STRATEGIES FOR MATERIAL WASTAGE MNIMIZATION ON BUILDING CONSTRUCTION SITES IN KADUNA STATE – NIGERIA

Okosun B.O., Oyewobi, L.O., and Odine, L.C.
Department of Quantity Surveying, Federal University of Technology, Minna

A major feature of average construction sites in Nigeria is the presence of material wastage in various forms and in large quantities. Construction materials often account for more than 50% of the total cost of buildings in Nigeria and a greater part of it is wasted during construction process. To this extent, the study evaluated the cost of wastage of some selected materials and waste minimization techniques adopted on construction sites. Mean Score, Ranking and T-Test were employed for data analysis. Findings revealed that the major factors that contribute to material wastage were poor supervision, improper material handling and faulty workmanship. In addition, the study indicated that there is no significant relationship between estimated and actual material waste on construction sites based on the P-value of 0.296 which was greater than 0.05. It was concluded that material wastage has an effect on contractor's profit margin and overall project cost which accounted for over 50%. Cement, blocks and formworks had the highest wastage indices of 6.01, 10.67 and 10.09 respectively. The study recommended that materials with high negative wastage indices should be given greater attention.

Keywords: Materials, Strategies, Waste, Construction Sites

INTRODUCTION

The construction industry is one of the vital constituent of any country's economy. The growth in construction activities increases the amount of construction waste generated (Babatunde, 2012). Dennis (2001) established that the construction industry has been found to be one of the major generators of waste in the built environment. Building materials account for 60 – 70% of the project cost (Mahesh, Chetna, Bhavsar and Rakesh, 2011). Up to 15 – 30% of purchased materials at construction sites end up as waste in landfill sites in many countries (McDonald and Smithers, 1996). Generally, construction activities which produce waste can be grouped into off-site and on-site operational activities. Off-site activities include prefabrication, project design (architectural, structural, mechanical and electrical design), manufacturing and transporting of materials and components. On-site construction activities relate to construction of a physical facility which consists of the substructure and superstructure of a building. Some degrees of waste materials are inevitable in the construction process. All estimators allow wastage factors in the pricing of BOQs. Over the years, experience has shown, however, that unless site management control is tight, wastage can frequently exceed, often by a large margin than the figure allowed in the tender document (Wahab and Lawal, 2011). This assertion is in line with Babatunde (2012), his study concluded that construction material wastage accounted for an average of 15.32% in construction sites which was higher than the allowable waste in the BOQ. Dennis (2001) asserted that many building materials that are wasted on construction sites, result in two cost factors (materials procurement cost and the waste disposal cost). Although the waste disposal cost of construction site waste form as little as 0.5% of the total budget of a typical building project, contractors realize that this cost can significantly affect their profit since contractors generally operate within a tight 5% profit margin.

blezy2003@yahoo.com

Okosun, et al., (2018). **LIVELIHOOD OPPORTUNITIES IN SOLID WASTE RECYCLING IN KADUNA METROPOLIS, NIGERIA.** Contemporary Issues and Sustainable Practices in the Built Environment. School of Environmental Technology Conference, SETIC, 2018

Most construction managers and building professionals are majorly concerned on how to control cost without any emphasis on waste control measures. Therefore it is crucial that materials be adequately controlled and a proper site management layout (Wahab and Lawal, 2011). Waste recovery for reuse and recycling can tremendously reduce the amount of waste that is destined for disposal by landfill. It is therefore important for the contractor to adopt waste management methods that will provide a sustainable built environment and give the contractor an edge in winning contracts. Hence the need to study construction wastage minimization techniques on construction sites in Nigeria.

LITERATURE REVIEW

The construction industry has been characterized as one that produces the highest amount of solid waste amongst all industries (Olatunji and John, 2013). Waste incurs additional cost either through it being carted away or that which results from the actual work. Waste arises from different activities carried out by the contractor during construction, maintenance and demolition which include wood, cement, glass, tiles, plastic, concrete, pipes and paint (Ekanayake and Ofori, 2000).

Ekanayake and Ofori (2000) categorized construction waste into four major categories as; design, operational, material handling and procurement (see Table 1). However design and operational factors are of major concern because little detail is paid to material waste minimization at these stages of a project. Babatunde (2012) quantitatively classified construction material waste as cutting waste, application waste, transit waste and theft and vandalism waste.

