ASSESMENT AND CONTROL OF MATERIAL WASTAGE ON CONSTRUCTION SITE (CASE STUDY OF CONSTRUCTION BUILDING SITES IN MINNA)

BY

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PGDICE 1081042

A THESIS SUBMITTED TO POSTGRADUATE SCHOOL IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF POST GRADUATE DIPLOMA (PGD) IN CIVIL ENGINEERING

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA

FEBRUARY, 2011

DECLARATION

1, Farouk Umar Audi hereby declare that this project is an original work which was design by me under the supervision and guidance of my supervisor, Engr. Olayemi James

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Date

ON

This project titled "Assessment and control of materials wastage on construction site case study of Minna by Farouk Umar Audi meets the regulations governing the award of Post Graduate Diploma (PGD) in Civil Engineering Federal University of Technology, Minna, Niger state and is approved for its contribution to knowledge and literary presentation.

Engr. Olayemi James | Date

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DEDICATION

I Dedicated to Almighty Allah, the author and giver of all wisdom and knowledge, the potentate and supreme structural engineer who founded the entire universe and suspended it in the air.

To the memory of my late father Alhaji Umar Balarabe Audi {1927-1999}

ACKNOWLEDGEMENT

I bow my head before Almighty God, the Omniscient God and the author and dispenser of knowledge and wisdom for making it possible for me to complete this project in good health and sound mind.

I am profoundly grateful to my project supervisor Engr. Olayemi James for being a father and a guardian· counselor and for his untiring effort and great patience not only in imparting the knowledge but also by offering constructive and creative information criticism towards the successful completion of this project.

I am indeed grateful to my H.O.D. Prof Salifu Sadiku, for been a great and cheerful dispenser of knowledge and also to my lecturers- Engr. S F Aritola, Engr. P N Ndoke, Engr. 0 D Jimoh, Engr. M Kudu, Engr S S kolo, Engr A Amadi, Engr. M Alhassan, Dr. T Y Tsado, Engr T A Ogeleka, Engr, A T Richard, Engr. Gata, Engr. Olayemi James for the knowledge they've imparted in me.

My endearing gratitude goes to my lovely family for their financial, moral and spiritual confidence in me. May Almighty Allah spare their lives to reap the reward of their labour (Amen).

I greatly appreciate all member of my class who touched my heart in a special way and gave me memories to last a lifetime; will also like to appreciate all that contributed positively to the success of this project.

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Notations

%		Percentage
X	=	Mean value
S		Standard deviation
p		Coefficient of variation
N		Number of sample
▌		Summation

ABSTRACT

This study titled assessment and control of materials wastage on construction site, majority building site looks into waste incurred during the use of these materials which is a recurrent problem on construction site in Nigeria. The study focuses on five areas: type of material waste; incident of waste; factors responsible for materials wastages on building site and their frequencies of occurrence; materials susceptible to excessive wastages; and effectiveness of the minimization of material waste incurred from the use of material. The results show that material management, control policy, inspection, materials handling and storage related factors contribute most to overall wastages of materials on building site. The study conclusively proffers recommendations in the area of proper inspection, management, control, motivation, training of site personnel and material handling.

CHAPTER ONE

1.0 GENERAL BACKGROUND

Building materials is any material, which is used for construction purpose. This includes materials that has been used at one time or another for creating various human and animal homes, structures and technologies. These deals with habitant and structure including homes; living space and their related structure have been from plastic to glass.

Production and assembly of various building materials is a multibillion Naira industry and environmental concern that has recently surfaced about the effects of such a massive resource extraction on a global scale. This project treats accessing the use of building material on a civil engineering site.

Since the amount of each material used leads to different styles of building, the deciding factors is connected with the quality of each of the type of materials and quantity required for a building project. This the waste of material in construction site result in breakage, loss of material to the ground and materials discard as unsuitable for the purpose they arc purchased for. It is however not part of the building company's plan but to the site and the people engaged on it. In essence, accessing the use of building materials in building construction site involves emphasis, which should be control.

In accessing the use of building materials on construction site, problems of waste of building materials lead to the finding of incidence of waste for particular materials used in a construction and how some of the waste can be evitable. This will be discussed in the course of project report.

1.1 AIM

Assessment of direct wastes on sites, during and after the construction of the building.

1.2 OBJECTIVES

1. Collection of data on material waste on site
II Accessing the waste of material incurred from storage place, workmanship and transportation.

III. Identification of various type of waste incurred on site.

IV. Analysis of result collected from the data.

1.3 SCOPE

The scope of this project covers operation in construction site with data from some years based on accessing the materials used on site involving the storage space, workmanship and transportation Since the control of building materials involves the control of material waste on construction site which is inevitable, suggestions on improvement in material waste control not only as created on site but by others outside the site, will be discuss to help avoid incurring unnecessary expenses which invariably reduces wastage and the overall cost of the project

Thus building construction sites are going to be considered in the work.

1.4 JUSTIFltATION

Waste of material in civil engineering portrays poor building management, waste of time and money. To client, contractor and even civil engineer, waste of building materials is a loss of profit Building materials are far too expensive to be wasted but in spite of this on site, allover the world; money is being thrown away as a result of breakage and losses during construction.

CHAPTER TWO

2.0 LITERATURE REVIEW

It is obvious that large quantities of building materials are allowed to be buried or burnt each year as a result of inadequate control on site. The problem is vast, not all the materials purchased for building operation are used in the construction. Losses are often considerable and whatever the scale, represent a reduction of profit.

It is globally/universally recognize that wastage of materials occur on building sites, which can be minimized if the circumstance leading to it are taking into cognizance. This is because building construction is a highly organized activity including the building team, materials, the site for construction and the type of structure to be erected. A building material becomes classified as waste if it may have been broken, disintegrated, misshapen, damaged or completely lost.

