AN ASSESSMENT OF SITE LAYOUT PRACTICES OF SOME CONSTRUCTION FIRMS IN ABUJA, NIGERIA

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DECLARATION

I declare that the work in this Dissertation entitled **"AN ASSESSMENT OF SITE LAYOUT PRACTICES OF SOME CONSTRUCTION FIRMS IN ABUJA, NIGERIA"** has been carried out by me in the Department of Building. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this Dissertation was previously presented for another degree or diploma at this or any other institution.

Usman MOHAMMED	Date	Signature

CERTIFICATION

This dissertation entitled **AN ASSESSMENT OF SITE LAYOUT PRACTICES OF SOME CONSTRUCTION FIRMS IN ABUJA, NIGERIA** by usman MOHAMMED meets the regulations governing the award of the degree of Master of science in Construction management of the Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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Prof Kabir Bala. (Dean, School of Postgraduate Studies)	Signature	Date

DEDICATION

This research dissertation is dedicated to my mentors, my heroes in persons of Hajiya Safiya Mohammed Abubakar and, Alhaji Mohammed Abubakar and those who gave me support in any way.

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ABSTRACT

Site layout involves the identification, sizing and placing of the temporary facilities (TFs) at the required positions within the boundaries of the construction project site.
The aim of this research is to assess the site layout practices of some construction firms in Abuja, Nigeria, with a view to improve productivity of workers in construction sites. Questionnaire was administered for the collection of data for the research. Purposive sampling technique was used to obtain the data. Relative importance index was used to determine the ranking for the various practices of site layout. Based on the research findings, 50% of the staff in the construction firms participated in designing site layout which implies that majority of the construction firms do site layout. 64.7% of the construction firms design site layout for residential buildings, 78.9% of the construction firms does site layout design for both small, medium and large projects, while 78.4% do site layout design for both short and long term project. Preparing site layout design before the commencement of site work ranked first with (RII) value of 0.785 which implies that the construction firms practiced site layout before the commencement of site work very well. While causes of occurrence of accident in construction site as a result of poor site layout practices ranked first with (RII) value of 0.575. The research recommends that site layout should be practice in other form of construction not only residential building.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Construction project site layout involves the identification, sizing, and placing of the temporary facilities (TFs) at the required positions within the boundaries of the construction project site. These temporary facilities may range from simple lay-down areas to warehouses, fabrication shops, maintenance shops, batch plant, and residence facilities. Required temporary facilities and their areas depend on many factors including project type, scale, design, location, and organization of construction work (Elbeltagi and Hegazy, 2004)

Site management in general, involves many tasks such as site investigation before construction process starts, material delivery and procurement management, keeping better site records, keeping good site communication and high level of information flow, monitoring performance regularly, establishing a well co-ordination system among different parts, and performing a good site layout planning (Osman *et al.*, 2003)

Most construction sites that run into trouble do so for reasons related to managerial factors rather than because of technical problems **(Elbeltagi *et al.*, 2004)**

The role of site managers is to control and maintain work performance and then taking actions to rectify situations where performance is unsatisfactory. Safety and accessibility should be given more consideration in site planning and also the designing of path for movement of transport rather than to limit the consideration only to distance and cost (Andayesh and Sadeghpour, 2013).

Among the important tasks of site management is the site layout planning. A detailed planning of the site layout and location of temporary facilities can enable management

to make considerable improvement by minimizing travel time, waiting time, and increasing workers morale by showing better and safer work environment (Mawdesley and Al-jibouri, 2003). Construction site layout planning has been recognised as a critical step in construction planning. The basic function of the process is to find the most suitable arrangement for the positioning of temporary facilities. Temporary facilities have to be placed right from the beginning of project to completion (M and P. Saka, 2013).

Site managers mostly abandon site layout design right from the inception of the construction project thinking that it will be done as the construction project progresses (Ebeltagi and Hegazy, 2004). It is important to realise that site planning is the condition that site personnel live with for the total duration of the constructing project (Osman et.al, 2003) Thus, careful pre-planning is imperative. According to the Construction Industry Institute of Geneva (2000) temporary facilities are important elements that can either enhance or adversely affect construction productivity (CII, 2000).

Efficient layout planning of a construction site is fundamental to any successful project. This usually consists of identifying the temporary facilities needed to support construction operation determining their size and shape and positioning them in the unoccupied areas within the site boundaries (Osman *et al.,* 2003). Examples of these temporary facilities include offices and tool trailers, parking lots, warehouse, batch plant, maintenance areas, fabrication yards or buildings, staging areas and lay down areas. The project manager or planner usually performs the task of preparing the site layout based on his/her own knowledge and expertise. Apparently, this could result in layout that differ significantly from one person to another. To put this task into more

perspective, researchers have introduced different approach to systematically plan the layout of construction site (Osman *et al.*,2003).

A good site layout design can avoid possible conflicts involving equipment and allows for smooth transportation during the entire project. It can also ensure that sufficient space is available so that all onsite equipment such as trucks, cranes and excavators can be safely operated. In current practice, the evaluation of good site layout design is done manually, relying heavily on the experience of the construction site planner (Tam and Tong, 2003). A good site layout would help site planner to reduce the cost of construction project and not even sacrifice safety involved in the site layout as well. In previous research, site facilities were considered within safety zone and forbidden in prohibited area (Lam and Ning, 2013). Site planning directly influences the construction progress and often impacts cost if there are any unforeseen conflicts (Su and Andoh, 2012). In present situation of construction project site management, the construction site managers or planners use the manual approach to mark up a single site layout drawing to include major temporary facilities that are needed on site throughout the duration of the construction project. Depend on knowledge of years of experience, common sense, which they have gathered and adoption of past site layout design in determining the positions of temporary facilities on construction project site (Elbeltagi and Hegazy, 2004).

1.2 Statement of Research Problem

Many large construction projects face accessibility problem due to poor site layout design. Most construction project sites encounter site layout design problems due to lack of knowledge in site layout design. Site layout design should be considered as a pre-requisite to the start of project construction (Ka-chi lam and Chun-kit lam, 2010).

Neglecting site layout design causes a lot of problems in construction site. These problems include the following (Ka-chi lam and Chun-kit lam, 2010). Increase in construction project time, Decrease in productivity of workers, Increase in the cost of construction project (Cost overrun), Causes delay in construction delivery (Time overrun), Change in the scope of work.

1.3 Justification of the Study

Site layout planning, in general, can be viewed as a complex problem that has many effects on construction project productivity, ranging from the site layout of small construction project to the site layout of large construction project. This problem has to be extensively addressed with respect to this research.

A well planned site including all temporary facilities and utilities lead to increasing productivity and safety, reducing areas needed for temporary construction and maximizing utilization (Elbeltagi and Hegazy, 2004).

In fact, the design of site layout plan is one of the preplanning tasks that has to be considered at the early stage of construction planning and accomplished in construction project. This task in construction project has an interactive relationship with the other planning tasks such as scheduling, selection of construction method, procurement and material planning, manpower and equipment planning, and financial planning. So, it becomes a task as important as other tasks that project managers have to accomplish through the entire life span of the construction project (Elbeltagi and Hegazy,2004)

1.4 Aim and Objectives

1.4.1 Aim

To assess the site layout practices of construction firms in Abuja, Nigeria with a view to improve the practices of site layout on construction projects.

1.4.2 Objectives

1. To articulate the concept of construction site layout practices of construction firms.
2. To ascertain the involvement of construction firms in site layout practices
3. To assess site layout practices of construction projects in Abuja
4. To determine the poor practices of site layout on construction firms in Abuja

1.5 Scope and Delimitation

1.5.1 Scope

The scope of this research considers the management of some construction firms in Abuja metropolis.

1.5.2 Delimitation

This research is limited to the management of some construction firms that are based in Abuja metropolis.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Concept of Site Layout Practices

The Planning of site layout for a construction projects is a fundamental task that has a significant effects on construction cost, productivity, and safety. (Hong and Ho, 2010). This involves the positioning of temporary facilities that are needed to support the various construction activities on site (Elbeltagi and Hegazy, 2004).

The temporary structures include offices, storage areas, workshops, and parking areas. Due to the complexity of the site layout planning problem, construction managers and site planners often perform this crucial task using past experience, and first-come-first-serve approach which leads to ambiguity and even to inefficiency (Lam and Ning, 2011). Construction sites have abundant space availability and accordingly the positioning of site facilities with respect to each other will greatly influence the travel time and productivity of construction equipment and personnel moving between these facilities. Interior spaces of buildings that are under construction can be used for material storage while the exterior space can be left for the temporary facilities such as office trailers and tower cranes (Elbeltagi *et al.,* 2004). Design of site layout plan is one of the preplanning tasks that have to be considered at the early stage of construction planning and accomplished in a construction project. It becomes a task as important as other tasks that project managers have to accomplish through the entire life span of the construction project (Elbeltagi and Hegazy, 2004).

Accessibility is one of the most important considerations in construction site layout planning. the routes path of the construction site need to be thoroughly designed to

ensure smooth delivery of materials, safe machine operation and relatively easy relocation of large objects on site. Construction site layout planning directly influences the construction progress and often impacts cost if there are any unforeseen construction conflicts within the domain of the construction site (Su *et al.,* 2012).

Traditional site layout planning is basically conceded with the positioning, of existence and timing of the temporary facilities that are used throughout the construction project (Lam *et al.*, 2013).

Efficient layout planning of a construction project site is a fundamental task to any construction project under taking with the aim to improve the general practice of layout planning of construction sites (Osman *et al.,* 2003).

2.2 Provision of Temporary Facilities for Construction Project Site

Site layout facilities in construction project site, are referred to as temporary facilities (TFs) which are always demanded and provided to support construction activities during the period of project undertaking (Thabet and Waly, 2003). Construction site layout planning and temporary facilities have a very close relationship in all construction activities which are highly depended on the provision of temporary facilities in order to have work done effectively and efficiently in a predetermined period of time and according to a complicated schedule. In most cases these type of arrangement for the temporary facilities is achieved through well-coordinated manner. (Su *et al*., 2012)

In general perspective in construction project site, temporary facilities should include the following. (Ebeltagi, 2004)

1. Facilities which are required to support construction works, such as false work as temporary support to facilitate various construction process, storage facilities for storage purposes within the boundaries of construction site, workshops, sub-contractors yards and other important facilities on the construction project site.
2. Facilities that are required for effective well-being of workers on site such as the site public convenience, washing/changing rooms, shelters, resting rooms, canteen for food, provision of access road to work, and other safety facilities.
3. Facilities which are required for the overall site shuttling, logistics, operation within the construction project site .
4. Facilities which are statutory required for the security of the construction site such as fencing the construction project boundary. Equipment for waste disposal, water treatment plant for construction activities, noise and dust control, or arrangement for temporary traffic diversion e.t.c. (Ebeltagi, 2004).

2.3 Construction Information Management With Respect to Effective Site Layout Design.

On site construction management is one of the most critical aspect for the successful execution of large-scale construction project site (Xu and Li, 2012). Accurate and timely understanding of the on-site flow of information about the work task to be performed and the construction resources that facilitate management decisions toward improving construction productivity. There are great challenges faced by the site engineers and planners in collecting and share information across the construction site due to harsh construction condition. These challenges necessitate the development of tools equipped with suitable sensing and communication capabilities to acquire and exchange construction information across the construction project site effectively and efficiently (Lam *et al.*, 2013).

