PROFESSIONALS' PERCEPTIONS ON CONSTRUCTION MATERIAL WASTE AND COST OVERRUNS AT THE DESIGN STAGE OF A PROJECT IN ABUJA, NIGERIA

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ABSTRACT

Material wastage and cost overruns are common problems affecting construction projects. These problems occur at different stages of a project. Empirical research that link material waste issues to cost overruns at design-management stage of a project remain at the sub-optimal level in Nigeria. Hence, this paper investigates the material waste issues that relate to cost overruns at design-management stage of a building project. The study population is building construction professionals within Abuja and the sampling method was purposive/judgmental, because only building-construction professionals handling projects that are worth 1.6 billion Naira and more, were consulted. Projects of this value are likely to be handled by more experienced professionals, who might be more familiar with the issues leading to material waste and cost overruns. Semi-structured but in-depth interviews were conducted with thirty (30) construction professionals from each project, comprising 15 project managers, 9 quantity surveyors, 5 site engineers and 1 senior technical officer of a waste management department. The interview data were analysed by using the deductive approach, which involves constant comparative analysis after the interview data have been sorted and coded to generate knowledge about any common pattern within the interviewees' evidence on material waste and cost overrun. It was found that designs must remain simple and necessary details and specifications be clear and readable to avoid assuming estimating figures, in order to minimise material waste and cost overruns. Based on these findings, it can be concluded that effective management of material waste at design stage would translate into a reduction in the level of cost overrun. The management of material waste should be revised based on the findings of this research and included as part of the pre-contract management process of a project.

Keywords: cost overruns, design management, material waste, Nigeria.

INTRODUCTION

Cost overrun and material waste are common problems in both developed and developing nations which makes it difficult for many projects to be completed within their budget (Saidu and Shakantu, 2015). Material waste has become a serious problem, which requires urgent

attention in the construction industry (Adewuyi and Otali, 2013). Most of this waste has not been well managed, thus causing health and environmental problems (Imam *et al.,* 2008), and affecting the performance of many projects (Ameh and Itodo, 2013; Saidu and Shakantu, 2016a). The problem of material waste is disclosed by various authors reporting on the situation: for instance, 10-15% of materials delivered to construction sites in the United Kingdom (UK) end up as waste (Osmani, 2011). The United States (US) generates 164m ton of construction waste annually, representing 30-40% of the country's municipal solid waste (Osmani, 2011). Osmani (2011) highlighted that 10% of materials delivered to site in the UK end up as a waste that may not be accounted for. Similarly, Ameh and Itodo (2013) observed that in every 100 houses built there is sufficient waste material to build another 10 houses in Nigeria.

The argument in the construction industry on how to reduce or totally remove cost overruns from projects has been on-going among the built environment professionals, project owners and the users for the past seventy years (Apolot *et al.*, 2010; Allahaim and Liu, 2012), but there is no substantial improvement nor significant solution in mitigating its detrimental effects (Allahaim and Liu, 2012).

Relating material waste to cost overrun, Osmani *et al.* (2008) highlighted that 33 percent of onsite waste is generated as a result of designers' failure to implement waste reduction measures and these waste have effects on cost overrun (Ameh and Itodo, 2013). Ameh and Itodo (2013) believe that building material wastage on construction sites accounts for cost overruns. For instance, material waste accounts for additional 15% of project-cost overruns in the UK; 11% in Hong Kong; and between 20% and 30% in Netherlands. Saidu and Shakantu (2016b) investigated the contributions of material waste to cost overruns in Abuja, Nigeria and concluded that building material waste contributes approximately 4 percent to project cost overrun.

Material waste and cost overrun are occasioned by several causes at different stages of projects, including planning, estimating, design and design management, and construction stage. Identification of these causes and the application of relevant control measures to minimise their occurrence is a step towards alleviating the consequences (Mou, 2008; Oladiran, 2009; Nagapan *et al.,* 2012; Saidu and Shakantu, 2015).