The critical point at which contractors and subcontractors can influence material waste is when buying materials for a project. This activity determines the materials that are to be considered in-expensive when compared to labour. A "waste allowance" is generally included within the order to account for design waste and construction process waste. These waste allowances are often generic and not inaccurate (Dennis, 2001). This can lead to either the order of a surplus of materials (usually entering the waste stream) or a materials shortfall (resulting in additional costs to purchase more materials). Little evidence exists on the practice of reconciliation between materials ordered and materials used (Jannatun and Zulhabri, 2014). Material wastage results in increasing the total project cost and reduces profit for contractors and subcontractors. If contractors can demonstrate willingness to support and engage in waste reduction measures and demonstrate that these have an effect on their waste, then they improve their chances of being identified as preferred bidders as they could help in meeting their waste targets (Dennis, 2001). According to Al-Hajj and Hamani (2011), there are several waste techniques which contractors or project managers can apply at every stages of a building project in order to reduce waste and increase contractor's profit margin. Some of these techniques according to Dennis (2001); Jannatun and Zulhabri (2014); Sawant, Hedaoo and Kumthekar (2016) include the 3 "R"s of construction waste minimization which are based on three (3) concepts namely recycling, reuse and reduction. Some other waste minimization practices also include Lean construction, material requisition, just-in-time principle, disposal method, waste management plan amongst others (Greenwood *et al*., 2003, Parijat*et al*., 2010 and Ayarkwa, 2012).

According to Akinkurolere and Francis (2005) the economic interest in re-using or recycling building materials is governed by some factors which are; the availability and thus the cost of natural or new building materials, the availability of disposal space, the tipping charges and the taxes for dumping, and the transportation cost. Effective waste management is of growing significance for the construction industry. Adding the cost of storing and transporting construction waste, along with the loss of revenue from not reclaiming waste materials, it makes financial sense for construction companies to take action to minimize waste.

Table 1: Sources of Material Wastage

Design	Operational	Material Handling	Procurement
Lack of attention paid to dimensional coordination of products.	Errors by tradesmen or operatives	Damages during transportation	Ordering errors (eg., ordering significantly more or less)
Changes made to the design while construction is in progress	Accidents due to negligence	Inappropriate storage leading to damage or deterioration	Lack of possibilities to order small quantities
Designers inexperience in method and sequence of construction.	Damage to work done caused by subsequent trades	Materials supplied in loose form	Purchased products that do not comply with specification
Lack of attention paid to standard sizes available on the market	Use of incorrect material, thus requiring replacement	Use of whatever material close to working place	
Designers unfamiliarity with alternative products	Required quantity unclear due to improper planning	Unfriendly attitudes of project team and operatives	
Complexity of detailing in the drawings	Delays in passing information to the contractor on types and sizes of products to be used		
Errors in contract documents	Equipment malfunctioning		
Incomplete contract documents at commencement of project	Inclement weather		
Selection of low quality products			

(Source: Ekanayake and Ofori, 2000)

Material Wastivity

Material wastivity concept was developed as an indicator of the wastage rate of a material and the contribution of the material wastage to construction cost overrun. Therefore, it is a proposed strategy in material management for disbursing the available resources and control of those materials such that greater attention would be devoted to these high wastage indices (Oladiran, 2008 and Mahesh *et al.*, 2011).

$$\text{Wastage level (\%)} = \frac{Mp - Mu}{Mp} \times 100\%$$

Where Mp = Purchased material

Mu = Used material

$$\text{Wastivity} = \frac{\text{Wastage}}{\text{Estimated consumption}} \times 100\%$$

Where;Estimated = what was originally proposed for the work.

Actual = what was used after the supply for the work.

RESEARCH METHODOLOGY

In order to examine the factors responsible for material wastage on the Nigerian construction sites and to assess the cost implication of material waste on the profit margin of contractors two sets of data were gathered. The first part involves a visit to five construction project sites in Kaduna in different locations and projects that were at different stages of construction were observed to stocktaking the level of material waste management on construction sites

Table 1: Sources of Material Wastage

Design	Operational	Material Handling	Procurement
Lack of attention paid to dimensional coordination of products.	Errors by tradesmen or operatives	Damages during transportation	Ordering errors (eg., ordering significantly more or less)
Changes made to the design while construction is in progress.	Accidents due to negligence	Inappropriate storage leading to damage or deterioration	Lack of possibilities to order small quantities
Designers inexperience in method and sequence of construction	Damage to work done caused by subsequent trades	Materials supplied in loose form	Purchased products that do not comply with specification
Lack of attention paid to standard sizes available on the market	Use of incorrect material, thus requiring replacement	Use of whatever material close to working place	
Designers unfamiliarity with alternative products	Required quantity unclear due to improper planning	Unfriendly attitudes of project team and operatives	
Complexity of detailing in the drawings	Delays in passing information to the contractor on types and sizes of products to be used		
Errors in contract documents	Equipment malfunctioning		
Incomplete contract documents at commencement of project	Inclement weather		
Selection of low quality products			

