KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY.

KUMASI - GHANA

OFFSITE BUILDING METHODS – THE BUILDING PRACTITIONERS' PERSPECTIVE IN REAL ESTATE DEVELOPMENT.

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A Thesis submitted to the Department of building Technology
College of arts and built environment
In partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN CONSTRUCTION MANAGEMENT

November 2015

DECLARATION

I hereby declare that this submission is my own work towards the MSc Construction Management and that, to the best of my knowledge, it contains no material previously published by another person, nor material which has been accepted for the award of any degree of the University, except where due acknowledgement has been made in the text.

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Date

DEDICATION

This work is dedicated to God Almighty, my family for their immense support throughout the period of this study and my friends.

ACKNOWLEDGEMENT

My profound gratitude goes to the Almighty God for his guidance throughout this programme especially when the going became tough. I also appreciate the support, correction and understanding nature of my supervisor, Mr J.C. Danku without whose support this research would not have been possible.

I also wish to thank my father Prof P. S. Kwawukume for his support and words of encouragement throughout the period of this research work. My sincere gratitude goes to my mother, all my siblings and Mr. Stephen Akunyumu especially for his contribution towards the success of this project. Finally, I cannot forget Architects Cyril Torkpo, Hansen Jonah, Maxwell Amankwah Adudofour-Poku, William Kwabena Bonsu and Abena Achiamaa Kankam for their invaluable help during the distribution and collection of the questionnaire.

ABSTRACT

Offsite construction involves the process of preparation, scheming, manufacture, moving and assembling building elements for fast site assembly. Although the use of offsite methods of construction provides several significant advantages and it can help solve problems associated with duration of work, quality and further reduce cost when compared to 'traditional construction' the use of these methods are hardly practiced in the Ghanaian building industry. In an attempt to address this, the study was to help simplify the Ghanaian construction industry's' perception on offsite construction methods and establish how it would help improve real estate development. To achieve the aim, the objectives were to find the extent of utilization of the offsite methods of construction, find the factors that limit the use of this method of construction and find solutions to the factors that limit the use of these construction techniques. Through the snowball method of sampling 115 architects and 96 general contractors were selected as research subjects. The study adopted the survey method, data was collected through the administering structured questionnaire and site visits. The data was then statistically analysed and found that offsite methods of construction reduce material waste, improves product quality, improves safety on site, increases profits and helps reduce construction duration. The challenges that were dominant were transportation restraints, the rigid nature inhibiting changes on site and restricted design options. Recommendations such as; forums and teachings about the changing and the use of construction methods should be held periodically for building practitioners in major firms. Comparative value analysis should be done for both traditional and offsite methods of construction especially on cost for the clients' consideration.

Keywords: Offsite construction, Building practitioners', Construction Industry

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INTRODUCTION

1.1 Research background.

There are several government reports that have stated offsite construction methods as part of solutions to help improve the quality of houses provided to augment the supply of housing and improve material quality (Venables *et al*. 2004). However, according to Ball most construction industries are unable to tap into this building technology (Ball and Barlow, 1999). The housing minister of the United kingdom at the time was quoted saying offsite construction methods is a key component in stepping up the housing sector but he construction industry was in a large extent very slow to make full use of the technology (Roskrow, 2004).

Although there are many issues that have been raised many studies have neglected the issues and are promoting its application overlooking the supply chain and its relevant associations. (Roy et al, 2003). There is a gap in the understanding of the whole nature of how offsite construction methods are set up to help the industry. (Pan et al 2004). This study aims to look into issues pertaining to perceptions the relevant building practitioners' on the use of offsite methods of construction.

The fabricated components are mainly done in factories who have the capability and capacity to handle such processes. These parts are fabricated both as a unit that would be joint together as a whole when it has been transported to the venue where the components would be assembled normally through special modes of transportation. Normally the foundations are done in-situ so once the components arrive they are permanently fixed onto the foundation and they are sealed properly. Offsite method of production is more or less the partial moving of a construction site to a factor, which in turns help save material wastage and eliminate the labour wastage since the components would be made with the help of automated equipment (Toole

and Gambatese, 2006). The benefits of these automated formed components are that they also meet the building codes if not exceed them as compared to the traditional method of construction.

The royal institute of charted surveyors construction faculty carried out research and found out that 63% of traditional methods of construction delivered on time and even that only 49% could meet the budget. Due to this research most construction firms have started shifting to the use of offsite methods of production to help reduce the inferiority and increase the productivity. In order for the concept of off-site production to be widely approved and implemented on site to the benefit of the client as well as the design team, care must be taken by the design team to consider the technique at an early stage of design (CIRIA 2003). Offsite production involves standardisation and pre-Assembly (Prefabrication).

Design Standardisation involves the modularisation, simplification and repetition of design detailing (Adams and Ferguson, 1989). The use of standardisation or building rationalisation depends on geometry and requires in- depth explorations on the part of the Designer or Architect. Its main goal is to achieve a harmonic fit of geometric orders in plan as well as in section, while at the same time resolving the problem of structural co-ordination among the various parts of a building without losing sight of its aesthetic appeal. Thus, allaying the fear of most clients the end product will be a dull and boring building without identity or flexibility. A house need not be symmetrical or boxlike in order to be modular (Hersey and Freedman, 1992). Repetitive components when encouraged will lead to the end of the era of material wastage on site due to materials not being the right size and thus the need to cut.

This is a major reason why major firms stated opting for safer, productive and clean methods of getting their components and these guarantees quality and reduces the cost based of the savings on waste.

Most often the reasons when clients and contractors are asked about the use of offsite methods of construction they all say it is expensive citing the transportation cost as a huge factor. About the benefits of offsite production they all did not have a clue since they have not taken the pains to find the advantages it can bring to the project. (Pasquire and Gibb, 2002).

There are a lot of benefits and advantages that are associated with offsite method of construction. In a large extent it reduces the cost of construction as in it reduces the number of professionals on site since most of the professional supervision are done in the factory, increase the quality, decreasing the construction time and by such reducing the schedules which in effect improves the safety on site.

Reduction of the negative impact was identified as another advantage if the offsite method of construction is used. (Venables et al, 2004). Waste materials are reused in the factory premises or are further recycled for other use. Unlike in the traditional way of construction the waste is either buried. Also Hazardous waste are contained in factory premises whilst it is exposed on the traditional sites

1.2 Statement of the problem

There are several government reports that have stated offsite construction methods as part of solutions to help improve the quality of houses provided to augment the supply of housing and improve material quality (Venables *et al*. 2004). However, according to Ball most construction

industries are unable to tap into this building technology (Ball and Barlow, 1999). The housing minister of the United kingdom at the time was quoted saying offsite construction methods is a key component in stepping up the housing sector but he construction industry was in a large extent very slow to make full use of the technology (Roskrow, 2004).

Although there are many issues that have been raised many studies have neglected the issues and are promoting its application overlooking the supply chain and its relevant associations. (Roy et al, 2003). There is a gap in the understanding of the whole nature of how offsite construction methods are set up to help the industry. (Pan et al 2004). . According to (Gibbs, et al 2001) much research has been done in ways of incorporating off-site production into the construction industry with the aim of improving higher quality standards and reducing on site construction duration and cutting down on material waste on site. The whole reason for doing this research to establish the limitations associated in the use of offsite methods of construction in real estate development.

1.3 Research Aims

The research is to help simplify the Ghanaian construction industry's' perception on offsite construction methods and establish how it would help improve real estate development.

1.4 Research objectives

The research has the following objectives:

1. To find the extent of application of the offsite methods of construction in the real estate development industry in Ghana.
2. To identify the factors that limit the use of offsite construction methods by Real Estate Developers in Ghana.

3. To identify measures to address the factors that prevents the offsite method of construction usage in the real estate industry.

1.5 Significance of study

Even though when it comes to construction the reduction of waste and the ability to get quality materials is supposed to be the hallmark of all the building practitioners' it is strange to find out most or majority of them still rely on the tradition methods on construction. One may say since they are repeating the same structures the artisans would become more specialized and eventually deliver quality works but the opposite is seen. The offsite method of construction in itself is designed to alleviate all these problems and help come out with the best quality of work. This study is concentrated on solving the factors that limit the use of offsite method of construction in real estate development. Offsite methods of construction can help reduce;

a. Waste in construction

   In the normal practice of quantity surveyors they estimate a region of 2.5 – 5% for waste when they make the budget for the facility to be built but observational studies carried out show that the wastage figure is really 10 to 15 % of building material only (skoyles,1987).

b. Construction Cost.

   With offsite production materials wastage is reduced to its barest minimum especially during production because excess materials are reused for the next component unlike in traditional method of construction where it take days and time to move to the next stage.

These findings and recommendations of the study would lead to initiatives aiming at solving the problems relating to housing shortage in Ghana.

1.6 Research Questions

These question were asked to help achieve the aim and objectives of the research

1. What is the extent of application of the offsite methods of construction in the real estate development industry in Ghana?
2. What are the factors that limit the use of offsite construction methods by Real Estate Developers in Ghana?
3. What measures can address the factors that prevent the offsite method of construction usage in the real estate industry.

1.7 Scope

The scope of the research was limited to key stakeholders in the Ghanaian building industry with particular reference to building practitioners'' which comprises of Architects , general contractors (quantity surveyors, civil engineers and site engineers), Suppliers and Manufacturers of off-site produced building components and Real Estate developers. All findings and fieldwork was limited to Accra and Kumasi.

1.8 An Overview of Method for the Study

The researched was approached as follows;

1. The major method is survey. This included the use of Questionnaires, Interviews and field observations
2. Questionnaires sought the views of professionals in the construction industry such as Architects, Civil Engineers, Quantity Surveyors and Contractors among others.

3. Review of relevant literature on off-site production with the aim of summarizing past research and drawing conclusions from various studies that address the related problems.
4. Establish the applicability of the concepts to the construction industry of Ghana.
5. Mathematical review was used to examine the measured methods and operational definitions that were applied to the problem areas of the study

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This part reviews the historical background of offsite construction methods, the different types of the offsite development techniques. It exhibits an exhaustive writing audit on a few samples of current use of offsite development procedures in the U.S, German and UK private, business, mechanical and institutional development areas. Furthermore this section gives an account of a background investigation done by researchers on different building practitioners.

Off-site manufacture is a subject of universal interest and gives a viable development method as far as quality, time, expense, capacity, profitability and security. It is received worldwide as

the perfect method for creating a gigantic exhibit of components from basic individuals, cladding units, and bathrooms to completely completed secluded structures (Gibb, 1999).