Consequently, Ameh and Itodo (2013) believed that building material wastage on construction sites accounts for cost overruns. This is because of the fact that, most managers of construction projects pay little attention to the effects of generated material waste on cost overruns at the design stage of a project. Many studies have been conducted in this field, for instance, Tam *et al.* (2007) assessed the levels of material wastage affected by sub-contracting relationships and projects types with their correlations on construction site; Ameh and Itodo (2013) assessed professionals' views of material wastage and cost overruns, as well as the most wasteful materials on construction sites. Saidu and Shakantu (2015) examined the relationship between quality of estimating, construction material waste generation and cost overruns in Abuja, Nigeria; Saidu and Shakantu (2016a) examined the relationship between material waste and cost overrun in the construction industry using literature based methodology and recommended further empirical investigations. Moreover, Saidu and Shakantu (2016b) developed a framework and an equaion for managing construction-material waste and cost overruns. Saidu and Shakantu (2016c) also determined the contributions of material waste to project cost overrun in Abuja, Nigeria. None of the above-mentioned research clearly identified the materials waste causes that are linked to cost overruns at the design stage of a project. These therefore, provides the need for a research that provides a holistic assessment of the material waste causes that have effects on cost overruns at the

design stage of a construction project. Hence, this paper sought the perception of construction professionals on the material waste issues that relate to cost overruns at design-management stage of a building project. To achieve this aim, the following objectives are formulated: To examine the material waste causes that have effects on cost overrun; and to examine the material waste control measures that have effects on cost overruns at the design management stage of building project.

LITERATURE REVIEW

Material waste and cost overrun

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

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

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

Ameh and Itodo (2013) assert that material wastage on site leads to an increase in the final cost of the building project. As materials are wasted, more are procured; and this thereby affects the estimated cost (Teo *et al.,* 2009). Ameh and Itodo (2013) highlighted that wastages from the following materials contribute to the total project cost: concrete 4%; block work 10%; waste from screeding and plastering 15%; packaging 5%; and formwork is based on the number of times it is re-used. Furthermore, research evidence has shown that the main factors causing construction material waste are almost similar to those causing construction-cost overruns on site; hence, Nagapan *et al.* (2012) categorised cost overruns and time overruns as parts of non-physical waste; while other material waste as the physical waste on a construction site. This shows that cost overruns, time overruns and construction material waste are generally categorised as waste. This is supported by Ma (2011) who defines waste as anything that does not add value. Therefore, cost overruns, material waste and material waste that may be lost to landfills do not add value to projects. Therefore, Nagapan *et al.* (2012) assert that construction waste is not all about the quantities of materials that are wasted; but it is also focused on factors, such as overproduction, waiting time, material handling, inventories, and the unnecessary movement of workers, which constitute a

significant part of non-physical waste, but are always given the least attention in the construction industry.

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

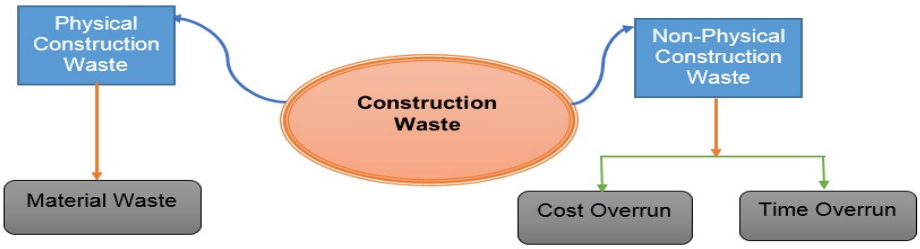

Figure 1. Classification of construction waste
Source: Researcher's Construct (2016)

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

Causes of material waste and cost overruns at design
This section relates the results of different studies on the causes of cost overruns and material waste at the design management stage of projects. These causes are presented in Table 1.