(Source: Ekanayake and Ofori, 2000)

Material Wastivity

Material wastivity concept was developed as an indicator of the wastage rate of a material and the contribution of the material wastage to construction cost overrun. Therefore, it is a proposed strategy in material management for disbursing the available resources and control of those materials such that greater attention would be devoted to these high wastage indices (Oladiran, 2008 and Mahesh *et al.*, 2011).

$$\text{Wastage level (\%)} = \frac{Mp - Mu}{Mp} \times 100\%$$

Where Mp = Purchased material

Mu = Used material

$$\text{Wastivity} = \frac{\text{Wastage}}{\text{Estimated consumption}} \times 100\%$$

Where;Estimated = what was originally proposed for the work.

Actual = what was used after the supply for the work.

RESEARCH METHODOLOGY

In order to examine the factors responsible for material wastage on the Nigerian construction sites and to assess the cost implication of material waste on the profit margin of contractors two sets of data were gathered. The first part involves a visit to five construction project sites in Kaduna in different locations and projects that were at different stages of construction were observed to stocktaking the level of material waste management on construction sites

Damages while transporting	4.33	3	4.53	2		
Client related					4.20	4
Undue Pressure to deliver, resulting in crash Programme	4.50	1	4.46	1		
Expectation of too High Standard	4.47	2	3.42	3		
Undue Interference with the Execution of the Project	4.38	3	3.97	2		

The findings in Table 2 above showed the contractor and consultant ranks of category of factors contributing to material wastage on construction sites. The study revealed that Supply, Material handling and storage factors mostly contribute to material waste, followed by operational factors, design variables client related factors and lastly phenomenal factors with mean scores of 4.38, 4.31, 4.28, 4.20 and 4.11 respectively. The table also showed from the contractor's ranking that, supply Material handling and storage factors were majorly due to improper material handling, and negligence/carelessness, while from the consultant's ranking, poor storage and improper material handling contributed mostly to supply factors. Poor supervision was the most contributory to design factors, followed by late changes and incorrect specifications. From the contractor and consultant's factors, followed by late changes and incorrect specifications. From the contractor and consultant's mean scores, faulty workmanship (4.71) was the most contributory to operational factors while excess material wastage input especially due to over excavation was the least contributory with an average mean score of 3.52. Client related factors were mostly as a result of undue pressure to deliver resulting in crash programme with mean scores of 4.50 and 4.46 from contractor and consultant rank respectively. Both contractors and consultant respondents agreed that phenomenal factors were due to damage by inclement weather and site accident / act of God that contribute to material wastage on construction sites.

Table 3: Ranking of contributory effects of material waste on construction projects.

S/N	Contributory Effect	Contractor Mean Score	Contractor Rank	Consultant Mean Score	Consultant Rank
1	Increases material shortage on site	4.70	1	4.38	2
2	Delay in completion time	4.50	6	4.17	4
3	Increase project cost	4.63	2	4.42	3
4	Increases use of man power	3.97	9	3.54	9
5	Increases cost of operating & maintaining landfill sites	4.48	7	4.00	7
6	Reduce clients value for his money	4.52	4	4.79	1
7	Increase environmental pollution	4.50	5	4.00	6
8	Reduce contractors profit margin	4.61	3	3.96	8
9	Reduce production productivity	4.30	8	3.38	10
10	Increase in disposal cost	3.42	10	4.04	5

Table 3 above showed contractor and consultant ranking of contributory effects of material wastage on construction projects. From the contractor's point of view, the major effect of material waste are, increases material shortage on site, increase project cost and reduces contractor's profit margin with mean scores of 4.70, 4.63 and 4.61 respectively. Increases use of man power and increase in disposal cost ranked the least with mean scores of 3.9 and 3.42. Consultant ranking showed that, reduces clients value for his money ranked first followed by increases material shortage on site and increases project cost, with mean scores of 4.79, 4.38 and 4.42 respectively. Consultant ranking of least contributory effect of material wastage on construction projects was in line with contractors results.

Table 4: Percentage cost of materials to the total cost of construction.

S/N	Percentage cost (%)	Frequency	Percentage (%)
1	Below 20%	0	0
2	20-30%	0	0
3	31-40%	0	0
4	41-51%	6	6.67
5	Above 50%	84	93.33
	Total	90	100

Table 4 shows the percentage cost of materials to the total cost of construction. It can be deduced that, above 50% ranked highest which accounted for 93.33% of respondent population while 41-51% came second which accounted for 6.67%. 40% below were null.