2.2 Historical background

Toward the end world war one United Kingdom developed industries because of the lack of professionals and building materials. The outcome was an intense deficiency of shelter. This deficiency fortified a quest for new strategies for development that would reduce this issue. Somewhere around 1918 and 1939 more than 20 steel-surrounded housing frameworks alongside different sorts of lodging in view of conventional in-situ and precast solid, timber and once in a while cast iron building techniques were produced. Over this period 4.5 million houses were manufactured however just around 5% were developed utilizing new routines for development. The greater part of houses were still customarily constructed as work and materials turned out to be less rare. In Scotland there was additionally a need to assemble new homes. A need that couldn't be fulfilled utilizing conventional building techniques essentially because of a deficiency of good quality blocks, an absence of bricklayers and the increasing expenses of stone and slate. This constrained the need to assemble considerably more houses utilizing elective routines for development contrasted with the south. (Taylor, 2009).

Study carried out by Glavinich (1995) emphasised the need to make use of the available resources effectively and efficiently, as it finally enables the construction work to be undertaken within the budget and shorter construction time. Low and Abeyegoonasekera (2001) supported Glavinich's study and also pointed out the importance of materials and fabricated elements were to delivered on site, logical sequence and operations were significant building methods that were stress on site.

2.3 What is Offsite Method of Construction

As indicated by Gibb and Pendlebury, Offsite construction involves the process of preparation, scheming, manufacture, moving and assembling building elements for fast site assembly .This included offsite pre-gathering, half and half building frameworks (PODS), panellized assembling frameworks, and secluded structures.

Off-site development is a use of present day techniques for development where building area meets the modern part, or by other word, a combination in the middle of building and assembling. Off-site development is the place any of building parts, or even an entire building, produced in processing plants far from the real site where the building will be sited, or just is the place the development site is unique in relation to the building site.

Off-site development has distinctive terms, terms like (construction, off-site get together, plant gathering, pre-get together, off-site produce, and so on.). The term off-site development is for the most part utilized these days to any piece of the development prepare that happens in industrial facilities.

Offsite creation, construction, pre-get together and modularisation are a piece of the wide range of inventive contemporary procedures accessible to customers, engineers and venture administrators looking for more prominent expense viability in development.

2.5 Definition of Terms

2.5.1 Offsite Pre-fabrication

Offsite pre-assembly alludes to a procedure by which different building materials, preassembled segments, or elements are joined together at a remote area for consequent establishment. It is for the most part centered around a framework, for instance: rooftop trusses; pre-amassed vessels complete with protection, stages, channeling and stepping stools (Tatum et al, 1986).

2.5.2 Hybrid Systems (Pod)

Hybrid systems are frameworks where pre-assembled fabricating offices, a completely plant got done with building unit with finished inward outfits and building administrations. For instance: manufacturing plant completed bathrooms with inside getting done with, pipes and electrical administration, plant finished office room.(Tatum et al, 1986).

2.5.3 Panelised Construction Systems

Panelized building systems comprised of the development of the building boards produced at an industrial facility. It likewise comprises of industrial facility manufactured basic segments rather than finished modules, transported to the site, collected and secured to a changeless establishment, regularly including extra plant based creation, for example, completed divider board with cladding, protection, inner completions, entryways and windows (NAHB, 2004).

2.5.4 Prefabricated Buildings

This alludes to industrial facility constructed homes of one or more units totally collected or created in an assembling plant far from the jobsite, then transported and gathered nearby. Particular building typically comprises of multirooms with three-dimensional units, which are developed and pre-amassed complete with trim work, electrical, mechanical, and pipes introduced (O'Brien, 2000).

The utilization of offsite manufacture is extremely powerful as far as capacity, quality, time, cost, agent wellbeing and the profitable utilization of work and different assets and appropriately utilized, offers a considerable open door for enhanced task execution (Tatum 1986) .

2.5.5 Cost of Construction

Construction Cost is the cost of all work, materials, labour, hardware, overhead and development Company's benefit (Tatum 1987).

2.5.6 Total Cost of Project

This incorporates the whole costs connected with the outline and development of the structures. As of late the development business has been admonished to expand its use of offsite advancements, or 'Current Methods of Construction' with a specific end goal to address the under-supply and poor form nature of housing regardless of the very much practiced advantages of such advancements, the take-up inside of the business (Tatum 1987)

2.6 Overview of Offsite Construction Methods

Offsite development systems can create critical advantages for housing gurus and designers, not the slightest of which is the diminished attention on location action. This is especially vital in a period of expanding requests on an officially extended work power. Similarly as with any better approach for doing things there are dangers, yet these can be alleviated through great venture arranging and administration (Bourn, 2005).

Off-site construction, as I mentioned, is part of modern methods of construction and is referred to as any of the components of the building built in a high quality controlled factories where they use advanced techniques to manufacture highly specialised doors, windows, stairs, wall panels, frame structure, and complete volumetric pods and then transport them to the location where it will be used and to be assembled on-site (O'Brien, 2000).

According to Tatum et al, 1986, Off-site construction has many advantages that are why nowadays there are more companies and contractors using this method rather than the

traditional way of construction, even governments make more pressure to use this method to speed up housing delivery.

Offsite development can give great quality homes less work force, in a shorter time, with in any event the same building execution and at comparative expense when contrasted with more settled systems (Gibbs, 2001).

Off-site assembling and banding together procedures progressively have impact in taking care of today's issue of moving towards an economical housing industry (Venables et al., 2004).

2.7 Advantages of Offsite Methods of Construction

2.7.1Benifits of effective use of offsite construction methods

According to Neale et al. 1993, some of the benefits of using offsite methods of construction are as follows;

- An enhanced workplace in the manufacturing plant
- enhanced work strategies
- access to work made simpler
- repetitive work arranged with more assurance
- semi-gifted agents can be prepared for a predetermined number of talented assignments
- reduce agent development in the middle of assignment and at breaks
- familiarity with materials and parts
- more effective sequencing of work by agents
- working strategies can be investigated to enhance methods
- less harm by different workers
- more effective utilization of site waste
- introduction of specialized tools and technique are easily done

Less time in development procedure, cost consistency, higher quality, helping the general public and nature, determining gifted work deficiency, lessen well-being and dangers, and helping the business and the economy. These are key focal points of off-site development.

2.7.2 Reduced time of construction

Business focal points give an immense consolation to the temporary workers and fashioners to utilize more off-site development parts with their outline and building procedures. The more noteworthy pace of assembling and on location collecting is a vital element for business pick up. Prior the conveyance of the building means prior the arrival of the venture. Secluded development for instance, that is an off-site development, is up to 40-60% faster than conventional building strategies (Poon, 2003). The consistency of the conveyance likewise is essential for the monetary estimation of the business as far as expense and income. The assembling procedure of the parts in quality controlled production lines is about precisely assessed and in addition the conveyance to the site and the get together operation.

2.7.3 Cost Expectedness

(Takim and Akintoye, 2002) submitted that cost-adequacy is an essential element to demonstrate the contrast between the off-site development strategy and the routine one. Roughly, around 80% of the development expenses are altered inside of the initial 20% of the configuration process.

While off-site development has been said in the past to be more costly than block and brick, now is being diminished to the same level because of the advancement of more systems and to the assortment of the segments, and these bringing significantly more noteworthy economies. (Takim and Akintoye, 2002)

2.7.4 Greater Value

Off-site fabricate for building segments fundamentally enhances the quality and the productivity of the building because of exclusive requirement of value control and test. Structures surpass prerequisites on sound and warm protection levels, so this implies are more practical. (Boyd et al., 2013)

2.7.5 Help the general public and nature

Off-site development has likewise can help the general public and nature. A great many reasonable homes are required to take care of developing demand, and there is expanding weight to further enhance proficiency and maintainability execution amid development and all through the lifetime of the structures (Gibbs, 2001).

Off-site development is ecologically cordial in the event that it is arranged well from the early phases of configuration and by coordinating all the inventory network together. Less vitality is by and large required to add to the modules or off-site made parts. With enhanced procedure control ,structures are pre-designed – each precisely the same thus can be adjusted for simplicity of tiling and this ought to prompt diminished levels of waste nearby of up to 70% and ensuing expenses. (Poon,Yuand Jaillon 2003). Moreover, with enhanced control of materials stream, crude materials can be reused as opposed to "skipped" as regularly happens nearby((Thomas – 2001).

The benefit of utilizing offsite development techniques identified with the diminishment of waste to landfill are that the material utilization in the industrial facility is lessened up to 90% by the watchful configuration and acquisition of materials, decreasing the measure of waste produced both on location and off-site (Poon, 2003).

Offsite assembling was distinguished as a key potential technique for advancing manageability inside of the development business. Supportability is expanded as sound and warm protection are moved forward.

2.7.6 Reducing dependence on professional work

While there is a huge deficiency of lodging in the UK, and the administration arrangements to fabricate more convenience houses, there is another issue confronting to accomplish these arrangements also the building business an entire which is the abilities deficiencies bricklayers, handymen and circuit testers. Off-site development manufactures more houses by reducing so as to lessen dependence on progressively rare talented work the quantity of work where semi-gifted processing plant work can be utilized amid the development of modules (Thomas– 2001).

2.7.7 Improve Health and Safety

As indicated by particular building organization it has been demonstrated that offsite development routines is a more secure system for development on the grounds that there are less segments included than customary strategies and there is no requirement for high amount of work nearby for the gathering procedure.

2.7.8 Business combination and economy improvement

Off-site development coordinates the production network. At the point when executed viably, the off-site development procedure includes key makers and suppliers ahead of schedule in the possibility and configuration phases of the task. This guarantees the pro aptitudes and information of these key suppliers are inserted inside of the undertaking and can impact the outline and development periods of the task. Where proper these key suppliers ought to be

given responsibility for configuration and included completely in the execution of conveyance, stockpiling and developments of materials and segments (Gibb, 1999).

The upside of utilizing offsite development techniques identified with the decrease of waste to landfill are that the material use in the processing plant is lessened up to 90% by the watchful outline and acquisition of materials, diminishing the measure of waste produced both on location and off-site (Poon, 2003).

Offsite assembling was distinguished as a key potential strategy for advancing maintainability inside of the development business. Supportability is expanded as sound and warm protection are progressed.

2.8 Types of off-site methods of construction

Off-site development can take various structures. The structure and degree of acknowledgment inside of the activities will rely on upon the kind of undertaking: 'Is there a vast extent of duplication or replication?' for instance; in inns and lodgings, the sort of customer: 'Is the customer an erratic or rehash customer?', and the connections and the courses of action between the venture individuals.

Off-site buildings and components systems range from small bolt-together sections to virtually complete buildings.

