construction and building investment; and thus the problem of construction material waste is well known in Nigeria; but it seems not to be given the recognition or the attention it deserves. This paper therefore used descriptive survey research design and thus random sampling technique; hence 161 construction professionals from two notable indigenous firms in Enugu state formed the population of the study, from which a sample size of 115 was arrived at. In the analysis descriptive statistics and multiple regression were employed for descriptive analysis and hypothetical testing respectively; while earned value analysis (EVA) was deployed in the secondary data for the effect of material waste on final project cost. Finally analysed was done using SPSS version 24 for ease of computation. The result of the research shows that that implementation of material recycling on site have a significantly positive impact on final cost of construction projects as it will reduce projects marginal cost. Also the study concludes that the variation between the volume of material used in a project and the volume of material waste in such a project will give similar or more percentage variation between the planned cost of the project and final cost of the project. This means that the effect of the material waste in a project will not reduce the final cost of a project but rather will increase the cost. It recommends that a pragmatic mathematical model for the quantification of onsite-material waste and the mathematical equation for managing material waste and cost overruns be developed by construction firms.

Key words: Construction materials; material waste; waste management; project delivery.

1. INTRODUCTION

A large quantity of waste is produced worldwide by the construction industry, which has a negative impact on both the environment and human health and safety due to a lack of clarity in the development and use of material waste management techniques [1]. Because of population expansion, lifestyle choices, consumption, and technological innovation, the rate of material waste creation has continued to rise, strengthening the need to address this environmental issue [2].

Improper management of construction materials during the execution of construction activities is a crucial factor that negatively impacts the performance of construction projects. To put it simply, if the flow of construction materials is not managed properly, it will unavoidably result in a significant variation in project cost [3]. By using corrective measures in cost variance, the project's overall cost can be somewhat decreased [4]. It is known that not all of the materials that are delivered to construction sites are used for the intended purpose, and that builders often use more materials because they were paid less than anticipated or because materials are lost or used on-site in ways that estimators are unable to record [5]. Many construction businesses still need to learn how to properly manage material waste on construction sites.

Construction project waste management could be referred to as practices involving such techniques as recycling and prefabrication, work procedures such as waste sorting, and other management techniques geared towards materials waste management in the construction industry [4]. Inherent in construction project works are various waste materials that could be considered a garbage, undesirable and harmful such as asbestos, and materials like rocks, soil, asphalt, bricks, concrete, plasterboard, wood, and polluted soil. Material wastes in project sites include concrete, masonry, timber, sandstone, metal, and limestone reliant on such waste [6]. According to [7], building waste also includes a significant proportion of paper and plastic, which arises from packaging materials and supplies, reclaimed timber from carpentry, and other materials left behind.

However, the construction industry in Nigeria, one of the main sectors that greatly contributes to the socioeconomic development and growth of the country, has most projects at

risk of cost escalation to the point where they require additional funding as well as specialized knowledge, which frequently results in technical and project management disputes among project stakeholders [8]. Poor waste management of construction materials is another factor contributing to these cost escalations [9].

In Nigeria, controlling material waste on construction projects is still a difficult undertaking. This has caused Nigerian construction projects to become more expensive over time [10]. Without taking into account that the majority of the factors causing needless financial loss stem from poor management of materials waste, many contractors have mistakenly developed the attitude of accepting it as part of the building processes due to the complexity that comes with trying to develop a sustainable management technique of materials waste on construction sites [11]. Furthermore, the Nigerian construction industry faces numerous obstacles in managing waste from construction materials in projects, including inadequately strict laws, lax enforcement, inadequate facilities and a collection network, low public awareness, insufficient capacity, and careless local contractor behaviour brought on by improper construction waste control and monitoring [11]. All of these issues have an impact on project costs. For instance, while Julius Berger Nigeria JBN was building the second Niger Bridge, more than 15,000 tons of old asphaltic concrete tore off the existing pavement near the Ogbaru section. The intended consumers either complained about the expense of transporting the waste to the necessary sites or the cost of labour needed to load the waste of such scale, making disposal of the waste more difficult [12]. One of the other issues was that there were just a few places (untarred roadways) where the garbage could be recycled. In light of this, managing the waste became an overwhelming undertaking. Therefore, this study aims to evaluate the influence of construction waste on project cost since handling construction material waste in projects is a widespread issue. The article is organized into five parts.