Table5: Level of usage of material waste management techniques

S/N	Level of usage of Material waste management techniques	Frequency	Percentage
1.	**Lean construction**		
	Very much in use	0	0
	Slightly in use	14	21.21
	Not in use	52	78.79
	Total	66	100
2.	**Just-in-time principle**		
	Very much in use	3	4.55
	Slightly in use	6	9.09
	Not in use	57	86.36
	Total	66	100
3.	**Waste management plan**		
	Very much in use	0	0
	Slightly in use	7	10.61
	Not in use	59	89.39
	Total	66	100

The analysis in Table 5 above showed the Level of usage of material waste management techniques. It can be deduced from the table above that, although very few of the respondents slightly use some of the above techniques, majority of the contracting respondents do not use lean construction, just-in-time principle and waste management plan which accounted for 78.79%, 86.36% and 89.39% respectively.

Table 6: Effect of Material Waste on Contractor's Profit Margin and Overall Project Cost

Effect	Mean Score
Very High Effect	4.00
High Effect	3.38
Low Effect	3.33
No Effect	2.71

As seen from Table 6 above, there is a very high effect of material waste on contractor's profit margin and overall project cost with a mean score of 4.00, followed by high effect (3.38), Low effect (3.33) and lastly no effect (2.71).

Table 7: Material wastage control strategies on construction sites.

Material wastage control strategies on construction site	Contractor Mean Score	Contractor Rank	Consultant Mean Score	Consultant Rank
Building information modelling	4.87	1	4.75	1
Use of Quality Materials	4.67	2	4.63	1
Proper storage, handling and usage of materials	4.78	1	4.60	3
Improved site security	4.62	4	4.60	4
Effective material planning and control policy	4.57	5	4.50	8
Record keeping	4.52	7	4.52	7
Preparation of material element schedule	4.63	3	4.57	5
vigilance of supervision	4.53	6	4.53	6
Adherence to standardized dimensions	3.83	13	4.11	11
Reuse of Materials	4.48	8	3.95	10
Effective waste Accounting System	3.92	11	3.82	12
Correct and comprehensive design details/specification	4.33	9	4.62	2
Avoidance of late changes at critical stages	4.21	10	4.47	9
Education and training of site personnel	3.87	12	3.80	13

Table 7 showed material wastage control strategies on construction sites. Contractors ranked proper storage, handling and usage of materials, use of quality materials and preparation of material element schedule (4.78, 4.67 and 4.63 respectively) as the major material waste control strategies on construction sites. Avoidance of late changes at critical stages;education and training of site personnel, effective waste accounting system and adherence to standardized dimensions were the least considered strategies by the contractors and consultants. The consultants ranked use of quality materials (4.63), Correct and comprehensive design details/specification (4.62) and proper storage,

handling and usage of materials (4.60) as the major material waste control strategies on construction sites.

Graphical Presentation of Data

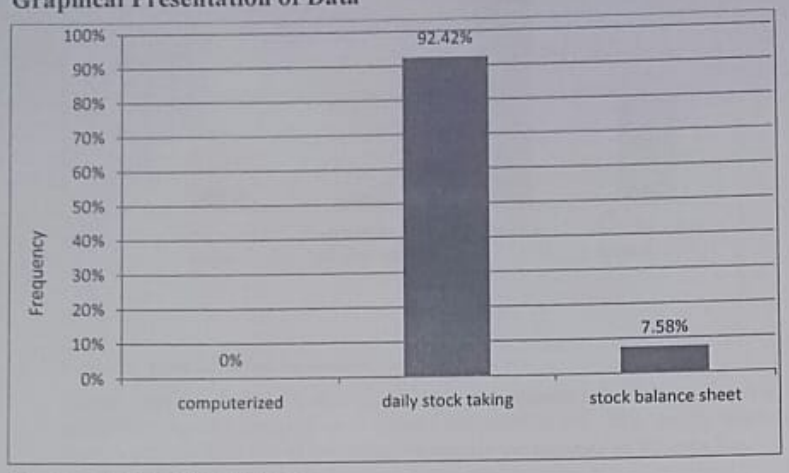

Figure 1: Material Record Systems

The results of the analysis in Figure 1 revealed that material record system is mainly by daily stock taking (92.42%) while 7.58% of the respondents record materials by stock balance sheet. None of the respondents have computerized material record system.

