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Adoption of Prefabrication for Construction Projects in Tamale

by

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MASTER OF SCIENCE

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DECLARATION

I hereby declare that this submission is my own work towards the award of 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 other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

The primary success parameters of every project are time, cost and quality. The need to control large quantities of waste is also an issue of great concern in the construction industry. The adoption of new technological advancement in the construction sector is seen as the way forward to achieving project success. Prefabrication has been adopted for construction project by many countries across the world. The aim of this study was to investigate the factors militating against the adoption of prefabrication for construction projects in Tamale. This was achieved by meeting the following objectives: To investigate the benefits in adopting prefabrication; To investigate the difficulties in the adoption of prefabrication; To investigate the measures in adopting prefabrication; and To examine the extent of usage of prefabrication. The research made use of literature review of existing work. One hundred and twenty (120) questionnaires were administered to respondents and desk study of selected stakeholders in the construction industry. The statistical tools used in the analysis comprised descriptive statistics and mean score ranking. Findings of the study indicated that project cost, quality, time are among some of the key benefits. Some of the hindrances identified were lack of direct financial grants, lack of practical technical training, inadequate suppliers of prefabrication, no policy to promote prefabrication and finally, the factors identified to promote future development of prefabrication were provision of direct financial grant, advancement of prefabrication skills in workers, incentive schemes to inspire the private sector and sustainability as a first priority. The results also indicated that, inspite of the difficulties in the adoption of prefabrication, stakeholders in the Ghanaian construction industry believe in the need to explore its use. The adoption of prefabrication will contribute to reducing the huge housing deficit and facilitate the industrilisation of the construction industry. Prefabrication has the capacity to offer alternative choice of solutions and to further improve quality and value for money for construction projects. The findings will contribute to the adoption of prefabrication for construction projects and has provided a broad view of the essence for the use of prefabrication in construction.

Key Words: prefabrication, modularization, project, success, industrialisation

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LIST OF ACRONYMS

BIM - Building Information Model

PMBOK - Project Management Book of Knowledge

CBO - Community Based Organization

KNUST - Kwame Nkrumah University of Science and Technology

GSS - Ghana Statistical Service

NGO - Non Governmental Organization

UK - United Kingdom

US - United States

GDP - Gross Domestic Product

IJETR - International Journal of Engineering and Technical Research

3D - Tri Dimensional

SD - Sustainable Development

IJAAS - International Journal of Advances in Applied Sciences

GFA - Gross Floor Area

IPCA - Irish Precast Concrete Association

CHPS - Community-based Health Planning and Services

UNEP - United Nations Environment Programme

USGBC - United States Green Building Council.

CIRC - Construction Industry Review Committee

MARA - Majlis Amanah Rakyat construction (Malaysia)

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I am also indebted to all my friends and loved ones and all those who helped, supported me and offered encouragement in the course of my studies.

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DEDICATION

I dedicate this work to the Almighty God, to my wife Ruikia Tido, to our children Michelle Yinmalya and Petra Piegyin, my Siblings and Parents (Mr and Mrs John Kutuba).

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Prefabrication may be defined here as the production of entire building, or substantial building constituents offsite, in a factory location prior to fitting or assembly onsite. This is an encouraging invention with a clear association to more environmentally friendly building practices (Hampson & Brandon, 2004). Prefabricated components are considered to be a feasible method of construction, and the use of precast concrete has been gaining popularity as an alternative construction method as opposed to the more common in-situ construction method (Irish Precast Concrete Association (IPCA, 2007). This study assessed how to promote the use of prefabricated components in the management of construction projects in Tamale.

There are two ways by which construction works are erected; these are in-situ and prefabrication. The former is the most common construction method used while the latter is rarely used in Ghana, even though this method is more efficient in terms of working within cost targets, meeting project time deadlines and achieving high quality works due to factory control processes. The decision between construction methods is usually based on project time, cost, quality, safety, environmental performance, socio-economic aspects (labour) and client satisfaction (Lombard, 2011). Lombard (2011), further explained that project time and cost are however, the most important of these factors.

The use of prefabricated components for construction works offers a virtually infinite diversity of products and strategic possibilities due to the convenience that workers have when making prefabricated elements which is mostly done at ground levels.

Prefabrication is one of the most versatile and sustainable building materials available for today's profligate paced, ecologically mindful building (The Association, 1996).

Prefabricated components can be used for both load and non-load bearing units. In recent years, especially in the UK, US, Finland, Netherland and many other countries, there has been sufficient experience on the use of prefabricated components for a number of design guide for major and mass construction works for both private and public construction works (Poon et al, 2009).

According to Kamar et al (2009a), the Malaysian government showed deliberate efforts to ensure that prefabricated components were widely used among all professionals involved in the built environment. They indicated in their report that the process spanned from 2003 -2010, this effort was given a strong cabinet backing by an endorsed blueprint document to use prefabrication method of construction for the industrialisation of the Malaysian construction sector. Currently, there is no deliberate policy in Ghana to promote the adoption of prefabrication for construction projects. This research also makes recommendations for the adoption of prefabrication method for the management of construction works as a tool to ensure project success and to industrialise the nation.

1.2 STATEMENT OF THE PROBLEM

The use of prefabricated components in the management of construction works in most parts of the country is rare, especially in the three northern regions of Ghana. Meanwhile, the use of prefabricated components, highly contribute to the industrialisation of the construction industry (Poon et al, 2010).

According to the Ghana Statistical Service, there is a huge growing housing deficit in Ghana which is becoming a canker and as a result has serious effect on the economic

growth, modernization and industrialisation of the construction industry in Ghana. The huge deficits affects the education sector, residential accommodation, health infrastructure, roads, and other social amenities (GSS Housing census, 2010). This can be solved by the advantage of prefabrication over in-situ in terms of time, quality, cost, safety, environmental performance and sustainability, socio-economic aspects (labour) and client satisfaction (Lombard, 2011).

It is an undisputable fact that, the people concerned with construction activities (clients, consultants, and contractors) do not highly patronise prefabrication methods of construction leaving the construction industry to continue to heavily rely on in-situ construction which does not encourage diversity in the method of construction (Feld and Carper, 1997).

There are a lot of uncompleted projects doted across the length and breadth of the country (Nicco-Annan, 2006). Also, most projects are far behind their completion schedule time, because a lot of time is spent on erecting formwork, mixing and casting concrete, waiting for the concrete to cure, striking of the formwork, and other activities which could have been avoided on site as it is in the case of prefabrication which just require assembling the components in to position. This could take just one third (1/3) of the time required (Seeley, 1993).

The quality of work on some construction sites, especially the public sector are sometimes low due to the fact that batching, mixing, testing of concrete and other activities are not accurately controlled, in the case of in-situ as compared to precast. Prefabricated components are manufactured under factory controlled conditions where almost every activity is highly mechanised, to ensure that the components manufactured

are of more quality in terms of the surface texture and incorporating services accurately. (Seeley, 1993).

The adoption of prefabrication will contribute to decreasing the enormous housing deficit and expedite the industrilisation of the construction industry. Prefabrication has the capacity to offer alternative choice of solutions and to further advance quality and value for money for construction projects.

1.3 RESEARCH QUESTIONS

The study sought to answer the following questions on how to promote the adoption of prefabrication method of construction in Tamale;

1. What are the benefits of adopting prefabrication?
2. What are the difficulties in the adoption of prefabrication?
3. What are the measures in adopting prefabrication?
4. What is the extent of usage of prefabrication?

1.4 AIMS AND OBJECTIVES

This dissertation aimed to investigate the factors militating against the adoption of prefabrication in Tamale.

This aims was achieved by meeting the following objectives:

1. To investigate the benefits in adopting prefabrication;
2. To investigate the difficulties in the adoption of prefabrication;
3. To investigate the measures in adopting prefabrication; and
4. To examine the extent of usage of prefabrication.

1.5 SCOPE

The study of the adoption of prefabrication for construction projects, has a lot of benefits. Any construction project has some basic parameters to meet, notably among them are time, cost, quality, safety, socio-economic aspects (labour), environmental performance and client satisfaction. The scope of study was be limited to time, cost and quality only, in the management of construction works.

The area of study for the purposes of this report was limited to Ghana and for that matter Tamale Metropolitan Assembly. This research also placed much prominence on how to improve and promote the adoption and utilization of the usage of prefabricated method of construction in Ghana. The survey of professionals and recommendations as contained in this dissertation were limited to the study area, but the principle of the study may be replicated elsewhere. This would cover modules such as columns, beams, kerbs, floors slabs, walls, staircase, girders and other elements of prefabrication.

1.6 RESEARCH JUSTIFICATION/RELEVANCE

This study is essential in the sense that, it would not only contribute to knowledge and theory, but would also bring to bear the promotion of the use of prefabrication for construction works in Tamale and how prefabricated component impact on time, cost and quality of projects, so that the appropriate government agencies and the general public would be familiar with the situation and hence can adopt the use of prefabrication method of construction.

The study will also help the Metropolitan Assembly and government to have in-depth knowledge about prefabricated method of construction and hence, how to effectively motivate stakeholders to adopt prefabrication method of construction, make policies to promote the adoption of prefabrication, how to improve on the general adoption of

prefabricated method of construction, implement by-laws to deliberately facilitate the usage of prefabrication and promote its use in Ghana.