Efforts have being made to apply sensing technology to construction project sites for automated data acquisition (Ning *et al.,* 2010). Three dimensional sensing technologies, such as Global Positioning System (GPS), Ultra-Wide Band (UWB), laser scanning and digital photogrammetric, e.t.c all these are used and consider as technological tools to enhance communication on site. However these pioneering effort prove that the advanced sensing technology have great potential to substantially improve productivity for the traditional site management process, productivity can only be achieved if the approaches is used effectively by distributing and sharing the information obtained at site to the project participants (Ning *et al.,* 2010). These project participants include the project manager, site engineer and the artisans on construction site so that they informed decisions. In particular, the information flow to the construction workers can generate a new breed of knowledge for worker (Su and Andoh 2012).

All construction project management system should meet the requirements as flows: the capability of site management with effective maintenance and also to understanding the current status of the construction project, the system should also provide the information for work task to site engineers and managers to effectively manage the construction project resource on site, and the system should have the function of real-time information flow and sharing to facilitate efficient interaction among construction participants (Lam *et al.,* 2011).

In spite of the rapid progress in the project management field, a number of negative issues are still affecting the management of construction project. These issues are still affecting the management of construction project these issues include use of appropriate tools and systems for communication co-operation and management (Lam *et al.,* 2010).

Construction site facilities for a good site layout design are usually have a specific work target and operation nature in which they still have some common characteristics as follows. (Wong *et al.,* 2010)

1. Essentially not easy to be substituted for carrying out specific construction work.
2. The temporary facilities must have temporary nature that can be relocate and use on another site.
3. The provision of maintenance and the installation of these temporary facilities can be quite timely and costly, thus the provision, relocation and maintenance and also dismantling of these facilities should be well planned in a very careful manner in order not to interrupted with the site layout design master plan of the construction project site (Wong *et al.,* 2010).

2.4 Provision of Site Layout Facilities According to Construction Project Stages

Construction site layout facilities for a construction project site can be further be classified based on construction stages for a particular construction project site. This depends on the type and scale of the project. Some of these stages can be as follows

a. At the start of the construction project: construction site layout facilities are to be set-up at the early stage of construction project undertaking. This usually include the provisions that must be provided before the effective carrying out of other major construction works or other work items that are to be demanded for concerning statutory requirements. The facilities are site fencing, supply and routing of the access roads the setting up for site offices for contractors and other site personnel, arrangement for the delivery and also positioning for the essential work equipment, and other provision as required by relevant statutory requirements (Wong *et al.,* 2010).

b. At the peak period of a construction project that is as the construction project progresses. When permanent structural works are to be executed. At these stage the facilities to be used for the construction project progress should be more specific. Some of these facilities are temporary in their nature. These facilities are tower crane, material hoist, workers lift, scaffold, and temporary platform, provision of access working fronts, false work or additional support to the required structures. and other equipment, And there is also mounting equipment which is mostly required for external works for buildings such as power wincher system for the installation of other finishing material like the curtain wall units which is to be operated a temporary provided track rail. (Wong *et al.*, 2012)

c. At final stage of construction project that is when finishing touching activities are on progress or other handing over preparation is to be carried out. In this stage of construction project almost all the construction site layout facilities are to be dismantle and remove away from the construction site. For instance like in case of a winching machine and a lifting rod that are to erected and set on the roof level to help in the dismantling process for a tower crane and lowering its components down to the ground level for removal. And therefore provision for the touching up & maintenance of the disturbed areas after the dismantling and removal of the temporary facilities is also require (Yahya and Saka, 2013).

2.5 Provision of Major Site Layout Facilities According To Type of Construction

Construction site layout facilities is relatively a general term that is used for the setting up and operation of a construction project site for the nature, scale and type of work. The following are features to be highlighted based on the construction project type (Wong and Ho, 2010).

a. Building construction project involves the construction of super high rise storey building, towers in a relatively confined site the construction site layout facilities for project of this type should include (Wong and Ho, 2010)
    i. Facilities and work spaces for construction material delivery or placing of concrete.
    ii. Crane tower is to be assisted for construction activities that are situated at the top floor level
    iii. Hoisting equipment that is used in materials delivery or components which are structurally completed at various floors.
    iv. Handling spaces for other building materials and semi-completed components which include precast items used on site.
b. Large scale building construction projects in particular with a very large construction project site area or involves works on site with a complicated shape or layout. This comprises for instance large scale excavation, deep trench excavation, work adjacent slope or sensitive structures either at grade or underground (Wong and Ho, 2010).
c. Complicated civil engineering project and various types of large-scale construction projects, example of these types of projects which include site formation, marine works, drainage works, slope treatment water supply railway construction, highways projects, tunnels and bridge construction and other infrastructural development projects. (Wong and Ho, 2010)

Provision for site layout temporary facilities for civil work projects are often in a highly dynamic nature due to the involved works that are mainly in a horizontally spread

layout without a lot of tall and independent structures. The following are example of some temporary facilities used in civil engineering works (Wong and Ho, 2012).

i. Machines access road or worker manual, these accesses can be erected. Over large area that is undulating e.g. bridge towers, or provide access to very steep slope.

ii. Provision of equipment for the transportation and lifting of bulky or very heavy materials such as the spoil materials for excavation for structural steel, precast or semi completed components. These materials can weigh up to hundred tons. The hundred equipment, for instance the various types of work machines for earth-work conveyors systems, cranes, launching equipment portal frame, hydraulic trolley or jack systems etc. Sometimes, such provisions may even include the setting up of temporary facilities such as pier for marine works or for the delivery of large and heavy materials transported to site by sea. And of course, an appropriate access routing should also be provided for the working and handing of the equipment.

iii. False work system for various purposes such as support for temporary work, flat form for machine stationing for material handling and for storage facilities, provision of additional work spaces (elevated or suspended) so as to give support to lay down reinforced concrete structure which is constructed in an in-situ manner to support an open-cut basement excavation pit or as support to fresh concrete structures which are prepared for the temporary placing of additional loading.

iv. Site layout and equipment for large scale earthworks, site formation for foundation works. A large number of very large work machines such as excavator, dumper trucks, graders, rock crusher, conveyor, drilling machine, piling rack for foundation large climates piling equipment are involved in these kinds of projects. This equipment often used in a difficult topographic condition mostly in remote areas.

v. Equipment for specialized construction works such as launching of gantry for the construction of viaduct or elevated bridges, Tunnel Boring Machine (T.B.M), travelling of form work systems or the equipment for tensioning works etc. (Wong and Ho, 2010).

2.6 Concerns and Relationship of Site Layout Construction Facilities and Construction Planning

Site layout facilities and other construction related logistic from the contractual point of view, support is highly difficult to be predicted perfectly or priced before the commencement of a project. However the reasonable catering and costing allowance of such work items will practically overshadow the success or profitability of a project (Xu and Li, 2012). Planning in construction is real and can be hardly being worked out using any programming software not because of any imperfection of the tools. There are unpredictability which comes mainly from highly dynamic situation, the existence of numerous works variables as well as the involvement of complicated human provision are required for the placing or renewing and or displacing of the equipment that may introduce large amount of additional cost input (Xu and Li, 2012). Typical situation can be found in a tunnelling project.

a. Additional resources and handling arrangement are required for the setting up of the site layout facilities equipment and or other associated works. Besides requiring a long period of time to set and erect some layout facilities that are needed. Much additional equipment or facilities to have them set up bored piles for marine long and supported on temporary marine piles and steel shed has to be provided for the purpose of the construction work (Wong and Ho, 2010).
b. Additional working space for smooth operation of the installed facilities are required project such as large scale site formation, slope, foundation or tunnel works require

high and sophisticated equipment for the carrying out of the job. Very large working space sometime on very difficult ground condition like on a steep slope, sides of a serving highway, or areas outside the boundary of the site that belong to other third parties, is required for the setting up and operation of the installed facilities.

c. The provision of many site layout facilities have complicated cost implication it is obvious that the additional input in the provision of the required facilities are usually improve in the expensive equipment. And also the installation cost, maintenance and cost of removal, or the participation and managerial input by sub-contractors analysis and estimate are to be carefully cost in appropriate stages can in most cases assist the sub-contractor to minimize the cost effect of such extra work to a reasonable and controllable manner.

d. Very expensive equipment may be involve, planning should be introduced. Equipment that are expensive which are often required to carrying out specific work in civil engineering project. Whether the equipment are to move forward from an immediate finished project, to buy a new or to hire them from other available sources or to be provided by a sub-contractor in a matter of resource planning consideration that may affect the master planning and profitability of the project.

e. Some components of work or construction operations may require a very long lead time that advanced planning and coordination is essential before works can be carried out on time, example of type of works include large and complicated precise or prefabricated components, or equipment which are very complicated and sophisticated in nature. Such type are bridges gantry or large diameter tunnel boring marines. Sometimes in building construction works such as prefabricated

construction using structural steel or large amount of component that are precast. Production and installation of curtain wall for covering of construction wall . These types of works often require a long lead times in the design sub-contracting, material decision, prefabrication quality control, resting and commission coordination (include approval) of the entire work and transportation of the items before they can be delivered to site for the operation to take place.

2.7 Site Layout Facilities Allocation in an Unequal Area

In an unequal-area construction site layout planning problem, Due to unequal level in the site area, the site layout facilities cannot be assigned to any free locations within the construction site without taking the dimensions or the sizes of the facilities and the locations into consideration. This is in order to solve the unequal-area site layout problem in this case study, the sizes of the construction site and the site facilities were all denoted as a series of units. These units are basically equal to the greatest common divisor of all the facilities areas (Ning and Lam, 2009).

2.8 Facilities Closeness Relationship

Effective placement of facilities within the site is significantly influenced or determine by flow and movement of resources within the construction site. This is basically the interactions between the construction site closeness or proximity. The relationship between the facilities and the factors that affect the closeness of relationship can be broadly divided into quantities and qualitative factors and therefore, fuzzy rule-based system in facilities layout planning is needed, the work flow of using fuzzy rule based system. These methods are used to calculate the facility closeness relationship (Ning and Lam, 2009).

The work flow of using fuzzy rule-bases system to calculate the facility closeness relation. For the first step, four quantitative factors, namely, material flows (MF), information flow (IF), personnel flows (PF) and equipment Flows (EF) and two qualitative factor. namely, safely/Environment concern (SE) and users preference (UP) are considered in the facility closeness relationship to illustrate the proposed method to solve construction site layout planning problem in this study according to these six factors are defined as (Ning and Lam, 2009).

Material flows (MF): The flow of parts, raw materials work in process and finished products between department the MF can be measured by unit per time.

Information flows (IF): The communication oral or reports between facilities information flow can be measured via a survey of involved personnel and it can be expressed by the number of communications per unit time.

Personnel flows (PF): The numbers of employee from one or both facilities that perform tasks from one facility to another.

Equipment flow (EF): This is defined by the number of material handling equipment (trucks mixer, etc.) used to transfer material between facilities.

Safety/Environment concern (SE): Represents the level of safety and environmental hazard, measured by the safety concerns, which may arise when the two facilities are close to each other, and may affect site workers by increasing the likelihood of accidents, noise, uncomfortable temperature and pollution

Users preference (UP): Represents the project managers desire to have the facilities close to or apart from each other (Ning and Lam, 2009).

2.9 Construction Site Layout Dynamic Searching

In order to solve the dynamic construction site layout planning problem. The suitable site layout design should comply with the overall construction project time with the consideration of the interactive relationships in the different construction phases, as well as the facilities to be used for each phase. continuous dynamic searching rather than a discrete dynamic searching this is used to fine the minimum value for the objective functions during the overall period of construction (Ning and Lam, 2009).