Material wastage is defined by the chartered institute of building (1979) "as the difference between the value of those materials delivered and accepted on site and those properly used as specified and as accurately measured in the work, after deducing the cost saving substitute materials and those transfer contribution significantly to overall construction cost (Wyatt, 1978) high rate of material wastages on building cite as currently experienced could be partly responsible for the prevalence of project cost overruns. This is probably a conservative estimate compared with the wastage on many sites particularly large scattered contract such as housing development studies had been under taken in the past on the problem of material wastage in construction. The identified factors responsible for material wastage includes, design error (Sarnrnan 1999), contractor failures to adopt effective on site control of materials (Skoyles, 1987), inadequate material, scheduling, scheduling, delivery, checking and off-loading of materials and component on sites, delivering more materials than are actually required on site due to over estimation, poor material handling and placing and in adequate care and protection of materials (Wyatt, 1978).

l3utler (J 979), reveal in his work the measurement of labor separately from material. This enables the assumption (Norms) by builders' estimator of material wastage to be correlated with the actual level of material wastage on site. He emphasized on planning which is aimed at laying down the direction in which a move is to made forward, taking into account the resource that are available in terms of the 5M's of management i.e. men, materials, machines, money and method.

Construction project planning is an activity requiring a mature and balanced out look, through knowledge and experience in construction technology and practice, purchasing and financial control. It equally requires a systematic and analytical approach (Nqoka, J987). Project planning also involves the determination of ways of ultimate objective is to minimize the input of resource in order to reduce cost so as to maximize profit.

2.2 TYPE OF MATERIAL WASTE

The motion of waste was ambiguous until clearly defined by Johnston (1981) as difference between materials ordered and those placed for fixing on building project. It is recognized that under certain circumstance, it is easy to waste material than to attempt to prevent it. Moreover to examine the physical loss of material alone considerably understate the problem. However the costs of materials waste occur and such as is divided into the varieties of waste which can be accounted for, these are direct waste, waste whose cost are indirect and waste which cost result from a waste-prone event.

2.2.1 Direct Wastc

This is the waste, which can be prevented and involves the actual loss or necessary removal and replacement of a material. Direct waste of material used is often simple in character without further obvious cost consequence, such as when loose bricks around a stack sink and are lost in the ground. More often there is not only just the financial cost involved in the materials' not ending up where intended, but the cost of removing them. While the materials cannot be seen and may be little more than nuisance. these are losses and must be accounted for as such during material waste reconciliation. Although not obvious the contractor bears this as a liability prepared for gardeners. This is known as consequential waste. This damage has to be repaired and involves cost, not just of replacement but also of inconveniences.

"(Motete et al., (2003) revealed that waste of any description is contrary to good building management. It is time consuming without profit, and often provokes needless confrontations, amongst other things, non-availability of material out of wasteful behavior affect bonus earning. It is a cost accountable factor, often causing contract time to run over its schedule. Material waste impact can have a knock - on effect on site. It is costly when crisis action has to be taken to divert supplies or, in the event of material shortages, incurring "over the odd" cost in obtaining supplies from alternative source to make good "waste deficits".

2.3 SITE ORGANIZA TION

Olaniyi, (I998) revealed that organization both on and off the site should be well planned which in tum implies that the economic potential of the work is likely to be fully realized. By careful planning, but during the work period and before its commencement, wastage of resource in terms of materials and manpower can be reduced to a minimum.

2.3.1 Site Layout Consideration

Before any work is begun on site, the contractor for must consider various preliminary items, which will inevitably influence all future site operation. The major factors to be considered are:

I Storage mode.

11 Plant and movement of plants

111 Access

2,3.2 Storage

In laying out a new site, the objective should be to reduce any multiple handing of materials to a minimum commensurate with cost factors, while ensuring that stored material are secure but readily available when required, Stores are located such that they do not interfere with any work in progress but are readily accessible for both the deposit and removal of goods.

2.3.3 Plant

The contractor's plant policy will to a large extent determine the selection of items of plant. The utilization of his own equipment, even if it is not the ideal item for executing a particular operation, may dictate the type of plant on site, where as adopting, a hiring policy will permit specialized items of plant to be brought on the site to give maximum output under specific working conditions. Many multi-purpose machines are now available, and these provide a degree of flexibility in site layout considering eg. loader excavator etc. plant movement must be considered from three point of views, working room requirement, mobility on site and serving requirement, mobility on site and servicing requirements.

Many excavating and lifting items of plant have slowing circles which extend outside their tracking requirements this working room must be consider when selecting an item of plant for a particular purpose, especially in confined areas.

Plant mobility should be such as not to reduce the efficient working of the site as a whole plant such as cranes may be static, semi mobile on tracks or mobile and selection should be based on optimum size coverage with minimum down time. Excavators have varying turning circles, while most earth - moving vehicle require reasonably firm turning surfaces

2.3.4 Access

There are two components to this factor, access to the site itself and access on the site. In the first case there may be limitation imposed by the locality of the site, such as road width, parking restrictions, traffic density and bridge weight or other environmental consideration such as noise level and other nuisance problem Each of these may affect the choice vehicle and method of delivery of goods and material both to and from the site. In the second case, once the materials or vehicles conveying the material have reached the site, there should be ready access to the various working areas or stores so that there is no time lost in waiting for item to be dealt with. This may necessitate the construction of temporary roadway or the early completion of permanent carriage ways.

2.4 CAUSES OF MATERIAL WASTE ON CONSTRUCTION SITE

Waste occurs on site for a number of reasons, most of which can be prevented, some of the causes include

Incorrect proportioning and mixing of mortar.

Incorrect jointing procedures.

Disturbance of units after lay ing

Failure to build walls "plumb and true to line and level".

Unfavorable curing conditions

Overestimating the quantity required due to lack of cost and measurement.

Careless handing of materials.

2.5 TilE ROLE OF MATERIALS

The materials we are concerned with begin as physical resources in or on the earth. Engineering materials are materials designed, made and used for practical purposes to carry mechanical installation, resisting corrosion or whatever.

Ore, coal, sand wood, rock pains 3.

Extract refiner

Metals chemical papers Iibrcd

Process 6

Single, crystal alloys, ceramic plastics, composite 7

Mine, drill harvest 2.