The study will be relevant to Non-governmental Organizations (NGOs) and Community Based Organizations (CBOs), government and the private sector and other players in the construction industry to adopt prefabrication to help industrialise the construction industry in Ghana

1.7 RESEARCH METHODOLOGY

To be able to get appropriate answers to the research objectives mentioned above, the research was conducted using the following methodology;

- A review of existing literature on the promotion and usage of prefabrication was conducted through books, academic journals etc, in addition, desk study of some selected projects were used to gather data.
- Questionnaire surveys were also used to collect data from professional and stakeholders who are in the construction industry.
- Through descriptive statistics and mean score ranking data collected was appraised to determine the criteria for project success in the study area. Inferences and commendations were advanced through the study results.

1.8 ORGANIZATION OF REPORT

The study was structured into five main chapters. Chapter one covers the whole of the research introduction which entails the background of the study, problem statement, research questions, aims and objectives, the scope and relevance of the study among others. The second chapter captures the main literature on previous work done around the subject area. Chapter three takes care of methodology for the study. The forth

chapter comprises data presentation and analysis. Chapter five captures findings, summary of findings, conclusions from the study and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Prefabrication may be defined here as the production of entire building, or significant building constituents offsite in a workshop background prior to fixing or assembly onsite. This is a favorable invention with a clear correlation to more ecologically pleasant construction practices (Hampson & Brandon, 2004). Prefabrication is a construction method which the industry has adopted for centuries.

The rejuvenation for the use of prefabricated elements to be adopted as a criteria for projects success may be linked to the "new" growth of BIM and green building, dire new developments recognised by McGraw-Hill Construction and other production stakeholders. The introduction of Building Information Modeling (BIM) in the construction industry is impelling design and building execution and how development stakeholders can cooperate with each other for successful projects. In the *Business Value of BIM Smart Market Report* (2009), it was established that a significant advantage of BIM is facilitating the improved use of prefabrication, which in turn enhances the project output and total impact on development return on investment. It was revealed that, 77% of contractors believe that BIM would promote the use of prefabrication on bigger, more multifaceted developments in the very near future if it is carefully adopted to manage construction works.

The emergence and fast growth in the use of green building has also significantly influenced its adoption in the construction industry. The *Green Outlook (2011),* projected that up to 35% of new non-residential building is green, this translated to a

$54 billlion market place prospect that was expected to increase up to $120 billion or above by the year 2015.

The *Green BIM Smart Market Report* (2010), considered at the combination of the BIM and green tendencies and it was revealed that building experts and stakeholder who adopt the use of BIM on green developments are probable to do use model-driven prefabrication for the efficient execution of their projects other than non-green BIM practitioners. Some of the impact of prefabrication on construction projects are the overall improvement on the productivity consisting of task programs, budgets, safety, quality, eliminating waste and making green houses. It was seen that some of the greatest critical productivity discoveries relating to prefabrication and modularisation consisted of the following:

i. 66% responded that development programs are reduced—35% by four weeks or above.
ii. 65% responded that development costs are reduced—41% by 6% or above and
iii. 77% responded that building site waste is reduced—44% by 5% or above.

One of the general description for precast components is given by Menegotto, (2010) as follows; precast concrete consist of a mixture of cement, water, and admixtures that is cast into a specific shape at a location other than in-service position. Prefabrication do not have a single definite definition, but seam that the term adhere to a general theme, namely; components produced in a controlled environment, either on or off-site (Deklert, 2013). *In my opinion, prefabricated components in the construction industry is any building component which is manufactured on site or off-site whichever is more suitable due to factory location and availability of means of transport other than production of the building components in its final position.*

The construction industry in Ghana should adjust for change from the ancient way of construction to a modern way of construction; which is cheaper, has high factory controlled quality and reduction in the overall project cost are some of the benefits that are associated with the use of prefabricated components for mass construction works. Prefabrication is a concept which is not new in the construction industry both internationally and in Ghana. According to Edicott, (2000), in more recent years, precast components (concrete) products and methods have been used internationally in the construction of school due to reduction in time advantage over traditional in-situ methods.

2.1 BRIEF HISTORY OF PREFABRICATION

According McGraw Hill Construction (2011), an initial example of prefabrication use was establish in Britain's great exhibition of 1851, which comprised of the erection of the Crystal Palace. This was designed in not up to two weeks, the construction used light and in expensive resources: iron, wood and glass. However, the building duration spanned for only a little months and this involved erecting the prefabricated modules after the demonstration, the palace was taken apart, piece by piece, and relocated to a new place.

Moreover, beside the Egyptians who used concrete for their construction works, the use of modern concrete (with aggregate) started in 1756 (Bellis, 2011). Concrete is one of the best commonly used construction materials, usually in the form of in-situ. It is also on record that, precast concrete construction was invented in 1905 by John Alexander Brodie (John Alexander Brodie, England City Engineer (1858-1934), 2011) and this technology was replicated in America and Europe and later the rest of the world.

It is opined by Pasquire et al. (2005) that, data of precast concrete projects are generally undocumented and that decisions to use precast concrete elements are not based on well-defined information. There is very little, if any, quantitative comparisons that project teams (client, engineers, and contractor) can apply to consider precast concrete as an option for the construction of buildings.

Even though, there are multiple benefits that prefabricated components has to offer, the adoption and promotion of precast components for construction works and for that matter the Ghanaian construction industry is still slow either in the government or private sectors. Despite the undisputable fact that some countries in the world (mostly in Europe, America and some Asia countries) decades ago, adopted the use of prefabrication for their construction works, there are similar barriers that exist in the countries that there is low patronage especially in Africa.

2.1.1 Modern Beginnings

In US, Modern prefabrication is supposed to have taken place in the beginning of the 1900s. This was used in housing development which started by means of prescheduled techniques grounded on recent bulk fabrication. The McGraw Hill Construction (2011), cited Aladdin and Sears Roebuck Firm who sold prefabricated houses that were transported to customers as mail-order homes.

The use of prefabrication increased in the course of World War II due to the requirement for the provision of bulk accommodation for soldierly workers. They first adopted Quonset sheds as military structures. These all-purpose, lightweight structures were easily transported wherever and their erection did not require any expert labor.

Also, during and after World War II, Japan and Europe all required substantial reconstruction needs and decided to adopt prefabrication and off-site building to plug

the deficit since that was faster and cheaper without compromising on quality. Because of this early adoption and acceptance of prefabrication as the criteria to meet their housing demand, European and Japanese construction firms are still considered some of the greatest advanced in relations of prefabrication construction methods.

In the US, commercial adoption and use of prefabricated buildings like hotels, offices, health facilities and educational facilities began to grow spanning the 1970s, to the 1990s, and into the 2000s, as request for buildings surpassed the supply of current buildings.

2.1.2 Recent Evolution

In recent years, construction modernisation has permitted the prefabrication of building elements to make substantial gains in the industry. In emerging methods and resources to manufacture and bring better refined and multifaceted facility kinds. For instance, the Hilton Palacio del Rio hotel in San Antonio which was constructed by Zachry Construction Company for the Texas World's exposition of 1968, was a 500-room luxurious hotel and was designed, finished and occupied in a record time of 202 working days. The whole building was erected by hoist in 46 days which continue to be in use today, this hotel is the highest prefabricated built structure in the United States. The development is an evidence to the robustness of modular production (McGraw Hill construction, 2011).

Prefabrication is now becoming more extensively accepted as a resource-efficient and greener building system. A clear demonstration of the acceptance is the use of prefabrication to build the Fort Sam Military garrison in San Antonio, Texas. The constructions are on track to meet lead silver endorsement due to decreased material waste and pollution and augmented use of salvaged resources.

2.3 PROJECT SUCCESS AND THE IMPORTANCE OF TIME, COST AND QUALITY

According to the PMBOK Guide, a project is a short-term endeavor to make a new product or service. *It is temporary, it is unique, it has a purpose, it has interrelated activities, it is progressively elaborated,* the CHAOS report outline characteristics of a project as;

1. Successful project are projects that are on time, within budget and with all features as originally specified;
2. Challenged projects are projects- which are completed, implemented, over budget, over time and with fewer features; and
3. Impaired projects are projects that are cancelled at some point during the development cycle.

2.3.1 Triple Constraint-(The iron Triangle)

A project success is measured by all the parameters illustrated in Figure 2.1. Project success has and still is dominated by the conservative methods of time, cost and quality (Toor & Ogunlana, 2010). In project management, time, cost and quality are the predominant parameters in assessing project realisation.

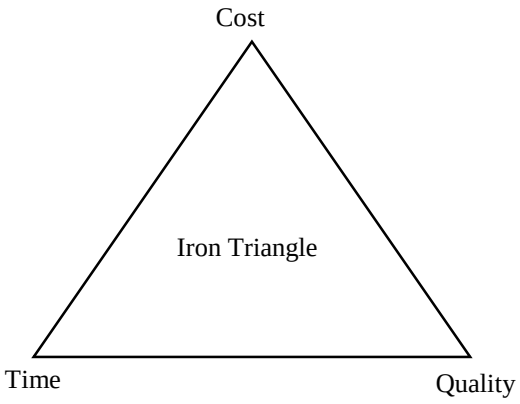

Figure 2.1: The iron triangle

Source: (Ebbesen & Hope, 2013; Lombard, 2011)

Participants in the construction industry (clients, contractors, consultants and project managers) accept the convention that there are many additional parameters as stated in the new iron triangle such as; scope, risk, resources, and customer satisfaction. All this measure project success and remains the basic parameters of project success (Lombard, 2011). But with regards to this studies only cost, time and quality would be considered since it became a more common method for measuring project success. (Ebbesen & Hope, 2013).The iron triangle is also used to explain the dependency between the three parameters (Ebbesen & Hope, 2013). According to the report project cost is most likely to be high when they are executed at a fast pace with high quality. But when constructed with fast pace with little costs incurred, alternatively, it may be difficult to deliver a product of high quality. Finally, projects which are executed using little cost and good quality may result in time consumption. Therefore, stakeholders should endeavor to deliver the "ideal project", not compromising on high-quality project to be delivered on time, quality and within budget.