Systems can be categorised as:

- Sub-assemblies
- Frames
- Panels (open or closed)
- Volumetric system
- Hybrids system

- Sub-assemblies

Sub-assemblies are the most traditional and widely used system in off-site manufacturing which is being used for many generations (Neale et al. 1993). This type of off-site construction can include elements using different type of materials such as concrete beams, block floors, and foundations. Prefabricated foundation systems can consist of precast, posttensioned, concrete beams. Prefabricated beam installation in progress on piles. The beams can be omitted and modular structures can be installed to span directly onto piles and pile caps. An additional examples for sub- assemblies systems are the glass reinforced plastic for chimneys, steel for curtain walling, and timber stairs.

2.8.1 Frames

Framed structures, which are pre-assembled in factories, supply the physical support to structures and are not new in construction. Lightweight pre-fabricated frames which can be delivered promptly to the site, speeding up the construction times for the main structural elements. The benefit of pre-assembled framed structures is that it can help in reducing site cutting and the inaccuracies that can arise from it. An example of framed structure is the steel frame module. Steel works in off-site construction are taking the most important part of the factory controlled construction due to the characteristics of the steel itself that can be shaped and moulded in any form; the result is light strong steel modules structures.

2.8.2 Panels

Panels are two dimensional frames that consists both the structural and the infill element, are sealed together on site. Examples of panels are pre-assembled floor, wall, and roof panels. Using the right sealants are very important to gain the benefit of off-site manufactured panels in order to stand up the frames rapidly. The simplest form of offsite manufactured panel systems is infilled with panels that are fixed to the structural frame because they are

lightweight. Where the most multifaceted form are the pre-assembled sandwich panels which consist of both, the structural element, internal and external finishes (Pasquire and Gibb, 2002).

2.8.3 Volumetric System

Modular construction is more sustainable than traditional techniques because of the minimum foundations that required and because it is built under factory conditions, the modules are in better quality and defects are minimized. Modular construction uses the same techniques from the industrial sector but the result does not look like “mass production product”. Sophisticated modules and panels can be produced and can be easily customised by the client’s requirements, and with new advanced techniques finishes: cladding and roofing, give the building its natural skin that suites the surrounding (Tatum 1986).

2.8.4 Hybrids System

2.8.4.1 Plant rooms

Plant room is a room or space in a building dedicated to the mechanical and electrical equipment’s and then they need an intensive labour. If plant rooms built off-site where there is cheaper labour, this can be more economically. Other advantage of plant rooms built in factory is if a project in time difficulties, always the installation of the services is squeezed, so using modular plant rooms certainly will help to avoid this problem.

2.8.4.2 Bathrooms Pods

Restroom development procedure can use Off-site development innovation, which in contrast with the conventional way, would ordinarily be completed nearby. On the off chance that we uproot the development procedure of the bathrooms to a controlled processing plant environment, bathrooms will turn out to be more natural, utilitarian, and with lower building expenses. Bathrooms that we call them "keen" will likewise turn out to be more normal with very earth toilets and showers frameworks and with more propelled innovation like tapes with

sensors. The nature of bathrooms cases is far better than the customary on location development, more snazzy, with brilliant materials, and better for the earth regarding a lower carbon foot shaped impression, lower levels of waste and lessened transportation of parts. Lavatory units are a monetarily arrangement when it incorporate with the entire development process in extensive amounts, for example, understudy facilities, lodgings, inns, healing facilities, and jails.

2.9 How Offsite Methods of Construction Is Practiced In the United Kingdom

Use of offsite development methods in England can be followed back to 1624 when the English conveyed with them to Cape Ann a panelized house made of wood for use by the angling armada. From that point forward, this house was thusly dismantled, moved, and reassembled a few times (Peterson, 1948). In the early piece of the twentieth century, significant action in mass construction frameworks for structures happened in the United

Kingdom. The impulse was an immense business sector interest for new lodging after World War I. The conventional building methodology couldn't give enough houses because of the development term and the absence of accessibility of talented laborers. The low generation of customary systems and demolition brought about by the war made an atmosphere for creative development routines and procedures (Waskett, 2001).

Be that as it may, offsite development procedures were not reliably created in the United Kingdom after World War I in light of the fact that a great part of the early exertion concentrated on the improvement and utilization of option development materials other than stone work and cement. In this way, at the time there was no noteworthy change in the way to deal with building that would propel the innovation (Waskett 2001).

Taking after the obliteration brought on by World War II, the UK government was influenced to give homes to warriors coming back from abroad, which likewise coordinated the need to

discover livelihood open doors for them. In September 1942, the U.K. Interdepartmental Committee on House Construction was framed to assume responsibility of creating option development materials and routines as far as enhancing productivity, economy, and development speed (Waskett 2001). The Committee essentially advanced the improvement of offsite development systems. Another extraordinary driving force of the utilization of offsite development procedures was the advancement of timber surrounding frameworks that happened from 1927 to 1941. The way that timber has dependably been anything but difficult to frame into boards gave the likelihood of manufacturing settlement units in the production line and afterward collecting them on location. Also, the advancement of Large Panel Systems (LPS) in 1948 essentially pushed the improvement of construction and preassembly methods. Inside of the most recent couple of years there has been an extraordinary increment in the utilization of offsite development strategies for structures, driven by a scope of components including requests for speedier development and deficiencies of gifted specialty laborers (BRE, 2003). The usage of offsite development strategies in the United Kingdom development industry has been overwhelmed by substantial development organizations whose motivating force for utilizing construction and institutionalization systems was to enhance efficiency and decrease development time. Frequently these strategies have been used in expansive urban zones on exceptionally congested jobsites. Modularization or measured outline has been portrayed as the way to offsite development methods in UK on the grounds that it offers clients unmistakable favorable circumstances over customary development procedures as far as work efficiency, undertaking timetable, item quality and a more secure workplace (Gibb, 2001).

In the UK, the utilization of offsite development procedures are more broadly acknowledged in the business division than the private and mechanical areas, because of the way that in England and Wales stone work frameworks are utilized for most of the private structures. Quick business improvement in London in the late 1980's made an awesome open door for expanding

the utilization of offsite development systems. Business customers requested a superior quality item, quicker conveyance, and at a sensible expense. The utilization of offsite development procedures was one of compelling ways to deal with address their issues. Expanded work costs and diminished accessibility of gifted work at the worksite were two contributing elements of the improvement of offsite development methods in the late 1980's. Construction has been recognized as a method for accomplishing speedier finishing on business premises. For instance, McDonald's eateries use construction innovation to assemble their new outlets. As of late they set a record of a finished outlet being fabricated and opened for business inside of 13 hours of beginning development on a readied building site (Blismas, 2006). As of now, in the UK, offsite development systems have impressive business suggestions for organizations and a scope of customers from inns to retail outlets is utilizing a few types of pre-assembled obtainment. Likewise, offsite development procedures have been connected in the UK mechanical development division too, predominately to assemble warming and cooling gear and other building administrations. Generally the establishment of building administrations is tedious and work serious, while pre-assembled secluded development can defeat these difficulties and meet forceful timetables (Blismas, 2006). In spite of some very much reported advantages that can be gotten from the utilization of offsite development strategies, the uses of these methodologies are still restricted. In 2004, offsite development strategies contained 2.1% of the development work in the UK, including new building, restoration, repair, and structural designing work (Goodier, 2004). A noteworthy reason was hesitance of customers to acknowledge advanced building strategies in that they experience issues finding out the advantages that by offsite development systems added to a task (Pasquire and Gibb, 2002). For huge numbers of those included in the development handle, the advantages of utilizing offsite development procedures were not surely knew. A study by Pasquire and Gibb (2002) exhibited that the choice of utilizing offsite development systems as a part of the UK is to a great extent

in view of recounted confirmation as opposed to thorough information. No formal estimation methodology or systems are accessible to analyze the consequences of utilizing offsite development with ordinary development. Choices with respect to the utilization of offsite development procedures are therefore hazy and complex because of interdependencies between development exchanges and assets. These complexities make the deduction and comprehensive assessments extremely troublesome. The uniqueness of every task made it extremely hard to build up a far reaching assessment framework looking at the utilization of offsite development procedures with routine methodologies. It ought to be brought up that an expansive piece of the imperviousness to development originated from the development organizations themselves instead of from the customers, as indicated by an exploration report directed by the Robert Gordon University, U.K. (Edge 2002). Another enormous test to the utilization of offsite development systems in the UK was the hazy effect of the development costs. Industry sources demonstrated that utilizing offsite development procedures expanded expenses around 7-10%, however the explanation behind the higher expenses has not been recognized yet because of numerous contributing variables, for example, inaccessibility of classified task money related data, higher plant overhead expenses, and utilizing present day development gear (BRE, 2003). A deficiency of gifted gathering specialists is another contributing hindrance to the utilization of offsite development methods in the UK. Contrasted with customary development procedures, offsite development systems require exceedingly talented work for exact nearby get together of manufacturing plant made building parts. Some of issues with pre-assembled fabricating routines originated from poor on location gathering specialists' abilities as opposed to surrenders of building materials, segments or structures. Other than the components said above, scientists in the UK demanded that inadequate industry limit of delivering building modules might likewise be an obstruction to expanded utilization of offsite development procedures (Gibb, 2004). With a specific end goal to look at the ebb

and flow usage of offsite development systems and distinguish the advantages and difficulties, UK government, analysts and other expert organizations have directed a lot of examination in this field.

2.10 How Offsite Methods of Construction Is Practiced In Germany

Offsite development strategies have been used in Germany for around 70-80 years. In the late 1920s and mid-1930s, the first mechanically created home was made as an image of innovation and advancement (Venables, et al, 2004). In 1947, a show of eighteen (18) preassembled houses was held in Stuttgart-Zuffenhuasen by an American development organization, six of regardless them exist today (Samstag, 2003). In the 1950s and 1960s, the German timber industry and home manufacturers vigorously put resources into the utilization of offsite development systems, prominently in the private segment. In 2002, more than 23,000 light confined pre-assembled homes were finished in Germany, comparable to 13% of the new private development volume for that year. In Eastern Germany, the utilization of offsite development methods was around 20% (Venables, et al, 2004)

Right now, offsite development systems have been broadly embraced in Germany. These procedures are most regularly utilized as a part of the development of new separated lodging. There are more than 100 producers in Germany with limits extending from 50 to 3,000 units every year. Most of the organizations are little family claimed. Be that as it may, like the Japanese development industry, the offsite development business sector has been ruled by five huge firms. They are Massa, Elk-Bien-Zenker, Kampa, WeberHaus and Schworehaus. Each of them produces 1,000 to 3,000 homes for every year and together record for more than half of the business sector (Venables, et al, 2004).