Assume that there were four facilities F_1, F_2, F_3, and F_4 which are required during two construction phases in a construction project site where F_1, F_2, & F_3 are assign to phases 1 and F_2, F_3 and F_4 were employed in phases 2. The adoption of continuous dynamic searching should be more advantageous than that of the discrete searching because the arrangement of the four facilities for the whole period of the construction which can be positioned on a single site layout. On the contrary, a re-handling cost i.e. more labour cost and time consume occurred when the discrete dynamic searching scheme is used. Moreover, the increase in materials to be transported, flows shall lead to a decrease in the safety level at the construction project site (Ning and Lam, 2009).

2.10 Construction Site Layout Planning With Respect To Decision Making Perspective

Construction site layout planning has been recognized as a tedious step in construction planning faced by site engineers and or planners, construction site layout planning is a decision-making process, which involves the identification of problems associated to construction site layout design. And also developing the solutions to those problems by choosing the best alternative and implementing the chose objective. Planning a good site layout is a decision making process which involves the determination of the construction site layout planning objectives. Which are usually multiple in nature, and

the layout constraints identification of the construction site layout facilities and the available site space. At times the construction in an unequal area which is very dynamic during the construction project undertaking. The generation of the construction site layout alternatives, which fulfil the objectives of site layout design and constructions, and finally selecting and evaluating the best site layout plan for implementation (Ning and Lam 2010).

After extensive literature reviews for previous construction site layout planning research works and discussions with project managers and site planners. Some construction site layout planning problems are identified as follows: suppose the requirements of the construction work were changed on the process of construction project accordingly the construction site layout should be altered. Problem of construction site layout design should be regarded as dynamic problem, under this type of situation. However most of the researchers that work toward this area in which they concentrated on the static construction site layout planning problems previous reviews of construction site layout design research works showed that the site facilities had been shaped as rectangular block, in which the temporary facilities can be assigned to any location. Academically this is called equal area construction site layout planning problem. The approach here is very convenient and it does not consider whether the location can occupy the assigned facilities in reality. This assumption is far away from the real life situation in construction site layout planning. moreover limited research works had been carried out so as to get solution for an unequal-area construction site layout planning problems although there is a research gap in solving unequal area construction site layout planning problem (Ning and Lam, 2009).

Most construction site layout planning research works focuses on the improvement of the computational capability of various optimization algorithms, by which a number of site layout alternative could be generated for evaluation and select the best construction site layout planning from the generated site layout alternative. As a matter of fact construction site layout planning is basically a trade-off problem in which construction managers and site planners need to make decision to select the best construction site layout among the layout alternatives generated from various optimization algorithms. This approach of optimization algorithms requires construction managers and site planners to consider and make check and balance with all the important attributes, such as cost minimization, safe working environment and efficient material transportation, without sacrificing the required quality. However some of these important attributes, such as security and noise control are not easy to handle and it is extremely difficult for decision makers to justify which construction site layout should be selected (Xu and Li, 2012)

finally, many researchers treated construction site layout planning as a single objective optimization problems, for instance ,minimizing the frequency of trip made by construction personnel, minimizing the total transportation costs of resources between facilities and minimizing the cost of construction facilities or the alternative cost between facilities (Ning *et al.*, 2011).

In order to solve the aforementioned problem, this study aims to develop a computationally intelligent construction site layout planning decision making system which consists of four stages: The input stage, the design stage, the evaluation and selection stage, and the output stage to help project managers and site planners to solve dynamic, multiple objective and unequal area construction site layout planning problems.

Site layout planning for construction project site can be classified generally according to two main aspects: (Zouein and Harmanani, 2002)

1) Method of facility assignment and
2) Layout planning technique.

With regard to these two methods, the method of facility assignment or the approach and manner in which the temporary facilities are assign on site, with respect to method of facility assignment two commonly methods are used. These two methods are: (i) Facilities to location assignment and (ii) Facility to site assignment. This method of facility to location assignment assigns a set of predefined facilities to a set of predefined locations on site such that the (number of locations is greater than or equal to number of facilities). The method of facility to site assignment on the other hand assigns a set of predefined facilities to any unoccupied space on the site. The disadvantage of method of facility to location assignment neglects one important issue, that of the size of the temporary facility to be placed. All the locations are assumed to be able to fit all facilities. This assumption is weakened by the fact that there are usually substantial differences in size among most construction project site facilities. The method of facility to site assignment is considered more generic as it assumes that the planner has not yet settled on the feasible locations for facility assignment nevertheless, during this type of assignment many spatial requirements must be satisfied simultaneously. This poses extra computational burden on any automated site layout planning system that adopt the later approach (Osman *et al.*, 2003).

The second aspect that is the layout planning technique concerns the technique used in performing the assignment process of temporary facilities. Many techniques have generally been utilized in the past research to perform the assignment process of the

temporary facilities which ranges from the purely mathematical models to knowledge based systems. However researchers have not reached a consensus on or knowledge a certain technique to be more suitable than the others (Osman *et al.*, 2003).

This mathematical technique usually involve the identification of one or more goals that the sought layout should strive to achieve a widely used goal in the minimization of transportation cost on construction site. These goals are commonly interpreted to what mathematician term "objective functions" this objective functions is then optimized under problem specific constants to produce the desired construction site layout. Systems utilizing knowledge based techniques, in contrast, provide rules that assist planners in site layout planning rather than performing the process based purely on specified optimization goals (M.J and S.H, 2003).

CAD has been experiencing great advances since the late 1980s. Its use became inevitable in many engineering disciplines. However the use of CAD applications in the construction stage of a project substantially lags behind the use of their counter parts in the design stage. Realizing their potential (Mahoney and Tatum, 2009) reported the broad benefit of using CAD in managing/planning many construction site operations to plan construction site layout planning as adoption of such systems allows easy and accurate visualization of the relationship between the permanent structure and temporary facilities on construction site.

Site layout planning is evidently graphical in nature. Site boundaries, existing buildings on site obstacles and temporary site facilities all occupy space and have distinct shapes this is the need to represent the relationship between all these entities in some sort of graphical format can be quite advantageous. for such reason, (Cheng and Oconner, 2004) utilized a geographical information system (GIS) to assist in the graphical

representation of CAD-based site layout planning systems, particularly those utilizing mathematical techniques has generally been limited till out time.

Current study introduces a novel approach for solving the site layout planning problem. It utilizes genetic algorithms (GAS), as function optioned, in determining the temporary facilities locations according to the graphical information depicted in a CAD environment. Based on the classification represented earlier, genetic algorithms approach performs a facility to site assignment using a mathematical layout planning technique (Osman *et al.*, 2003).

2.11 Present Practice of Site Layout Design

Field practitioners and site planners use drawings to mark up the major temporary facilities that are required on site throughout the entire construction project duration. it depends on their day to day knowledge which they gathered for years with their experiences, common sense and adoption of past experiences of site layouts in determining the positions of temporary facilities on site. But they cannot keep track of all factors that could affect the selection, location facilities to be placed (F and Moselhi, 2006)

2.12 Site Layout Planning Elements

A well planned site which comprises of all temporary facilities and utilities lead to

i. Increasing productivity and safety.
ii. Reducing areas needed for temporary construction and maximizing utilization.

The following elements should be considered in good site layout **(Elbeltagi and Hegazy, 2005).**

2.12.1 Site accessibility

Accessibility will keep the morale of the equipment and the drivers of the vehicle, high minimization of the chances for the occurrence of accidents, and also save time in manoeuvring to arrive at and leave the project in a very good time. In case of large projects, proper planning is required to set the layout of roads which will lead from the nearest highway. Internal roads are necessary for easy flow of vehicle as well as the flow of the work itself. And also parking lots are provided for the owner, office and craft personnel, but this facility must be planned where space does exist **(Elbeltagi and Hegazy, 2005).**

2.12.2 Security

It is very necessary to have a proper guard at the entrance of the construction project site. It should be provided by a booth also, it is necessary to keep track of all visitors entering in to the construction project site. Lighting is necessary to have a stand by generator for site lighting, fencing is necessary from the security check point to the entire site boundary

(Elbeltagi, 2005).

2.12.3 Safety

The prevention of fire and other hazard that may arise at construction project site is every important. Fire outbreak is a major cause of damages at construction project sites. In this regards provision of fire extinguishers at construction project site is necessary because they are the basic requirements for the safety of fire (Elbeltagi and Hegazy 2004).

2.12.4 Information signs

Site map is very necessary at construction project site to show the details of the project by displaying it in the construction project site office and at the entrance gate. This should be done by the construction project superintendent or the project manager and or the site planner (Ebeltagi and Hegazy, 2004).

i. **Provision of traffic regulatory signs**: Traffic regulatory signs are usually considered on large scale project so as to guide the traffic and avoid any occurrence of accidents at the construction project site.

ii. **Display of labour and management relation**: Rules and policy has to be provided this will help in eliminating the disputes that may arise between labour and management.

iii. **Provision of emergency exit notes and underground services**: It is paramount important to display the emergency escape routes on every angle and floors, as the construction operation progresses and also indication of the points were those underground facilities are necessary (Ebeltagi and Hegazy, 2004).

2.12.5 Office

The provision of site offices for all the project Stake holders is necessary. The offices to be provided should be closely together and close to the construction operation area at the construction site and in a safe and noise free area so that to prevent noise of machine to the office. The offices should be well prepared with office equipment. The Stake holder's offices should include the job office, the general contractor office, sub-contractor office and the project consultant's offices.

Accommodation: For large scale construction project provision of accommodation for all the staff involved in the project is necessary so that the work will be progressing with respect to time. (Elbeltagi and Hegazy, 2004).

2.12.6 Sanitation and water supply

It is very necessary to provide and supply water to all angle of the construction project site as well as the provision of public convenient for the staff around so that they will be comfortable. (Ebeltagi and Hegazy, 2004).

2.12.7 Storage and site cleaning

Storage facilities have to be provided for safe storage of construction materials so that unnecessary movement of materials will be eliminated. (Ebeltagi and Hegazy, 2004).

2.12.8 Material handling

Provisions of materials handling equipment are necessary because almost one third of all construction operations can be classified as material handling. The proper use of the equipment for material handling and advance planning for minimizing the multiple handling will result in direct cost and time savings (Ebeltagi and Hegazy, 2004).

2.12.9 Crafts change-houses

Crafts men on site has to be provided with change room and restroom for waiting of work shift as well as store for clothes storage and washing are (Ebeltagi and Hegazy, 2005)

2.12.10 Batch plant and fabrication shops

Batch plants are provided on projects where it is more economical to produce in-situ concrete on construction project site than to buy a ready mix. An onsite batch plant is accompanied by aggregate storage piles, cement silos and tank for admixtures. Shops

are used where material and equipment are fabricated on site. There is need for laboratory for testing of samples. This fabrication shops should include electrical, mechanical, carpentry and paint shops e.t.c (Yahya and Saka, 2014).

2.13 Characteristics of Temporary Facilities

It is very important to have the idea and knowledge for the characteristics of temporary facilities to be used before planning the site layout for the construction operation to take place. The temporary facility characteristics are as follows (Yahya and Saka, 2012).