Ebbesen & Hope (2013) demonstrated the dependency between the iron triangle parameters. They considered the parameters in relation with each other, and how they indirectly impact on one another.

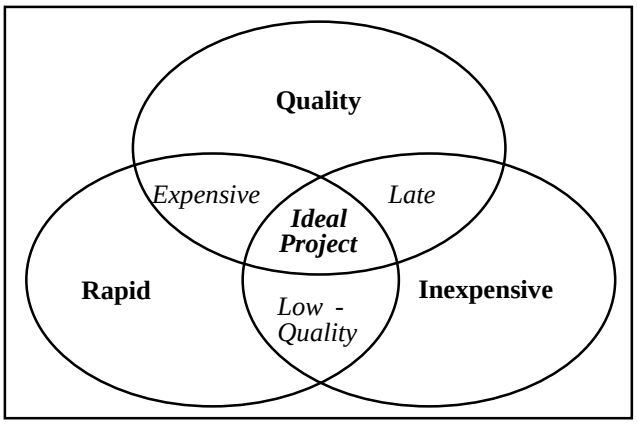

Figure 2.2: Dependence model of the iron triangle

Source: (Ebbesen & Hope, 2013; Lombard, 2011)

2.4 USING PREFABRICATION AS A CRITERIA FOR ACHIEVING PROJECT TIME SUCCESS

According to Driscoll (2013), time is money in the construction industry. He opined that construction time is one of the principal considerations in the construction industry. He further, related construction projects time with costs. He pointed out that effective time management is relevant to eliminate time and cost overruns in any construction project (Driscoll, 2013). Lombard (2011), conducted a study on how design factors influence time and cost for in-situ concrete construction and prefabrication projects. It was identified through interviews conducted with professional consultants in the construction industry that, prefabrication construction was more dependent on standardisation and repetition when compared to conventional in-situ concrete construction. Therefore, when standardisation and repetition is limited in a construction project, in-situ concrete construction might be the preferred method of construction. Late changes to a project may have a larger effect on prefabrication as compared to in-situ concrete construction. Therefore early involvement and collaborations among stakeholders are important in order to eliminate the potential late changes in a project. Contract strategies that encourage early involvement and collaboration, such as the design-build approach, are important in reducing project changes, especially for the implementation of precast construction.

Raghavendra et al (2016), comparing cast-in-situ method to the prefabrication method of construction, the latter consumes less time in the project cycle because, the prefabricated materials and elements are delivered to the site just-in-time and placed into position which reduces unnecessary handling, double handling and equipment use. This allows other activities and trades to begin work more quickly which facilitates the construction project time and is more economical with fewer disturbances for the

surrounding. They further explained that cast-in-situ method of construction requires a lot of time since concrete requires minimum of 28 days to achieve 99% strength of its total strength.

According to Raghavendra et al (2016), in recent times most building construction projects consider the speed of construction and tight construction schedules as basic factors and this is where prefabrication method of construction excels. To clearly explain the advantages of prefabrication, two factors should be carefully noted:

a. Design the building layout to maximize repetition of precast units.
b. Design construction details to maximize the number of standardized components.

According to Raghavendra et al (2016), the duration of prefabrication in building projects studied, were calculated through the data collected from the prefabricated manufacturers. The duration period for the completion of the projects successfully was put in three stages – the sub-structure, superstructure and finishing works. It was noted that substructure construction took the same time for cast in-situ and prefabrication. However, for the superstructure, construction was completed early with prefabrication. This is because, the walls, slabs and other elements were manufactured off site and installed on site as and when the elements were required during the time of the project. They demonstrated that as depicted in the Table 2.1.

Table 2.1: Total Duration of Prefabrication Construction

Sl. No.	*Description*	*Duration*
1	*Sub Structure- (Site Cleaning, Earthwork, Foundation, Basement, Soil Filing)*	*22days*
2	*Super Structure-(Wall Panel Framing and roofing slabs)*	*12 days*
3	*Finishing Work- (Electrical, Plumbing, Painting, Tiling and Windows)*	*31 days*

Source: MacGraw construction (2011)

Prefabrication method of construction takes less time in completing the works compared to cast-in-situ. This is due to the electrical installation works which is already fitted in the case of prefabrication of walls and slabs. Plastering work is not most times needed for prefabricated elements, because prefabrication produces good finishing appearance. It was realized that, the total duration for the construction of a double storey residential building with prefabrication technology was 65 days while with the conventional (cast in-situ) method was 128 days (Tables 2.1 & 2.2).

Table 2.2: Total duration for Conventional Construction

Sl. No.	*Description*	*Duration*
1	*Sub Structure- (Site Cleaning, Earthwork, Foundation, Basement, Soil Filing*	*22 days*
2	*Super Structure-(Column Lintels & Sunshade, Beams, Roof Slabs)*	*52 days*
3	*Finishing Work- (Electrical, Plumbing, Painting, Tiling and Windows)*	*54 days*

Source: MacGraw construction (2011)

2.5 USING PREFABRICATION AS A CRITERIA TO SAVE PROJECT COST

Cost in the construction industry remains the principal parameter (Piek, 2014) citing (Khosravi & Afshari, 2011). Notably was the fact that, cost cannot be easily measured in the construction industry. He further outlined that, construction projects cost emanates from various phases, such as the design phase, construction phase and the operation and maintenance phase also known as the life cycle cost.

For instance, Lombard (2011) conducted a theoretical example project which he formulated in his study to demonstrate the effect of time savings during the building usage. His study revealed that, the yearly income required in order to break even after a usage period of 30 years can be reduced by 2.67 % when the construction duration is reduced by 20%. He conducted further assessment for projects with reduced

construction durations, varying construction cost and reduced maintenance cost, to observe the impact of these parameters on the life cycle cost of a project. The results showed that, a project of shorter construction time resulted in reduction in the required annual income, in order to achieve break even. Also, an increase in construction cost, increases the annual income required to break even. It was also revealed that, as the maintenance cost increases as a percentage of the initial cost, an increase in annual income is required to break even. These examples he used were not exact project values but approximations. However, it demonstrated that project teams should consider the effect of time savings, construction cost savings and reduced maintenance cost on the life cycle cost of a project in the decision between various construction methods.

Prefabrication is an ideal solution for constructing a residential building due to the production of similar types of elements repeatedly in bulk, thus, reducing cost. Prefabrication provides flexibility and durability with cost efficiency. Comparing maintenance cost in both methods of construction, it is less in prefabrication as proposed by Toong Khuan Chan, Faculty of Architecture Building and Planning, University of Melbourne, Australia.

The cost of prefabrication may vary with the type and the size of construction. For instance, in small projects the cost of prefabrication increases due to the production levels. However, for bigger projects the cost may decrease significantly due to the higher levels of production.

In figure 2.3, the construction cost of the footing, columns beams and slab, which are made by using steel frame, precast frame and combination of both, are compared. Results showed that precast frame with precast concrete floor are more economical

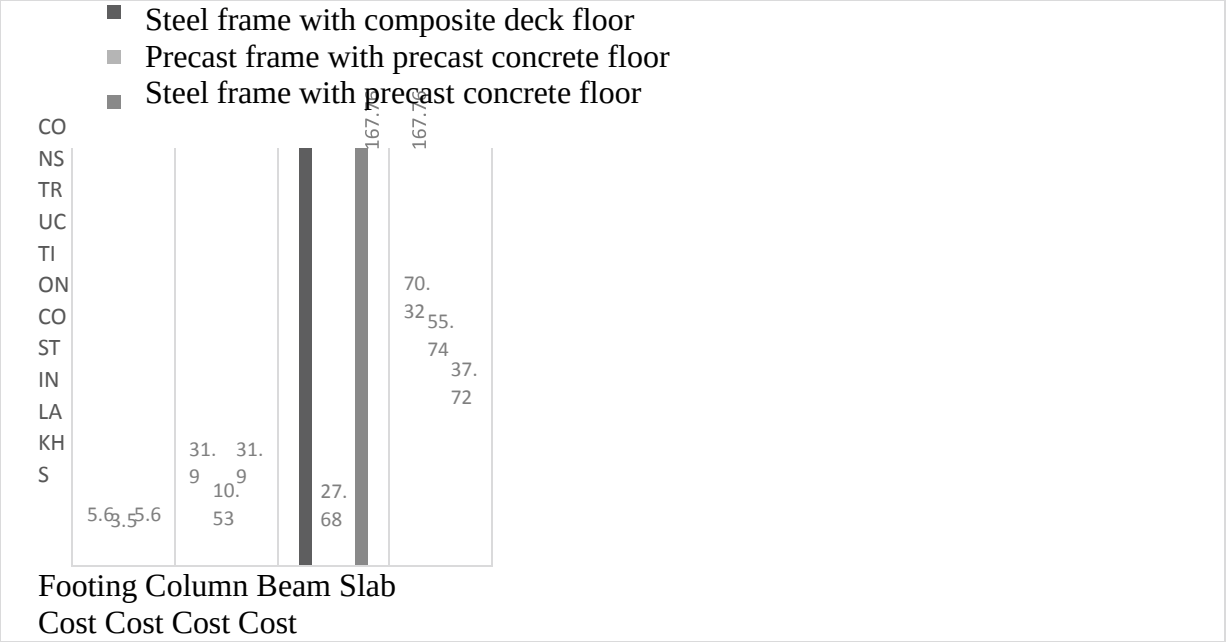

Figure 2.3: Construction cost of building

Source: Raghavendra et al (2016)