Recycle 13.

Manufacture 8.

Ore, oil wood

The earth I.

Dispose 12.

Waste 11.

Performance services use 10.

Products (cars, bridge, ships telephone) etc 9.

Fig 2.0: Shows the life cycle of engineering materials discarded when cut into length on first being planned re-uses. The main waste of timber and plywood in columns, wall and beam formwork arises from cutting. Since formwork panels are usually made on site prior to erection, all cut of pieces were measured as cutting waste. One aspect of timber in formwork that can serve as a means of preventing its wastage is that it can be reuse. This is important since the number of maximum reuse usually provide the basis for norms use in estimating the price for Iorrnwork.

Reinfurcernent (bar and Fabric)

Cutting is the most common cause of waste of bars on site and occurs mainly during prefabrication when straight bar are cut to various lengths steel bar are also cut to fit reinforcement already fixed. Cutting waste on site for fabric is normally in odd, small irregular pieces of little value; at least half of it is in the re-usable larger sheets, which are usually wasted too. Prevention of waste in reinforcement bars can be done by adequate storing.

Concrete

The losses in concrete which occur during deliveries of ready mixed concrete are mainly due to spillage, these represent only a small percentage of the total losses literatures reveals that production waste in trenches varies considerably with mean of 5% losses on non-housing sites range between 5-10% for both on site and ready mixed concrete with mean of 2% with operations using formwork.

Where no formwork I used it is likely to be on housing sites and between 4-12%, with a mean of about 6%. Site mixed concrete can give higher losses in the range of7-10% and mean of2.5% ready mixed concrete has a lower range of 5-9% and a mean of 6% on some site, waste of concrete is due to negligence can occur. The result of these is categorized generally as waste, which is to be controlled by proper mixing of the material with good delivery method proper placing and avoid improper curing.

Cement mortar',

Cement that is generally used is known as Portland cement because of its resemblance to thee color of the stone of that name. It is manufactured from chalk and clay. Sand-this is obtained from pits of quarries is the best for mortar because of its angularity (sharp), failing this, that from river bank or beds is used. Sea sand is unsuitable for mortar as it contains salts, which attract and retain moisture, in addition to producing a whiting power or efflorescence, which discolors the brickwork or masonry. Sand should be well graded, clean, sharp and free from loam, clay or other impurities Dirty sand can reduce the adhesive value of the mortar considerable cement mortar is a mixture of one volume cement 30 volume of sand, water is added. As cement mortar sets comparatively quickly, it should only be mixed in small amount and not be used after it has started to set. Cement mortar is used in construction of pillars, working below damp course level Waste here can thus be controlled by usage before it starts to set, proper mixing proportion and good delivery method.

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Blocks

Building blocks are wall unit larger in size than a brick that can be handled by one man. They are made of concrete or clay.

Clay blocks: Hollow clay building blocks to llS 3921 (1974). The blocks are made from selected brick clays that are press-molded and burnt. The standard is 290 long x 62.5, 75, 100 & 150 thick.

They are comparatively lightweight, do not suffer moisture movement, have good resistance to damage by fire and poor thermal insulating properties. Mainly used for non-load bearing partition.

Concrete blocks: extensively used for both load bearing and non-load bearing walls, externally and internally.

Metete etal, (2003) revealed that disadvantage of concrete blocks, as a well unit is that they suffer moisture movement, which may cause cracking of applied, finishes such as plaster. To minimize cracking due to shrinkage by loss of water, vertical movement joints should be built into long block walls at intervals of up to twice the height of the wall.

Sandcrete

Tejomauwo(2000). Revealed that cement most commonly used is ordinary Portland cement, which is delivered to the site in 50kg bags when the fine cement powder is mixed with water, chemical action between water and cement takes place and at the completion of this reaction the nature of the cement has so changed that is binds itself very firmly to most materials.

If the cement is thoroughly mixed with sand and water, the reaction takes place; the excess water evaporated leaving the cement and sand gradually hardening in a solid mass. The usual mix of cement and sand for mortar is 1:3/4 by volume with sufficient water to make it plastic. Waste from here result from harmful segregation of the mixture, which leads to unsatisfactory sandcrete. Thus the need to reduce these is necessary by proper mixing of materials and avoiding too much

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vibration during construction.

Sandcrete Block

Sand crete blocks are made from a mixture of hard, durable and clean sand, cement and water. On hardening the blocks achieve enough strength to be used as walling unit.

Masonry

Masonry is built of natural and artificial stones, Adedeji L.G. (1999) revealed that among natural stones are taken and cut quarry stones (from limestone, dolomite, sandstone and other rocks) in mass up to 50kg, hewn stones for facing and decorative masonry of limestone, tuffs, shell rock and other light weight rock. The most popular artificial stone materials are ordinary clay (solid), porous, hollow and porous and hollow bricks clay facing and lime sand bricks, hollow ceramic stones, small light weight concrete stones with three through cavities up to 32kg in mass and others.

Rubble concrete masonry consists of 50% concrete and 50% rubble or cobblestone and is performed in sheathing or wedged against trench walls. The largest dimensions of stones should not exceed one-third of masonry thickness. Other types include solid brick work, lightweight brickwork, faced masonry refractory masonry etc.

Bricks

Bricks are chiefly from clay and shale standard brick is 215 x 102.5 x 65 with which a 10 mortar joint become 225 x 112.5 x 75 to BS 3921, part 2.

Tejumauwo (2000) revealed that most brick are machine made and used for general purpose (on account of their relative cheapness), there is also demand for hand made bricks for superior facing work. The preparing drying and burning process are similar to those of machine made but the molding is done by hand.

Characteristic - good bricks should be thoroughly burnt, this makes them hard and durable (the quantity of lasting for a long period emitted when 2 bricks are struck together indicates that, they have been built satisfactorily. Generally the bricks should be true to size and shape with straight edges and even surfaces, so as to facilitate laying them in position. They should be free from cracks chips and large particles of lime unless desired; uniformity of color is not specified.