1. **Environmental satisfaction and safety regulations**: All temporary facilities to be considered and use should satisfy the environmental and safety regulations. Special attention and consideration should be paid to temporary facilities like the batch plants, which have high pollution potential. Site mangers and planners have to make proper arrangement to control the air, water and noise pollution from such type of facilities.
2. **Availability of diverse solutions for the same problem**: Construction planner or manager can come up with some arrangement to establish a temporary facility. For instance now if a warehouse is required the construction site planner or manager can build a warehouse on the site, use the existing facilities on the site, some construction site planners or site managers decided to rent a building near the site, or plan a just in time delivery for further progress of work. Based on the usage of warehouse, each alternative can be further divided into several sub items. The materials to be used in constructing temporary facilities could be range from wood, bricks to a steel structure.

3. **Relatively short life span of a specific location:** The life span of temporary facilities for construction project depends on the scope and the project duration. These temporary facilities are to be removed mostly as soon as the project gets to an end.
4. **Reutilization with a minimum loss for the same or modified function at another different location:** It is very necessary to construct temporary facilities with good material so that they can be reuse again because of their shorter life span at construction project. That is why construction site planners and site managers consider reutilization of the temporary facilities. This can lead to an economical manner to save money in the construction operations. With appropriate modification most of the temporary facilities can be used for more different purposes. Proper keeping of the materials on site will help to increase the frequency of the reutilization and also reduces the construction cost of the project.
5. **Easy dismantling, assembly and exploitation:** materials to be used for the construction of temporary facilities should be that kind of materials which are easy to assemble and dismantle which will reduce both assemble and disassembly time. Temporary facilities should be removed in a very short period of time as soon as the project is completed. Temporary facilities should be removed easily without any damage to the structure.
6. **Standardization of design:** use of standard materials for the construction of the temporary facilities will increase the frequency of reutilization and reduce the working hours and cost incurred for the construction of the facilities. The approach here will make easy maintenance, transportation and storage of the temporary facilities easily.

7. **Identification and sizing of temporary facilities:** The identification of the temporary facilities required for a specific project and determining their areas is a very difficult task which requires thorough consideration of the project conditions and local regulations. In present practice of site layout planning is often done in a speedy approach by adjusting the previous plans. This is done based on the project managers experiences and the common sense they have in many situations, some facilities which are required and by laws, such as site first aid office or a fire route may be omitted. Accommodating these facilities later can be costly and can cause loss of site productivity (Elbeltagi and Hegazy, 2004).

2.13.1 Selection of temporary facilities

One of the characteristics of the temporary facilities is the availability of diverse solutions for the same function. This section describes some of the considerations when selecting the required temporary facilities for a specific project (Ebeltagi, and Hegazy, 2004)

2.13.2 Type of construction

The construction of industrial plant, such as the power plant requires more storage facilities like the fabrication area for process mechanical and electrical work than other construction projects such as a high way construction project (Ebeltagi and Hegazy, 2004).

2.13.3 Type of contract

For turnkey contract, the contractor can consolidate the administrative and construction operations, means that few but larger and more efficient temporary facilities can be selected. on the other hand, if the project is managed under a series of different

contracts, This will translate into a higher number of smaller temporary facilities serving each individual contractor (Ebeltagi and Hegazy, 2004).

2.13.4 Project location

Projects that are located in an uninhabited regions or in a place where skilled labour is scarce which requires additional facilities for living, eating and recreational facilities on site. Project far away from industrial centres requires more on site services such as batch plant, equipment maintenance shops, storage area, and even some other worshiping centres for family convenience (Ebeltagi and Hegazy, 2004)

The selection of some of the temporary facilities depends on the man power permanent resident from the site. The work force is break down into three categories as shown in Figure 2.1

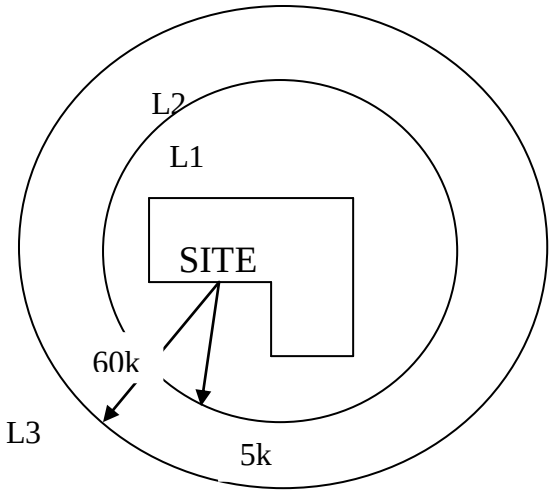

Figure 2.1 work force break down (Ebeltagi and Hegazy, 2004)

L1: Local labour force (5km from site) no transportation is needed

L2: Nearby labour force 5- 60km from site) No lodging is needed but daily transportation is needed.

L3 Far away (more than 60km from site) lodging facilities needed for a specific project must be determined prior to their size and location.

Table 2.1 gives a list of common temporary facilities that can be used in a project while some temporary facilities are to be selected from this list for a specific project, taking into account the factor cited above as well as other temporary facilities justified by the uniqueness of the project (Ebeltagi and Hegazy, 2004).

Table 2.1: List of Temporary Facilities

Facility No	Facility Name
1	Job office
2	Owner representative office
3	Subcontractors office
4	First aid office
5	Information and guard house
6	Toilet on site
7	Staff/Engineer dormitory
8	Staff/Engineer family dormitory
9	Labour family dormitory
10	Labour family dormitory
11	Dining room for labour
12	Bathroom for labour
13	Restroom for labour
14	Equipment maintenance shop
15	Parking lot for mechanics
16	Prefabricated rebar storage yard
17	Rebar fabrication storage yard
18	Fabrication rebar storage yard
19	Carpeting shop
20	Storage yard for lumber
21	Storage yard for formed lumber

22	Cement warehouse
23	Batch plant and aggregate storage
24	Craft change-house
25	Sampling/testing lab
26	Pipe jointing yard
27	Pipe storage yard
28	Welding shop
29	Parking lot
30	Tank
31	Long term lay down storage
32	Machine room
33	Electrical shop
34	Steel fabrication shop
35	Sand blast shop
36	Painting shop
37	Scaffold storage yard
38	Material warehouse.

(Ebeltagi and Hegazy, 2004).

2.14 Modelling of Construction Site Layout Problem Model

Construction site layout planning model is designed to arrange the temporary facilities required at various time intervals (phases) of construction project under set of constraints. While achieving Multi-Objective Functions Generally in multi-objective optimization problems pareto optimal solutions are determined so that decision makers can choose their preferred plan among these pareto optimal solutions. The efficiency of

construction site layout planning model will be significantly affected by its precision in representing the actual situations (M. and P.Saka, 2013).

2.15 Distance Measurement

In determining the first objective function that minimizes the total handling cost of interaction flows between facilities this study proposes more accurate approach to represent travel distance between facilities. Neglecting the presence of obstruction can significantly affect the reliability of the results. The rectangular distance is modified to consider presence of obstructions. Obstruction can be a building under construction or any other facility

(M and P.Saka, 2013). In the modified rectangular distance measurement approach, if on obstruction exists in the rectangular route between two facilities, the route is modified to avoid passing through the obstruction via the shortest path (M and P.Saka, 2013).

2.16 Approaches to Represent the Time Dimension in Site Layout Planning

The role of construction objects such as equipment material, works spaces and temporary facilities to support construction activities. The time and duration for which the temporary facilities stay on site depends on the activities that they are associated with as the construction project progresses and construction activities change, the required objects, and accordingly, the space required on the site to accommodate them, are subject to change. Different approaches have been used in past literature to represent changes in site layout planning. These approach were generally identified either as static, when they don't reflect changes or as dynamic, when they reflect change were time. However, close examination of models previously identified as dynamic reveals

that they can in fact be grouped under two separate approaches one of which is phased, while the other in actually dynamic. This section provides a comparative analysis of the main underlying assumptions that differentiate between static, phased and dynamic approaches for representing the time factor in site layout planning through an lustration case (Andayesh and Sadeghpour, 2014).

CHAPTER 3

3.0 Research Methodology

This research work used quantitative method of research. In order to achieve the stated aim of the research, past literatures, such as journals, text books, published research work and some other relevant materials were used. These were used to obtain the secondary data. The primary data was obtained by means of well-structured questionnaire which were distributed to the staff of construction firms that are based in Abuja.

The questionnaire gave a clear view of site layout practices in construction firms within Abuja, Nigeria.

3.1 Research Design

A mixed method approach involving the use of quantitative data complementarily (Bryman, 2008) was adopted. Significant time and effort was devoted to collect secondary data from journals, articles and past literature with the aim of assessing the site layout practices of construction firms. The information obtained from the journals and past literatures as well as past research were used to design the questionnaire in order to obtain opinions on the practical use of site layout design. The steps and stages used by the research is described in Figure 3.1

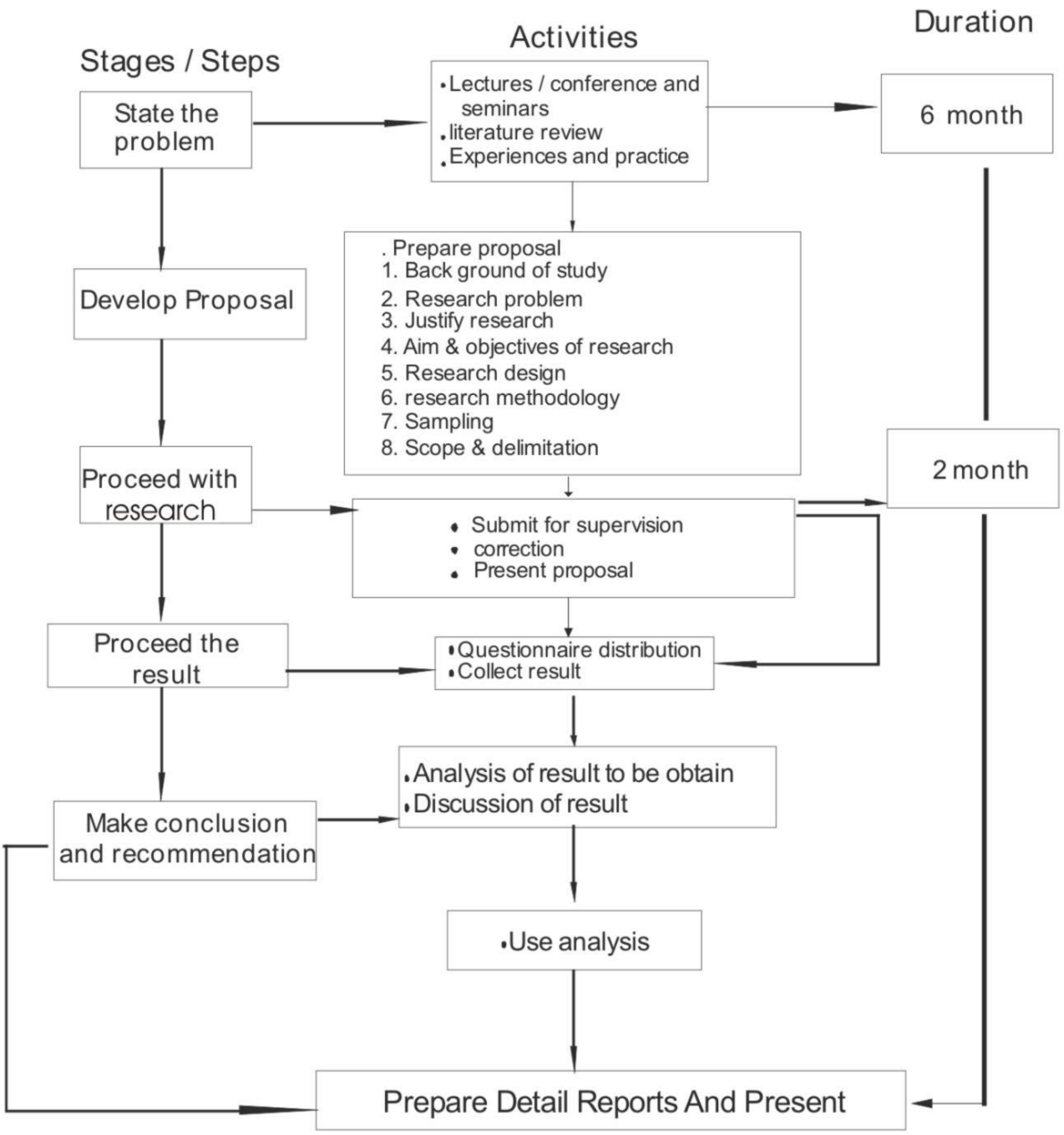

Figure 3.1: Research Design

3.2 Research Method Adopted for the Study

The research involve answering question relating to how site layout are design, and hence used descriptive method as described in Abdulazeez (2012).