2. LITERATURE REVIEW

2.1 Concept of Material Waste

Material wastes are those that are useless for construction purposes and they are disposed of. Similarly, [13] defined material waste as non-value-adding elements in construction projects, highlighting its detrimental impact on the industry. [14] have identified the impacts of material wastage to include pollution, resource depletion, climate change, and energy consumption. The other effects are time overrun, cost overrun, and a source of dispute [15][16].

Numerous factors, including the construction process, the attitudes of the construction personnel, the materials utilized, and the site circumstances, might influence the causes of material waste [16]. Although a variety of causal factors have been found in the context of this study, the ones that are relevant to this investigation are those that were identified by [17]. 22 waste sources were found and grouped into six categories: client-related, management-related, supply and storage-related, design-related, construction-related, and extraordinary events. Commonly mentioned human-induced issues that may be lessened by using efficient waste management techniques include design changes, insufficient monitoring, and inappropriate material handling [18].

Waste generation from construction activities is a significant contributor to environmental pollution. As this research progresses, it will become evident that effective waste management has continued to be a major priority to the construction industry in a means to keep the environment safe for the people living in it. In terms of onsite management activities, adherence to design documents, minimizing the number and extent of design changes, and more accurate estimation of materials required at each construction stage are identified as practices with significant potential to reduce waste generation [19]. Effective onsite management of construction waste is also crucial for determining its proper disposal. Onsite management of construction waste plays a crucial role in determining its final destination and proper disposal.

2.2 Factors Contributing to Materials Wastage in Construction Sites

The various factors contributing to materials waste were grouped into six categories, namely, client, management, supply and storage, design, construction and phenomenal occurrences [20] (see figure 1) below:

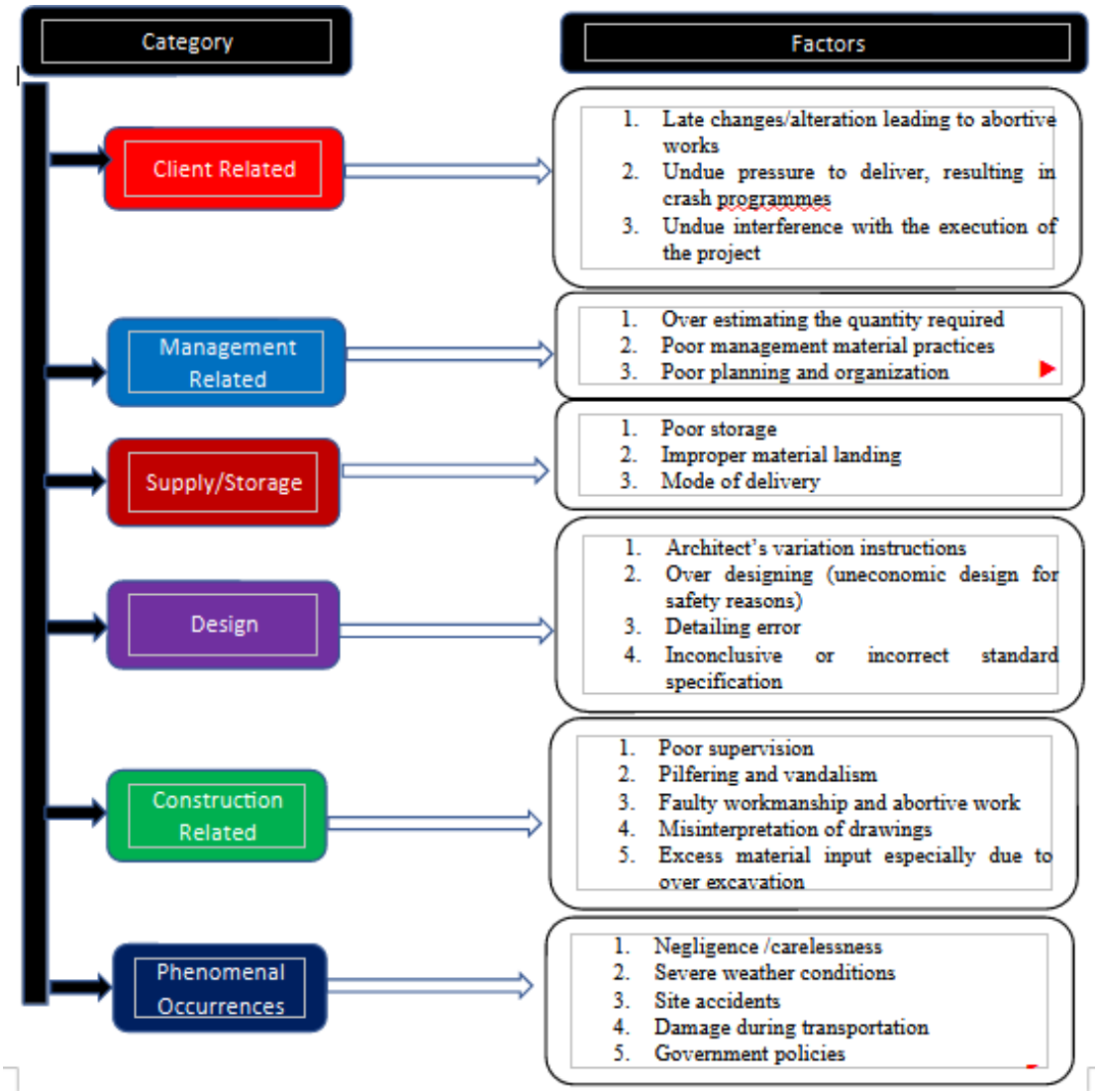

Figure 1: Contributing factors to material wastage in construction, Source: [20]

2.3 Waste Management in Construction

A key component of construction is waste management, where the goal is to minimize and reuse the amount of trash produced [21]. By combining social, environmental, and economic concepts that promote sustainable development, sustainable building is intended to be accomplished. Generation, storage, collection, transfer, processing, and disposal are the main phases of waste management [21]. At every level, a variety of strategies can be used to guarantee efficient administration. Throughout the whole building process, from design to demolition, waste creation may be unavoidable, but reduction is achievable [22]. Previous studies [19] [23] have highlighted that one of the most appropriate strategies for managing waste is to minimize them through design. Generating less waste initially reduces pressure on subsequent stages of the waste management process. Conversely, the final stage— disposal— is fundamental in determining the success and effectiveness of the entire management process, because poor and indiscriminate waste disposal would constitute environmental degradation. Therefore, it is important to carefully select and adopt disposal methods that are environmentally friendly for construction material wastes due to their invaluable characteristics that could serve as resources for other industries.

Before waste management is done, is paramount to categorise construction waste:

There are two categories of construction waste at the site: physical waste and non-physical waste. Materials that are lost, damaged, irreparable, or useless during building operations are referred to as physical waste. Non-physical wastes, on the other hand, are associated with delays and cost overruns in building projects, including time and money [24]. Only physical wastes, such as those from construction and demolition, are the subject of this study. The biggest source of construction waste is waste from building and demolition.

These wastes are produced at every stage of the building process, from design to occupation, as their names suggest [25]. Waste resulting from building, remodeling, and demolition operations is referred to as construction and demolition (C & D) trash [26]. Various sources of these wastes include errors made during the design stage by architects, inadequate procurement by contractors, poor planning, improper handling of materials during construction, leftover raw materials, and changes in building design due to the involvement of multiple decision-making stakeholders [27].