Inferior bricks are generally under burnt and as a consequence are easily broken and are very porous, these are neither hard nor durable and are incapable, of withstanding heavy loads. If they contain course grain of uncombined lime, any water absorbed causes the lime to expand, resulting in the partials disintegration of the bricks. They are invariably of poor appearance.

2.7 STORAGE OF SOME BUILDING MATERIALS

2.7.1 Bricks: Tejomauwo, (2000) reveals that the improper handling of facing bricks can damage the face, thus impairing the appearance of the finished wall. Carelessness with common bricks can at worst give rise to invisible partial fracture which can affect the strength of the finished work or at best result in unnecessary wastage and incorrect stacking or either create an untidy site and even dangerous condition for anyone in the area.

Brick often arrive on pallets or banded together with still straps, in each ease they can be stored as delivered until needed.

2.7.2 Blocks: Adedeji, (1999) revealed that no delivery blocks should be checked against. The specification as to type and size. They should be stored on edge, on a dry surface or on boards old blocks to keep them off the ground and if they are in the open should be covered with polythene or a tarpaulin to keep out rain.

2.7.3 Timber: Olaniyi, (1998) revealed that all whether primed or not it should be stacked off the ground and sheeted over to keep it as dry as possible.

2.7.4 Sand and Cement: Once delivered all materials including sand, must be stored in clean, dry, covered store from contact with the ground.

2.8 COLLECTION OF WASTE OF MATERIAL USED ON SITE

Tejomauwo, (2000) revealed that transitionally, construction waste are collected at the site without regard to the ultimate disposal. Little thought is given to disposal possibilities and all classes and types are collected together. In vertical construction, a trash chute is usually used to collect the daily debris material from each floor into a central collect point waste material from any demolition are piled at a central point for disposal, if recycle or reuse of materials is contemplated, segregation at the collection point is essential. It is far more economical to segregate at the collection point than to attempt separation once the material are at the disposal site, because some waste may be recycled, some disposal off by wasting.

2.9 PLANT AND EQUIPMENT FOR MATERIAL HANDLING

2.9.1 Cranes

Structural components and process equipment are erected with the aid of various type of self-propelling erecting crane (rail mounted or wheeled) Mast-and-boom crane simple lifting devices, erecting hoists and in particular instances, helicopter and dingibles as described in scheduled of material control in Appendix I source (Tejomauwo, 2000)

2.9.2 Dumpers

The dumper is a familiar sight on almost every large and small construction site. It causes in several sizes for a variety of tasks. It is used for tipting concrete, laterite aggregates, mortar etc.

around the site. The dumper includes wheel barrow, tipper and fiat as described in Appendix with source (Tejornauwo, 20(0)

2.6 INCIDENCE OF WASTE

How much waste is occurring?

A detailed knowledge of the incidence of material waste is essential, particularly for the manager, site worker and student, in understanding the problem of waste prevention in practice. While significant incidence will be noted particularly for brick and blocks during storage, the variety of result in different conditions points to where there was a good level of pracucc. Quite clearly construction sites waste large amount of materials. Waste, irrespective of it's causation was about 10-20% of all materials delivered to site in a typical year in the united kingdom (1985).

Studies shows that the amount of material wasted is usually form of allowance made for it in estimating. The principal materials must higher than the which the industrial assumed in the used in traditional construction exhibit a high average value for direct waste. Variation of material waste levels between sites is substantial, although some sites exhibit a consistence trend. For example, there is tendency for private housing to show higher levels of waste than housing in the public sector. As a general observation from literature books and past project the levels double that allowed for in estimating. While overall waste level indicate the largely unnecessary burden the construction industry bears, the industries does not contribute to its prevention, except to emphasis the importance of developing means to control it. Each kind of material is also unalterable in ways specific to itself Therefore each needs to be studied separately.

2.6.1 Incidence of Waste in Carcassing Operations

Concrete work includes formwork and sundries reinforcement, and both ready and site mixed concrete.

Form Wo.·k

In the case of formwork, waste is defined as the difference between the deliveries of materials and plant, and the materials used a number of times in the forms, as indicated by the design, following the builder's planned method of working. The total timber used was taken to be the quantity required by the site prior to cutting. Hence, waste represents damaged pieces of timber and pieces

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 METHODOLOGY

The project is going to be conducted by identifying the source and accessing the composition of the data of material waste collected from site. Thus to achieve this, the following were carried out.

I. Collection of data by oral interview with workers.

II. Collection of data from literature books

III. Collection of data from literature books and past project between 2005-2010 and analyzed by statistic.

IV. Conclusion based on the result of analysis (iv) (iii) above and recommendation.

3.1.J Tools of Resear-ch

; To obtain the required information for compilation of this project work apart from consulting textbook, journals and literature books, a proper research was carried out by:

I. Distributing questionnaires

II. Visibility studies and oral interview with sate workers

III. Collection of data from past work

IV. The case study

3.1.2 Distri buting Questionnaires

Questionnaires were prepared as described in appendix II and distributed to staff of different organization handling various project. The Questionnaires were later collected after they had been properly filled for the purpose of analysis.

The questions asked were classified under personal company, storage of material and waste of material. Out of 100 questionnaires distributed, 80 were returned filed. The questionnaires were given to site engineers, architects, surveyor, site supervisor/builder and foreman. The questionnaires help in getting information on accessing and controlling the use of material on site and knowing the percentage of waste incurred on some material for construction purposes.

Table 3.0: Illustrate the distribution of questionnaires, number returned percentage being analyzed in the project work.

Sf N	WORKER	NO. DISTRIBUTED	NO RETURN	PERCENTAGES
1	Engineer	30	26	26.0
2	Architects	16	12	12.0
3	Surveyor	16	10	10.0
4	Builder & site supervisor	24	22	22.0
5	f-oreman	14	10	10.0
	TOTAL	100	80	80

3.1.3 Visibility Studies and oral Interview with Workers

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Apart from distribution of questionnaires, sites were visited to obtain information on condition of material also to assist in filling some of the questionnaires the oral interview was done by obtaining information from the building teams who could spare their time to 'discuss. The site visited had few educated people on site, as such most of the questions are directed to the engineers and site supervisor on the site.