3.3 Population and Sampling

3.3.1 Population size

The population of this study consist of construction firms in Abuja metropolis. This construction companies cuts across both those involved in building and civil works. The population size of the study is denoted by (**N**). Where N is (245 according to FIRS, 2014)

3.3.2 Sampling sizing

This research used purposive sampling technique as a tool to obtain data from the construction firms in Abuja. A well-structured questionnaire was given to the management of the construction firms to achieve the listed objectives of this research. The sample size is denoted by (n). Where n is (71)

The sample size is determined by using the kish formulae which is described as follows:

$$n = \frac{M}{1+\frac{M}{N}}$$

Where n = sample size

N= total population

$$M = \frac{s^2}{V^2}$$

V= standard error of the sampling distribution

S= standard deviation of the population element

Using a total error of 0.1 at 95% confidence level

V is 0.05 and P is 0.5

$S^2 = 0.5 \times (1- 0.5) = 0.25$

N = 245. (Number of registered construction firms based in Abuja. according to FIRS 2014.)

$$M = \frac{0.25}{0.0025} = 100$$

Hence M = 100

$$n = \frac{100}{1 + \frac{100}{245}} = 71$$

Therefore the sample size (**n)** for the survey is 71. This implies that 71 questionnaires were distributed the across the targeted construction firms based in Abuja.

3.4 Data Collection Technique

The questionnaire distributed to the construction firms were used in obtaining the research data in order to gather information regarding to site layout practices in construction sites.

3.4.1 Administration of data collection instruments

Questionnaires were administered to the construction firms in the study area.

3.5 Questionnaire Design

The research used a well-designed questionnaire that is divided into three sections to capture the objectives of the research. The first section of the questionnaire considers the respondents profile and some information related to the firms. The second section

considers the parameters of effective site layout practices. The third section considers the awareness of site layout practices and measures for improvement of site layout practices in some construction firms in Abuja, Nigeria.

3.6 Data Analysis Technique

The research used the statistical package for social sciences (SPSS) as a tool in carrying out the statistical analysis for this study. Which act as both a descriptive and inferential tool.

3.6.1 Relative importance index (RII)

Relative importance index was used in the study to rank the site layout practices of construction firms in Abuja.

$$\textbf{Relative importance index (RII)} = \frac{\sum fx}{\sum f} \times \frac{1}{k} \text{---------- 1}$$

Where,

$\sum fx$ = is the total weight given to each attributes by the respondents.

$\sum f$ = is the total number or respondents in the sample.

K = is the highest weight on the Likert scale.

Ranking of the items under consideration was based on their RII values. The item with the highest RII value is ranked first (1) the next second (2) and so on.

The rating of all the factors for degree of significance was based on the value of their respective relative importance index (RII). The guide for the rating is given in Table 3.1 below:

Table 3.1 Guide to degree of significance. Source: Vanduhe (2012)

Degree of significance	Rating
Very significant	0.76 above
Significant	0.67-0.75
Fairly significant	0.45-0.66
Not significant	0.44 below

CHAPTER 4

4.0 DATA PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS

4.1 Data Presentation and Analysis

This part of the study dealt with the presentation and interpretation of data obtained from the field survey, analysis of the data and discussion of findings as they relate to the objectives of the study.

Table 4.1: Breakdown of Questionnaire

	Respondents (%)
No. Distributed	**71**
No. properly filled and returned	**39**
Percentage response	**54.9%**

. Source: Field survey (2015)

From table 4.1 seventy one (71) questionnaires were administered, thirty nine (39) questionnaires were returned. Based on the assertion of Moser and Kalton (1971), the result of a survey could be considered significant if the response rate is not lower than 30-40%. Therefore, the percentage of the returned questionnaires is adequate for analysis.

4.2 Company Information

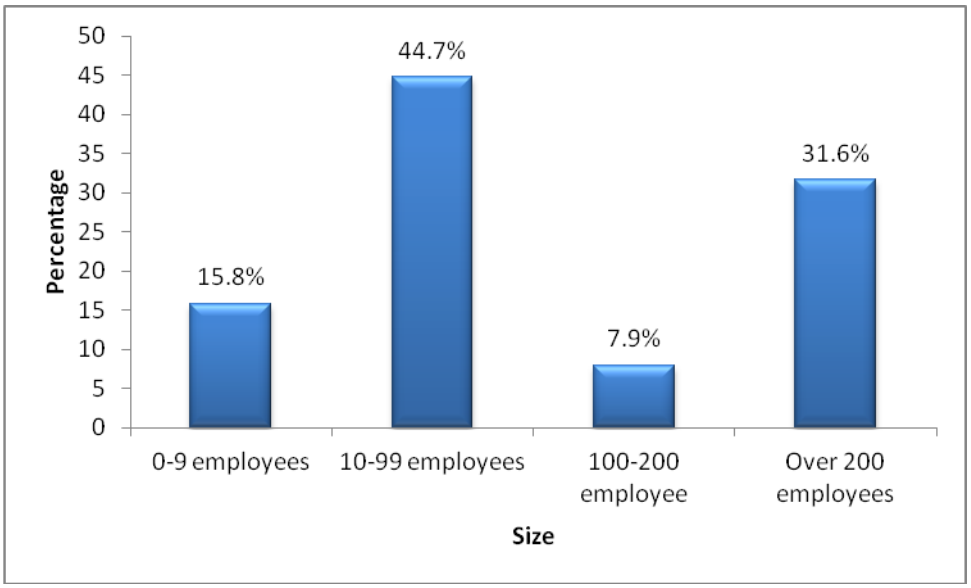

Figure 4.1: Size of the Company
Source: Field Survey (2015)

From Figure 4.1 majority of the companies have employees between 10-99 which formed a percentage of 44.7%. While those with employees between 100-200 have the lowest percentage of 7.9%. This implies that 44.7% of the construction companies have 10-99 employees. This implies that the companies falls within the category of small construction firm.

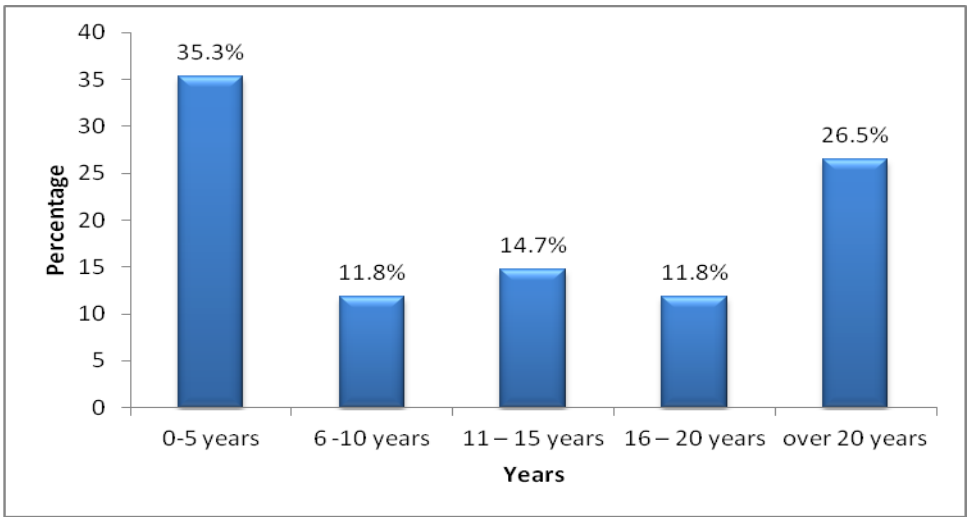

Figure 4.2: Years of Working Experience of Staff
Source: Field Survey (2015)

From Figure 4.2 the various years of experience of the staff in construction firms, majority of the staff has 0-5years of working experience which represent 35.6% while the minority has 6-10years and 16-20years of working experience which represent 11.8% for both respectively. This implies that 35.3% of the staff in construction firms have working experience between 0-5years.

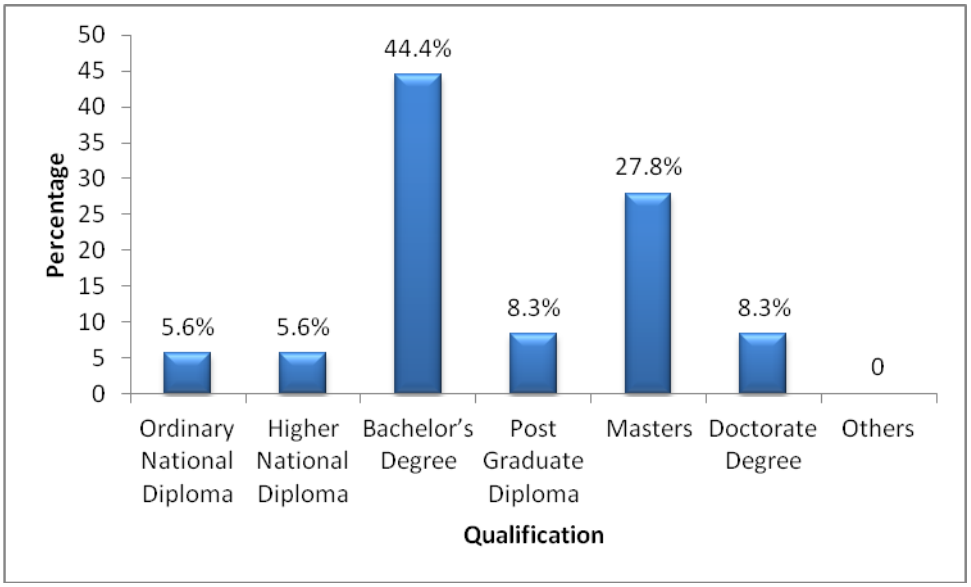

Figure 4.3: Highest Academic Qualification
Source: Field Survey (2015)

From Figure 4.3, majority of the staff has bachelor's degree which represent 44.4% of the respondent. Minority has ordinary national diploma and higher national diploma which represent to 5.6% 8.3% of the construction companies have employees with doctorate degree.