A percentage of the German offsite construction makers have extended their operations to other European nations. In 2002, fares of pre-assembled homes represented 5% of the aggregate

German lodging industry business. Significant fare markets incorporated the UK, Switzerland and Austria. Pre-assembled homes were likewise sent out to other European nations, furthermore to Russian and Japan (Venables, et al,2004).

As happened in the UK, pre-assembled homes in Germany used to be seen as lower quality than customary site-fabricated homes. The original of fabricated houses in Germany was alluded to as "cardboard houses" because of low quality. Be that as it may, at present the picture of pre-assembled houses has changed altogether because of expanded quality. The business has enhanced its picture through the advancement of institutionalization, confirmation plans, and predictable advancement of the benefits of utilizing offsite development procedures. In 2003,

LBS Inc., an expansive German home loan bank, directed a study to research momentum observations about the acknowledgment of pre-assembled houses. The study uncovered that 95% of the respondents saw offsite development procedures as dependable and a handy methodology, and 82% of the respondents would think about purchasing as an industrial facility fabricated home (Venables, et al, 2004)The purposes behind the high acknowledgment of offsite development strategies in

Germany are credited to the consistent advancement upheld by in-house R& D, preparing and quality certification procedures gave by producers (Venables, et al,2004).

German development affiliations have reliably given numerous preparation chances to the producers and on location gathering specialists (Venables, et al, 2004). Proficient affiliations, for example, the Bundedverb and Deutscher Fertigbau (BDF) and the Deutscher Fertigbau Verband (DFV) in Germany have assumed a significant part in accomplishing higher acknowledgment for the utilization of offsite developments methods. Furthermore, those affiliations additionally underlined on preparing, which brought about an increment of 6%

assembling individuals and 7% of business in offsite development in 2002 (Venables, 2004). In Germany, offsite development methods have been utilized as a part of building development with an assortment of building materials. Timber-based offsite development frameworks take the type of post–beam development, and auxiliary protected boards (SIP), or a mix of both. Outer completes ordinarily comprise of rendering or cladding. The particulars for the timber development in Germany set higher benchmarks than those in the UK, with more prominent sympathy toward the last nature of the completed item. Post-and-shaft frameworks are gone for the upper end of the lodging business sector and application is still extremely restricted. Cement and brick work frameworks are utilized for building boards and material components. Likewise, particular solid lodging and mechanized creation of solid boards for dividers and storm cellars are additionally used in the German development industry (Barlow 2004).

2. 11 How Offsite Methods of Construction Is Practiced In European Countries

Most European nations have utilized offsite development procedures as a part of different structures for a long time, and each of them added to a framework that fits their own way of life and development innovation. In the Netherlands, most homes are fabricated by a half and half strategy for solid shells and a couple of special cases of timber casings. The fundamental utilizations of offsite development methods in the Netherlands were for rooftop and divider boards. The system is called supported optimizing lodging methods. This technique uses steel burrow formworks with cast set up cement to finish a building with 50 units or more, because of the prudent scale (Gibb, 2002). In the Netherlands, the basic dividers of structures are preassembled and protected, utilizing timber depression internal leaves fusing windows and entryways. The internal leaves of hole dividers are pre-assembled timber-encircled development, comprising of timber boards, a plasterboard inward skin, protection, vapor boundaries, soggy rooftop courses, windows, and door jambs((either PVC or timber

surrounded). Smooth-confronted gypsum squares are utilized as a part of the building for non-burden bearing inward dividers, which give format plan adaptability, and better solid and imperviousness to fire. Rooftops are pre-assembled with pivoted timber components fusing rooftop lights and vents. The pre-assembled timber pivoted rooftop components are intended to sit on divider plates on the overhang and peak dividers (Waskett, 2001).

Contrasted with traditional development innovation in the Netherlands, offsite development methodologies diminish development time from 21 months to 12 months, with 33% more usable floor territory. They likewise decrease the building expense up to 17%. Most overwhelm contractual workers are exploiting these routines and materials. It has been effectively connected in the business for over 25 years (Waskett, 2001).

2.12 Advantages That Come With The Utilizing Of Offsite Methods Of Construction

Numerous writing studies have investigated the advantages of construction, preassembly and modularization forms. These methodologies have enormously added to the change of the development business as far as development length of time, development costs, and item execution, efficiency and customization. The advantages of offsite development strategies are condensed underneath.

2.12.1 Planning of Project

Sparing in time is a standout amongst the most considerable advantages of the construction, preassembly, and modularization procedures utilized as a part of the development business. Lessening nearby generation time greatly affects shortening general undertaking timetables. The site work is generally defenseless against interruption from extremes of climate, which is one of the fundamental variables of the development plan. The utilization of pre-assembled segments nearby lessens the dangers of deferral and insurance necessities in a given

undertaking. At present planning issues bringing about countless development organizations can bring about enormous efficiency issues. Construction innovation is one response to shortening the timetable and enhancing effectiveness (Venables, et al, 2004). Notwithstanding lodging, some significant retail customers are effectively included in construction routines in the persistent lessening of development time in the business division of the business. In general, construction, preassembly, and modularization have dynamic impact of calendar funds.

2.12.2 Advantages on Construction Cost

The utilization of construction strategies at an undertaking permits cost investment funds at each phase of the generation affix because of large scale manufacturing, for example, material reserve funds at the obtainment stage and work reserve funds at the development stage. A CII investigation of modern ventures found that now and again expenses were diminished by as much as 10% of general undertaking expenses and 25% of on location work costs (Tatum 1987). Taken a toll diminishments were to a great extent ascribed to the lower expense of offsite work. Also, investment funds may be connected with site overhead lessening, establishment efficiencies, and the institutionalization of outline (CII 2002). Taken a toll diminishments can likewise be clarified as far as art profitability expanding and work rates diminishing nearby.

2.12. 3 Safety of Site

Construction can build the on location security record by lessening the presentation of laborers to harsh climate, stature, unsafe operations, and on location working time. Laborers in a creation shop are not influenced by severe climate. Pre-assembled segments additionally give all the more working space to lighten the potential plausibility of mishaps on location (Ball, 1998).

2.12.4 Quality of Offsite Production Components

Higher item quality through the utilization of pre-assembled segments can be accomplished by exact outline and close supervision on location, which lessens the sum and extent of progress. The more exact profiles and institutionalized measurements of parts lead to better quality control on the product. At present, Construction IT programming guarantees arrangement and accuracy of a given task are kept up both on location and in the industrial facility. PC helped fabricating innovation permits every item in the line to shift from one another. Programming incorporates outline hone with assembling to give mass modified generation (Russell, 1981).

2.12.5 Labour Force

Construction can offer chances to lighten the issue of talented work deficiencies. In plant situations the nature of the completed item is much less demanding to guarantee than on location. Every one of those remaining parts is to guarantee that the on location gathering meets the obliged norms to permit the item to execute as outlined. Contrasted with the conventional development approach, construction has lower workmanship prerequisites on location attributable to streamlined work content (Blismas, 2006).

2.12.6 Material Waste

Watchful quality control of the assembling procedure empowers development waste to be controlled and minimized through suitable outline and reusing opportunities. Negative natural effect can be lightened by lessened nearby development time, less clamor, and less waste delivered nearby. Likewise, industrialized development procedures can enormously build material inputs and decrease costs. One particular plan being produced with European

Community (EC) subsidizing has been cited as having the accompanying foreseen advantages (Blismas, 2006).

• half diminishment in the measure of water utilized for the development of an average house

• half diminishment in the utilization of quarried materials in the development

• At slightest half decrease in the vitality utilization

2.13 Disadvantages of Using Offsite Method Of Construction

In any case, the writing concentrates additionally discovered a few difficulties of utilizing offsite development method, which are condensed as takes after.

2.13.1 Project Scope and Planning Stage

The greatest drawback of construction, preassembly, and modularization in development is the increment of pre-task arranging stage. There is a requirement for expanded building exertion forthright (CII, 2002). In this manner, configuration work and broad arranging must be absolutely directed before creation. Moreover, coordination of outline, transportation, and on location establishment are basic segments for effective execution.

2.13.2 Transportation Limitations

Transportation logistics assumes an extensive part in deciding offsite development practicality. The system and course of transportation force size and weight confinements and additionally width and stature limitations amid travel (CII, 2002). Roadway transport, as the most well-known technique used, normally limits the extent of secluded building or preassembled fabricating segments to 12-14 feet in width, and 50-55 feet long. Likewise, and their weight additionally confined by the limit of lifting gear ordinarily between 10 to 30 tons. Moreover, there exist the U.S. parkway limitations alongside lifting limit of crane. Produced assembling parts must be excessively intended to ease conceivable harm amid travel, which prone to expand outline and development cost (Pendlebury, 2004)

2.13.3 Client Perceptions

In light of the writing examined, the general negative view of offsite development strategies was a standout amongst the difficulties in both the U.S. what's more, abroad with the exemptions of in Germany and Japan. In the U.S., pre-assembled structures have dependably been mistaken for production houses, "trailers", despite the fact that there is a major diverse between these two sorts of structures (Hass et al.,2000)