Those who could fill the questionnaires collected them and returned later of which some were not eventually returned the oral interview and visibility studies help to access the use of material during construction. Some of the sites visited are in superstructure level while other are in substructure level

3.1.4 Data Collected from Past Project WOJ"k

Data are collected from past work to access the use of material's construction site. Sixty questionnaires were distributed to the target population of contractors, out of which twenty-seven able response rate. An analysis of the demographic characteristics of respondents showed that 75% had upward of twelve years experience in the construction industry with first degrees as their highest academic qualification

Processing those profiles of long experience and education background, the respondent's opinion was adjudged to be adequate for the research.

The exploratory survey results revealed six basic groups of factors responsible for material wastages on building sites. They include storage factors, client, management and construction related factors. Others are design and force majeure as shown in Table 4 to 6 with source (Gwatau, Nimlyat 2006, Iregbu Adciza 2008).

3.1.5 The Case Study

About five sites represent the case study of this project. Table 2 represents the visual studies for material on site during the visit. The table includes the name of company materials on site during and location of site.

Table 3.1: Visual study table for material on site during visit to site in Minna metropolis

SECTION	NAME O"F COMPANY	MATERIAL ON SITE	STAGES DURING VISIT	LOCATION OF SITE
A	YARMOUK CONSTRUCTION LIMITED	Reinforcing rod, sand, granite, blocks timber, water, cement	Super structure level, erection of columns	Minna
B	JPATEL LIMITED	Sand, cement, nail, timber, reinforcement rod, water	Casting of ground floor slab	Minna
C	NAIDA LIMITED	Cement, timber, block, sand, water, reinforcing bar	Roof and finishes	Minna
D	NOMIS NIGE|UA LIMITED	Reinforcing bar, wood, cement, sand, granite	Casting of pipe stack beam	Minna
E	INFIQUES LIMITED	Timber, cement, water sate	Plastering	Minna

from Table 3.1; most of the materials on site are keep in the open space only few materials are kept in the storage store i.c. cement so as for it not to solidify on action of' moisture.

x_i = successive each result obtained in sample

X = mean value of the samples

The co-efficient of variation (PO is a check to determine whether the mean (x) should be modified or not.

If (P) > 10%, There must be modification and if (P) < 10%, target

Mean Fbrn is is known.

The modified (fum) is given as:

$$Fbrn = \left(\frac{l\text{-}I.SP}{100} -0.\right]) X (\sim)$$

CHAPTER FOUR

4.0 PRESENTATION OF RESULTS

4.1 RESPONSE FROM PAST WORK

The study utilized structured questionnaires to collect the necessary data. This was carried out in two stages the first stage involved non-standardized in depth interviews conducted for 12 heads of building construction companies who are registered with the corporate affairs commission and are operating as general contractors within minna metropolis The responses obtained at the exploratory survey stage were used to design questionnaire, which was later administered.

The data analysis involved the computations of mean rating (MR) of each variable by respondent within a given subset. In each computation, the total number of respondent (TR) rating each variable, was obtained and used to calculate the percentages of the number of respondents associating a particular rating point to each variable this was done as follows:

Mean Rating (MR): This is was calculated as the sum of products of each rating point (Rp) and the corresponding percentage response to it (R%) out of the total number of responses (TR) involved in the rating of a particular variable this is given in equation I as:

MR 5 (RP]P/Yo) (41)

Where i=l

RP] = Rating point ranging from 1-5

IZj= Percentage response to rating point i.

4.1.1 The Degree of Contribution of Factors Affecting Material Wastages,

Table 4.0: Below shows the degree of contribution of factors affecting material wastage on site.

Table 4.0: Degree of Contribution of Factors Affecting Material

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	FACTORS RESPONSIBLE FOR MATERIALS WASTAGES	LEVEL OF CONTRIBUTION TO MATERIAL WASTAGE							
		VH	H	AV	L	VL	MR	RO	TR
		.5	4	3	2		MR	RO	TR
		%	%	%	%	%			
	Management related (a) poor planning and organization	76	13	0	11	0	4.54	2	27
	(b) poor control and monitoring	60	30	10	0	0	4.50	3	27
	(c) poor material management	70	25	0	0	5	4.55		27
	(d) Overestimating the required quality	3	37	50	10	0	3.33	II	27
	(e) Indiscriminate use of materials		60	40	0	0	3.60	1I	27
2	Construction related (a) Misinterpretation of drawings	2	44	0	50	4	2.9	18	27
	(b) faulty workmanship	40	37	23	0	0	4.12	5	27
	(c) Productivity problems eg. use of female operatives	0	42	32	20	0	3.22	16	27

	(d) excess input due to excavation	32	40	28	0	0	4.04	6	27
	(c) pilfering and vandalism	20	45	0	35	0	3.S0	13	27
	(f) poor supervision	65	20	0	S	10	4.25	4	27
3	Force majeure (a) act of God and site accidents	0	2	50	48	0	2.54	21	27
	(b) negligence damage by other trades	0	10	30	60	0	2.50	22	27
	(c) damage by inclement weather	0	16	44	40	0	2.76	19	27
4	Client related (a) expectation of high standard	0	40	0	45	15	1.85	24	27
	(b) repeat works/late changes	0	0	27	33	40	1.87	23	27
	(c) too much pressure to deliver project	0	28	2	70	0	2.S8	30	27
	(d) unnecessary interference to deliver project	0	0	10	SO	40	1.70	25	27
5	Design related (a) uneconomic designs due to client brief	0	20	60	20	0	3.40	14	27
	(b) Architects variation instruction detailing errors	0	20	47	33	0	3.S2	8	27
	(c) detailing errors	0	20	47	33	0	3.52	12	27
	(d) wrong materials &	0	50	36	0	20	3.10	17	27

	standard specification								
6	Supply and storage (a) Improper materials handing	33	27	0	50	0	3.73	9	27
	(b) poor storage	50	0	30	20	0	3.80	7	27
	(c) Mode of delivery eg. loose as against packaged forms	34	11	48	0	7	3.65	10	27
	TOTAL SUMMA TION						83.32		

Levels of contribution to material wastage: Very High = VH: High = H; Average AV; Low = L; Very Low =VL; RO=Rank order; TR Total No. of respondents.

form table 4, based on mean ration (MR) values using equation 4, management and construction related group of factors were perceived to exert the most significant impact on overall wastage of materials on site. In the management related group of factors, poor control and monitoring are the most significant contribution to material wastage.