Table 1: Relationship Between The Cause of Material Waste and Cost Overruns with Respect to Design Management

Sn	Causes of material waste and relationship between the causes of cost overruns	Material Waste		Cost overruns	
		Author and date	Location	Author and date	location
1	Frequent design changes and material specification	Osmani, Glass and Price (2008); Nagapan *et al.* (2012); Adewuyi and Otali (2013)	UK; Batu, Malaysia; Rivers state, Nigeria	Allahaim and Liu (2012); Abdul Rahman et al.(2013); Shamugapriya and Subramani (2013)	Saudi Arabia; Malaysia; India
2	Error in design and detailing	Al-Hajj and Hamani (2011); Babatunde (2012); Wahab and Lawal (2011)); Nagapan *et al*. (2012); Ameh and Itodo (2013	UAE; Nigeria; Nigeria; Malaysia; Nigeria;	Ahiaga-Dagbui and Smith (2014); Allahaim and Liu (2012); Love et al. (2011)	UK; Saudi Arabia; UK
3	Lack of design information	Nagapan *et al.* (2012); Oladiran (2009); Wahab and Lawal (2011)	Batu, Malaysia; Nigeria; Nigeria	Shanmugapriya and Subramanian (2013); Abdul-Rahman et al. (2013)	India; Malaysia
4	Design complexity/complication	Nagapan *et al.* (2012); Osmani *et al*. (2008); Wahab and Lawal (2011)	Batu, Malaysia; UK; Nigeria	Allahaim and Liu (2012); Baloyi and Bekker (2011)	Saudi Arabia; South Africa

5	Poor communication flow among design team	Al-Hajj and Hamani (2011); Osmani *et al.* (2008)	UAE constructio n; UK	Abdul Rahman et al. (2013); Shanmugapriya and Subramanian (2013)	Malaysia; India
6	Poor knowledge of the changing design requirements	Nagapan *et al.* (2012)	Malaysia	Nega (2008)	Ethiopia
7	Poor management of design process	Osmani, et al. (2008)	UK	Abdul Rahman et al. (2013)	Malaysia
8	Inexperienced designer or design team	Adewuyi and Otali (2013); Nagapan *et al.* (2012)	Nigeria; Malaysia	Allahaim and Liu (2012); Abdul Abdul Rahman et al. (2013)	Saudi Arabia; Malaysia
9	Interaction between various specialists	Nagapan *et al.* (2012)	Malaysia	Aziz (2012)	Egypt
10	Designing uneconomical shapes and outlines	Osmani et al. (2008); Oladiran (2009); Adewuyi and Otali 2013)	UK; Nigeria; Nigeria	Nega (2008)	Ethiopia
11	Difficulties in interpreting specification	Osmani, et al. (2008)	UK	Allahaim and Liu (2012)	Saudi Arabia
12	Designing irregular shapes and forms	Nguyen et al. (nd)	Geelong, Australia	Kasimu (2012)	Nigeria
13	Designing non-standard dimensions, allowing cutting and chiseling	Nagapan *et al*. (2012)	Malaysia	Kasimu (2012)	Nigeria
16	Incomplete drawings	Osmani et al. (2008)	UK	Kasimu (2012); Lee-Hoai, et al. (2008)	Nigeria; Vietnam

RESEARCH METHODOLOGY

In order to choose a relevant method for this research, an inductive reasoning was applied. A qualitative research method that is rooted in the phenomenological research paradigm was adopted, and this helped the researchers to study the attitudes and behaviours of the research subjects within their natural settings (Babbie and Mouton, 2010). This qualitative method involves analysing words; refers to issues relating to people, objects and situations; and it focuses on naturally occurring, ordinary events in their natural settings (Farrell, 2011). This enables the researchers to examine the material waste issues that have effects on cost overruns at the design stage of a construction project.