Raghavendra et al (2016), explained that the direct cost of the precast frame with precast concrete floor comes out to be 23.10% lesser than the steel frame with composite deck floor. However, in one of the case studies they conducted on a double storey residential building, it was revealed that the cost of the construction by using precast elements resulted in 13% more than the cost of the cast-in-situ method. This was due to the fact that the prefabrication method of construction has an upper hand in the construction of heavy industrialised infrastructure but its implementation in the construction of individual houses has had a lot of constraints in India just as it is in Ghana. It was also noted that, construction companies in developed countries had comparatively high labour wages and thus, they increase the capital investment in order to decrease the labour input. Because prefabrication method of construction is basically more of equipment made products and less of labour intensive works, it was realized that, it proves to be economical in countries such as Australia. Meanwhile, construction companies in developing countries like India and Ghana rely heavily on cast-in-situ by

exploiting the cheap and large number of labour inputs, getting better cost savings than the prefabrication construction. It was noted that the construction sector in a developing country like India accounted for about 11 % of its GDP and serves as the main source of employment for 33 million people. According to an article by the 'Economic Times', a survey in India revealed that there are only 2% skilled work force in the country. Because financial incentives are offered by the Indian government to initial investors in prefabrication construction, the initial cost in prefabrication construction is higher, making it difficult for new investors in the sector to make it. This can be emulated by the Ghana government.

2.6 USING PREFABRICATION AS A CRITERIA TO PROMOTE PROJECT QUALITY

Quality is the entirety of features and characteristics of a product, service or its entity that allow on its capacity to fulfill specified or implicit requirements. Pierk (2014), citing Lombard (2011) asserted that construction quality has the ability to reduce potential time and cost savings when the quality aspects of applications in construction are overlooked. From the customer perspective, conformance to requirement and fitness of use is quality. These have an indirect impact on the time and cost of construction projects, and for that matter should be critically looked at to ensure the project success. Lombard (2011) defined construction quality by identifying different scopes of quality. He identified them as long and short term quality, noting the construction phase of a project as the short term quality and the operational phase of the project as the long term quality.

For instance, in Spain, the government built over 200 public school centers at Catalonia using industrialised precast expertise since the year 2000. These schools were erected in a remarkably short time quick on-site assembly, high quality product and within reasonable cost (Oriol, el at 2010). The benefits of prefabricated components in the management of construction projects has been tried and tested in so many countries and for that matter Ghana can emulate that in the management of construction projects especially when mass production is required within a specific time and quality required within an estimated budget.

According to Raghavendra et al (2016), the current technological advances leads to the changes in the way of doing business in areas of the construction industry. Construction companies that still rely on the use of traditional methods in construction process do not have the opportunity to be successful in this modern competitive business environment. The gradual adoption of the new modern trends and methods in technological advancement is a necessity for the success of companies and the development of the construction industry. For instance the use of precast concrete elements can be used to help reduce the amount of waste generated on the construction site by up to 50% of a construction project as compared to cast in-situ method. They further outlined that the design system which can be executed by the manufacturing company is tridimensional (3D) modelling software that helps keep the different interface between the construction elements. A further study on the software will help designers to better understand the design and specification of components that cannot be manufactured or transported. Practically, the waste reduction principle needs to be implied as basis to manufacturing and construction on site as much as possible. Web-based quality management system can be used to offer several advantages in the quality control process of prefabrication and precast concrete. This dissertation was aimed at

obtaining the information that ensure the quality of standards and specifications of prefabrication and precast concrete which can control the properties of the elements. The use of prefabrication considerably reduces mistakes and increases construction speed. This leads to savings in construction time and cost. It is obvious that a better quality control system is achieved when prefabrication is used (Dineshkumar and Kathirvel, 2016).

It can therefore be concluded that prefabrication is economical when carefully compared to other conventional in-situ methods which are being used since 700 B.C. Prefabrication and precast is a cost and time saving construction method which ensures quality of concrete to its maximum extent.

2.7 ADVANTAGES AND DISADVANTAGES OF PREFABRICATION STRUCTURAL COMPONENTS

Cudney (1998) outlined the following advantages and disadvantages of prefabricated structural element:

2.7.1 Advantages of Prefabrication

a. Duration of construction is slightly shorter.
b. Initial cost of construction is slightly lower.
c. Concrete quality is better and in good finish.
d. Benefit of precast flooring having long span ability thus reducing the use of formwork since it is self-supporting.
e. More adaptable in harsh condition.
f. Reduces waste

2.7.2 Disadvantages of Precast

a. Relatively higher maintenance cost since the gap between two components needs to be sealed.

b. The gap provide avenue for leakages and needs to be repaired at regular period of time.

c. The depth of the beams affects the head room and lighting.

2.8 BENEFITS OF USING PREFABRICATION

According to McGraw Hill Construction (2011), the following benefits of prefabrication were outlined;

2.8.1 Time Savings

McGraw Hill construction (2011), interviewed Doug Renna, development boss at T.G. Nickel & Associates, where the construction supervisor, defines the results of them using prefabrication to ensure they succeed in delivering their projects successfully as key to their current level of performance, He cited an example of how they erected a 175,000-square-foot building using prefabricated element within a time span of four months, that is from January to April. He indicated that they worked through the winter months with no interruption, secondly he cited another instance where the company erected a six-story structure in less than four months. "It was estimated that this saved a minimum of six months off the building's original program. This success was attributed to two interrelated elements, first, the use of prefabricated elements to quickly enclose the building rapidly. This paved way for workers within the interior to start fixing the sheet rock together with other internal finishes to work considerably more professionally. Manhar Bhatt, project manager at Goshow, also attributed the success to the phasing of the process which enabled the prefabrication of different segments of the construction elements which contributed significant time savings. In my opinion the

time taken to complete any construction work is a key success indicator. Since the early completion of every project, contribute to fulfilling the project's goal, it should never be overlooked. Prefabrication as tried and tested in some jurisdiction, highly contribute to reduce project duration and should be used as a criteria to influence the success of projects in the study area.

2.8.2 Fewer Onsite Resources

When using prefabricated elements for construction works, little or no scaffolding is necessary since the bricks are pasted to a prefabricated wall in a manufacturing works, instead of positioned on site. Numerous stakeholders who utilize the use of prefabrication in their projects, attest to the benefits that are associated with improvements in time, budget and safety.

2.8.3 Achieving Green Goals

According to Amanda Langweil, the manager of sustainability at Goshow Architects, as cited by McGraw Hill Construction (2011), prefabrication enhances with the underlisted green objectives:

i. **Waste:** Prefab work is done in an organized setting which makes room for ample less waste, because any left-over material can be stored and recycled by the firm for another development in the future;

ii. **Materials:** The use of some improved materials such as split tile brick, which are lighter than face brick, implies fewer raw material use. It also has improved acceptances to incorporate the measurements required for the project elements. For instance, McGraw Hill Construction (2011), estimated that, the use of split tile brick resulted in savings of 70%–80% of the raw material used compared to face brick;

iii. **Tighter Envelope:** Huge prefabricated sections have less connections that must to be closed on site; and

iv. **Site Impact:** The absence of scaffolding reduced the site effect.

2.8.4 Quality

Impeccable comportment of the metal studs in the prefabricated sections help reduces deflection of the structure and would help the physical structure. There is also uniformity through the building that would not have been seen during manufacturing. Testing and accreditation would be done alongside manufacturing. The sturdiness of the construction due to the metal braces, contribute to both the wall sections and floor slabs not to compromise the inconsistencies that may occur at characteristic onsite construction.

2.9 SECTORS WITH OPPORTUNITY FOR PREFABRICATION

According to MacGraw Hill construction (2011), they identified the use of prefabrication in the following types of building projects, this illustrated the applicability across non-residential construction. The sectors using prefabrication most were five that is:

i. Healthcare (49%);
ii. Higher Education (42%);
iii. Manufacturing (42%);
iv. Low-Rise Office (40%);and
v. Public (40%).

These subdivisions are currently facing serious deficits in Ghana and also present resilient prospects in the construction market. The use of prefabrication as a means for

reducing housing deficits as well as contributing to project success is a matter that should be given good attention for adoption in Ghana.

In Ghana, it is estimated that the current housing deficit is about 1.5 million, this is contained in the Ghana Statistical Service 2010 population and housing census. The healthcare sector alone requires thousands of Community-based Health Planning and Services, CHPS compounds, district hospitals, regional hospitals and referral hospitals, this method of construction would be well-suited for such projects across the length and breadth of the country.