2.4 Examples of common construction and demolition wastes

These types of wastes are generated right from the time the project begins through to the completion time. They include:

Wood

This material is used in different forms in a construction site. It may be chip wood, plywood, shavings, sawdust and may be used as elements such as doors. Wood becomes a construction waste if it is rendered useless and thrown into the garbage [28] (see figure 2 below)

Figure 2: Wood waste in a building site, Source: [29]

Timber is known to rot when it comes to contact with water and so, if not properly managed, it becomes a problem to use it for its intended purpose. To maximize the use of wood by the contractors and reduce wastage variety of wood products are bonded mechanically to produce Engineered Wood Products (EWPs) which are structurally efficient and largely renewable [29]. This type of production makes it possible to reuse and recycle wood products collected from demolition and use them in another phase of the construction. If properly managed, timber is the most environmentally friendly building product.

Masonry wastes

Masonry products are materials that are obtained from natural raw materials such as clay and soil. They include building blocks and concrete. If disposed of, they form a large part of construction wastes are generated from these materials through demolition and cutting of the large-sized materials while being shaped [29] (see figure 3)

Figure 3: Concrete Demolition Waste along Trans-Amadi, Port Harcourt, Nigeria, Source: [30]

The best management practices of these materials are through proper planning such as procuring the materials on-site just before they are used so that they could not be rendered useless while using them. Also, recycling is one of the best ways to reduce these wastes. If carefully handled, they can be used in a different phase [29].

Metal wastes

The increasing use of metals in construction indicates a corresponding rise in the generation of metal waste. Metals are among the most preferred building materials due to their availability in various forms and shapes. In Nigeria, the management of metal waste has been poorly managed, which has led to environmental hazards because a large percentage of the metals thrown as wastes are not recycled and reused to manufacture other materials [29] (see figure 4)

Figure 4: Metal waste in a construction site, Source: [30]

Ceramic wastes

Ceramic wastes encompass materials such as porcelain, tiles, sanitary ware and bricks. It is estimated that over 30% of debris collected from construction sites is ceramic waste [31]. Ceramic wastes are generated from off-cuts and through breakage because of poor handling of the materials

on site while fixing. In developed nations, the recycling of ceramic wastes is being practiced and this is done by mixing the ceramic wastes with concrete while building, which is rarely the case in developing countries like Nigeria [32]. From figure 5 below, the outcome is a material with increased compressive strength.

Figure 5: Ceramic waste in a construction site, Source: [29]

Other wastes

Construction wastes are extensive and cannot be fully addressed in a single study. Additional materials include drywall, plastic, glass, electrical wiring, among many others. Demolition wastes are generated from the process of dismantling a construction.. Examples of demolition wastes include, but are not limited to masonry blocks, concrete, timber, metals and aluminum. Construction wastes are generated from the construction process itself.

2.5 Materials Waste and Project Cost Overrun in Nigerian Construction Site

One of the most important factors and a key factor in project success is cost. It has been considered a significant issue at every stage of the project management process. Despite its acknowledged importance, building projects frequently fall short of their budgetary targets. Poor cost performance, or the failure to finish a project within the allocated budget, is a concern facing the Nigerian construction sector [33]. Accordingly, [34] contend that while Nigerian infrastructure projects are comparable to those of commonwealth nations like the United Kingdom, the country's cost overrun issue is more serious than that of other nations. In Nigeria's construction business, cost overruns are more common and a more serious issue than schedule overruns [35].

Additionally, waste may significantly damage a building project's performance because it primarily affects construction expenses. Material waste would raise the overall cost of building projects on construction sites [36]. Any country's socioeconomic progress is aided by the construction sector, however it faces issues with material waste, time overruns, and cost overruns [37]. Material waste and cost overruns are worldwide problems that make it difficult to finish many building projects on time and within budget [38]. Research from all around the world has shown that a large amount of manufacturing expenses are attributable to material waste. According to a recent research by [16], material waste accounts for an average of 4% of project cost overruns. Therefore, poor waste and material management raises the overall cost of construction projects [38].