The study population is building construction professionals handling projects within Abuja, the Federal Capital Territory of Nigeria. Abuja was selected because it is one of the metropolitan cities of Nigeria that has the highest population of professionals within the built environment and has many on-going construction projects.

The sampling method was purposive/judgmental, because only building-construction professionals handling projects that are worth 1.6 billion Naira /8 million USD and more, were consulted/interviewed. Because projects value of 8 million USD and above are likely to be handled by more experienced professionals, who might be more familiar with the issues leading to material waste and cost overruns than the projects of lesser value. Through purposive sampling, the research targeted the most visible and experienced leaders. Leedy and Ormrod (2014) noted that the size of a purposive sampling technique for a phenomenological research ranges between 5 and 25 participants. For this research, semi-structured but in-depth interviews were conducted with thirty (30) construction professionals, each from individual project, comprising 15 project managers, 9 quantity surveyors, 5 site

engineers and 1 senior technical officer of a waste management department on the issues that relate to material waste and cost overruns at the design stage of a construction project.

The research instrument (interview guide) enabled the researchers to be consistent with the questions posed to the respondents and enabled the collection of data based on the perception of the construction professionals in Abuja with regards to the issues that link material waste to cost overruns in the construction industry.

Probing questions were asked during discussion with the interviewees, in order to obtain further information. An average of thirty-five (35) minutes was spent in conducting each interview. The interviews were conducted between December, 2014 to March, 2015 and the approximate conversion rates as at November, 204 were: Nigerian Naira to US dollar = ₦200 = 1USD. All the thirty (30) respondents identified in this research through the purposive sampling method responded to all the questions presented for discussion.

The application of 'deductive analysis method' of data in qualitative research enabled the researchers to extensively condense raw data into brief and summary format, and to establish clear links between the research purpose and the summary findings derived from raw data (Dey, 2005). The recorded, transcribed and interpreted interview data were analysed by using the 'deductive approach'. This method involves constant comparative analysis of the data after it has been sorted and coded to generate knowledge about any common pattern within the interviewees' evidence on material waste and cost overrun. The analysis began by comparing the opinions made by the first two interviewees. The process continued with a comparison of the data from the comments and inputs from each new interviewee, until all the responses had been compared with each other. The similarities and differences among the interviewees' responses were used to develop a conceptualisation of the possible association between the various data items. The results are presented under sub-themes.

Reliability and Validity of the research:

All information presented in this research are factual, substantiated by the collection of the relevant data. All the feedbacks are incorporated in the study instrument in the research report. There, the results can be trust worthy.

RESULTS AND DISCUSSION

Relationship between design, material waste generation and cost overruns

The respondents disclosed that a relationship exists between the design material waste generation, and cost overruns. This relationship is summarised as follows:

A good quality design management should generate the necessary specifications, drawing details, constructability, maintainability issues, and envisages the issues relating to geophysical surveys for the type of foundations to be selected for a project.

The respondents also noted that good quality design management allows project stakeholders to define their requirements at an early design stage to avoid variation, rework, and cost overruns. It also allows early engagements of experienced designers/professionals, as inexperienced designers could either under-design or over-design a project.

Furthermore, materials would be designed to their standard sizes/units to allow tolerances, which would reduce the rate of cutting/chiselling and material wastages that could negatively affect the project cost. Therefore, it could be a colossal loss to the project, if these issues are wrongly handled.

These results corroborate the findings of Adewuyi and Otali (2013); and Nagapan *et al.* (2012) on the causes of material waste related to those of cost overruns as stated in Table 1 of this study.

The results also validate the findings of Love *et al.* (2011); Allahaim and Liu (2012); Abdul-Rahman *et al.* (2013) on the issues relating to cost overruns as highlighted in section 2 of this research.

Design complexity by different professionals

The definition of design complexity by the respondents is summarised as follows:

A design that exceeds the traditional design techniques; a design that does not follow the norms of traditional practice; a design that does not use available human or material resources; requiring a laboratory build-up, special technology and consultants; or when the processes of achieving the desired quality is not readily available.