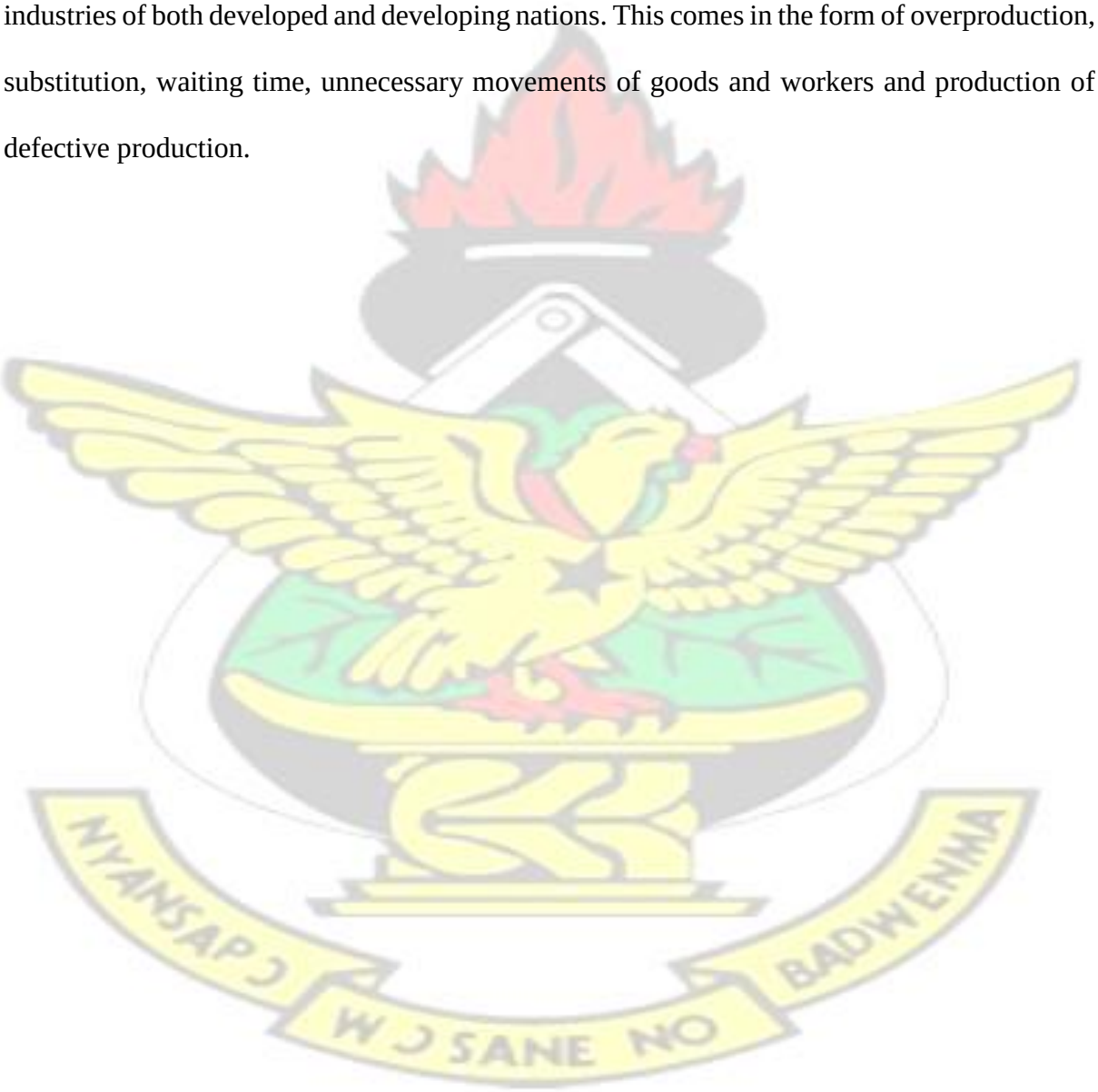
2.13.4 The Ease to Roll out Improvements on Location

The powerlessness to roll out improvements on location amid development may diminish the utilization of offsite development methods. Offsite development procedures, specifically for particular structures, require a very much characterized scope early the task arranging stages (CII, 2002).

2.14 Findings of Literature Review

The results of improving the construction industry by using offsite methods of construction are evident in the project cost. The early involvement of off-site production into the project design stage, could achieve 1% to 14% cost saving (Gray 1983). There is also achievement of effective saving of overall project cost (Griffith et al., 1997), a more efficient human resource output, early completion of the project and also high project productivities (Sidewell et al., 1997). It cuts down on material waste (Koskela, 1992), and eliminates many traditional construction work task with serious risk factors (Gibb, 2004). On the other hand, the reasons why when clients and contractors are asked about the use of offsite methods of construction they all say it is expensive citing the transportation cost as a huge factor. About the benefits of offsite production they all did not have a clue since they have not taken the pains to find the advantages it can bring to the project. (Pasquire and Gibb, 2002).

In adding up to this, the Ghanaian construction industry has specific problems which have led to the housing deficit being experienced. These include use of expensive building materials, lack of adequate mechanization in the housing construction industry, lack of adequate qualified construction manpower and skilled artisans, land tenure and cost, shortage of housing finance and low income of prospective buyers. (Boadu et al. 1992). Research by (Formoso et al, 1999) all point to the fact that material waste control is a major problem facing the construction industries of both developed and developing nations. This comes in the form of overproduction, substitution, waiting time, unnecessary movements of goods and workers and production of defective production.



CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter shows how the methodology the researcher adopted. It identifies the research methods, research design how the sample frame was attained, the statistical method used, the sampling techniques used in getting the population, the population definition and finally the sample used in the research.

The paper highlights relevant research works on real estate developers' practices and strategies on the use of offsite methods of construction. From the literature review questionnaire survey was developed as well as questions to be asked during site visits and offices of respective building practitioners.

3.2 Research Method

When the primary data of a survey is normally picked through surveys and interviews it is best to use the descriptive methods of survey (Zikmund, 1997). To get the best result for the survey, the descriptive method of survey was adopted. With the aim and the objectives of the study in mind, the literature review helped formulate the questionnaires used in the survey. Site visits were also done to get to know more about the materials and their properties comparing them with the traditional materials used in building.

3.3 Research Design

It was imperative to get information form a particular group of people to help establish the current opinions. The researcher found it appropriate to use a survey because he wanted to get to know all the diverse views and based on that when the researcher is analysing the data it

would make it easier to generalize the population interest pertaining to the particular group in the survey.

A comprehensive literature review, site visits, data collection and analysis were employed by the researcher.

3.4Sample Frame

The study was able to cumulate the diverging views of the major rend changers in the real estate business in Ghana. These included architects, general contractors (site engineers, structural engineers, quantity surveyors) and manufacturers.

3.5 Statistical Methods

In the research since various players would be studied there was the need to use the stratified random sample design of analysing the data. Each key player of the industry would be put in one stratum. (Scheaffer et al., 2006). Architects form one stratum, the contractors form on stratum, the real estate developers then the manufacturers of offsite also another.

3.6 Sample Design

3.6.1 Sampling Technique

When selecting the population cannot be attained by following the theory of probability in the choice of elements from the sampling population it is best to use the non-probability sampling technic. This form of sampling is used when the population cannot be individually identified (Kumar, 2014)

With the difficulty of ascertaining the actual numbers of registered architects and contractors and also find where their registered offices of all would be the study sample was derived by a non-probabilistic method of sampling and the be precise the snowball sampling method. With this sample technique the researcher identifies the authorities or the major players in the

industry who then refer them to people with the characteristic being sought. Through the snowball method a total of 24 architectural firms and 32 construction firms are obtained and targeted for the research. Those who met the requirements were owners, Chief Executive Officers, project managers, architects and general contractors (quantity surveyors, structural engineers and site engineers)

3.6.2 Definition of Population

Respondents were limited to architectural, constructional and real estate developers in Greater Accra and Ashanti region. The choice of this group was made on the basis that they are well established and they had done major works with offsite methods of construction. The decision to focus on these two regions was based on the snowball method of sampling.

3.7 Sample

Since the population needed were hard to pinpoint and it wasn't all firms that had dealt with the offsite methods of construction the researcher through the snowball methods of sampling identified a total of 24 architectural firms and 32 construction firms since the total number of staff that fell under the targeted respondents were unknown 120 questionnaires each was sent to both the architectural and the construction firms.

3.8 Difficulties and Problems Encountered

The major difficulties the researcher encountered was finding the appropriate people to be surveyed and their offices if the people were known. There were instances where the researcher had problems in terms of the respondents' depth of knowledge. The questionnaires had open ended questions to help get other views for the respondents unfortunately some had bad handwritings so majority of their submissions were illegible. Some of the offices which were

identified or recommended were no longer functioning or had moved to a location which was not shared to the people around the old office.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.0 Introduction

This chapter deals with the findings and analysis of the data compounded from the survey questionnaires, the site visits and the interviews of the respective building practitioners'. The reports on the findings are also discussed.

4.1 Survey results

The questionnaire was sent to 120 architects and 120 to construction firms. Among those 115 (95%) of the architects responded and 96(80%) general contractors responded. The total number of people who were sampled totaled 211 with 115(55%) being architects and 96 (45%) representing the general contractors who comprise of quantity surveyors, site engineers, structural engineers) and real estate developers.

4.1.2 Demographic Variables

The respondents of the survey represented construction professionals undertaking works in 2 geographical locations in Ghana, namely Accra and Kumasi. The years of experience of the various professionals ranged between 2-15 years and over. A total of 30 out of 115 professionals representing 26.% have been in the Ghanaian construction industry for more than 10 years and about 65 representing 56 % have had 6 –10 years of work experience and 20 representing 17% have had 2 – 5years of work experience.

4.2 Findings on Architects Survey

4.2.1 Knowledge in the Use of Offsite Methods of Construction

Table 4.1 Architects Knowledge in Offsite construction methods

Categories	Frequency	Percentage
High	30	26.1
Average	85	73.9
total	115	100.0

26% of the respondents rated their level of knowledge as above average and the remaining 74 % as average. This brings to the fore the need to intensify the education of construction industry professional on the importance of technology advancement in construction.

4.2.2 The Importance of the Offsite Methods Of Construction

Amongst the 115 respondents 60% of them said offsite construction techniques improves quality of work, 69% say it produces cleaner work, 4% say it increases profits,13% of the respondents say it improves safety, 31% are of the view it improves project schedule and 39% say it helps reduces the amount of waste on site.

4.2.3 Recommendation of Construction Methods To Real Estate Developers

21.7 per cent of the architects recommended the use of offsite construction methods to real estate developers often; while 17.4 per cent recommended the use averagely and a greater percentage of 60.9 did not often recommend the use of offsite construction methods

Table 4. 2 Recommendation of use of offsite construction methods

Category	Frequency	Percent
Often	25	21.7
Average	20	17.4
Not often	70	60.9
Total	115	100.0

4.2.4 Comparing Waste Generated By Traditional Methods Of Construction To Offsite Construction Methods

As to which produces less waste between offsite construction methods and traditional methods a resounding 100% responded to offsite construction methods producing less waste. When asked to further explained that the standardisation reduces material waste due to mass production of building elements. Others said the wood formwork and related waste was minimized also the formwork is usually not needed with the offsite construction methods thus less cost and time used or needed in that aspect of construction.

4.2.5 Cost of Methods

69.6 per cent of the architects claimed offsite construction methods to be more expensive that the conventional methods while 30.4 per cent claimed an opposing view.

Table 4.3 Cost of methods

Category	Frequency	Percent
Prefabricated	80	69.6
in-situ/conventional	35	30.4
Total	115	100.0

4.2.6 Method of Preference

A slim majority of 52.2 per cent of architects preferred the use of prefabricated components to the conventional, while 47.8 per cent preferred the use of the conventional

Table 4.4 method of preference

Category	**Frequency**	**Percentage**
prefabricated	60	52.2
In situ	55	47
`total	115	100

4.2.7 Best suited offsite method for building projects

70% believed offsite construction would be more appropriate for buildings, 56% chose residential buildings, 89% recommended parking and storage buildings and 47% said transport buildings.