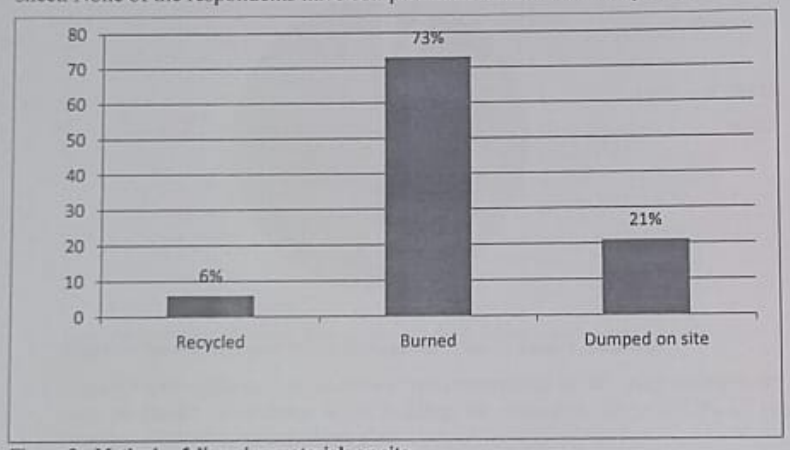

Figure 2: Methods of disposing materials on site

Figure 2 revealed the methods of disposing materials on site. 73% of the respondents burn materials on site, 21% dump materials on site while only 6% recycle their materials.

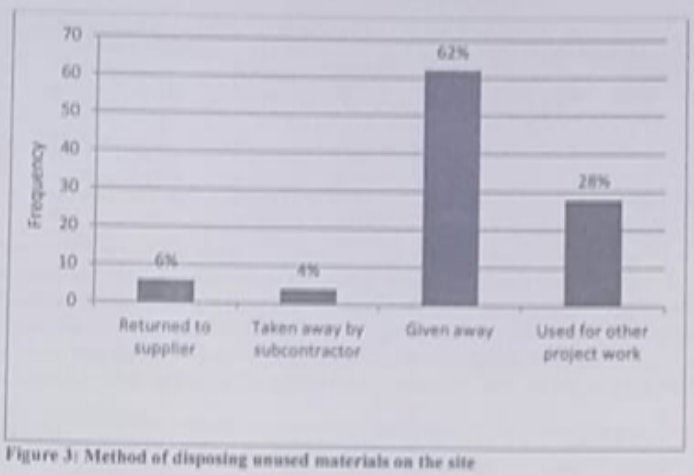

Figure 3: Method of disposing unused materials on the site

Figure 3 above shows the method of disposing unused materials on the site. 62% of the contractor respondents give away unused materials on site, 28% use the materials for other project works while 6% of the unused materials are returned to the supplier.

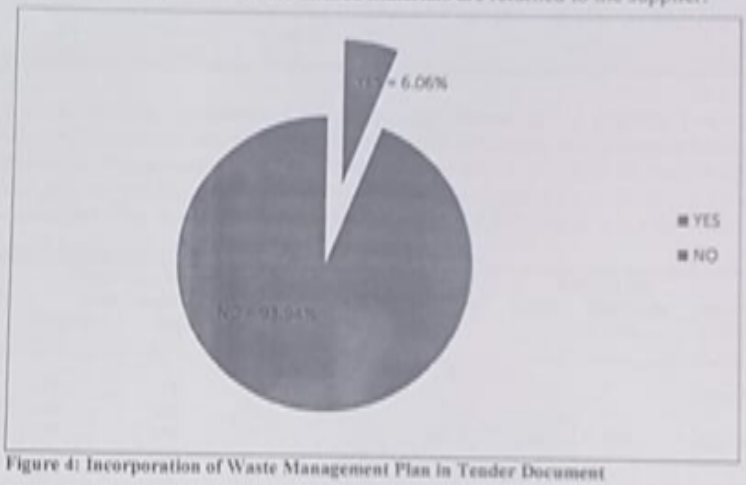

Figure 4: Incorporation of Waste Management Plan in Tender Document

Figure 4 above shows that 93.94% of the respondents do not incorporate waste management plan in tender documents when bidding for contracts. Only 6.06% of the respondents incorporate waste management plan.

Test of difference in wastage assessment of key construction materials obtained from site records and Bill of Quantities.

Table 8: T-test for Cement

	CEMENT (bags)					ANALYSIS		
Project Site	**Total usage** Estimated (bags)	Actual (bags)	**Wastage (bags)**	**Wastivity (%)**	**Mean**	**T-test**	**Significant value**	**Action on hypothesis**
1.	8,450	8,910	-460	-5.44				
2.	6,480	6,720	-240	-3.70				Statistically non significant. Accept Ho
3.	9,200	10,320	-1,120	-12.17	-554.00	-1.21	0.298	
4.	5,650	5,900	-250	-4.42				
5.	16,150	16,850	-700	-4.33				

It was observed that, the estimated and actual bags of cement had negative T-test value. Significant differences do not exist between estimated and actual, which therefore accept the hypothesis Ho. From the results above, it was inferred that the estimated bags of cement was not significantly different to the actual bags of cement. This was from the significance value of 0.298, which was higher than 0.05.