4.3 Involvement of Staff of Construction Companies in Site Layout Practices

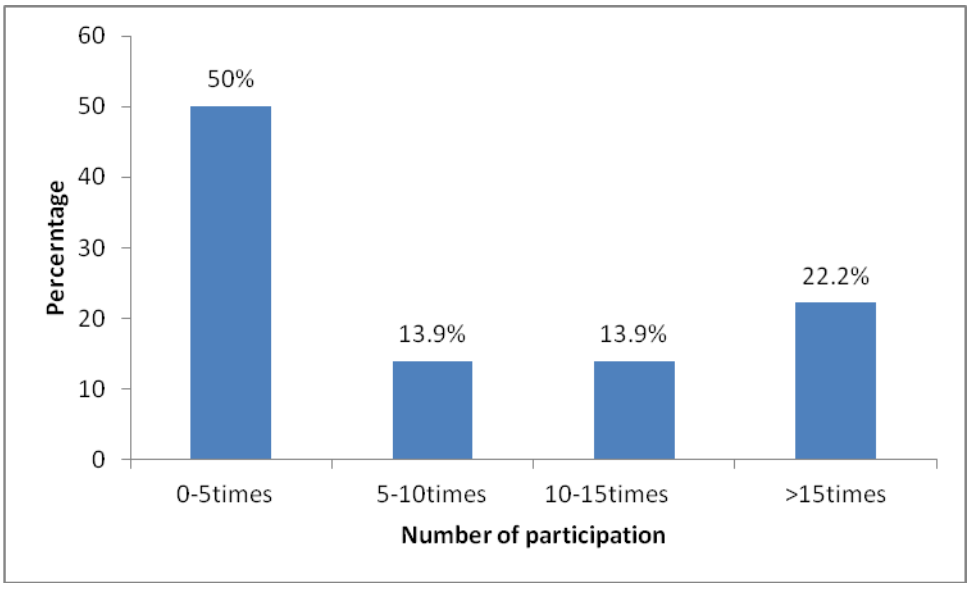

Figure 4.4 Number of Times of Participation in Designing Site Layout
Source: Field Survey (2015)

From Figure 4.4 showing the number of participation of the staff in designing site layout in which majority of the staff fall between 0-5times in designing site layout which represent 50% of the respondent. Minority of the staff fall between 5-10times and 10-15times which result to 13.9%. This shows that majority of the staff in the construction firm does not have much experience in designing site layout.

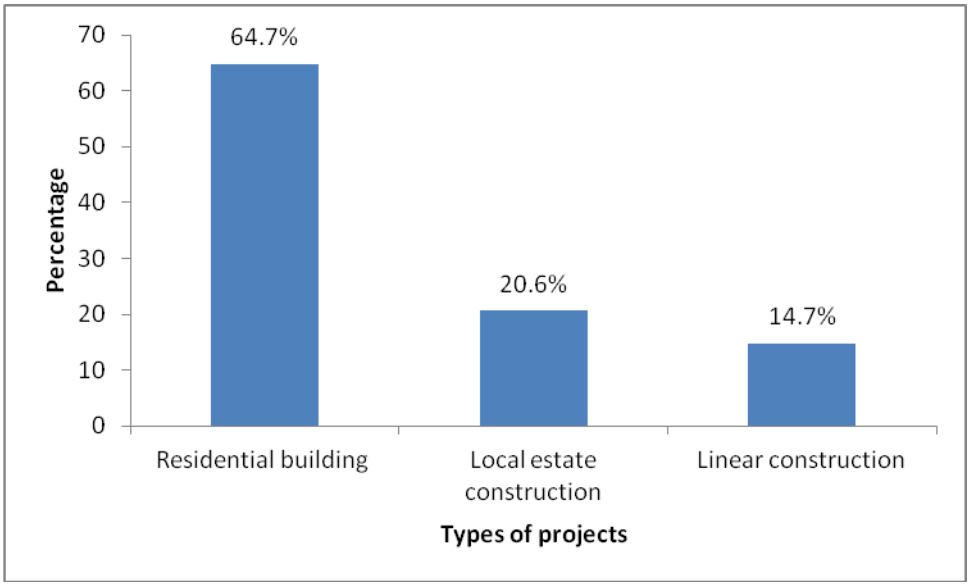

Figure 4.5 Type of Project with Site Layout Design
Source: Field Survey (2015)

From Figure 4.5, majority of construction firms do site layout design for residential building construction project which represent to 64.7% while the minority (14.7%) of the construction firms do site layout design for linear construction. This implies that majority of the construction companies does mostly building construction in which they may have much experience.

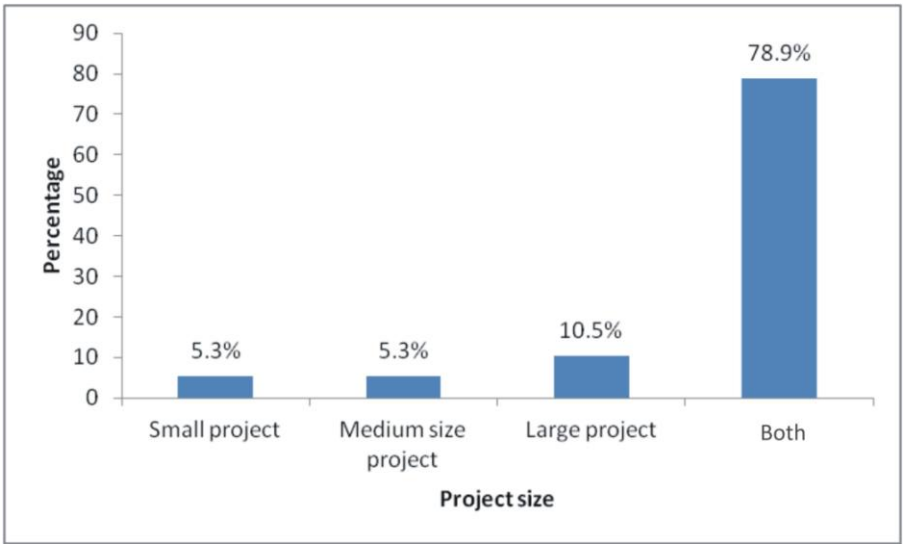

Figure 4.6 Project Size in Planning of Site Layout Design before the start of Construction Project

Source: Field Survey (2015)

From Figure 4.6, majority of the firms does site layout design for small, medium and large construction project which represent 78.9% while the minority does for small and medium size project which amount to 5.3% for both small and medium size respectively. This may implies that majority of the construction companies does site layout design for all sizes of project.

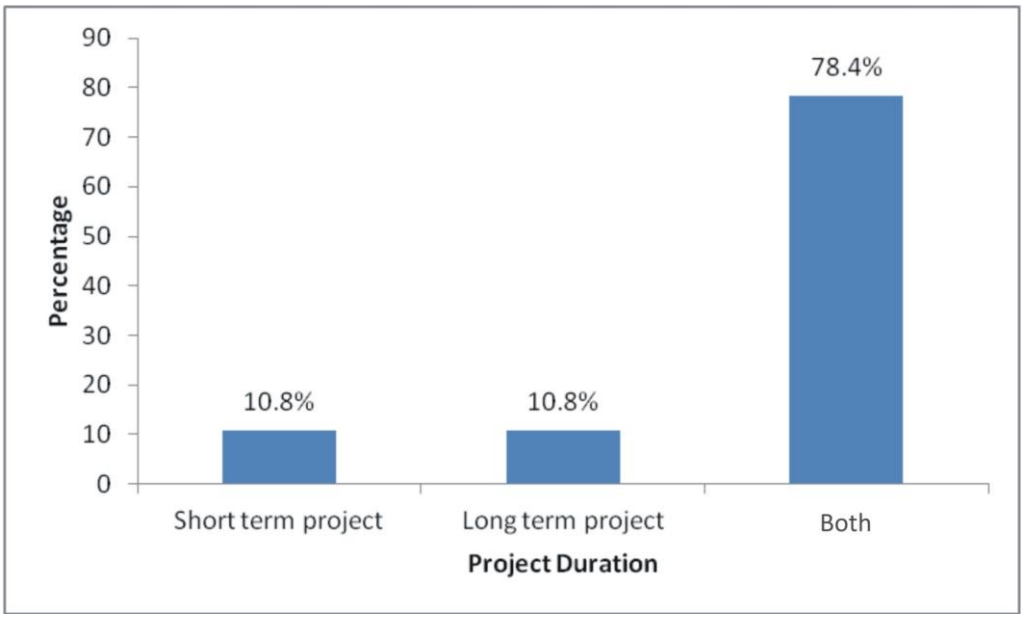

Figure 4.7 Project Duration in Site Layout Design in Construction
Source: Field Survey (2015)

From Figure 4.7 majority of the construction firms does site layout for both short and long term project which represent 78.4%,While first minority does site layout design for short term and the second minority does for only project with long term duration which represent 10.8% respectively. Since the majority of the construction companies do site layout design for both short term and long term construction project this may be due to their consistency in construction.

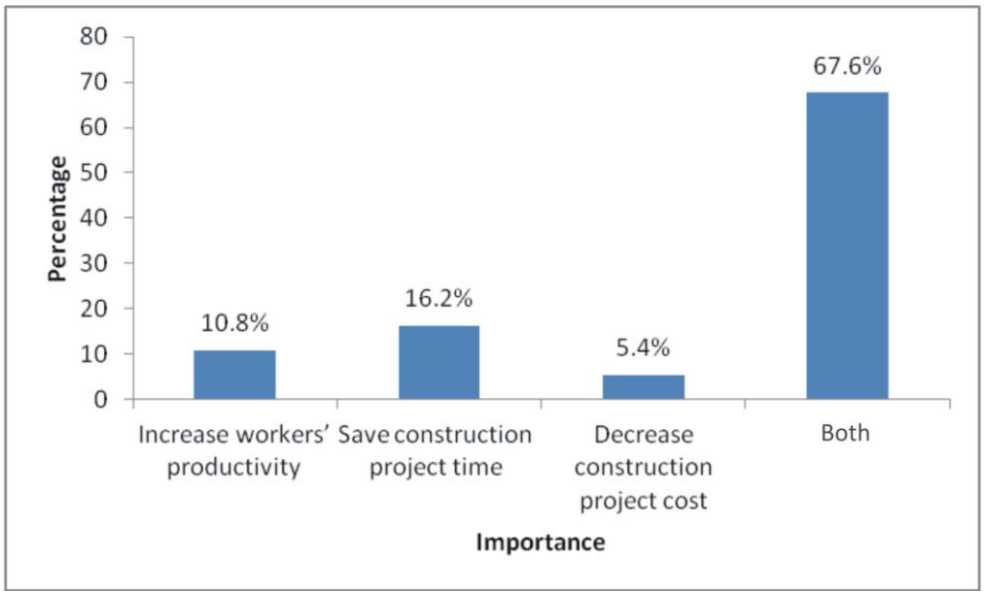

Figure 4.8 The Importance of Site Layout Design
Source: Field Survey (2015)

From Figure 4.8, majority of the construction firms benefits from all the importance of site layout design which represent 67.6% while the minority benefits from only decrease in construction project cost, which leads to 5.4%. As the majority of the construction companies benefit from all the three importance of site layout design this is due to proper use of their site layout design in the construction project sites.