Relating to the shape of a design: design complexity relates to the simplicity or irregularity of a designed shape (geometric shapes, curves, and irregular outlines) requiring materials to be cut to fit into a position. This result is in line with the definition of Seeley (1999), on design complexity.

The site engineers view design complexity as a design that is difficult to understand and execute; lacking details and requiring assumptions; not being able to translate by site engineers with unclear details and specifications; a design that lacks standardization in material sizes/units and requiring constant cuttings and chiselling to fit into position.

The quantity surveyors perceive design complexity as, when the necessary details, dimensions, and the specifications used for preparing the quantity take-off or estimate are not clear or not available.

Contribution of design management to design complexity
A complex design does not necessarily mean a bad design; but inexperienced designers may contribute to the complexity, or when the project requirements are not clearly defined to the professionals involved. Therefore, good design management should consider all the ambiguous design problems, which might reduce the complexity, the material waste, and the cost overruns for projects. This result corroborates the findings of Ameh *et al.* (2010); Osmani *et al.* (2008); and Allahaim and Liu (2012) as stated in section 2 of this study.

Contributions of design complexity to material-waste generation and cost overruns

Lack of standardization in material sizes leads to constant cuttings of materials to fit in position, which results in material-waste generation; and thereby contributes to project- cost overruns. Also, a complex construction technique and cuttings in material sizes due to design complexity lead to material-waste generation, and thereby contribute to cost overruns. However, good understanding of complexity in design would reduce the magnitude of the material waste to be generated. These results corroborated the findings of Osmani *et al.* (2008) as stated in the section 2 of the study.

In other words, design complexity could lead to re-design, variation, and rework and thus contribute to project-cost overruns.

Also, straight and regular shaped designs generate less waste compared to irregular and complex designs.

Design-complexity related material waste causes that have effects on cost overruns
The material-waste causes that have effects in causing cost overruns with respect to complexity in design by the respondents were: inexperienced designer; designing unstandardized dimensions requiring cutting and chiselling; difficulties in interpreting specifications; designing uneconomical shapes and outlines/designing irregular shapes and forms; designing materials that are not readily available/locally obtainable; use of sophisticated systems and components; buildability analysis; lack of monitoring and improving on previous mistakes; poor monitoring of design process; and inadequate design information. These results support the findings of Kasimu (2012), who identified the problem of incomplete drawing as a major cause of cost overruns. Others are: Shanmugapriya and Subramanian (2013); Osmani *et al.* (2008); and Ameh *et al*. (2010).

Relationship between design complexity and the occurrence of variations in a project
The relationship between the design complexity and occurrence of variations revealed that: the more complex the design, the more likely the variation, and a wrong interpretation of design leads to rework and variation.

Moreover, the ability of maintaining specifications in a complex design is very difficult, as some of the materials might not be readily available in the local markets, while some may be required to be manufactured abroad. Thus, the originally specified materials may be replaced with local ones, and non-availability of designed or specified materials, as a result of complexity would lead to variation. Consequently, a design that is not fully detailed, the construction could be subject to re-measurement and re-work, thereby causing a variation. Complex designs always require unique skills and the availability of sophisticated equipment; and a shortage of skilled manpower and poor workmanship, as result of complexity, could give rise to a variation in design. This result also corroborates the findings of Aziz (2013) as stated in section 2 of this study.

Material waste causes that have effects on cost overruns with respect to design management
The material-waste causes that have effects on project-cost overruns at the quality of design management stage of projects were: "error in design and detailing; lack of design information; design complexity/complication; frequent design changes and material specification; inexperienced designer or design team; difficulty in interpreting material specifications, poor communication flow among design team; poor knowledge of the changing design requirements; readability, constructability and maintainability problems of design; and the lack of standardisation in design/sizes and units. These results imply that design and detailing errors are mostly caused by an inexperienced designer. These could lead to a wrong estimation; because, the estimates are lifted and solely depend on the design, and thereby having a serious impact on the project cost. These are in line with the findings of Ameh and Osegbe (2011); Love et al. (2011); Memon *et al.* (2011); Baloyi and Bekker (2011); Allahaim and Liu (2012); and Shamugapriya and Subramanian (2013) on the practical causes of cost overruns and material waste.