Table 9: T-test for blocks

Project Site	BLOCK (NO,S) Total usage Estimated (NO'S)	Actual (NO'S)	Wastage (no's)	Wastivity (%)	Mean	ANALYSIS T-test	Significant value	Action on hypothesis
1.	53,200	54,700	-1,500	-2.82				Statistically non
2.	15,200	15,800	-600	-3.95				significant, Accept
3.	231,500	251,500	-20,000	-8.64	-5050.00	-1.348	0.249	Ho
4.	4,000	5,050	-1,050	-26.25				
5.	18,000	20,100	-2,100	-11.67				

It was observed that, the estimated and actual bags of cement had negative T-test value. Significant differences do not exist between estimated and actual, which therefore accept the hypothesis Ho.The non-significant values was greater than 0.05. From the results above, it was inferred that the estimated bags of cement was not significantly different to the actual bags of cement. This was from the significance value of 0.249, which was higher than 0.05.

Table 10: T-test for tiles

Project Site	TILES (M2) Total usage Estimated (no)	Actual (no)	Wastage (M^3)	Wastivity (%)	Mean	ANALYSIS T-test	Significant value	Action on hypothesis
1.	140	145	-5	-3.57				Statistically non
2.	300	450	-150	-50.00				significant, Accept
3.	150	158	-8	-5.33	-12.20	-0.313	0.770	Ho
4.	350	258.32	91.68	26.19				
5.	50	39.66	10.34	20.68				

It was observed that, the estimated and actual bags of cement had negative T-test value. Significant differences do not exist between estimated and actual, which therefore accept the hypothesis Ho.The non-significant values was greater than 0.05. From the results above, it was inferred that the estimated bags of cement was not significantly different to the actual bags of cement. This was from the significance value of 0.770, which was higher than 0.05.

Table 11: T-test for form work

Project Site	Form work (M) Total usage Estimated (no)	Actual (no)	Wastage (M)	Wastivity (%)	Mean	ANALYSIS T-test	Significant value	Action on hypothesis
1.	170	150	20	11.76				Statistically non
2.	300	320	-20	-6.67				significan,
3.	250	280	-30	-12.00	20.00	0.964	0.389	Accept Ho
4.	500	450	50	10.00				
5.	800	720	80	10.00				

It was observed that, the estimated and actual bags of cement had negative T-test value. Significant differences do not exist between estimated and actual, which therefore accept the hypothesis Ho. The non-significant values was greater than 0.05. From the results above, it was inferred that the estimated bags of cement was not significantly different to the actual bags of cement. This was from the significance value of 0.389, which was higher than 0.05.

DISCUSSION OF FINDINGS

The study ranked individual factors that contribute to material wastage on construction sites from the contractor and consultant respondents. It was found out that material handling and storage factors were mostly due to improper handling, negligence and poor storage of materials on site. This was due to improper handling of materials by construction workers on site, such as blocks which are prone to wastage. Some of the construction sites did not have a safe and secure storage. This resulted in poor storage of some materials such as cement, which were not properly protected from weather conditions. Design factors were majorly due to poor supervision, late changes / alteration and incorrect specifications. Due to the complex nature of construction works, it is hardly possible to complete a project without changes to original plans or the construction process itself. Many of the decisions made during the design stage of a project and the choice of construction method will influence the amount of waste produced during construction and over the entire life of the building. Late changes / alteration by clients in design while construction is in progress often

result in re-work / variation which account for more usage of materials that was not budgeted for in the bill of quantities thereby leading to cost overrun of the construction project.

Faulty workmanship and poor material management practices contributed to material wastage from operational factors. This was due to the fact that construction works were not properly supervised in accordance with design specifications and usage of unqualified work men. Skilled tradesmen are very important in the use of materials because there will be no rework if they are properly coordinated and supervised to know the schedule of different activities. This result agrees with the findings purported by Muhwezi (2012). The material wastage practice is mostly the 3 R's which is not sufficient enough to curb material wastage on sites. Site accidents also contributed to material waste as a result of site layout problems which hinder workmen from utilizing materials on site effectively. It was observed that standardized dimensions of some materials were not strictly adhered to which contributed to waste on sites.