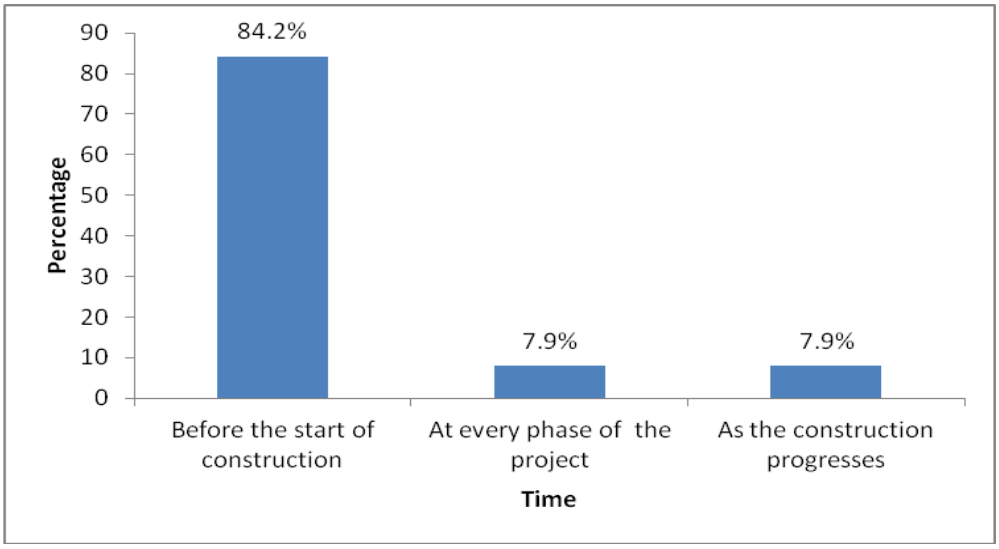

Figure 4.9 Time to Provide Site Layout Design in Construction

Source: Field Survey (2015)

From Figure 4.9, majority of the construction firms provide site layout design at the beginning of the construction project which represent 84.2%.While first minority provide site layout design at every phase of construction project and second minority provides as the construction project progresses which represent 7.9% respectively. As the majority of the construction firms do site layout design before the start of construction project this may be due to the benefit and proper use of site layout design at start of construction project.

4.4 Site Layout Practices

Table 4.2 Site Layout Practices

S/No	Practices	Frequency of responses					∑f	∑fx	Mean	RII	Position
		1	2	3	4	5					
1	Preparing site layout designs before the commencement of site works	1	2	5	13	17	38	157	3.9	0.7	1st
2	Ensuring good positioning system for the temporary facilities.	3	5	5	16	7	36	127	3.1	0.635	7th
3	Construction of fence at the boundaries of construction site.	3	4	6	9	16	38	145	3.625	0.725	3rd
4	Provision of the public convenience for workers on site.	5	6	6	9	9	35	116	2.9	0.58	11th
5	Provision of canteen for workers meals at site	5	9	11	10	3	38	111	2.775	0.555	13th
6	Provision of workers recreational facilities	14	13	5	3	1	36	72	1.8	0.36	20th
7	Provision of first aid centers for workers emergency responses.	4	7	8	11	8	38	126	3.15	0.63	8th
8	Provision of access roads for trucks and light weight vehicle.	3	1	9	12	12	37	140	3.5	0.7	5th
9	Provision of site offices for clients, contractors and consultants.	2	2	8	14	12	38	146	3.65	0.73	2nd
10	Provision of security office	3	4	9	9	13	38	139	3.475	0.695	6th
11	Provision of security check points	8	7	14	4	2	35	90	2.25	0.45	18th
12	Provision of site clinic	12	9	12	2	2	37	84	2.1	0.42	19th
13	Provision of fire prevention and fire fighting equipment	6	9	11	7	5	38	110	2.75	0.55	13th
14	Provision of information signs and signals	4	4	10	13	6	37	124	3.1	0.62	10th
15	Provision of site map showing the site and temporary facilities	7	6	13	8	3	37	105	2.625	0.525	16th
16	Provision of traffic signs	6	8	11	7	5	37	108	2.7	0.54	15th
17	Provision of safe and safety equipment	1	7	6	18	4	36	125	3.125	0.625	9th
18	Provision of accommodation for site workers.	7	11	4	6	8	36	105	2.625	0.525	16th
19	Provision of site stores	4	2	5	13	14	38	145	3.625	0.725	3rd
20	Provision of fabrication and maintenance shop.	6	7	12	8	5	38	113	2.825	0.565	12th

not applicable=1, low level of application=2, moderate level of application=3, High level of application=4,Highest level of application=5 (Ebeltagi and Hegazy, 2004)

From table 4.2 showing good site layout practice, 'preparing site layout design before the commencement of site work' ranked first with (RII) value of 0.785 which is very significant. This implies that the construction companies prepare site layout design very well before the start of construction project ' Provision of site offices for clients, contractors and consultants.' Ranked second with (RII) value of 0.73 which is significant. This implies that the construction companies practiced the provision of site offices for clients, contractors and consultant. 'Construction of fence at the boundaries of construction site', and 'provision of site stores' both ranked third position with (RII) value of 0.725 which are also significant. Which implies that they practiced it very well 'provision of access roads for trucks and light weight vehicle' is ranked as fifth position with RII value of 0.7 which is significant. This shows that the construction companies provide access roads for trucks and light weight vehicle very well. 'Provision of security office', ranked sixth position with (RII) value of 0.695 which is significant. This implies that the construction companies do the provision of security office very well. 'Ensuring good positioning system for the temporary facilities', ranked seventh with (RII) value of 0.635 is fairly significant, which implies that the construction companies fairly does good positioning system of the temporary facilities. 'Provision of first aid canters for workers emergency responses' ranked eight positions with (RII) value of 0.63 which is also fairly significant. This shows that the construction companies fairly provide workers emergency responses i.e first aid centre 'Provision of safe and safety equipment,' ranked as the ninth position with (RII) value of 0.625 which is fairly significant. Which implies that they fairly provide safe and safety equipment. 'Provision of information signs and signals' ranked as the tenth position with (RII) value of 0.62 which is also fairly significant. This is also considered as fairly practiced by the construction companies. 'Provision of workers recreational facilities ' ranked as the last

position with (RII) value of 0.36 which is not significant. This implies that the construction companies do not practice the provision of workers recreational centres.

From the result obtained above it can be inferred that good site layout practice is majorly preparing site layout design before the commencement of site work, which takes care of the planning of activity on construction sites and controls movement on the site. The Provision of workers recreational facilities did not have significant impact on good site layout practice because it does not directly affect construction site activity.

4.4 Effect of Poor Site Layout Practices of Construction Projects

Table 4.3: Effect of Poor Site Layout Practices of Construction Projects

S/No	Effect	Frequency of responses					∑f	∑fx	Mean	RII	Position
		1	2	3	4	5					
1	Decrease the productivity of workers	6	9	8	3	2	28	70	1.75	0.35	9th
2	Causes delay in construction delivery	5	8	13	6	6	38	114	2.85	0.57	2nd
3	Increases the cost of construction	2	11	8	11	4	36	112	2.8	0.56	3rd
4	Causes activities overlap by wrongly allocation of temporary facilities	10	8	6	9	4	37	100	2.5	0.5	7th
5	Causes difficulties in materials access	9	9	6	9	4	37	101	2.525	0.5	5th
6	Causes difficulties in site transportation	8	6	10	9	3	36	101	2.525	0.5	5th
7	Causes poor communication among workers	7	11	13	4	3	38	99	2.475	0.4	8th
8	Causes insecurity in construction site	10	6	9	7	5	37	102	2.55	0.51	4th
9	Causes the occurrence of accident in construction site.	6	9	8	8	7	38	115	2.875	0.52	1st

no problem =**1**, low level of problem faced =**2**, moderate level of problem faced =**3**, High level of problem faced=**4**,Highest level of problems faced =**5**

Source: Field survey (2015)

Table 4.3 above shows the Problems as a result of poor site layout practices. 'Causes the occurrence of accident in construction site' ranked first with a relative importance index (RII) of 0.575 which is fairly significant. This implies that accident occurred fairly in construction project site ‘Causes delay in construction delivery' ranked second with RII value of 0.57 which is also fairly significant. This implies that poor site layout fairly causes delay in construction delivery 'Increases the cost of construction', 'Causes insecurity in construction site', ranked third and fourth respectively and are considered fairly significant. This implies that the increase in cost of construction and insecurity are fairly considered in construction site. 'Causes difficulties in site transportation', 'Causes difficulties in materials access' both ranked fifth with RII of 0.505 which is also fairly significant. This implies that difficulties in site transportation and material access are fairly poor. 'Decrease the productivity of workers' ranked least with a RII of 0.35 and is therefore considered to be not significant which means that decrease in poor site layout design does not have any effect on workers' productivity. From the result obtained above it can be inferred that the problems of poor site layout design and management majorly causes accident in construction site because of the congested nature and the volume of work carried out on most construction site. 'Decrease the productivity of workers' ranked least because most of the labourers on construction site in Abuja are adapted to working in constrained environments.

CHAPTER 5

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

This research focused on the assessment of site layout practices of construction companies that are based in Abuja, with a view to improve the practice site layout in construction firms

Below is a list of major findings from the research;

1. In the participation of the staff in designing site layout, majority of the staff falls between 0-5times in designing site layout which result to 50%.
2. In the type of project with site layout design, majority of construction firms does site layout design for residential building construction project which result to 64.7%.
3. The size of project to which site layout design was consider before the start of construction project, majority of the firms does site layout design for small, medium and large project which result to 78.9%.
4. The project duration to which site layout design was considered in construction project, were by majority of the construction firms does site layout for both short and long term project which result to 78.4%.
5. In the importance of site layout design, majority of the construction firms benefits from all the importance of site layout design which leads to 67.6%
6. The time in which site lay out design is to be provided, majority of the construction firms provide site layout design at the beginning of the construction project which result to 84.2(%).

7. The level of participation of engineers or planners in designing site layout, majority of the engineers and or planners of the construction firms have averagely participated in designing site layout which result to 51.4(%).
8. In the site layout practice, several practices were identified, such as ' Provision of site offices for clients, contractors and consultants.' Ranked second with (RII) value of 0.73 which is significant. This implies that the construction companies practiced the provision of site offices for clients, contractors and consultant. 'Construction of fence at the boundaries of construction site', and 'provision of site stores' both ranked third position with (RII) value of 0.725 which are also significant. However, 'preparing site layout design before the commencement of site work' ranked first with (RII) value of 0.785 which is very significant.
9. In the Problems of poor site layout practice. Several causes were identified such as ‘Causes delay in construction delivery', 'Increases the cost of construction', and 'Causes insecurity in construction site'. However ‘causes the occurrence of accident in construction site' ranked first with a relative importance index (RII) of 0.575 which is fairly significant.

5.2. Conclusion

The following conclusions were made based on the objectives of the research as stated in chapter one.

1. Improper site layout practices leads to low productivity, as poor site layout causes delay in construction delivery and increase cost of production.
2. Majority of construction firms are involved in the provision of site layout design for residential building projects.

3. From the research good site layout practice is majorly achieved by preparing site layout design before the commencement of site work.
4. From the research poor site layout practices majorly leads to occurrence of accident in construction site.
5. Majority of the construction firms benefits from all the provision of site layout design.

5.2 Recommendation

The following recommendations were made based on the objectives of the research as stated in chapter one.

1. From the research since majority of the firms practice site layout for residential building projects, the research recommends that it should also be practiced in other forms of construction projects.
2. Since the preparation of site layout design before the commencement of site work was identified to be key factor in good site layout practice, therefore it should be enforced or implemented as criteria in every planning process of construction project.
3. To avoid the delay in construction delivery and occurrences of incessant accidents on construction site, site layout design should not just be provided, but it should properly fit into the peculiarity of the construction site, putting into consideration the nature of activities, the topography and orientation of the proposed project.
4. The research recommends that further studies should focus on the extent and the specificity of the benefit of the provision of site layout design.

5.3 Contributions to Knowledge

The following are the contributions to knowledge

1. The research has provided a plat form for the assessment of the problems caused by poor site layout design in construction sites in Abuja.
2. Based on the research findings good site layout design in construction sites is paramount, therefore the research has identified a means of reducing construction site accident and delay in construction in Abuja.
3. The research has also provided a basis of addressing the participation of staff in the site layout design in construction sites and their level of involvement.