Material waste control measures that have effects in controlling cost overruns at design stage of a project.

The material-waste control measures that have effects in controlling cost overruns at the design stage of a project were: explicit detailing in design; interpretable designs and specifications; engaging an experienced designer; error-free design; standardising designs and units; adequate design information and consultation; design for materials optimization; design for offsite construction; improving on previous design mistakes. The results are also in line with the findings of Abdul-Azis *et al.* (2013) on the control measures for project-cost

overruns. Also, the results confirm the findings of Osmani *et al.* (2008) on the management measures for material waste at the design stage of a project.

CONCLUSION AND RECOMMENDATIONS

Material waste and cost overrun are identified as global problems which affect the success of many construction projects. The research addresses the problems of little attention being paid by most managers of construction projects to the effects of material waste on project-cost overruns. The research successfully investigated the material waste issues that have effects on cost overruns at the design management stage of building projects.

The research concludes that good quality design management allows project stakeholders to define their requirements at an early design stage, in order to avoid variation, rework, and cost overruns, as inexperienced designers could either under-design or over-design a project.

It is also concluded that error in design and detailing, frequent design changes, designing unstandardised dimensions, difficulties in interpreting specifications, and designing uneconomical shapes and outlines, are the major material-waste causes that have effects on cost overruns with respect to design management.

Material waste causes that could lead to cost overrun at design stage could be controlled by adopting the following measure: explicit detailing in design; interpretable designs and specifications; engaging an experienced designer; standardization in designs and units; adequate design information and consultation; and improving on previous design mistakes.

Based on these findings, it can be concluded that proper attention to material waste issues at the design management stage of any project has the potential to minimise the rate of cost overrun. Therefore, careful attention should be given to the issues identified in this study, as they would assist in achieving a reduction in the rate of material waste and cost overrun for a project.

REFERENCES

Abdul-Azis, A. A. Memonl, A. H. Abdul Rahmann, I. and Abd Karim, A. T. (2013). Controlling Cost Overrun Factors in Construction Projects in Malaysia. *Research Journal of Applied Sciences, Engineering and Technology,* 5 (8): 2621-2629.

Abdul-Rahman, I., Memon, A.H. and Abd. Karim, A.T. (2013). Significant Factors Causing Cost Overruns in Large Construction Projects in Malaysia. *Journal of Applied Sciences,* 13(2): 286-293.

Adewuyi, T. O. and Otali, M. (2013). Evaluation of Causes of Construction Material Waste: Case of River State, Nigeria. *Ethiopian Journal of Environmental Studies and Management,* 6: 746-753.

Ahiaga-Dagbui, D.D. and Smith, S.D. (2014). Dealing with Construction Cost Overruns using Data Mining. *Construction Management and Economics,* 32 (7-8): 682-694.

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

Allahaim, F.S. and Liu, L. (2012). Cost Overrun Causes, the Framework in Infrastructure Projects: Toward a Typology. *37th Australian University Building Educators Association, International Conference* (AUBEA, 2012) Sydney, University of NSW (UNSW), 1-15.

Ameh, J. O. and Itodo, E. D. (2013). Professionals' Views of Material Wastage on Construction Sites. *Organization, Technology and Management in Construction. An International Journal,* 5(1): 747-757.

Ameh, O.J. Soyingbe, A.A. and Odusami. K.T. (2010). Significant Factors Causing Cost Overruns in Telecommunication Projects in Nigeria. *Journal of Construction in Developing Countries,* 15 (2): 49–67.