Findings from the study also revealed overall rank of factors. It was seen that supply, material handling, storage, and operational factors were the most factors and should be given adequate consideration. The finding from this study is different from Olatunji and John (2013) and Akinkurolere and Francis (2005) as this study identified 23 individual factors and categorized them into five (5) major group. However some of the factors were adopted from Ekananaye and Okorie (2000). They were further subjected to rank analysis from the consultant and contractor perspective on waste in the construction industry.

The study also showed that material waste increases material shortage on site, reduces client value for his money, reduces contractor profit margin and increases project cost. The findings agree with that of Olatunji and John (2013) that material waste give rise to shortage of materials and increases project cost. Material waste has a very high effect on contractor profit and overall project cost. The objective of giving client value for his money is defeated and this jeopardizes the chance of the contractor winning further projects.

It was observed that the 3R's of waste management technique was very much in use as compared to other technique (lean construction, just-in-time principle and waste management plan), which were rarely used by the contractors on site. Findings from other studies concentrated on 3R's of material waste management (Dennis, 2001, Shen *et al.*, 2002, Mahesh *et.al*, 2011, Jannatun and Zulhabri, 2014, Sawant, Hedaoo and Kumthekar, 2016,). This study found that other waste techniques have been used by very few contractors but it is yet to be fully implemented on construction projects in Nigeria.

Majority of the contractor respondents do not consider waste management plan as part of their tender documents in producing their construction works more effectively. This document would have helped in planning resources in order to control waste especially when handling similar projects.

Materials are usually recorded by daily stock taking. There was no computerized method of material record in place. Unused materials on site are most times given away while on site materials are disposed by majorly burning and dumping on site. This brings to play lack of qualified personnel to purchase standard materials on site and lack of usage of Just – in – time principle and Lean construction techniques.

The quantification of waste method in this study is different from Situ and Wan (2013) as this study employed the use of wastitivity and t-test analysis. Although, Mahesh *et al.*,(2011) quantified material wastage of cement, steel reinforcement, sand, coarse aggregate and bricks; this study specifically covered cement, blocks, tiles and formwork.Findings from the T-test analysis hypothesized that there is no significant relationship between estimated and actual material waste on construction sites. This was from the P-value of 0.296 which was greater than 0.05, therefore the hypothesis was accepted. Cement, blocks and formworks had the highest wastage indices signifying that the wastage level of these materials and their contribution to building projects are most critical on construction sites.

The Contractors ranked proper storage, handling and usage of materials, use of quality materials and preparation of material element schedule as the major material waste control strategies on construction sites. Avoidance of late changes at critical stages; education and training of site personnel, effective waste accounting system and adherence to standardized dimensions were the least considered strategies by the contractors and consultants. The consultants ranked use of quality materials, Correct and comprehensive design details/specification and proper storage, handling and usage of materials as the major

material waste control strategies on construction sites. Education and training of site personnel ranked the least. This was due to the fact that sustainable built environment has not been made a priority amongst contractors. According to Al-hajj and Hamani (2011), he proposed that there is need for training site personnel on material storage systems.

CONCLUSION AND RECOMMENDATIONS

It was concluded that material wastage has an effect on contractor's profit margin and overall project cost which accounted for over 50%. This jeopardizes the chance of the contractor winning further projects. Cement, blocks and formworks had the highest wastage indices signifying that the wastage level of these materials and their contribution to building projects are most critical on construction sites. It was seen that supply, material handling, storage, and operational factors were the most factors and should be given adequate consideration. Late changes / alteration by clients in design while construction is in progress often result in re-work / variation which account for more usage of materials that was not budgeted for in the bill of quantities thereby leading to cost overrun of the construction project. It was observed that the 3R's of waste management technique was very much in use as compared to other techniques. Material waste management plan is not incorporated in tender document. Avoidance of late changes at critical stages; education and training of site personnel, effective waste accounting system and adherence to standardized dimensions were the least considered strategies by the contractors and consultants. The following recommendations were made for the study;

1. Materials with high wastage indices should be given greater attention, the concept of wastage index developed in this research can be used as basis for distributing available resources in planning, supervision and material control, storage and handling.
2. Firms should employ expertise in using computer on site for effective material record keeping system.
3. There is need for designers to remain in touch with clients in the design stages to avoid late changes / alterations during construction stage.
4. Contracting firms need to evolve better means and facilities in which building materials could be well stored with pallets at the base or as maybe applicable to prevent undue damage which may lead to wastages.
5. Site waste management plan should be incorporated in tender document.
6. Modern waste management techniques should be adopted over the already used 3-Rs technique.

REFERENCES

Akinkurolere, O. O., and Francis, S. O. (2005). Investigation into Waste Management on Construction Sites in South Western Nigeria. *American Journal of Applied Sciences*, 2 (5), 980 – 984.