4.1.2 The Basic Categories of Factors Contributing to Material Wastages and their Frequency of Occurrence

Table 4.1: Represent the basic categories contributing to material wastages and their frequency of occurrence.

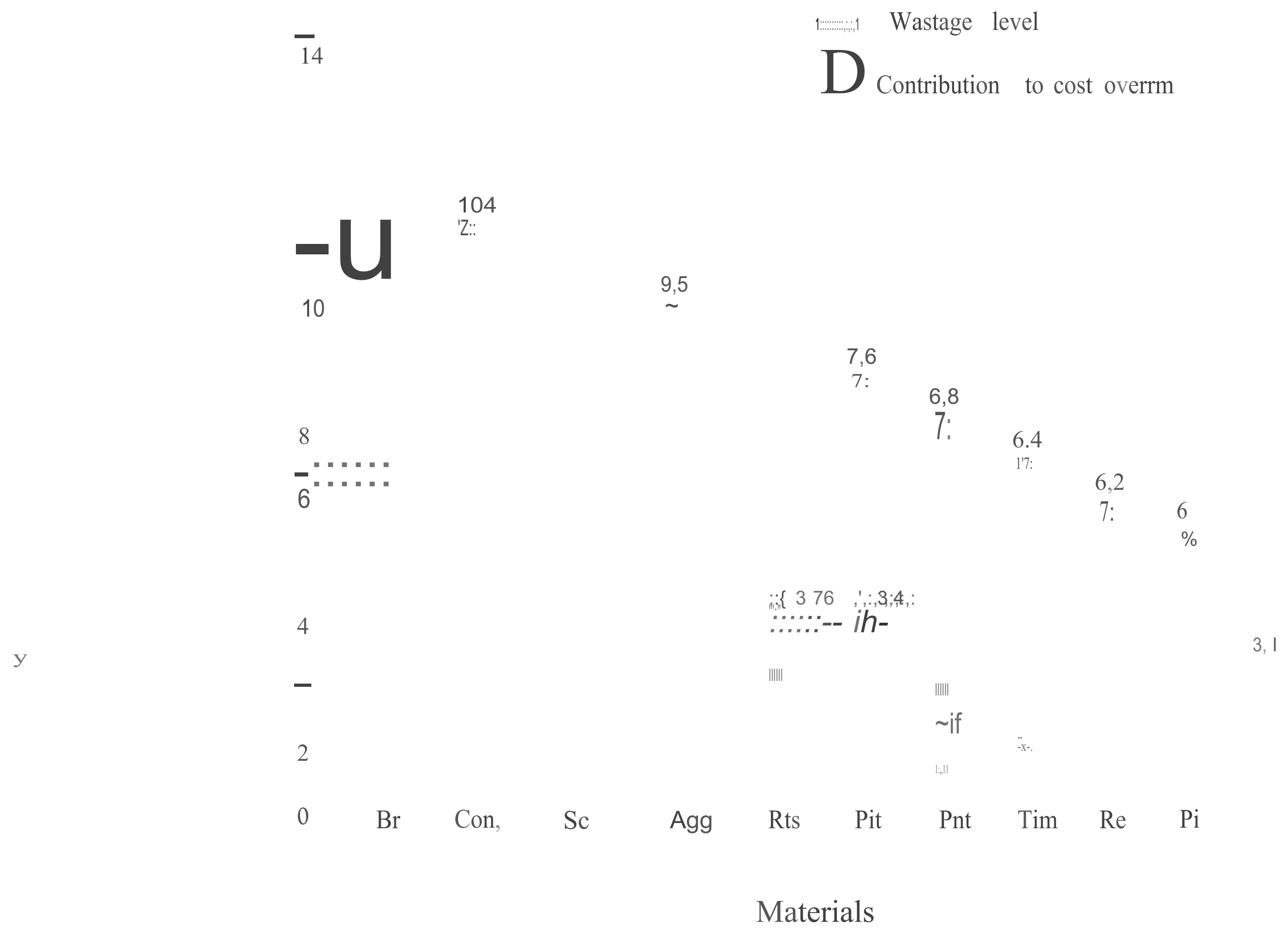

fig 4,0: Histogram showing Wastage Levels and Contribution to Cost Overrum

from the respondents rating, concrete, bricks and sand Crete blocks have the highest mean valve signifying their levels of contribution to project cost overrum. The sights of broken bricks and wasted heaps of concrete littering most construction sites further gives credence to this study, They are not only hazardous but pose serious threats to safety and health of workers on site, From table 4.3; most company work on material management and waste control policy with a value 12.8

4.1.8 Site Training of Material Management and Waste Control

Table 4.4: Represent site training of material management and waste control on site of all five companies.

Table 4.4: Training of material management and waste control

DURATION	YES	% OF YES
6 month	48	50
1 year	22	27.5
2 years	10	12.5
TOTAL	80	100

Mean value = 26.67

Standard deviation = 15.86

Co-efficient of variation 59.5%

Target Mean - 6.60

Table 4.4; shows that most companies gives training for material management and waste control police on site.

4.1.9 Factors Affecting Purchasing of Materials

Table 4.5: Represent factors considered in the purchasing of materials in all the five companies visited.

Table 4.5: Factors affecting purchasing of materials

FACTORS	FREQUENCY	% OF FREQUENCY
Size of store	2	2.4
Storage specification	4	5
Duration of project	2	2.5
All	72	90
TOTAL	80	100

Mean value = 20

Standard deviation = 30.03

Co-efficient of variation 150.2%

Target Mean - 14.02

Table 9: Indicate that all the factors are mainly considered during the purchasing of material for site use.