4.2.8 Prefabricated Materials Recommendation

Among the architects 87 per cent have their firms recommending 16-30% prefabricated components while 13 per cent have their firms recommending 31-45% use of prefabricated components.

Table 4.5 Percentage Recommended

Category	**Frequency**	**Percent**
16-30%	100	87.0
31-45%	15	13.0
Total	115	100.0

4.2.9 Waste Produced On Conventional Sites

A resounding 100 per cent agreed that waste on conventional sites was high.

4.2.10 Reduction of Waste on Site

Also 100 per cent established offsite construction methods reduced material waste on site

4.2.11 Reasons for usage of offsite construction method

Table 4.6 reasons why the use of offsite construction methods

Reasons	1	2	3
To make up for the lack of professionals	28	x	10
To make up for the weather	17	37	X
To cut design time	X	X	10
To cut construction time	52	19	7
To rise product excellence	X	23	38
To cut the complete price of the scheme	6	X	X
To surge efficiency	X	20	X
To make up for the limited onsite working area	5	X	X
To decrease material waste generated on site	7	13	42
To increase site safety	X	X	8
To rise revenue margin	X	3	X
To augment reputation	x	X	X

Table 4.6.1 3 Reasons for usage of offsite construction method

Category	**Percentage**	**Rank**
To cut construction time	45	1st
To make up for the weather	32	2nd
To decrease material waste generated on site	36	3rd

4.2.12 Reasons restraining the usage of offsite construction method

Table 4.7 reasons that limit the use of offsite construction methods

Reasons	1	2	3
A. the office does not recommended offsite methods of construction	24	10	6
B. designers don't recommend it	7	22	11
C. building regulations prevent or limit the use	x	11	5
D. Monetary establishments limit the use o the technique	x	x	13
E. inexperience workers	11	13	7
F. is it expensive to implement	6	x	X
G. Transportation limitations	5	34	22
H. external factors limit the use of the technique.	7	x	X
I. few design options	18	16	33
J. rigid nature of the components unable to make changes easily	37	9	18

Table 4.7.1 3 main reasons that limit companies from using the methods

Category	percentage	Rank
rigid nature of the components unable to make changes easily	37	1st
Transportation limitations	29	2nd
Few design options	28	3rd

4.2.13 Materials used in place of the traditional ones

With the material used in offsite construction methods components 8.7 per cent viewed them as fragile, 60.9 per cent viewed them as sustainable and 30.4 per cent viewed them as adequate

Table 4.8 Material used

Category	Frequency	Percent
Fragile	10	8.7
Sustainable	70	60.9
Adequate	35	30.4
Total	115	100.0

4.2.14 Future Usage Of Offsite Methods Of Construction In The Next 5-10 Years?

56.5 per cent of the architects were of the view that in 5 to 10 years offsite construction methods usage will be about 16-30% per cent and 43.5 per cent were of the view that the usage will be 31-45%.

Table 4.9 Future Usage

Category	Frequency	Percent
16-30%	65	56.5
31-45%	50	43.5
Total	115	100.0

Findings on Contractors and Real Estate Developers Survey.

4.3.1Building Components That Lend Themselves Easily To Prefabrication.

Item	Frequency	Percentage

Wall panels	10	10.4
Roof panels	21	21.8
Floor panels	12	12.5
Plumbing and service walls	6	6.25
Frame structure of building	47	48.9
total	96	100

4.3.2 Categories In Which Offsite Method Of Construction Is Mostly Used

Item	**Frequency**	**Percentage**
Residential	4	4.1
Commercial	13	1305
Industrial	48	50
Heavy construction	31	32.2
total	96	100

4.3.3Waste Produced On Convention Sites

85.4 per cent of the contractors and real estate developers were of the view that material waste on conventional sites were high while 14.6 per cent were of the opposing view that material waste on conventional sites was not high.

Table 4.10 Material waste on Conventional sites

Category	**Frequency**	**Percent**
High	82	85.4
Not High	14	14.6
Total	96	100.0

4.3.4 Offsite Construction Reduces Material Waste on Site

78 per cent were of the view that the use of offsite construction methods can help reduce material waste on site, while 21.9 per cent were of the view that the use of offsite construction methods will not reduce material waste on site.

Table 4.11 Offsite construction methods reduce waste on site

Category	Frequency	Percent
Yes	74	77.1
No	22	22.9
Total	96	100.0

4.3.5 Cost Of Methods

A whopping 90.6 per cent believe the use prefabricated components to be more expensive as to the use of in-situ/conventional methods. 9.4 per cent believe the in-situ/conventional methods to be more expensive.

Table 4. 12 cost of methods

Category	Frequency	Percent
Prefabricated	87	90.6
in-situ/conventional	9	9.4
Total	96	100.0

4.3.6 Method of Preference

When questioned about the preference 12.5 per cent preferred the use of prefabricated components while 87.5 per cent preferred the in-situ/conventional methods.

Table 4.13 choice between prefabricated components and in-situ/ conventional methods of construction

Category	Frequency	Percent
Prefabricated	12	12.5
in-situ/conventional	84	87.5
Total	96	100.0

4.3.7Motivatorsto Use Off-Site Construction Techniques

Table 4.14 Motivation for offsite construction methods use

Category	Frequency	Percent
Noise limitation	23	24.0
Waste reduction	61	63.5
Work time and other restrictions	12	12.5
Total	96	100.0

4.3.8 Waste Generated On Site

72.9 per cent believed the use of offsite construction methods helped reduce the volume of waste generated on site while 27.1 per cent believed the use of offsite construction methods does not reduce the volume of waste generated on site.

Table 4. 15 whether offsite construction methods reduce waste

Category	Frequency	Percent
Yes	70	72.9
No	26	27.1
Total	96	100.0

4.3.9 How does the use of offsite construction affect cost?

All contractors and real estate developers interviewed believed the cost would be reduced if offsite method of construction is used.

4.3.10 cost reduction

46.9 per cent shared the view that the use of offsite construction methods reduced cost between 11-15% while 53.1 per cent believed the use of offsite construction methods reduced cost between 21-25%.

Table 4.16 Cost reduction form Use of offsite construction methods

Category	Frequency	Percent
11-15%	45	46.9
21-25%	51	53.1
Total	96	100.0

4.3.11 Increase of Profit Margin

85.4 per cent were of the view that the method can increase profit margins while 14.6 per cent were of the impression it would not.

Table 4.17 Increase profit margin

Category	Frequency	Percent
Yes	82	85.4
No	14	14.6
Total	96	100.0

4.3.12 Reasons for usage of offsite construction method

Table 4.18 reasons why companies use offsite construction methods

Reasons	1	2	3
To make up for professionals	4	x	3
To make up for the weather	10	4	9
To cut design time	2	x	5
To cut building time	30	12	2
To surge product value	7	13	12
To cut cost	11	10	11
To increase work output	5	14	12

To make up for small working areas	10	31	14
To decrease waste on site	4	12	24
To increase safety on site	1	x	3
To increase revenue margin	12	x	1
To for reputation	x	x	x

Table 4. 18.1 3 main reasons why companies use offsite construction methods

Category	percentage	Rank
To cut building time	32	1st
To make up for small working areas To	33	2nd
decrease waste on site	25	3rd

4.3.13 Reasons restraining the usage of offsite construction method

.Table 4.19 reasons that restrain your company from using offsite construction methods

Reasons	1	2	3
A. the office does not recommended offsite methods of construction	11	14	2
B. designers don't recommend it	31	12	16
C. building regulations prevent or limit the use	x	x	x
D. Monetary establishments limit the use o the technique	x	x	x
E. inexperience workers	8	9	13
F. is it expensive to implement	13	7	5

G. Transportation limitations	12	33	17
H. external factors limit the use of the technique.	x	x	x
I. few design options	14	15	14
J. rigid nature of the components unable to make changes easily	7	6	29

Table 4. 19.1 3 top reasons that limit the use of offsite methods of construction

category	Average	Rank
designers don't recommend it Transportation limitations rigid nature of the components unable to make changes easily.	33 34 30	1st 2nd 3rd

4.3.14Materials used in place of the traditional ones

Of the quality of material used 55.2 per cent viewed the materials as being fragile, while 32.3 per cent viewed the material as being sustainable and 12.5 per cent viewed the material as being adequate.

Table 4.20 description of materials used in place of traditional materials.

Category	Frequency	Percent
Fragile	12	12.5
Sustainable	53	55.2
Adequate	31	32.3
Total	96	100.0

4.3.15 Future Usage of Offsite Methods Of Construction?

In 5-10 years 9.4 per cent believe it will be between 0-15%, while 35.4 per cent perceive its use to be 16-30% and a further 55.2 per cent view its use to increase to 31-45 per cent.

Table 4.21 Future Usage

Category	Frequency	Percent
0-15%	9	9.4
16-30%	34	35.4
31-45%	53	55.2
Total	96	100.0

4.4 Analysis

Study results uncovered that house manufacturers are generously more fulfilled by the use of conventional development strategies than of offsite systems for development. These figures outline the idleness inside of significant house manufacturers against the uptake of offsite techniques for development. Additionally, house manufacturers give off an impression of being a great deal less fulfilled by current offsite techniques for development execution in their own industry than different areas. Some may contend that house manufacturers are difficult to it

would be ideal if you yet this finding does not inexorably recommend house developers don't trust that there are extensive potential advantages from utilizing offsite strategies for development. Rather, the present low level of fulfillment with offsite strategies for development application may be to a great extent owing to the low level of utilization of such advances (Pan et al., 2006) with manufacturers, as anyone might expect, being strong of their favored work systems Furthermore, on the grounds that the majority of the respondents had really made next to no utilization of offsite procedures themselves, their answers may be one-sided by outer impacts and viewpoints. About 73% of house builders who were surveyed established that they had an idea of what offsite construction methods was. Amongst them 70% had used it in civic buildings, 56% for residential buildings, 89% for parking and storage and 45% transport buildings in their various practices. This shows that the people in the survey have vast knowledge of the offsite construction methods. When asked about their preferences 47.8% did not prefer the use of offsite whilst 52.2% preferred the use of the offsite methods of construction. Amongst the 115 respondents 60% of them said offsite construction techniques improves quality of work, 69% say it produces cleaner work, 4% say it increases profits,13% of the respondents say it improves safety, 31% are of the view it improves project schedule and 39% say it helps reduces the amount of waste on site. Even though majority of the surveyed people that constitutes 60%, they had high praise for the offsite construction methods but when it come recommendation to clients the 39.1% recommend whilst a majority of 60.9 do not recommend.