Al-Hajj, A., and Hamani, K. (2011). Material Waste in the UAE Construction Industry: Main Causes and Minimisation Practices. *Architectural Engineering and Design Management*, 7(4), 221 - 235.

Babatunde, S. O. (2012). Quantitative Assessment of Construction Materials Wastage in the Nigerian Construction Sites. *Journal of Emerging Trends in Economics and Management Sciences*, (3(3), 238 – 241.

Carlos, T. F., Lucio, S. M., Claudia, D.C., and Eduardo, L. I. (2002). Material Waste in the Building Industry: Causes and Prevention. *Journal of Construction Engineering and Management*, 128 (4), 316 – 325.

Dennis, S. M. (2001). Report on Construction Site Waste Management and Minimisation. *International Council for Research and Innovation in Building and Construction (CIB). International Report*. 5 – 50.

Ekanayake, L. L., and Ofori, G. (2000). Construction Material Waste Source Evaluation, *Proceedings of the 2nd Southern African Conference on Sustainable Development in the Built Environment*. Pretoria, South Africa, August 23 - 25, 1 - 6.

Formoso, C. T., Soibelman, L., DeCesare, C. and Isatto, E. L. (2002). Materials Waste in Building Industry: Main Causes and Prevention. *Journal of Construction andEngineering Management*, 128 (4), 317.

Greenwood R., Jones, P., Snow, C., and Kersey. (2003). *Construction Waste Minimization: Good Practice Guide*. Wales: Center for Research in the Built Environment.

Garas, G.L., Anis, R.A., and Gammal A.E., (2001). Materials Waste in the Egyptian Construction Industry.*Proceedings of the 9th international group of lean construction conference*, Rent Ridge crescent, Singapore, 6-8 August.

Jannatun, N. I., and Zulhabri, I. (2014). Sustainable Construction Waste Management Strategic Implementation Model. *Journal of Environment and Development*. 10, 48 – 59.

Machete, S. M. (1997). Waste Management in Construction Sites of Emerging Contractors in South Africa. *In:* Stephenson, P (Ed.), *13th Annual ARCOM Conference*, 15-17 September 1997, King's College, Cambridge. *Association of Researchers in Construction Management*, 1, 193 – 202.

Mahesh, D.M., Chetna, M.V., Bhavsar, J.J., and Rakesh, J.H. (2011). A study on Basic Material Waste in Building Industry: Main Causes and Prevention. *National Conference on Recent Trends in Engineering and Technology*. 13 – 14 May, 2011,, Gujarat, India.

McDomald, B., and Smithers, M. (1996). *Implementing a waste management plan during the construction phase of a project: a case study*, Australia.

Muhwezi, L., Chamuriho, L. M., Lema, N. M. (2012). An Investigation into Materials Wastes on Building Construction Projects in Kampala-Uganda. *Journal of Engineering Research*. 1(1), 11 – 18.

Oladiran, O. J. (2008). Materials Wastage: Causes and their Contributions' Level. Proceedings of CIB-2008, 15-17 November, Dubai.

Ogunbiyi, M. A. (2004). The Nigerian construction industry. Prospects of the labour force (the builders view, the professional builder, J. Nig. Inst. Build., pp45-60

Olatunji, A., and John, S. (2013). Materials Management and Waste Minimization on Construction Sites in Lagos State, Nigeria. Proceedings of the 4th International Conference on Engineering, Project, and Production Management.

Parijat, Yogendra K., and Koshy, V. (2010). Enhancing sustainability of construction projects through waste minimization. *International Conference on Sustainable Built Environment*(ICSBE-2010) Kandy, 13-14 December.

Poon, C. S., Yu, A. T. W., and Ng, L. H.(2001). On-site Sorting of Construction and Demolition Waste in Hong Kong. *Resources, Conservation and Recycling*. 32 (2), 157 – 172.

Sawant, S. B., Hedaoo, M., and Kumthekar, M. (2016). Impact of the Construction Waste on the Cost of the Project. *International Journal of Engineering Research*, 5(1), 126 – 128

Shen, L.Y., Tam, C.M., Tam W.Y.V., and Sam, H. (2002). Material Wastage in Construction Activities- A Hong Kong Survey. *International Journal of Project Management*,20 (7), 125-132.

Situ, A. M., and Wan, A.Z.W.Z. (2013). Quantification of Waste in Conventional Construction. *International Journal of Environmental Science and Development*, 4(3), 296 – 299.

Wahab, A.B., and Lawal, A.F. (2011). An Evaluation of Waste Control Measures in Construction Industry in Nigeria. *African Journal of Environmental Sciences and Technology*, 5 (3), 246 – 254.