4.1 10 Stages without Incu r'ring Waste

Table 4.6: Represent the stages without incurring waste of material during construction.

Table 4.6: Stages without incurring waste

STAGES	FREQUENCY	% OF }<'REQUENCY
Design level	80	100
Foundation	0	0
Super structure level	0	0
Finishing	0	0
TOTAL	80	100

Mean value = 20

Standard deviation = 34.64

Co-efficient of variation 173.2%

Target Mean - 16.32

Table 4.6; indicate that all the companies visited sees the design level as the stage without incurring waste.

4.1.11 Material Handling Method

Table 4.7: Represent handling method as suggested by all eighty respondents

Table 4.7: Material handling Method

METHOD OF HANDLING MATERIAL	FREQUENCY	%OF FREQUENCY
Manual	36	45
Equipment and machines	20	25
Manual equipment and machinery	24	30
Other	0	0
TOTAL	80	100

Mean value = 20

Standard deviation = 12.96

Co-efficient of variation 64.81 %

Target Mean - 5.48

Table 4.7: Shows that larger percentage of companies use manual method mainly because of cost of acquiring or renting machineries and equipment for site and manual method cost less.

4.1.12 Site Type Placement of Material

Table 4.8: Represent site type placement of material

Table 4.8: Site type placement of material

SITE TYPE & STORAGE PLACEMENT OF MATERIAL	FREQUENCY	%OF FREQUENCY
On field	46	57.5
Enclosed place	34	42.5
TOTAL	80	100

Mean value = 40

Standard deviation = 6

Co-efficient of variation 15%

Target Mean =- 1

Table 4.8: Indicate that larger percentage of companies keep their material on field as a result of not being able to acquire storage store or shield for material due to restriction of space on site.

4.1.13 Waste Disposal Method

Table 4.9 Represent waste disposal method table with response [rom all eighty respondents.

Table 4.9: Waste disposal method

METHOD OF HANDLING MATERIAL	FREQUENCY	%OF FREQUENCY
Burning	12	15
Burying	8	10
Removal [rom site	60	75
TOTAL	80	100

Mean value = 26.7

CHAPTER FIVE

5.0 DISCUSSION OF RESULTS, CONCLUSION AND RECOMMENDATIONS

5.1 DISCUSSION OF RESULTS

5.1.1 Exploratory survey

Hundred questionnaires were distributed to the target population of staff of different organization handling various project out of which eighty useable responses were received representing 80% useful response rate.

An analysis of these characteristics of represents showed 90% had upward of six years and above experience in the construction industry. Possessing these profiles of long experience and sound educational background, the respondent's opinion was adjudged to be adequate for the research.

5.1.2: Factors Responsible for Material Wastage

The exploratory survey results revealed seven basic groups of factors responsible for material wastage on building sites they include that material management and control related factor; site training factors, storage and placement factor, material handling factors, factor considered for purchase of material, storage without incurring waste. Others include recycle, and reuse of material and disposal method. The study examines the key factors affecting material wastage peculiar to some building site in Minna metropolis. The work also addresses the issues of' construction project management and control as related to affective (successful) project execution in the Nigerian construction industry.

It is evident that in management related group of factors, poor control in the use of materials, poor inspection and Storage and placement factor is the most significant contributor to material wastage on construction site. This is also consistent with earlier finding from past work

(Gwatau, Nimlyat 2006, Iregbu Adeiza 2008), Laments on the 'serious lack of awareness and care amongst management and supervisory staff regarding the utilization of material and equipment'. What appeared to be at variance with the expectation of this study is the perception of respondents relating recovery (reuse) and recycling of material as not very effective considering the level of daily pilfering on sites.

Conclusively, waste occurred because of frequent overlapping of factors, which include poor material management and control, unacceptable low standard of workmanship absence of supervisor of material both on packing and delivery (poor inspection), poor storage and placement factor, faculty execution by poor material handling, and poor site training on the sue of material on site.

Through finding effective approach of factors for the minimization of material wastage which enables an improvement in waste control, not only as created on site but by others outside the site, for instance by architects and by manufactures of materials and plant.

It can be inferred from these findings that waste of material is a problem and that as improvement in material management and control, provision of good storage facility and proper inspection of material in project execution is the key to its alleviation within the building firm, this helps in gaining economical, operation, to offset uncertainties and change, to focus attention on objectives, to facilitate project cost and time tracking, to resolve delays and change orders (variation) on a predefined and equitable basis and to allocate contractual responsibilities and provide for clear lines of communication.

The prevalence of material prone to excessive wastage were analyzed and their relative contribution to waste of material.

The material studied were brick, concrete, sandcrete, mortar, timber, reinforcement Rod and sand. It is evident from research work that brick, concrete, sandcrcte block and mortar are the major contribution and the percentage of waste of these material have increase over the year compare to level of waste from finding and past work (Gwatau, Nimyat 2006, Iregbu Adeiza 2008). In

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whatever form, material wastages have serious implication to the stake holders in the expected profit from a project; to the client or developer, it escalates the development cost and undermines value; to the consumer and society at large, it results in high purchase prices and rental charges

5.2 CONCLIJSION

The research was an attempt to critically examine the use of material on construction site, the waste incurred and measure for curtailing of these wastages. The conclusion drawn from the study is that the factors underlying material wastages on building sites has been grouped into seven, namely, material management and control policy related factor, site training factors considered for purchase of material, stage without incurring waste and others include recycle and reuse of material and disposal method. These are the most frequent occurring and are responsible for overall wastage of material on most sites.

y

The most outstanding factors in the entire group are poor inspection, control, stage and placement (delivery) which are management related.

I3ricks, concrete, sandcretes blocks and mortar features as the materials prone to excessi ve wastages and contribute significantly to project cost overrun with a percentage of 10-20% of material delivered to site ends up as waste. The most effective's strategy for curtailing material wastage in accessing and controlling the use of material on constructions.