Apolot, R. Alinaitwe, H. and Tindiwensi, D. (2010). An Investigation into the Causes of Delay and Cost Overrun in Uganda‟s Public Sector Construction Projects: In, *Second International Conference on Advances in Engineering and Technology,* 2010, Uganda: 305-311.

Azhar, N. Farooqui, R.U. and Ahmed, S.M (2008). Cost Overrun Factors in Construction Industry of Pakistan. *First International Conference on Construction in Developing Countries (IC CIDC–I).* Karachi, Pakistan. 499-508.

Aziz, R.F. (2013). Factors Causing Cost Variation for Constructing Waste Water Projects in Egypt. *Alexandria Engineering Journal* 52: 51–66.

Babatunde, S.O. (2012). Quantitative Assessment of Construction Material Wastage in Nigerian Construction Sites. *Journal of Emerging Trends in Economics and Managent Sciences* 3 (3): 238-241.

Babbie, E. and Mouton, J. (2010). *The practice of social science research*. Cape Town: Oxford University Press Southern Africa.

Baloyi, L. and Bekker, M. (2011). Causes of Construction Cost and Time Overruns: The 2010 FIFA World Cup Stadia inSouth Africa. *Acta Structilia,* 18 (1), 51-67.

Dey, I. (2005). *Qualitative data analysis: A user-friendly guide for social scientists*. New York: Taylor & Francis e-Library.

Farrell, P. (2011). *Writing a Built Environment Dissertation: Practical Guidance and Examples.* Bolton, UK: Blackwell's Publishing.

Golafshani, N. (2003). Understanding Reliability and Validity in Qualitative Research." *The Qualitative Report Volume* 8 (4): 597-607.

Hussain, J.M. Abdul Rahman, I. & Memon, A.H. (2013). The Way Forward in Sustainable Construction: Issues and Challenges. *International Journal of Advances in Applied Sciences (IJAAS),* 2 (1), pp. 31-42.

Imam, A. Mohammed, B. Wilson, D.C. & Cheeseman, C.R. (2008). Country Report: Solid Waste Management in Abuja, Nigeria. *Waste Management,* 28, pp. 468–472.

Kasimu, M.A. (2012). Significant Factors that Cause Cost Overrun in Building Projects in Nigeria. *Interdisciplinary Journal of Contemporary Research in Business,* 3(11): 775-780.

Leedy, P.D. and Ormrod, J.E. (2014). *Practical Research Planning and Design.* Tenth Edition. Edited by Pearson new international Edition. Edinburgh Gate, England: Pearson Education Limited.

Le-Hoai, L. Lee, Y.D. and Lee, J.Y. (2008). Delay and Cost Overrun in Vietnam, Large Construction Projects: A Comparison with Other Selected Countries. *KSCE Journal of Civil Engineering,* 12(6): 367-377.

Love, P. Edwards, D. and Irani, Z. (2011). Moving Beyond Optimism Bias and Strategic Misrepresentation: An Explanation for Social Infrastructure Project Cost Overruns. *IEEE Transaction on Engineering Management.* 12.

Ma, U. (2011). *No waste: Managing Sustainability in Construction.* Surrey: Gower Publishing Limited.

Mou, K. (2008). The Role of Government and Construction Waste. Msc Dissertation, The Centre of Urban Planning & Environmental Management, University of Hong Kong, Hong kong, pp. 1-179.

Nagapan, S. Abdul-Rahman, I. and Asmi, A. (2012). Factors Contributing to Physical and Non-Physical Waste Generation in Construction Industry. *International Journal of Advances in Applied Sciences (IJAAS),* 1 (1): 1-10.

Nega, F. (2008). Causes and Effects of Cost Overrun on Public Building Construction Projects in Ethiopia. Msc Dissertation, Ethopia.

Nguyen, B. Gupta, H. and Faniran, S. (n.d). Waste Minimization Strategies in the Construction Industry-A Geelong Case Study." Geelong, 1-10.