The motivation behind enhancing the employments of the offsite routines for generation there was the need to distinguish the main three (3) purposes behind utilizing or not utilizing offsite development systems by An/Es and GCs' reactions.

The main three (3) inspirations for draftsmen/architects to utilize offsite development strategies in rank request were

1) To diminish the development span,

2) To make up for climate condition and

3) To diminish material waste produced nearby. What's more,

The main three (3) challenges in rank request were

1) Inability to roll out improvements in the field by utilizing off-site development methods.

2) Transportation limitations and
3) Limited configuration choices in utilizing off-site development strategies.

The main three (3) inspirations for general temporary workers to utilize offsite development strategies in rank request were

1) to lessen the development length of time,

2) To make up for the limited working space nearby and

3) To lessen material waste created nearby

The main three difficulties for general temporary workers in rank request were

1) Architect/specialist did not indicate utilization of offsite development systems

2) Transportation limitations

3) Inability to roll out improvements in the field by utilizing off-site development methods.

This may likewise bolster the perspective that development organizations are normally hazard loath and do exclude numerous trailblazers or early-adopters (Moore et al., 2002), liking to permit others to take the danger of growing new items before they embrace them for themselves. Other than house developers, the end business sector has indicated little enthusiasm for how lodging is fabricated. Examination found that area and cost are the two principle determinants of which house to purchase. Size and appearance are imperative, yet outline based issues, for example, format, and mechanical contemplations, for example, upkeep, development, protection, and so forth are of more minimal significance (Edge et al., 2002). Inside of the connection of the current basic deficiency of lodging supply, it can be contended that the estimation of states of mind ought to concentrate on the huge house developers who represent most by far of lodging consummations and subsequently are determinant in expanding the take-up of offsite advances. Concerning pattern in the take-up of offsite routines for development, this paper has demonstrated that about 66% of the house manufacturers trust that the business needs to expand the take-up of such innovations, which mirrors the discoveries of some late studies. (Hooper and Nicol 2000) additionally distinguished that numerous expansive house manufacturers trusted that critical mechanical change would affect upon the business later on. (Goodier and Gibb 2004) found that about 75% of the suppliers overviewed imagined that the take-up of offsite strategies by industry was expanding in their part. (Repel et al. 2003) anticipated a development in the offsite creation business sector of 9.7% for every annum (by worth) up to 2010. In spite of some irregularity in the genuine figures, every one of these sources demonstrate a promising prospect of utilizing offsite systems for development as a part of the house building segment.

The discoveries of this study have accentuated the significance of connecting with all the business players in conveying lodging supply in both amount and quality. This paper has given

to the development group a system of techniques for empowering the take-up of offsite advances in the lodging segment. Every one of the systems are interrelated and require duties from government and the business however changing people groups' discernments is major. The contractual workers talked about different reasons including the subcontractors would not have liked to utilize offsite development procedures, the long lead-time (materials acquisition time) and planners were battle with offsite development strategies, temporary workers would not have liked to change the methods and routines. Be that as it may, on a shared view they all both the general contractual workers and draftsmen concurred that

• Quality:

Client's gathering trusted that the utilization of offsite development procedure enhanced item quality.

• Design Options

The Non-clients reacted that the utilization of these procedures constrains the outline choices.

• Management Efficiency

Client's gathering concurred that the utilization of offsite development procedure enhance nearby administration productivity.

• Overall Project Cost

Client's gathering differ that offsite development procedure build general venture cost.

In rundown, there was a larger amount of uplifting state of mind toward utilizing offsite development strategies. So when solicited what they see the future from offsite development methods in the following 5-10 years? 56.5% of the respondents trusted that utilizing offsite

development procedures would increment by 16-30% and 43.5% the expand would be by 3145%. While, 9.4%% of general contractual workers trusted that utilization of offsite development methods would increment by 0-15%. 35.4 thought it would increment by 1630% and 55.2% said it would increment by 31-45%. Had the discernment that it would reduce.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter talks about the conclusion and recommendation of the study. The recommendations made to address the principle discoveries acquired from the data analysis.

The purposes of the study was to help simplify the Ghanaian construction industry's' perception on offsite construction methods and establish how it would help improve real estate development. The objectives were to find the extent of application of the offsite methods of construction in the real estate development industry in Ghana. To identify the factors that limit the use of offsite construction methods by Real Estate Developers in Ghana and to identify measures to address the factors that prevents the offsite method of construction usage in the real estate industry. The section ends with suggestions for further research.

5.2 Conclusions 5.2.1 Extent of application of the offsite methods of construction in the real estate

development

The study recognized that there is generally a low acquaintance of the concept of off-site methods of construction among stake holders of the Ghanaian construction industry, especially

real estate developers though there is the knowledge of the need to improve quality and increase efficiency and productivity in the project delivery process. Only a few of the stake holders contacted had been involved in the application of off-site production. Construction professional seldom recommend its use. Most Ghanaian contractors are a bit conventional and as such would like to stick to the traditional construction method for now.

Suppliers and manufacturers of prefabricated building components are also not doing so well except in the use of prefabricated composite floor slabs, kerbs, pavement slabs and of late ornamental columns

5.2.2Perceived benefits and factors that limit the usage of the technique

The conclusions in this study showed that both the planners and general contractors (site engineers, quantity surveyors, and structural engineers) saw that the utilization of offsite development procedures gave additional advantages;

- Reducing the general venture plan,
- Increasing item quality,
- Increasing general work profitability,
- Increasing nearby security execution,
- Reducing interruption of other contiguous operations, and
- Reducing negative ecological effect of development operations.

The study likewise showed both the designers and general contractors apparent two hindrances to the utilization of offsite development strategies:

- Transportation limitations and
- The ability to alter design during construction periods

Both gatherings differ that by utilizing offsite methods of construction for development, the general undertaking expense would be increased. The research demonstrated that the planners

and general contractors impression of utilizing offsite development methods were measurably distinctive ;

1) General contractors concurred that the use of offsite methods of construction:

   Would lessen the requirement for professionals at the construction site,

   Would prevent design choices,

   Would cause the need for more managerial works on site
   Would decrease cost of construction.

2) Architects differed and stated that;

- Owners' negative impression of offsite development systems point of confinement determining these strategies in their undertakings

- Utilizing offsite development methods would expand cost

The discovering additionally showed that the planners and general temporary workers who had used offsite development systems before saw diversely of utilizing these strategies with the engineers and general contractual workers who have never utilized these methods as a part of the terms of the effect of value, configuration choices, jobsite administration effectiveness, general undertaking expense and proprietor's negative discernment on the utilization of offsite development procedures.

5.2.3 Waste control

It was identified by all the architects and general contractors who had used the both offsite method of construction and the traditional method of construction that it generates far less material waste than the traditional method of construction. The average wastage level of the traditional construction method was found to be greater than that of off-site production. Analysis was done for the wastage reduction in seven trades including; concrete,

reinforcement, plastering, floor screed, formwork, masonry and tiling. It was obvious that the reduction in material wastage alone based on the seven building trades discussed can reduce the cost of the building considerably. Off-site production will only bring about cost saving when there is full mechanisation of the construction process in Ghana by turning construction into an assembling industry rather than following the conventional construction method of waste on site.

5.2.4 The reasons and limitations to the application of offsite methods of construction

Through the survey the researcher was able to table the top three reasons that incite building practitioners' to use offsite methods of construction.

1. Reduce the time taken to put up structures
2. Reduce the cost of the total construction
3. The schedule of the project would be reduced.

The main three (3) reasons that sway building practitioners in utilize offsite development strategies in rank request were to

1. Reduce the general work calendar,
2. Reduce development length of time,
3. Reduce general task cost and adjust for the climate conditions.

This study recognized the main three (3) challenges that control building practitioners from utilizing offsite development methods as a part of rank request were:

1. Inability to roll out improvements in the field;
2. Transportation restrictions,
3. limited outline choices

The main three (3) challenges that limit building practitioners from utilizing offsite development strategies as a part of rank request were

1. Transportation restrictions;
2. Limited outline alternatives of utilizing off-site development systems and
3. Inability to roll out improvements in the field.

Over all there were four key factors identified from both the questionnaires and the interviews and research done that were constraints follows;

- Industry and business sector society: hesitance to change by key partners.
- Skills and information: instruction and preparing being to a great extent concentrated on current conventional practices, as opposed to creative thoughts without bounds and resultant poor dissemination of the rising aptitudes and learning of the innovation in the business.
- site jobs: the lawful limitations on transportation of huge components requires costly escorts.
- Cost/ effectiveness: high transportation and taking care of expenses, particularly where there is a requirement for long separation haulage and the utilization of substantial cranes for tall structure development.

In synopsis, this study found that offsite methods of construction have not been broadly used in the Ghanaian building industry, particularly for the cross breed and measured building frameworks.

A few advantages of utilizing offsite development were recognized by building practitioners, including diminishing development length of time, enhancing item quality, enhancing general work profitability, enhancing nearby security execution, enhancing jobsite administration

effectiveness, and decreasing nearby disturbance and the negative natural effect. The critical difficulties of utilizing offsite development procedures were observed to be transportation restrictions, powerlessness to roll out improvements on location and constrained outline choices.

5.3 Recommendations

The key commitment of this study to existing load of information incorporate the ID of components that breaking point the utilization of this system for development and discover answers for the variables that utmost the utilization of these development strategies.

From the above conclusions, the study prescribes the accompanying methodologies if received, may not just expand the attention to the utilization of offsite systems for development, however in the long run will enhance the development business.

a) Building practitioners firms ought to put more in innovative work in territory of redid outline and option materials. Discoveries from this study demonstrated that constrained configuration choices were a standout amongst the most critical hindrances to expand the utilization of offsite development systems. Subsequently, it would be extremely useful to give redid plan choices to connect with clients' inclinations by utilizing 3D and 4D CAD and Building Information Modeling (BIM) frameworks. Same illustrations of configuration programming bundles incorporate Autodesk's Revit, Autodesk and Autodesk 3D max. Each modified configuration ought to incorporate an assortment of decisions of materials, fittings and decorations. Moreover, makes, material suppliers and general temporary workers ought to cooperate to enhance the productivity of material conveyance frameworks to fulfill all outline alternatives. Moreover, material makers and suppliers, proficient associations and exploration

organizations ought to likewise put resources into creating elective development materials to conquer the transportation restrictions on the utilization of offsite development methods.

b) One of the purposes for customers and originators hesitance to utilize offsite development routines is the nonappearance of learning of the degree of quality expansion that could be accomplish by the utilization of the innovation contrasted with the attempted and tried customary arrangement of building. Relative quality investigation between both frameworks has be done to particularly on expense for the customers thought.

c) Owners, fashioners and general contractual workers ought to team up with one another on pre-undertaking arranging contrasted with customary development, a standout amongst the most critical hindrances of the utilizing offsite development procedures is the failure to roll out improvements on location, which was likewise been distinguished as one of the main three restrictions by both designers and general temporary workers in this study. To defeat this test, the scientist prescribes that the makers, modelers/architects and general temporary workers ought to team up on enhancing item quality, on location workmanship, and draw in with the proprietor in pre-task arranging amid the calculated configuration stage to minimize the likelihood of on location changes. The Construction Industry Institute has numerous productions on the best way to lead viable pre-undertaking arranging.

d) Develop and give mindfulness preparing to producers, general contractual workers and architects in the utilization of offsite development methods. The discoveries from this

study show that absence of information of offsite development systems is a noteworthy boundary. Hence, the development and configuration order ought to work with full grown produces and suppliers to create proceeding with training course to expand the consciousness of draftsmen and general contractual worker's information of the utilization of offsite development procedures.