It is to prevent wastage from occurring in the first place. findings from study show that inspection (monitoring), control and proper handling of materials are most reliable strategies.

5.3 RECOMMENDATION

from this research work the following recommendation are drawn:

1. Appoint a materials controller with defined responsibilities for all materials on site and sufficient, authority to control procedures.
11. Proper inspection (supervision) should be carried out before project execution to reduce waste.

iii. In the event of waste, motivation and training of site personnel on use of materials should be considered as some of this material can be use appropriately where suitable for use to reduce waste.

iv. Effective material management and control policy should be encouraged to reduce the level of waste.

v. Responsibility of material must begin with the person handling them e.g carpenter, bricklayer, thus trade foreman must take more responsibility

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APPENDIX 1

SCHEDULE OF MATERIAL CONTROL OF SITE

A. Table AI: Represent the Schedule of Material Control on Site

Table AI: Schedule of Material Control on Site

MATERIALS	HANDLING	STORAGE	PROTECTION
Fine and coarse aggregate	Delivery by high sided trucks, check quality, grading and quantity. Tip into selected area. Transport hopper dumper and barrow	In prepared bay, adjacent to the mixer. In selecting grading and particle size.	Cover against frost, snow or rain. A void contamination with mud, clay or oil.
Cement	Delivered in 50kg paper sack on timber pallets use gagged cement in order of delivery	On raised platform in shed or in open covered completely tarpaulin or polythene sheet.	A void accident bursting of sacks restrict rising moisture affecting cement in store cover against rain. Now and ice.
concrete	By crane, skip. hopper, dumper, or barrow. transferred by concrete pump from delivery to placing point	In special hoppers or skips when trans ferring to upper levels. On suitable sized timber or metal sheet with side supports to resist	A void mud or other deleterious matter affecting concrete at any stage. restrict rain, snow, frost after mIxmg

		concrete spreading	
Mortar	Delivered in premix load either in bulk or containers. Transport on site in skips, dumper offload closed to word area.	In containers or in moulds ready for adding cement deposit bulk delivery on suitable timber, metal sheet or concrete base having side supports to prevent spread.	A void contaminations by mud or other deleterious matter. cover with sheet to prevent rain. snow or frost affecting the material.
I3locks	Delivery on pallets offload by vehicles crane, forklift etc transfer on site by forkli It, crane etc.	Stack on prepared base do not form stacks more than three packs high	Avoid tipping blocks [rom dumper. avoid contamination with mud or sulphate.

source: (Tejurnauwo 2000)

APPENDIX II

fEDERAL UNIVERSITY Of TECHNOLOGY MINNA,

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY,

DEPARTMENT OF CIVIL ENGINEERING.

Dear Sir/Madam,

This questionnaire is specially prepared for research work only.

The title of the research work is "Accessing and controlling the usc of materials on construction site"

This is not a test and so no answer is right or wrong. The information provided by you shall be treated confidentially; therefore you are expected to express your opinion frankly and freely.

Please indicate your response by using X on the option and state otherwise in the space provided.

v

Thanks for your anticipated co-operation.

PART A: PERSONNEL

1. Rank/Level Age: Sex: .
2. Profession... . .
3. How long have you been in the profession?

a. Less than Syrs D b. 6-10yrs ~ lSyrs D

d. 16 - 20yrs D e. above 20yrs D

4. Have you been involved in the construction/execution of a building project? a Yes

b. No D D

S. What are geo- technical! en vironmental factors constraint on site?

/

PART B COMPANY

1. Name of the company .

2. State the location/address ..

3.

4. a. Does your company have management policy on material used on site? Yes

D

b. If yes state the policy .

i. Control of material on site ~ontrol of material on transit D

III. Control of material on delivery D

5. a. Does your company gives a practical site training of material management? Yes

No D D

b. If yes how often

L Gmonths Dii. 1- Years ~ears D

6. Is there a particular stage in building process which waste do not occur? a. Design Level

b. roundL:Jevel D

c. Superstructure level ~ishing stage D

PART C: STORAGE

Ia. Does your company have a safety manual for material on site')

Yes D No D

b. Ifno, Please State reasons .

2a. Does your company makes a material acquisition? Yes NoD D

b. If no, please state reason(s) .

3. How does your company keep materials on site? .

a. On field D b. Enclosed place D

4. What type of site have you worked so far?

a Open site Db Close site D

5. List possible materials kept outside store on site.

.... ,.. , . .' ,., .,.. , . , , . .

6. What are factors considered in the purchasing of materials?

a. Size store D b. Storage store EJation of Project D

d. All D

PART D: MATERIALS AND WASTE

1. Do you inspect all materials on delivery on site Yes No D D

b. If No please state reason(s) .

2. How do you handle materials on site? Using Manual Using Manual using eqL:Jnts and machinery's Manual equipment anf ma~hinery others (please specify)

3. How do you store the following materials on site?

(a). Cement D .

(b) Sand .

(c) Reinforcing .

(d) Concrete .

(e) Mortar .

(f) Blocks .

(g) Timber ''' .

(h) Sand Crete .

(i) Bricks .

4. What are the causes of wastages of the materials in (3)

a.

b.

c.

d.

e.

r

g.

h.

I.

Materials	1- 5%	6- 10%	II - 20%	21 - 30%	30 above
1. Cement					
2. Sand					
3. Reinforcing					
4. Concrete					
5. Mortar					
6. Blocks					
7. Timber					
8. Sand crete					
9. Bricks					

6a. Do you inure waste on transit and unloading material? Yes No D D

b. If No please state reasons .

7. How do you dispose waste material on site? (a) Burning D

(b) Burying ~moval from site D

8a. Do you recycle/reuse waste on site? Yes No D D

b. If No please state reason(s) .

9. Ilow do you recycle/reuse the material in (3) above when they result into waste?

a.

b.

c.

d.

e.

r

g.

h.

1.

IGa. Do you keep record of material waste on site? Yes No D D

b. If yes, Please state reason(s) .

Thanks for your cooperation.