The internal arrangement of hospital wards permits for effective use of modularisation and prefabrication. According to McGraw-Hill construction financial estimate, the market activity in the health sector building was estimated to surge in 2011 and 2012 to become more than a $28 billion market prospect in 2012 in the US.

Just like the health sector, the education sector suffer similar challenges, like dormitories and school projects which have structures that are complementary to prefabrication, educational facilities permit for use of prefabricated scope scheme, and these developments also gain from quicker construction programs. For example the government of Ghana has initiated the construction of 200 community day schools, called the E blocks which are similar in design hence the use of prefabrication as a criteria for this projects to be successful is of high essence. As the biggest construction sector by worth (over $43 billion in 2011) in the US, apart from residential buildings, education grants a substantial opportunity for prefabrication/modularisation, both presently and in the forthcoming. As a result it is important for the education sector to endure to explore prospects in the use of prefabrication since it has the maximum portion of non-residential building activity.

2.10 DIFFICULTIES FOR NOT USING PREFABRICATION ON SOME PROJECTS

According to the McGraw Hill Construction (2011) the top most reason for present professionals not using prefabrication is that, the architect did not design it into the development, the situation in Ghana is yet to be established by the end of this study.

Additional top motives for present developers not using prefabrication/modularisation on some projects are:

i. Development kind is not appropriate (29%); and
ii. Proprietor do not want manufactured modular components (32%).

These discoveries indicates that the use of prefabrication/modularisation in some circumstances were predominantly reliant on the judgements of the owner and the architect. Their study revealed that, some of the difficulties to using modularisation comprise taking to compel to a well-defined range initial in the development phase, improved conveyance and logistics necessities, and the inadequate number of suppliers of off-site manufacture which may be similar reasons for the very low patronage of prefabrication in the study area.

2.11 USING PREFABRICATION AS CRITERIA TO ACHIEVE SUSTAINABLE CONSTRUCTION AND WASTE REDUCTION

Since the last two decades, sustainable development and sustainable building have been of growing issue in the world. Kibert (1994) defined sustainable construction as ‘‘the provision and efficient management of a sound built environment based on resource efficient and ecological principles”. Sustainability is living, producing and consuming in a way which meets the needs of the present without denying the ability of future generations to meet their own needs (Twidell and Weir, 2006). Sustainability

provides and keeps the circumstance under which humans and nature can exist in productive harmony, which allows meeting the social, economic and other standards of present and future generations Sustainable Development (SD) may also be defined as: development which satisfy the demands of the current generation without compromising the ability of future generations to meet their own needs; and SD aims to integrate economic, social, and environmental policies in order to achieve reduced consumption, social equity, and the preservation and restoration of biodiversity, (Farley and Zachary, 2013)

The construction sector is both a key contributor to socio-economic prospects and a critical user of energy and natural resources; therefore its participation is basic to meet sustainable development in our community (United Nations Environment Programme UNEP, 2003). In the US, houses consume about 37% of total energy, 68% of all electricity, 12% of fresh water supplies, 88% of potable water supplies and 40% of raw materials used (United States Green Building Council, USGBC, 2003). Resource preservation and waste minimisation are becoming highly relevant parameters of sustainable construction. Waste reduction is a way that prevents, eliminates or decreases waste at its origin or allow reuse/recycling of the waste for design significance (Guthrie and Mallett, 1995). Minimisation at the onset for new construction development includes both design schemes and construction technology/materials selection (Poon and Jaillon, 2002). The study identified prefabrication as a panacea to minimise waste emanating from design and building stage, which should also be seen as a concern to the Ghanaian construction industry. Up to 30% of building waste are due to inefficiencies, mistakes, delays, and poor communication (The Economist, 2000). It should also be noted that 10% of building budget is spent in reworks (Construction Industry Institute, CII USA). 25-50% of

building budget is lost to waste and inefficiencies in labour and materials control. This losses incurred in errors in information when putting designs to actual construction.

2.12 TIME OVERRUN

Every construction project has a duration for completion and achieving the finishing of building developments projects on schedule is one of the minimum requirement. Moreover it appears it is common for projects not to be finished within their schedule duration. It is however good to note that this problem has become a worldwide problem. A study by International Journal of Advances in Applied Sciences (IJAAS, 2013) revealed that the Vietnamese government has noted this with keen concern, especially with government-funded and related projects. Also in Nigeria, a study conducted noted that out of 3,407 developments only 24 developments were finished on schedule, besides 1517 were delayed and 1812 were abandoned. Omoregie and Radford (2006) stated that the least average percentage increase period of developments in Nigeria were seen to be 188%. Furthermore another study was surveyed in Bosnia and Herzegovina and it was revealed that, out of 177 projects, 51.40% do not meet their completion dates. Al-Momani, (2000) carried out a research on 130 public developments in Jordan and it was realised that delays happened in 106 (82%) of the projects. In Ghana a similar survey was carried out on 47 projects and it was found that 33 (70%) of the projects did not meet their completion dates, Frimpong et al. (2003). Also, in Saudi Arabia, 70% of projects encounter time delay with approximate sector time delay of 10% to 30% of the initial project time estimated in the contract. Similarly, in Malaysia the construction sector is also facing the same challenge of time overrun. Additionally Abdullah et al (2009) reported that more than 90% of large MARA construction projects faced late completions since 1984. Endut et al (2009) conducted studies on time performance of 359 projects in Malaysia

(301 new constructions while 58 refurbishment projects). Out of these 301 were public funded related projects and 51 private projects. The study revealed that only 18.2% of the public sector projects and 29.45% of private sector projects had 0% time deviation (no delays) while the average percentage of time overrun for other projects was 49.71%. Construction time delay can be attributed to one or more reasons which may include problems of funding and payment for completed works, poor contract management, changes in site conditions, shortage of materials, design changes, weather condition, and construction method among others.

2.13 COST OVERRUN

Cost is one of the most significant parameters that must be critically observed throughout the phase of a project. Regrettably, majority of developments did not succeed to achieve project completion with the estimated budget. Apart from, time overrun, cost overrun is also a major challenge in the construction sector as revealed in the International Journal of Advances in Applied Sciences (IJAAS, 2013).

Cost overrun is a phenomenon that is found in both developed and developing economies. Meanwhile the situation is more serious in developing countries where these overruns are sometimes over the estimated budgets by 100%.

A study by Omoregie and Radford (2006), revealed that the least approximate percentage increase in cost of construction in Nigeria was 14%. Another research in Slovenia on 92 traffic constructions built demonstrated that 51 % of agreed building projects encounter cost overrun according to the journal. In Croatia 81% of 333 estimated projects were facing the problem of cost overrun. Also, in Bosnia and Herzegovina, a research study on 177 structural projects revealed that the agreed budget was not achieved in 41.23% of the projects. It is to be noted that a developed

country like the United Kingdom's (UK) construction industry is not left out, it was discovered that about one third of the clients complain that their development projected budgets generally overrun their estimates as reported in the journal.

There are several reasons that can be attributed to this perineal cost overrun in the construction industry all over the world. They include lack of contractor's experience, poor site management and supervision, incorrect time and budget estimates, schedule delay, consistent design changes, fluctuation of prices of materials, cash flow and financial difficulties faced by contractors and method of construction which is of concern for this studies.

2.14 MEASURES IN ADOPTING PREFABRICATION

There is also a vibrant role for governments and sector stakeholders in developing pilot projects or technology reviews. By presenting physical, real world practices by the use of display houses and achievable examples could be used to provide a higher criteria for the adoption of prefabricated principles for construction success (Gaze et al., 2007; Lovell, 2007). The intention to invest in such developments would introduce constructors to prefabrication systems in a low-risk situation, and provide an opportunity to publicise the outcomes to people in the construction industry (Gaze et al., 2007). Furthermore, piloting with new materials and construction methods would be motivated (Turner and Vaughan, 2012). The absence of direct provision of financial grant, government and the private sector in the construction industry can still significantly impact the market. One such instance is the adoption of the phrase 'Modern Methods of Construction' in place of 'prefabricated' in the U.K. which has targeted to avoid some of the stigma attached with the method (Lovell and Smith, 2010). This has changed the negative conceived mind of stakeholders around to a more

positive one with a focus and an unsuitable similarities to the current market which may serve to facilitate the position of prefabrication.

Besides government influences, there may also be a function for sector players. There are a number of organisations that would directly support and promote the growing use of prefabricated building products, such as the Manufactured Housing Institute in the US, PrefabNZ in New Zealand (Bell, 2010) and the present establishment of prefabAUS in Australia (prefabAus, 2013). Allowing for higher sector of industry and consumers regarding the benefits of prefabrication, along with a growing inclusion into university or technical education curricular can facilitate in promoting its adoption (Aburas, 2011).

A lot of developing countries have been found to be projecting towards enhancing the quality of the products of building and growing the productivity of the construction industry with better use of mechanisation, prefabrication skill and advancement of the skill of workers. Diverse types of prefabricated building systems were initiated in the early 1970s by construction firms in Europe and the US to deal with the growing request for housing. Great levels of precast demand were surveyed in Denmark, Netherlands, Sweden and Germany in the 1990s (Construction 21 Steering Committee, 1999).