Ogunsemi, D., and Jagboro, G. (2006). Time–cost Model for Building Projects in Nigeria. *Journal of Construction Management and Economics,* 24 (3), pp. 253–258.

Oladiran, O. J. (2009). Causes and Minimization Techniques of Materials Waste in Nigerian Construction Process, *Fifth International Conference on Construction in the 21st Century (CITC-V); Collaboration and Integration in Engineering, Management and Technology,* 20-22, May 2009, Istanbul, Turkey.

Osmani, M. (2011). Construction Waste. Chap. 15 in *Waste: A Handbook for Management*, by Letcher and Vallero, 1-565. San Diego: Academic Press an Imprint of Elsevier.

Osmani, M. Glass, J. and Price, A.D.F. (2008). Architects' Perspectives on Construction Waste Reduction by Design. *Waste Management*, 28, 1147–1158.

Saidu, I.and Shakantu, W.M.W. (2015). A Relationship between Quality-of-Estimating, Construction Material Waste Genration and Cost Overrun in Abuja, Nigeria. *Fourth Construction Management Conference, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa.* Edited Emuze, F.A.; 95-104, 30 November-1st December, 2015.

Saidu, I. and Shakantu, W.M.W. (2016a). A Study of the Relationship between Material Waste and Cost Overrun in the Construction Industry. *The 9th cidb Postgraduate Conference Cape Town, South Africa. "Emerging trends in construction organisational practices and project management knowledge area.* Edited Windapo, A.O., 124-134, Feb, 2-4, 2016.

Saidu, I. and Shakantu, W.M.W. (2016b). A Conceptual Framework and a Mathematical Equaion for Managing Construction-Material Waste and Cost Overruns. World Academy of Science, Engineering & Technology. *International Journal of Social Behavioural, Educational, Economic, Business and Industrial Engineering,* 10 (2), pp. 555-561.

Saidu, I. (2016). Management of Material Waste and Cost Overrun in the Nigerian Construction Industry. An Unpublished PhD Thesis, Department of Construction Management, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa.

Seeley, I. H. (1999). *Building Economics.* London: Macmillan Press Ltd.

Shanmugapriya, S. and Subramanian, K. (2013). Investigation of Significant Factors Affecting Time and Cost Overrun in Indian Construction Projects. *International Journal of Emerging Technology and Advanced Engineering*, 3 (10), 734-740.

Teo, S.P. Abdelnaser, O. and Abdul, H.K. (2009). Material Wastage in Malaysian Construction Industry. *International Conference on Economics and Administration, Faculty of Administration,* University of Bucharest Romania*,* 257-264.

Tam, V.W.Y. Shen, L.Y. Tam, C.M. (2007). Assessing the Levels of Material Wastage Affected by Sub-Contracting Relationships and Projects Types with their Correlations. *Building and Environment,* 42, 1471–1477.

Wahab, A. B. and Lawal, A. F. (2011). An Evaluation of Waste Control Measures. *African Journal of Environmental Science and Technology,* 5(3): 246-254

Yuan, H., W. Lu, and J. J. Hao. (2013). "The Evolution of Construction Waste Sorting on-Site." *Renewable and Sustainable Energy Reviews* 20: 483–490.

Appendix

INTERVIEW GUIDE

On

"Professionals' perceptions on construction material waste and cost overruns at the design stage of a project in Abuja, Nigeria"

Preliminary questions

Name of the person being interviewed_____

Position_____

Name of the Firm/Organization_____

Name of the project_____

Project location _____

Project value (₦) _____

Years of experience in the industry: _____

Highest educational qualification _____

Please describe your role in the organization

Quality of Design Management

1.1 Describe the constituents of and the quality of design on your project?
1.2 Is there any relationship between quality of design management and material waste generation?
1.3 Does the quality of design affect project cost overrun? Please elaborate?
1.4 Define, design complexity