5.3.1Recommendations for future study

Real estate developers, architects and building construction firms should invest more in research and development in area of customized design and alternative materials. This demonstrates a need to painstakingly investigate the parts of the way of life of the business and the business sector in Ghana which are obliging the development business to receive this imaginative innovation and to address the difficulties and dangers connected with offsite development strategies and the comparing relief measures will give the chance to uncover and tended to the issues and guarantee more prominent uptake of the innovation in Ghana. Further top to bottom exploration into the other recognized obstructions with noteworthy levels of effect is additionally required.

This study concentrated on offsite development routines in connection to structures. There is a need to analyze in subtle element the suitability of offsite development strategies for different structural designing ventures including completing budgetary examination, hazard estimation and maintainability valuation.

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APPENDIX

APPENDIX ONEQUESTIONNAIRE FOR ARCHITECTS

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF ARCHITECTURE AND PLANNING
FACULTY OF ARCHITECTURE AND BUILDING TECHNOLOGY
DEPARTMENT OF BUILDING TECHNOLOGY

Research topic:

OFFSITE BUILDING METHODS – THE BUILDING PRACTIONERS PERSPECTIVE IN REAL ESTATE DEVELOPMENT.

INTRODUCTION

Although the use of offsite methods of construction provides several significant advantages and is a possible solution for addressing time, quality and cost concerns often associated with 'traditional' construction the use of these methods are low in the Ghanaian building industry.

The objectives are to investigate the current degree of utilization of the offsite methods of construction, find the factors that limit the use of this method of construction and find solutions to the factors that limit the use of these construction techniques.

The findings and recommendations of the study would lead to initiatives aiming at solving the problems relating to housing cost in Ghana

This study is conducted as part of a graduate study at KNUST. It is my belief that the stakeholders will provide practical and convincing answers to the questions below to enable me present a good report on strategies that will be appropriate to help improve the Ghanaian construction industry. Thank you in advance for your contribution to this research study. Please respond to the following by either writing in the blank space provided or ticking the appropriate box.

Name of company …….

Job title …….

Work Experience …….

1. How will you rate your knowledge in off-site construction techniques (OCT). Very High [ ], High [ ], Average [ ], Below Average [ ]

2. Why do you think off site construction techniques are important

- improves quality of work
- cleaner work
- increased profits
- improves safety
- improves project schedule
- waste reduction

3. How often do you recommend the use off-site construction techniques in your consultancy to Real Estate Developers?

Very often [ ], often [ ], Average [ ], not often [ ]

4. Does off site construction produce less material waste than when traditional methods are used?

- Off-site construction produces less material waste.
- Traditional construction produces less material waste.

Explain

…….....

……...

…….....

5. On the basis of a financial analysis, which one is more expensive;

prefabricated components ( ) or in-situ / conventional means of construction. ( )

6. Which will you go in for?

Prefabricated Components [ ] Conventional [ ]

7. What kind of project or building sectors would be more appropriate for offsite construction byyour understanding?

- Civic buildings
- residential buildings
- Parking and storage
- Transport buildings

8. What percent of offsite construction is being recommended or specified by your firm?

0 - 15% ( ) 15 – 30 % ( ) 30-45% ( ) 45-60% ( ) 60-75% ( )

9. Do you agree that the material wastes on conventional sites are high?

- Material wastes on conventional sites are high
- Material wastes on conventional sites are not high

Explain

……

……

……

10. Do you agree that offsite construction can help reduce the material waste on site?

A. Yes. State Why? (Please be as specific as possible)

B. No. State Why? (Please be as specific as possible)

……

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……

11. Please tick the top 3 reasons why your company uses off-site constructiontechniques.

1- Very important: 2- Moderately Important, 3 –low important,

Reasons	1	2	3
To compensate for the shortage of skilled craft workers			
To compensate for weather condition			
To reduce design duration			
To reduce construction duration			
To increase product quality			
To reduce overall project cost			
To increase overall labour productivity			
To compensate for the restricted working space onsite			
To reduce material waste generated on site			
To improve project safety performance			
To increase your company's profit margin			
To enhance your company's reputation			

12. Please tick the top 3 reasons that restrain your company from using Off-Site construction techniques.

1- Very important: 2- Moderately Important, 3 –low important,

Reasons	1	2	3
A. Owner company restricts using off-site construction techniques.			
B. Architect do not specify the use of off-site construction techniques.			
C. Local building regulations restrict the use of off-site construction techniques.			
D. Financial institutions restrict the use of off-site construction techniques.			
E. Lack of skilled assembly craft workers onsite.			
F. Using off-site construction techniques will increase the construction cost.			

G. Transportation restraints			
H. Collective bargaining agreement prohibited the use of off-site construction techniques.			
I. Limited design options in using off-site construction techniques.			
J. Inability to make changes in the field by using off-site construction techniques.			

13. How would you describe materials used in place of the traditional materials used in offsite construction?

- Fragile
- Sustainable
- Robust
- adequate

14. Where do you anticipate the use of off-site construction techniques will increase in the Next 5-10 years?

- 0% - 15% usage
- 16%- 30% usage
- 31% - 50% usage
- 51% - 75% usage
- 75%- 100% usage

APPENDIX TWOQUESTIONNAIRE FOR CONTRACTORS AND REAL ESTATE DEVELOPERS

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF ARCHITECTURE AND PLANNING
FACULTY OF ARCHITECTURE AND BUILDING TECHNOLOGY
DEPARTMENT OF BUILDING TECHNOLOGY

Research topic:

OFFSITE BUILDING METHODS – THE BUILDING PRACTIONERS PERSPECTIVE IN REAL ESTATE DEVELOPMENT.

INTRODUCTION

Although the use of offsite methods of construction provides several significant advantages and is a possible solution for addressing time, quality and cost concerns often associated with 'traditional' construction the use of these methods are low in the Ghanaian building industry.

The objectives are to investigate the current degree of utilization of the offsite methods of construction, find the factors that limit the use of this method of construction and find solutions to the factors that limit the use of these construction techniques.

The findings and recommendations of the study would lead to initiatives aiming at solving the problems relating to housing cost in Ghana

This study is conducted as part of a graduate study at KNUST. It is my belief that the stakeholders will provide practical and convincing answers to the questions below to enable me present a good report on strategies that will be appropriate to help improve the Ghanaian construction industry. Thank you in advance for your contribution to this research study.

Please respond to the following by either writing in the blank space provided or ticking the appropriate box.

Questionnaire for Contractors and Real Estate Developers.

Name of company …….

Job title …….

Work Experience …….

1. As a Real estate developer or building contractor, tick some building components that lend themselves easily to prefabrication.

   - wall panels
   - roof panels
   - floor panels
   - plumbing and service walls
   - frame structure of the building.

2. Have you utilized the off-site construction techniques in your previous project recently? In which of the following construction categories:

   - Residential
   - Commercial
   - Industrial
   - Heavy construction

3. Do you agree that the material wastes on conventional sites are high?

   - Material wastes on conventional sites are high
   - Material wastes on conventional sites are not high

Explain

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4. Do you agree that offsite construction can help reduce the material waste on site?

A. Yes. State Why? (Please be as specific as possible)

B. No. State Why? (Please be as specific as possible)
…….....

…….....

5. On the basis of a cost analysis, which one is more expensive;

- prefabricated components
- or in-situ / conventional means of construction.

6. Which of these do you prefer?

Prefabricated Components [ ] Conventional [ ]

7. What are the motivations to use off-site construction techniques in your project? a) Noise limitation

b) Waste reduction
c) Short 'weather window'
d) Work time and other restrictions in sensitive sites
e) Lack of work space around the building for site storage

8. Did the use of off-site construction techniques reduce the amount of waste generated on site?

A. Yes. State Why? (Please be as specific as possible)

B. No. State Why? (Please be as specific as possible)

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9. Did the waste reduction by the off-site construction techniques (OCT) help reduce the total cost of the project?

Yes ( ) No ( )

10. How significant was the cost reduction

0 - 5% ( ) 5 – 10 % ( ) 10-15% ( ) 15-20% ( ) 20-25% ( )

11. Is there the possibility that using offsite construction methods could increase the general contractor's profit margin?

Yes ( ) No ( )

12. Please tick the top 3 reasons why your company uses off-site construction techniques. 1- Very important: 2- Moderately Important, 3 –low important,

Reasons	1	2	3
To compensate for the shortage of skilled craft workers			
To compensate for weather condition			
To reduce design duration			
To reduce construction duration			
To increase product quality			
To reduce overall project cost			
To increase overall labour productivity			
To compensate for the restricted working space onsite			
To reduce material waste generated on site			
To improve project safety performance			
To increase your company's profit margin			
To enhance your company's reputation			

13. Please tick the top 3 reasons that restrain your company from using Off-Site construction techniques.

1- Very important: 2- Moderately Important, 3 –low important,

Reasons	1	2	3
A. Owner company restricts using off-site construction techniques.			
B. Architect/Engineers did not specify the use of off-site construction techniques.			
C. Local building regulations restrict the use of off-site construction techniques.			

D. Financial institutions restrict the use of off-site construction techniques.			
E. Lack of skilled assembly craft workers onsite.			
F. Using off-site construction techniques will increase the construction			
cost.			
G. Transportation restraints			
H. Collective bargaining agreement prohibited the use of off-site construction techniques.			
I. Limited design options in using off-site construction techniques.			
J. Inability to make changes in the field by using off-site construction techniques.			

13. How would you describe materials used in place of the traditional materials used in offsite construction?

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- 0% - 15% usage
- 16%- 30% usage
- 31% - 50% usage
- 51% - 75% usage
- 75%- 100% usage