In most countries across the world, prefabrication is useful in the construction sector to enhance productivity, improve quality, and cope with a shortage of skilled labour.

Though the Hong Kong Construction Industry Review Committee (CIRC) commended a broader adoption and promotion of prefabrication to advance the quality and to decrease the generation of construction waste, Jaillon and Poon (2009) stated that, the private sector still depend deeply on cast in-situ methods of construction involving the

use of timber formwork, in-situ concreting, substantial amount of wet trades and bamboo scaffolding. In the same article, Jaillon and Poon stated that, major improvements in prefabrication construction method involving volumetric and modular prefabricated elements, and large increases in number of prefabricated elements used in public housing projects. It is motivating to note that incentive schemes were essential to inspire the private sector to promote the use of prefabrication such as prefabricated non-structural external wall in the Joint Practice Note 2 (Government of Hong Kong, 2002)

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Research methodology is a significant constituent of any research and offers the structure upon which the research development is conducted (Brow, 1996). Hence, it is vital that the methodology is sound and conducted thoroughly to efficiently produce an exact and a precise data in order to achieve the goal and objectives.

Apusiga (2008) stressed that the comprehensive description of the research process, method of data collection, sampling procedure, sampling size, approaches of data analysis and the scope of the study should be outlined in the methodology section. Accordingly this has been adopted for this dissertation.

3.2 SELECTING THE STUDY LOCATION

Every research undertaken requires the selection of study location that exhibits the phenomenon to be investigated. In the Tamale metropolis, prefabrication method of construction is rarely adopted for the management of construction works in the building industry. Despite the enormous benefits of prefabrication method of construction the Tamale metropolis is yet to realize this and fully enjoy the benefits. There are dozens of various construction works across the length and breadth of the Metropolis for the Ghana government, Non-governmental Organisations (NGOs) and the private sector projects. Tamale is the fastest growing city in West Africa and hence the construction industry is a major player or contributor.

3.3 RESEARCH DESIGN

Appropriate research design is a structure and plan of investigations conceived so as to get solutions to research questions or problem (Kerlinger, 1986). Apusiga (2005) argued that, the strategy is a whole structure or programme at the study. It comprises of a plan of what the researcher is motivated to do from the hypothesis and their functioning inferences to the concluding examination of data.

Traditional research design, is a blue print or comprehensive strategy of how an investigation survey is to be accomplished, the operationalisation of variables so they can be measured, picking a sample of concern of study, collecting data to be used as foundation for answering research questions and analyzing the outcomes (Thyer, 2008).

Another definition states that a research design is a routine strategy that is implemented by the investigator to answer question validly, objectively, accurately and economically (Apusigah, 2005)

In this study the research design adopted was the descriptive method, this was considered appropriate due to the fact that the study involved systematic collection and presentation of data to give a clear picture of the situation. However, both quantitative and qualitative approaches were applied because most authorities in research method admit that the two distinct process (quantitative and qualitative) can co-exist, but the most significant differences is the method in which each convention treats data (Saunders, 1997)

3.4 SAMPLING METHOD AND SAMPLE SIZE

In order to make sound generalization and draw inferences, there was the need to conduct sampling in the research process. Apusigah (2005) asserts that the investigator desires to choose only limited interviews from the space for studies.

According to Apusigah (2008) a study founded on characteristic sample, is regularly healthier than a lager sample or the entire population. This idea is further elaborated by Karma (1990), who is explicit on the size of a sample and says that the use of sample ought neither to be extremely larger nor too small. It should be ideal and should be at the discression of the researcher.

One method to decide sample size is the purposive sampling method, this method was selected for this study. This sampling technique was chosen because it was the most effective of exploring the heterogeneous data since data required was anthropological, and the sources of data to be collected was of more meaning and of high benefit to the study, the data to be collected was of more intuitive nature and the actual population could not be ascertained from authoritative sources.

Clients (Government, NGOs, Estate developers etc.), consultants and construction contractors who are the stakeholders in the construction industry were purposively taken care of.

In this study, the chosen sample size was one hundred and twenty (120), that is major stakeholders comprising of clients, contractors and consultants were surveyed. This choice took into account an optimal sample that fulfilled the requirement of efficiency, representativeness, reliability and flexibility (Saunders, 1997).

Table 3.1 Questionnaire sample for respondents;

Item	***Respondent***	***No of questionnaire***
1	*Construction contractors*	*60*
2	*Clients (Estate Developers)*	*40*
3	*Consultants*	*20*
Total		*120*

Two main sampling techniques were applied for the selection of the element of the sample, namely probability sampling and non-probability sampling (Twumasi, 2001). According to Twumasi (2001), probability guarantees the rule of statistical regulation which conditions that if on average the sample choice is a random one, the sample will have the same configuration and features as the universe.

In this research the selection of stakeholders above was purposive. The selection of individual contractors, consultants and clients respondents who made up the sample size were selected by the fish-bull or lottery method (Twumasi, 2001).

3.5 SOURCE OF DATA

The study made use of primary and secondary source of data. Primary sources from which data was collected included interviews, questionnaire and observation, these were specific tools that were used according to the various categories of respondents at the time (Apusigah, 2008). Secondary data was sourced from existing data concerning the research topic from text books, journals, internet and magazines.

3.6 DATA COLLECTION INSTRUMENTS

Generally, there are various instruments for collecting data in social research, however, for the purpose of this study, interviews (unstructured interview and interview guide,) field observations and questionnaires were the primary instruments used for data collection as indicated below.

3.6.1 Observation

This study applied both direct and indirect participant observation techniques in data collection (Thyer, 2008). Observation in the view of Yin (1994) provides evidence that do not depend on verbal behavior and enables the researcher to critically observe the phenomenon under study directly.

The purpose was to facilitate a deeper understanding of issues and cross checking of responses considered being inconsistent to what was observed. This process helped to improve the validity of the findings.

3.6.2 Questionnaire

A questionnaire is a written instrument that contains a series of questions or statements that attempt to collect information on a particular topic. Structured questionnaires were administered to a cross section of respondents to solicit their information on the topic. A total of 120 questionnaire were administered

3.7 ETHICAL CONSIDERATION

A number of ethical considerations were addressed in the case of the research, these included assurance of anonymity and confidentiality of personal information. The nature, purpose and procedure of study was explained to the respondents and they were aware that they were free to refuse to answer any question or drop out of the study at any time and it will not affect them. Permission to conduct this research were sought from stakeholders before the actual work began in order to ensure access and acceptance. Access to construction sites and acceptance in obtaining permission to carry out research in a construction sites, consultant office or organizations is relevant (Apusigah, 2008).

3.8 DATA ANALYSIS

Data analysis is defined by Apusigah (2008), as the composition of definite methods along with probing for patterns of relationship that exist between data groups. Yin (1994), asserts that there is the need for searching the data for ‘patterns’ which may explain or identify causal links in the data base. In a related study Yin (1994) also stipulated that an amount of carefully related procedures are implemented with the

determination of summarising the data collected and establishing them in such a way that may answer the research questions. Subsequently on this, quantitative method was used. This heightened the assertion that data examination must be a distinct phase coming after data gathering (Yin, 1994). The researchers first concentrated on the whole data and attempted to reconstruct it again more meaningfully. Data were then categorized and organized in search of patterns, themes and meaning. Categorization enables the researcher to make comparison and contrast between patterns, to reflect on certain patterns and complex trends and make sense of them.

Data from respondents were analysed using statistical package for social sciences (SPSS) version 16 together with Microsoft excel. Mean score ranking was the main approaches employed to analyse the questions.

Mean score ranking, was adopted from the Lim and Alum (1995). The ranking was done to establish the maximum frequent issues. According to Lim and Alum (1995) the use of mean score ranking accelerates the identification of strategic methods concerning adopting prefabrication construction. It provides a diagnostic justification of the serious effects the issues of the questionnaire on prefabrication construction will have on the adoption of prefabrication. The higher the mean score value, the more important the numerous issues have on adopting prefabrication in Ghana construction industry and therefore consideration needs to be focused in the direction of the effects of such issues.

CHAPTER FOUR

RESULTS, DATA ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

This chapter comprises, the analysis of questionnaires, interviews, and observations made in the course of the study. A cross-section of building contractors, architectural and engineering consultants and clients or developers who are key stakeholders in the construction industry within the Tamale Metropolis were engaged in the data collection process as respondents.

As far as this chapter is concerned, one hundred and twenty (120) questionnaires were administered and out of the total number, seventy (70) were received representing 63.63% of total returned questionnaires.

Histograms, Tables, pie charts and percentages below are then used to present the data collected. The data was subjected to rigorous statistical analysis after respondents reacted to all the items contained in the questionnaire alongside interviews, observations exercise concerning the research topic.

4.2 DEMOGRAPHIC

4.2.1Type of Respondents

Figure 4.1 shows the number of respondents with their percentages from the following category: contractors, architectural/engineering and clients. 41 out of 70 (representing 59%) of the respondents were contractors, 19 out of 70 respondents were architectural/engineering (representing 27%), and 10 respondents were clients or developers or government agency (representing 14%).