Various factors can lead to material waste and cost overruns during different phases of a project, such as planning, estimating, design and design management, and construction. Mitigating the impact of these causes requires identifying them at every step and putting in place appropriate control measures to reduce their recurrence [37]. There is still no solution to the waste of construction supplies issue. According to [38], for instance, the trash produced by constructing 100 homes in Nigeria is enough to build an additional 10. Moreover, 10% of the materials sent to construction sites in the UK are wasted [39].

According to [37], material waste and cost overruns at every step of a project often overlap by 86.74%. Various microeconomic and macroeconomic elements are additional contributing factors that have nothing to do with the phases of project management. They also divided the material waste causes that contribute to cost overruns into four categories: operations, site conditions, storage, and security. There is, however, very little research evidence demonstrating a significant correlation between construction material waste and cost overruns in the Nigerian construction industry. [40] classified time and cost overruns as non-physical waste, whereas other material waste is the physical waste on a construction site. In order to identify techniques for efficient waste management and to comprehend how waste contributes to cost overruns in the Nigerian construction sector, research on these topics must be done.

3. RESEARCH METHODOLOGY

This section explains the research method applied to investigate the impact of construction material waste on project cost and how it can be managed. In this study, the descriptive survey research design was utilized in this study. This is so because of the absence of archival data in most Nigerian construction organizations. Meanwhile it is simple and survey means—to view comprehensively, and in detail or— the act of obtaining data for mapping. Also, survey is used in this study because it is wide and inclusive in coverage, it generally seems to bring things up to date and relate to the present state of events. The study area is Enugu State Nigeria and the study was carried out in Independence Layout and Emene, Enugu State. The choice of this area was purposive, because of the predominance of construction industries in the area. The population of this study is 161 professionals that include Architects, Quantity Surveyors, Civil Engineers, Structural Engineers, Mechanical Engineers, Electrical Engineers, Construction Project Managers, Land Surveyors and Developers in Pawid Constructs Limited Enugu (specializes in Building and Road construction) and Akiota Works Limited (Specialises

in Dams, Water Works and Power Plant Projects)

The sample size was statistically determined using the formula of Taro Yamane. The formula is stated below Where:

$$n\frac{N}{1+N(e)^2}$$

N = Population size
e = Level of significance
n = sample size
Thus:

$$n = \frac{161}{1 + 161x\ (0.05)^2}$$

$$n = \frac{161}{1 + 161x\ 0.0025}$$

$$n = \frac{161}{1 + 0.4}$$

$$\frac{161}{1.40}$$

$$n = 115$$

A standardized questionnaire on a five-point Likert scale was used in the study to collect responses from participants. Since it has been utilized by numerous writers, the study's methodology is not new. This was consistent with Tunji-Olayeni et al. (2018) doing a survey of a similar nature where thirty-five artisans chosen by purposive sampling on building sites in Lagos, Nigeria, were given a standardized questionnaire. A survey approach is appropriate for characterizing trends in a sizable sample of respondents, according to Plano-Clark and Creswell (2015). Frontline construction workers served as the study's respondents; they were present on ongoing building sites to guarantee that they were qualified to reply to questions based on their professional backgrounds. 101 questionnaires were returned and were appropriate for analysis out of the 115 that were distributed. This resulted in a response rate of almost 88%. Akintoye and Fitgerald (2000) thought this was sufficient, recommending that the benchmark response rate for the construction sector be between 20% and 30%. Multiple linear regression for the hypothesis and descriptive statistics to address the research topic are two statistical techniques used in the data analysis procedure. Similar to simple regression, multiple regression may be described as follows: The model describes the connection between dependent variables Y and a collection of K independent variables X1, X2, X3,……XK:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \cdots \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + e$$

The test was conducted at 5% level of significance. Statistical software for social science (SPSS) version 24 was employed for conducting multiple regression analysis in this study. The decision rule is thus if power of text (p - value) or significance is less than α, the null hypothesis is rejected, and the alternative hypothesis accepted, but if the other way round, the test is therefore said not to be significant.