REFERENCES

Abdul-Azeez A.D. (2012). Development of a Prototype Electronic Document and Record Management System (EDRMS) for Small and Medium Building Firms Unpublished PhD Dissertation, Ahmadu Bello University, Zaria, Nigeria.

Adamu, J.K., Dzasu, E.W., Haruna, A. and Balla, K.S. (2011), "Labour Productivity Constraints in Nigeria Construction Industry", Continental Journal of Environment Design and Management, 1(2), 9-13.

Akinci, B, and Fischer.(2002). Automated generation of work spaces required by construction activities. *Journal of Construction Engineering and Management-Asce, 128*(4), 306–315.

Andayesh, M, and Sadeghpour, F. (2013).Dynamic site layout planning through minimization of total potential energy. *Automation in Construction*, *31*, 92–102.

Benjaoran, V, and Bhokha, S. (2010). An integrated safety management with construction management using 4D CAD model. *Safety Science*, *48*(3), 395–403.

Bryman, A. (2008). Social Research Methods (Third edition ed.) New york: oxford university press.

CAD-based construction site layout planning system using genetic algorithms. Automation in construction 749-764.

Construction Industry Institute Report.(2000).Improving Site Productivity in the Construction Industry. International Labor office, ILO, Geneva.

Dawood, N, and Marasini, R. (2003). Visualisation of a stockyard layout simulator "SimStock": a case study in precast concrete products industry. *Automation in Construction*, *12*(2), 113–122.

Easa, S, and Hossain, K. (2008).New Mathematical Optimization Model for Construction Site Layout. *Journal of Construction Engineering and Management*, *134*(8), 653–662.

Edwin Adakole Agbo and Calistus Ayegba. (2014). Critical Factor influencing Construction labour Productivity in Carpentry and Steel fixing in North Central Nigeria. *International Journal of Development and sustainability.*

Elbeltagi, E, and Hegazy, T. (2004).Dynamic Layout of Construction Temporary Facilities Considering Safety. *Journal of Construction Engineering and Management*,*130*(4),534–541.

Hesham, M. Osman, Maged, E. Georgy, Moheeb, E. Ibrahim, (2003). A hybrid

http//:surveyanalysis.org/index.php?title=Design_Effects_and_Effective_sample_size&oldid=6733

Hung, W. H. and Kang, S.C. (2009).Physics-Based Crane Model for the Simulation of Cooperative Erections. (p. 11). Sydney: 9th International Conference on Construction Applications of Virtual Reality.

Jiuping Xu, Zongmin Li. (2012). Multi-objective dynamic construction site layout planning in fuzzy random environment. Automation in construction

Kish L, (1965) Survey sampling. New York Wiley, Retrieved from

Lam, K. C. and Ning, X. (2009). Conjoining MMAS to GA to Solve Construction Site Layout Planning Problem. *Journal of Construction Engineering and Management-Asce*, *135*(10), 1049–1057.

Yahya.M and M. p.saka,(2013).Construction site layout planning using multi-objective artificial bee colony algorithm with levy flights. Automation in construction.

Mawdesley, M. J, and Al-Jibouri, S.H. (2003). Proposed genetic algorithms for construction site layout. *Engineering Applications of Artificial Intelligence*, *16*(5–6), 501–509.

Moser, C. A. and Kalton, G. (1971) Survey Methods in Social Investigation, UK: Heinemann Educational.

Raymond W. M Wong, and Dr. Christabel Ho. (2010).Consideration between Site Layout Facilities, Provision of Work Equipment and Construction Planning for Extremely Large and Complicated Construction Projects.

Sadeghpour, F, and Moselhi.(2006). Computer-aided site layout planning. *Journal of Construction Engineering and Management-Asce*, *132*(2), 143–151.

Saunders, M., Lewis, P., & Thornhill, A. (2003). *Research Methods for Business Students*, 3rd Ed. London: Prentice Hall Financial Times.

Su, X, and Andoh, A.R. (2012).GIS-based dynamic construction site material layout evaluation for building renovation projects. *Automation in Construction*, *27*, 40–49.

Tam, C. M.Tong, T.K.L. (2003).GA-ANN model for optimizing the locations of tower crane and supply points for high-rise public housing construction. *Construction Management and Economics*, *21*(3), 257–266.

Vanduhe, B.A. (2012). ―An Investigation of Factors affecting Residential Building Maintenance‖. Unpublished B.Eng. Project submitted to the Department of Civil and Water Resources Engineering University of Maiduguri.

Waly, A. F. and Thabet, W.Y. (2003). A Virtual Construction Environment for preconstruction planning. *Automation in Construction*, *12*(2), 139 154.

Ning.X, K. C lamb, M. C. K. lam,(2011). A decision making for construction site layout planning, Automation in construction.

Xin.ning, ka-chi lam, mike chun-kit lam (2010) A decision-making system for construction site layout planning. Automation in construction.

Zouein, PP, and Harmanani, H. (2002).Genetic algorithm for solving site layout problem with unequal-size and constrained facilities. *Journal of Computing in Civil Engineering*, *16*(2), 143–151.

APPENDIX I

QUESTIONNAIRE

Dear Respondent,

I am undertaking a research as part of my M.sc program in the Department of Building, Ahmadu Bello University, Zaria on **Assessment of Site layout Practices of Construction projects sites In Abuja Nigeria.** The study intends to provide a guideline with respect to site layout design and management in construction projects with a view to improve the productivity of workers.

This questionnaire will only take you an average of just 15-20 minutes to fill. I would be grateful if you spare your time to respond to the questionnaire.

The information to be provided will be treated confidentially and used for data analysis only.Thank you very much for your cooperation.

Usman Mohammed

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SECTION A (Background Information)

1. Name of your organization (optional)……

   ……

2. Address of the organization …….....

   ……

3. Kindly indicate the size of your company. a. 0-9 employees[ ] b. 10-99 employees [ ] c. 100-200 employees [ ] d. Over 200 employees [ ]

4. Please indicate the years of working experience of your firm. a. 0-5 years [ ] b. 6 - 10 years [ ] c. 11 – 15 years [ ] d. 16 – 20 years [ ] e. over 20 years [ ]

5. Kindly tick your highest academic qualification. a. Ordinary National Diploma [ ] b. Higher National Diploma c. Bachelor's Degree [ ] d. Post Graduate Diploma e. Masters [ ] f. Doctorate Degree [ ]g. Others (Please Specify) …….

SECTION B (Assessment of Site Layout Practices in Abuja)

6. How many times have you participated in designing site layout? a. 0-5times b. 5-10times c.10-15times d. >15times

7. In what type of project do you provide site layout design? a. residential building b. local estate construction c. linear construction (e.g road, railway, sewer, canal, transmission line)

8. In a project of what size do you consider planning of site layout design before the start of construction project? a. small project b. medium size project c. large project d. all of the above.
9. In a project of what duration do you plan for site layout design in construction a. short term project (some months) b. long term project (more months, years) c. all of the above
10. please choose among the importance of site layout design a. increase workers productivity b. save construction project time c. Decrease construction project cost. d. All of the above.
11. When do you provide site layout design in construction? a. Before the start of construction [ ] b. At every phase of the project [ ] c. As the construction progresses [ ]
12. Kindly rate the level of participation of your engineers or planners in designing site layout in Abuja. 5. Very high (≥ 70) [ ] 4. High (60-69%) [ ] 3. Average (45-59%) [ ] 2. Low (30-40%) [ ] 1. Very Low (≤30%) [ ]

SECTION C

The following represent good **site layout practices.** Using a the Likert scale of 1-5, please kindly rate the level of application of these practices by your firm on large construction sites with representation as follows ; not applicable=1, low level of

application=2, moderate level of application=3, High level of application=4,Highest level of application=5

S/No	Practices	Rank				
		1	2	3	4	5
1	Preparing site layout designs before the commencement of site works					
2	Ensuring good positioning system for the temporary facilities.					
3	construction of fence at the boundaries of construction site .					
4	Provision of the public convenience for workers on site.					
5	Provision of canteen for workers meals at site					
6	Provision of workers recreational facilities					
7	Provision of first aid centres' for workers					

	emergency responses.
8	Provision of access roads for trucks and light weight vehicle.
9	Provision of site offices for clients, contractors and consultants.
10	Provision of security office
11	Provision of security check points
12	Provision of site clinic
13	Provision of fire prevention and firefighting equipment
14	Provision of information signs and signals
15	Provision of site map showing the site and temporary facilities
16	Provision of traffic signs
17	Provision of safe and safety equipment
18	Provision of accommodation for site workers.

19	Provision of site stores
20	Provision of fabrication and maintenance shop.

The following represent **problems as a result of poor site layout practices.** Using the Likert scale of 1-5, please kindly rate the level of problems faced by your firm at construction sites with representation as follows ; no problem =1, low level of problem faced =2, moderate level of problem faced =3, High level of problem faced=4,Highest level of problems faced =5

S/No	Practices	Rank				
1	Decrease the productivity of workers	**1**	**2**	**3**	**4**	**5**
2	Causes delay in construction delivery					
3	Increases the cost of construction					
4	Causes activities overlap by wrongly allocation of temporary facilities					
5	Causes difficulties in materials access					
6	Causes difficulties in site transportation					
7	Causes poor communication among workers					
8	Causes insecurity in construction site					
9	Causes the occurrence of accident in construction site.					

APPENDIX II

Title: Size of the Company

Size	Frequency	Percentages (%)
0-9 employees	6	15.8
10-99 employees	17	44.7
100-200 employee	3	7.9
Over 200 employees	12	31.6
Total	38	100

Title: Years of Working Experience of Firm

Years	Frequency	Percentages (%)
0-5 years	12	35.3
6 -10 years	4	11.8
11 – 15 years	5	14.7
16 – 20 years	4	11.8
over 20 years	9	26.5
Total	34	100

Title: Highest Academic Qualification

Qualification	Frequency	Percentages (%)
Ordinary National Diploma	2	5.6
Higher National Diploma	2	5.6
Bachelor's Degree	16	44.4
Post Graduate Diploma	3	8.3
Masters	10	27.8
Doctorate Degree	3	8.3
Others	0	0
Total	36	100

Title: Number of Participation in Designing Site Layout

Number of Participation	Frequency	Percentages (%)
0-5times	18	50
5-10times	5	13.9
10-15times	5	13.9
>15times	8	22.2
Total	36	100

Title: Type of Project with Site Layout Design

Type of project	Frequency	Percentages (%)
Residential building	22	64.7
Local estate construction	7	20.6
Linear construction	5	14.7
Total	34	100

Title: Project Size in Planning of Site Layout Design

Project size	Frequency	Percentages (%)
Small project	2	5.3
Medium size project	2	5.3
Large project	4	10.5
All of the above	30	78.9
Total	38	100

Title: Project Duration in Site Layout Design

Project duration	Frequency	Percentages (%)
Short term project	4	10.8
Long term project	4	10.8
All of the above	29	78.4
Total	37	100

Title: Importance of Site Layout Design

Importance	Frequency	Percentages (%)
Increase workers' productivity	4	10.8
Save construction project time	6	16.2
Decrease construction project cost	2	5.4+
All of the above	25	67.6
Total	37	100

Title: Time to Provide Site Layout Design in Construction

Time	Frequency	Percentages (%)
Before the start of construction	32	84.2
At every phase of the project	3	7.9
As the construction progresses	3	7.9
Total	38	100