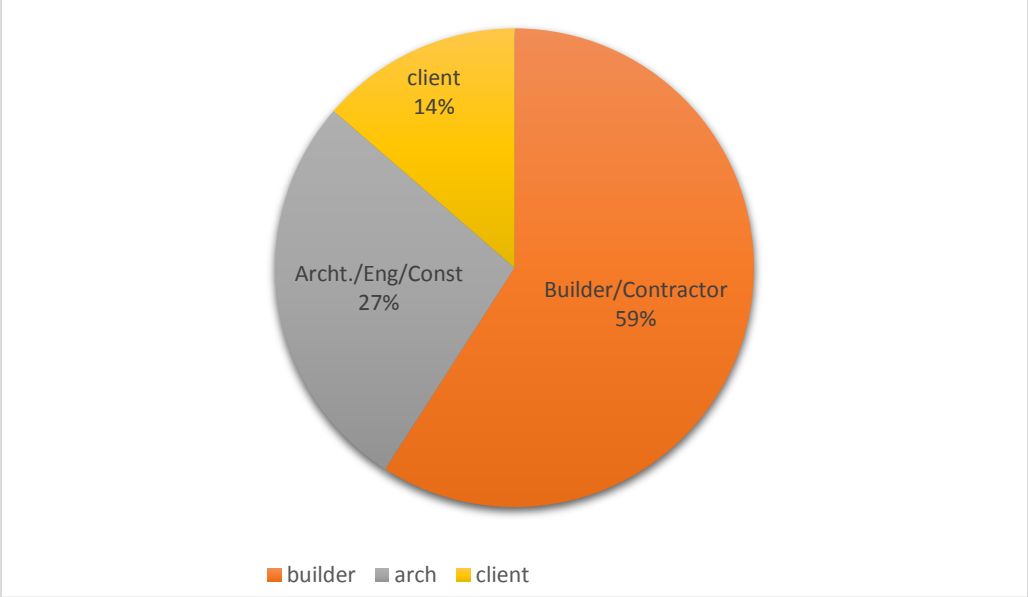

Figure 4.1 Type of Respondents Company

Source: Field survey (August 2016)

4.2.2 Level of Education

Figure 4.2 depicts the level of education by respondents, 57.14% of the respondents have tertiary education (including Technicians, HND, degree and above), 32.9% of the respondents have secondary education, 5.7% of them have basic education whiles 4.29% of the total respondents had no education. It was noted that all the respondents who were not educated were contractors. Majority of the respondents were educated and had a good understanding of the questionnaire that they were required to respond to.

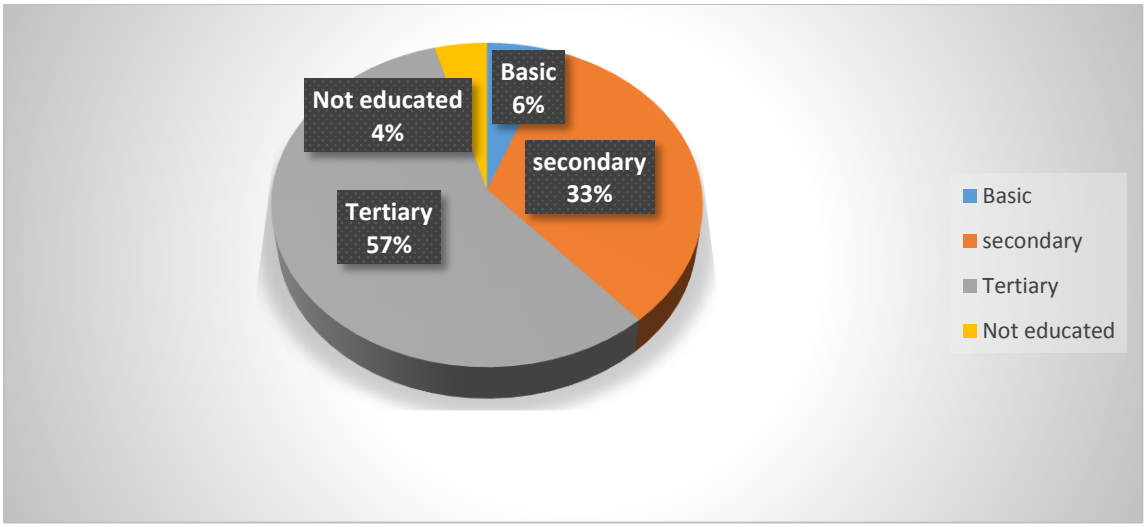

Figure 4.2 Level of Education

Source: Field survey (August, 2016)

4.2.3 Years of Working Experience

Table 4.1 shows the years of working experience of respondents, 5 respondents (representing 7.1%) have working experience between zero to five years. 16 respondents out of 70 respondents have 6-10 years working experience (representing 22.9%). In addition, 12 of the respondents have between 11-15 years working experience (representing 17.1%), 35 respondents have 16-20 years working experience (representing 50.00%), and 2 respondents have over 20 years working experience (representing 2.9%). This implies that majority of the respondents are quite experienced in the construction industry as far as responding to this questionnaire is concerned.

Table 4.1 Years of Working Experience

Respondents	Frequency	Percent
0-5	5	7.1
6-10	16	22.9
11-15	12	17.1
16-20	35	50
OVER 20	2	2.9
TOTAL	**70**	**100**

Source: Field survey (August, 2016)

4.3 BENEFITS IN ADOPTING PREFABRICATION.

From the literature review, many researchers had identified a number of advantages/benefits when applying prefabrication. For the purpose of this study twelve items were outlined as depicted in Table 4.2. For each of the identified benefits, respondents were required to assess the relevance level of the benefits by choosing one of the evaluations namely, least relevant, fairly relevant, relevant, very relevant and extremely relevant.

To investigate the benefits of prefabrication, the SPSS tool was used to calculate the frequency, mean, and the results ranked. Shorten construction time when using prefabrication was ranked first with a mean value of 4.10. The respondents explained that construction time is very important for every project success especially when projects are designed to meet specific demand and requirements. Macgraw Hill Construction (2011) identified the usage of prefabrication to ensure that they succeed in delivering their projects successfully as key to their current level of performance. They further explained that, the building services are incorporated during prefabrication work at the factory and this lead to significant reduction in construction time. The Project Management Book (PMBOK) also defined a successful project as those that are on time, within budget and with all features as originally specified.

Reduction in construction cost and frozen design at the early stage were ranked second and third with 3.50 and 3.23 as their mean values respectively. Some of the respondents opined that when standardised designs are used especially when the projects are mass with a repetitive nature the frozen design has a direct impact on the cost, since the elements will be repeated. As explained by (Khosravi and Afshari, 2011), they noted that, cost cannot be easily measured in the construction industry since it emanates from various phases, such as the design phase, construction phase and the operation and maintenance phase. Omoregie and Radford (2006), conducted a research which revealed that the least approximate percentage increase in cost of construction in Nigeria was 14%, and further demonstrated that the situation is more serious in developing countries where these cost overruns are sometimes over the estimated budgets by 100% of the budgeted cost of the project.

Better quality of the end product was ranked fifth by the respondents, since prefabrication is done under factory control environment. The quality of construction has the potential to reduce the cost as well as the time of any project (Lombard, 2011).

Achieving green goals and better supervision were also ranked sixth and seventh respectively; in this era of attaining construction sustainability, prefabrication is a key tool to achieving that (MacGraw Hill Construction, 2011). Prefabrication works are noted to have better supervision results, since they are inspected and tested under factory control condition before they are installed.

Reduction in construction waste and aesthetic issues were ranked eighth and ninth respectively. (Poon and Jaillon, 2002), identified prefabrication as a panacea to minimise construction waste emanating from design and building stage.

The least ranked parameter was fewer onsite resources because when using prefabricated elements for construction works little or no scaffolding is required (MacGraw Hill Construction, 2011)

Table 4.2 Advantages/benefits of applying prefabrication

item	*Statement of advantage*	*Frequency*	*Mean*	*Std. Deviation*	*Rank*
A	*Shorten construction time*	*70*	*4.10*	*1.374*	*1st*
B	*Reduce construction cost*	*70*	*3.50*	*1.225*	*2nd*
C	*Frozen design at early stage*	*70*	*3.23*	*1.253*	*3rd*
D	*Better quality*	*70*	*3.14*	*1.04*	*4th*
E	*More adaptable to hash conditions*	*70*	*3.01*	*1.357*	*5th*
F	*Achieving green goals*	*70*	*2.97*	*1.659*	*6th*
G	*Better supervision*	*70*	*2.91*	*1.305*	*7th*
H	*Reduce construction waste*	*70*	*2.83*	*0.884*	*8th*
I	*Aesthetic issues*	*70*	*2.74*	*1.337*	*9th*
J	*improve environmental performance*	*70*	*2.70*	*1.172*	*10th*
K	*Integrity of the building*	*70*	*2.67*	*0.989*	*11th*
L	*Fewer onsite resources*	*70*	*2.61*	*1.231*	*12th*

Source: Field survey (August, 2016)

4.4 DIFFICULTIES IN ADOPTING PREFABRICATION

Apart from the benefits attributed to the usage of prefabrication, there are equally difficulties/hindrances in the adoption of prefabrication, this were investigated in the course of this study. Again from the literature review and desk study, a number of difficulties/hindrances were identified as the factors militating against the adoption of prefabrication. Twelve items were outlined as tabulated in Table 4.2. For each of the identified difficulties/hindrances, respondents were required to assess the relevance level of the difficulties by choosing one of the evaluations namely, least relevant, fairly relevant, relevant, very relevant and extremely relevant.