4. RESULTS

4.1 Demographic Profile of Respondents

Table 1: Demographic Profile of Respondents

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	Variables	Freq.	Percent (%)
Gender	Male	74	73.3
	Female	27	26.7
Profession	Architect	20	19.8
	Builder	23	22.8
	Engineer	18	17.8
	Quantity Surveyor	17	16.8
	Project Manager	23	22.8
Years of experience	Less than 5 years	18	17.8
	5 - 10 years	37	36.6
	11 - 15 years	36	35.6
	16 - 20 years	2	2.0
	Above 20	8	7.9
Academic Qualifications	ND	23	22.8
	HND	41	40.6
	B.Sc/BTech	25	24.8
	M.Sc/MTech	12	11.9
	PhD	0	0.0

Table 1 depicts the details of the respondents involved in the survey. The details include their gender, profession, years of experience and academic qualification. It further shows the general information of the 101 respondents who partook in the conducted study. The analysis reveals that a greater part (73.3%) of the participants are males, while 26.7% was represented by their female counterpart. The result further shows that in terms of profession, the study consisted more of Builders (22.8%) and Project managers (22.8%) than Architects (19.8%), Engineers (17.8%), and Quantity surveyors (16.8%). It was also observed that most the respondents' years of experience in construction industry fell between 5 - 15 years (72.2%), followed by those who just got employed (less than 5years) (17.8%), least fell within those from 16 and above (9.9%) in the industry. Lastly, the academic qualifications of the respondents were also checked to avoid misunderstanding of the subject matter. It was found that the study comprised more of HND holders (40.6%), than B.Sc/BTech (24.8%), ND (22.8%), and M.Sc./MTech (11.9%) holders. It was deduced from the above general information of the participants that respondents are well equipped with professional experience to give reasonable insight in the subject under consideration.

4.2 Material waste management practices in Nigeria construction industry

Table 2: Material waste management practices in Nigeria construction industry

Item	SA	A	N	D	SD	$\bar{x}$	SD
Using less material in design and construction will prevent waste.	38	46	7	9	1	4.10	0.9
Autonomous technology use during execution will prevent errors and faulty workmanship which will in turn prevent material waste generation.	32	27	15	20	7	3.60	1.3
Using less hazardous materials will reduce waste.	9	28	24	30	10	2.96	1.2
If detailed technical information about the construction materials or construction process can be taken account by the designers, a significant amount of waste can be avoided and reduced.	25	21	4	22	29	2.91	1.6
Adequate estimating and ordering of material reduces wastes.	33	14	9	17	28	3.06	1.7
Implementing efficient material saving construction techniques reduce construction waste.	26	26	8	12	29	3.07	1.6
Using recyclable materials in construction reduces waste	22	25	3	21	30	2.88	1.6
When properly sorted, material such as clean concrete and asphalt can be recycled for use in construction	31	27	15	21	7	3.53	1.3
Large proportion of waste such as such as debris, rubble, earth can be reused for public fill.	11	30	27	22	11	3.07	1.2
Using raw materials for the same equivalent use eliminates wastes.	37	43	8	6	7	3.96	1.1
Creating value added products reduces waste	59	24	9	6	3	4.28	1.1
Using anerobic digestors and incinerators on site will help in energy recovery and waste reduction	35	27	16	13	10	3.63	1.3

Source: Field data, 2024

Table 2 shows the result of the data obtained in quest to unravel the material waste management practices employed in the construction industry. The responses indicate that using less material in design and construction will prevent waste (M=4.10, SD=0.9), autonomous technology use during execution will prevent errors and faulty workmanship which will in turn prevent material waste generation (M=3.60,SD=1.3), adequate estimating and ordering of material reduces wastes (M=3.06,SD=1.7), implementing efficient material saving construction techniques reduces construction waste (M=3.07, SD=1.6), when properly sorted, material such as clean concrete and asphalt can be recycled for use in construction (M=3.53, SD=1.3), large proportion of waste such as such as debris, rubble, earth can be reused for public fill (M=3.07, SD=1.2), using raw materials for the same equivalent use eliminates wastes (M=3.96, SD=1.1), creating value added products also reduces waste (M=4.28, SD=1.1), and the usage of anerobic digestors and incinerators on site will help in energy recovery and waste reduction (M=3.63, SD=1.3).

It is apparent from the result that only nine of the items under consideration were picked as materials waste management practices and their consequent impact amongst the selected professionals in the construction industry.

4.3 The effects of material waste management on final cost of construction project

Table 3: Material waste management effect on final cost of construction project

Item		P-value	**Decision**
The adoption of autonomous technology during project execution, in turn eliminates cost overrun of construction projects	0.032	0.754	Insig.
Adequate practice of waste reduction eliminates chances of cost overrun at project completion	0.006	0.950	Insig.
Waste (debris, rubble, earth) reuse practice helps the effective and proper management of cost from project inception to completion	0.128	0.203	Insig.
Implementation of material recycling on site curbs chances of poor turn over and insolvency	0.824	0.000	Sig.

Source: Field data, 2024

Table 3 is a response of the professionals to unravel the impact to which materials waste management has on the final cost of construction projects. From the table, it can be seen that only implementation of material recycling on site was found to have a significantly positive impact on final cost of construction projects (r=0.824, p-val=0.000).

4.4 Hypothesis Testing

Ho1: Material wastage management has no significant effect on final cost of construction project.

Table 4: Independent variable (material wastage management)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.309[a]	.096	.086	.64617
a. Predictors: (Constant), MatWastMange2				

Table 4 indicates that the independent variable (material wastage management) accounts for about 9% of the total variability in the model. This is not a good representation of the equation pertaining materials wastage management and final cost of construction project.

Table 5 : Anova

ANOVA[a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	4.367	1	4.367	10.460	.002[b]
	Residual	41.336	99	.418		
	Total	45.703	100			
a. Dependent Variable: FinalCost						
b. Predictors: (Constant), MatWastMange2						

Table 6: Coefficents

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.164	.380		8.322	.000
	MatWast Mange2	.078	.024	.309	3.234	.002
a. Dependent Variable: FinalCost						

From tables 5 -6, $p - val = 0.002$ at, the decision is to reject the null hypothesis and conclude that the materials wastage management have a significant impact on final cost of construction projects.

Table 7: Earned Value Analysis of Selected Projects in Enugu State to show the Impact of Material Waste on Project Cost

Projects	**Year**	**Volume of material used (M3)**	**Volume of material waste recorded**	**% Variation**	**Planned Project Cost (Naira)**	**Project cost so far (Naira)**	**Cost Variations (Naira)**	**% Variation**	**CPI = EV/ AC**	**Remark**	**Status Of The Project**
Construction of University of Nigeria College of Medical Science Building, Phase I, UNTH, Ituku Ozalla	2024	14,221m^3	1,345m^3	9.5%	493.5 million	547million	53.5miil ion	9.1%	0.9	Over Budget	Completed
Construction of Administrative Building, University of Nigeria, Enugu Campus	2024	13,416m^3	991m^3	7.4%	300million	339million	2,125,000	11.5 %	0.88	Over Budget	Completed
Construction of St. Michael's Priory Building, Enugu: Phases 1, 2, and 3 for the Society of Saint Pius X, Saint Michael's Priory, Enugu	2021	17,689m^3	3,722 m^3	21%	950million	1.279billion	475,000	22.6 %	0.74	Over Budget	Completed
Average CPI									**0.84**		

EV (Earned Value) = % Work Complete x Budget
AC (Actual Cost) = Amount spent on Project
CPI (Cost Performance Index) = EV/AC
Since the aforementioned projects have all been completed, the work completion percentage (%) is 1 (i.e., 100%). This determines the earned value (EV) of each project. The Cost Performance Index computation provides information on the project's financial health. A number less than one suggests a project that is over budget, a value of one shows a project that is on budget, and a value more than one indicates a project that is under budget, according to the formula CPI = EV / AC.

< 1	= 1	> 1
OVER BUDGET	ON BUDGET	UNDER BUDGET

From the table 7 above, the average cost performance index for the three projects carried out in Enugu State by both Akiota Works and Pawid Constructs is 0.85, which connotes that averagely, the projects are always over budget which means that majority of projects has actual project costs that exceeds the planned/budget costs. Furthermore, a major reason to this is from the volume of material wastage recorded. It is imperative to note that the percentage variation of the material waste recorded in project 1 which is 9.5% contributed to about 9.1% cost variation in the project; for the second project, the percentage variation of the material waste recorded which is 7.4% contributed to about 11.5% cost variation of the project which is highly significant than in project 1. Finally in project 3, 21% variation of material waste contributed to about 22.6% cost variation in the project.

5. DISCUSSION

The study in evaluating the impact of construction materials wastes management in project cost, indicated that using less material in design and construction, adoption of autonomous technology, adequate estimating and ordering of material, implementing efficient material saving construction techniques recycling of materials such as clean concrete and asphalt, creating value added products, and the usage of anerobic digestors and incinerators on site, are practices adopted for materials waste management for construction projects. Hence this findings connote with that of [4] on material waste management practices. Though the both studies are not

geographical tailored to the Nigeria construction industry. For the construction industry in Nigeria, [41] finds that rework caused by non-compliance with drawings and specifications, design variation, and modification are the primary contributors to construction material waste in Nigeria. As a result, recycling materials as a waste management method would become less common in the Nigerian construction sector if rework is dramatically minimized and project design and implementation are properly integrated. [41] confirmed that the component with the lowest grade was insufficient waste of construction materials. [42] stressed that contractors and consultants have similar understandings of the factors that contribute to construction waste generation, which supports [41] remarks. In their view, poor supervision of construction workers leading rework is the major factor contributing to material wastage in the Nigerian construction industry.

The study shown that the installation of material recycling on site has a considerable favorable influence on the final cost of building projects when it comes to the impact of material waste management. This aligns with the findings of [43], which demonstrated that material recycling on site and during construction would be a workable solution to lessen its severe impact, even though materials wasted due to errors and rework would ultimately impact the project's cost and even necessitate a time extension, increasing the project's ultimate cost. According to [an estimate for a project i1] s usually insufficient since there is a lot more waste created by building projects in Nigeria, even with the 5% provision established to address material waste during the planning phase. [44] pointed out that because of material waste during construction, more building materials are usually acquired in Nigeria. Therefore, according to [45], implementing a circular economy approach of material recycling will lower the project's ultimate cost by 15–25%. Furthermore, according to [45], the circular economy of material recycling will minimize project marginal costs, the cost of purchasing virgin materials, waste disposal expenses, and environmental taxes during construction, all of which will lower the project's overall cost.

6. CONCLUSION

Cost overrun is a problem that affects 95 percent of completed projects worldwide, and the debate over how to reduce or eliminate it has been going on for the past 70 years. This is because on-site material waste raises the final project cost, while material waste has become a serious issue in the Nigerian construction industry that needs immediate attention. Research from throughout the globe has demonstrated that waste from construction materials accounts for a comparatively high portion of manufacturing expenses. Due to a lack of professional understanding, the construction sector in Nigeria continues to pay little attention to the impact that created material waste has on cost overruns. However, this study found out that implementation of material recycling on site have a significantly positive impact on final cost of construction projects as it will reduce projects marginal cost. Also the study concludes that the variation between the volume of material used in a project and the volume of material waste in such a project will give similar or more percentage variation between the planned cost of the project and final cost of the project. This means that the effect of the material waste in a project will not reduce the final cost of a project but rather will increase the cost. In order to lessen the need for new materials, cost overruns, and the strain on the country's existing landfills, the study recommends the federal government of Nigeria establish an enabling environment by developing a policy that would promote the establishment of a recycling market. Issues including site and environmental conditions, design standards, and building methods must be carefully considered in the early phases of a project in order to minimize material waste and cost overruns. Finally, construction companies should develop a mathematical algorithm for managing material waste and cost overruns as well as a practical mathematical model for quantifying onsite-material waste. This will allow the professionals to assess how much waste is generated and determine how much can be reduced.

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