4.4.1 Lack of direct financial grant

Lack of direct financial grant was ranked first with a mean values of 3.63, as the most intriguing hindrances to the adoption of prefabrication. The respondents explained that construction equipment required for prefabrication manufacture, transportation and installation are capital intensive but the lack of direct financial grant and incentives were lacking in Ghana. However it is motivating to note that, in Hong Kong, incentive schemes were used to inspire the private sector to promote the use of prefabrication such as prefabricated non-structural external wall in the Joint Practice Note 2 (Government of Hong Kong, 2002). A commitment which is still lacking in Ghana, this results was identified as the major drive to promote the use of prefabrication.

4.4.2 Higher initial construction cost

Higher initial construction cost was ranked second with a mean value of 3.29, this was seen as one of the factors that hinder the adoption of prefabrication for construction works in Tamale, it was noted that, the respondents viewed the use of prefabrication to be too expensive at the initial stages of adopting prefabrication, this argument is supported by Gibbs (2001). The higher initial cost was seen as a demotivation toward the adoption of prefabrication. It must be noted that the project management hand book view a successful project as projects that are on time, within budget and with all features as originally specified; on the contrary it the book however stated that, challenged projects are projects- which are completed, implemented, over budget, over time and with fewer features. This implies that successful projects must have value for money Latham (1994). It must also be noted that cost in construction remain a principal parameter (Piek, 2014) and must not be over looked under any circumstance.

4.4.3 Development type not appropriate to use prefabrication

Development type not appropriate to use prefabrication was ranked third with a mean score of 3.19. The respondents argued that some of the projects they execute were such that, they were not appropriate to use prefabrication because, the projects were complex and not standardized, and in some instances the projects were small and did not require repetition in any form which is the main advantage of prefabrication.

4.4.4 Lack of practical technical training

Lack of practical technical training was ranked fourth with a mean value of 3.17. This was seen as one of the most intriguing issue in the adoption of prefabrication on the part of worker in the construction industry in Tamale; the survey revealed that most of the stakeholders had theoretical knowledge but no practical training in the usage of prefabrication. Lack of experience can result in construction project failures, construction failure is seen by Felt and Carper (1997) as a combination of factors such as mistakes, oversight, misunderstanding, ignorance, incompetence and dishonest performance. It can then be concluded that the lack of technical training would have a negative impact on the adoption of prefabrication. The lack of skill labour can be addressed through inclusion in the curriculum of University and Technical training programmes to equip construction workers with the adequate technical expertise required to carry out prefabrication work.

4.4.5 Inadequate suppliers of prefabrication

The next relevant ranked item was inadequate suppliers of prefabricated products, this had mean value of 3.14. It was observed that there were few small scale prefabricated suppliers in the metropolis and this was a factor that could affect the adoption of prefabrication in the metropolis.

4.4.6 Lack of adequate transport and logistics

Lack of adequate transport and logistics for prefabrication was ranked sixth with mean score of 3.13, it was also observed that the few suppliers and contractors did not have adequate transport logistics for prefabrication works, this were also linked to the higher initial cost since prefabrication is capital intensive, this may also be improved by direct investment into the sector by the Government. These reasons were similar to those identified by MacGraw Hill Construction in the United Kingdom.

4.4.7 Proprietor does not want prefabrication

Proprietor does want prefabrication was the next ranked item with a mean value of 3.00 the respondents were of the opinion that, some of their clients do not want prefabrication method of construction because, they felt that, either the cost would be high or the construction personnel do not have what it takes to execute prefabrication works, some simply do not just like this method of construction.

4.4.8 Limited site space

Limited site space was all ranked seventh with a mean value of 3.00, adequate space to keep prefabricated items before they are installed on site is very relevant to prefabrication works, sometimes they are no adequate space for transportation and even storage of prefabricated components on site before use, this is common with sites that are located at the Central Business District (CDB), where the whole area is completely developed and congested with heavy human and vehicular traffic are a major hindrances to the adoption of prefabrication construction.

4.4.9 inflexible for design changes

Furthermore, inflexible in design changes was ranked eighth with mean scores of 2.99. The respondents opined that, due to the standardised nature of prefabrication it is

difficult to alter the design later when the proprietor or design team deems it fit to do so and this becomes a major challenge in the adoption of prefabrication since variation of work can occur at any stage of any construction project.

4.4.10 Prefabrication not included in design

Prefabrication not included in the design was the next ranked item with mean value of 2.79, some of the respondents also explained that, the projects that they bid or undertake do not have prefabrication components, and they the contractors cannot include that and therefore prefabrication cannot be used for such projects. The exclusion of prefabrication in the entire project by the design team hinder the adoption of prefabrication for construction work.

4.4.11 No policy to promote prefabrication

No cabinet blue print backing on the adoption and usage of prefabrication was ranked as the next hindrance to the adoption of prefabrication with mean value of 2.73. According to Kamar et al (2009b), the Malaysian government showed deliberate efforts to ensure that, prefabricated components were widely used among all professionals involved in the built environment. They further stated that, it was a process which spanned for many years. The government of Ghana may have to come out with a regulatory framework to promote the adoption and usage of prefabrication.

4.4.12 Leakages problems

Granting that leakages may occur at joints of prefabrication if not properly sealed (Cudney, 1998). Leakage problems was found not to be a major problem in the adoption of prefabrication as it was the least ranked of all the factors that hinder on the adoption of prefabrication.

Table4.3 Difficulties in adopting prefabrication

item	*Statement of advantage*	*Frequency*	*Mean*	*Std. Deviation*	*Rank*
A	*Lack of direct financial grant*	*70*	*3.63*	*1.157*	*1^{s}*
B	*Higher initial construction cost*	*70*	*3.29*	*1.181*	*2nd*
C	*Development type is not appropriate*	*70*	*3.19*	*1.067*	*3rd*
D	*Lack of practical technical training*	*70*	*3.17*	*1.434*	*4th*
E	*Inadequate suppliers of prefabrication*	*70*	*3.14*	*1.289*	*5th*
F	*Lack of adequate transport and logistics*	*70*	*3.13*	*1.227*	*6th*
G	*Proprietor do not want prefabrication*	*70*	*3.00*	*1.330*	*7th*
H	*Limited site space*	*70*	*3.00*	*1.228*	*8th*
I	*Not included in the design*	*70*	*2.74*	*1.337*	*9th*
J	*No cabinet backing to promote prefab*	*70*	*2.73*	*1.166*	*10th*
K	*No demand for prefabrication*	*70*	*2.66*	*1.297*	*11th*
L	*Leakages problem*	*70*	*2.39*	*1.171*	*12th*

Source: Field survey (August, 2016)

4.5 MEASURES TO PROMOTE FUTURE ADOPTION OF PREFABRICATION

This dissertation identified some recommendations for the promotion, effective development and adoption of prefabrication in the construction industry in Tamale and Ghana as a whole. These suggestions were itemised into eleven points as presented in Table 4.3.

The provision of direct financial grant to the construction industry was considered as the most effective parameter for future developments. Construction prefabrication work is capital intensive and would require some direct financial support to effectively

trigger the adoption of prefabrication method of construction. Incentive schemes were essential to inspire and motivate the usage of prefabrication in the private sector to promote the usage of prefabrication such as prefabricated non-structural external wall in the Joint Practice Note 2 (Government of Hong Kong, 2002). Similarly, this initiative was also adopted in America, Japan, UK and the whole of Europe in their initial stages of adopting prefabrication as a method of construction.

The advancement of prefabricated skills and using prefabrication as a substitute for shortage of skill labour were ranked second and third with mean values of 3.46 and 3.37 respectively. This survey revealed that, there is lack of practical knowledge on prefabrication skills among some workers in the construction industry in Tamale. Prefabrication method of construction require special skills in their execution and lack of it will adversely affect its adoption, the education sector must ensure that, practical training are incorporated in the curriculum of University and Technical training institutions to ensure practical training in the execution of prefabrication works are inculcated and taught during training. On the contrary the usage of prefabrication can also be adopted as a substitute for shortage of skill labour because large components are manufactured in the factory and assembled on site with few workers within a shorter time without compromising on quality.

Piloting prefabrication construction method was ranked fifth with a mean value of 3.17. This was advocated by (Turner & Vaughan, 2012). Direct piloting of prefabrication in mass projects which are repetitive in nature and can be standardised should be encouraged by stakeholders especially government who is the largest provider of infrastructure in Ghana, so that elementary challenges can be improved upon before this principle is extended to cover larger scopes.

The promotion and adoption of prefabrication as a means to facilitate sustainability in the construction sector was a major item, though least ranked with a mean value of 2.97. Kibert (1994) defined sustainable construction as ‘‘the provision and efficient management of a sound built environment based on resource efficient and ecological principles”. Sustainability is living, producing and consuming in a way which meets the needs of the present without denying the ability of future generations to meet their own needs, the usage of prefabrication can help in achieving this universal goal.

Table 4.4 Future development of prefabrication

item	*Statement of advantage*	*Frequency*	*Mean*	*Std. Deviation*	*Rank*
A	*Provision of direct financial grant*	*70*	*3.53*	*1.370*	*1st*
B	*Advancement in prefab skills in workers*	*70*	*3.46*	*1.315*	*2nd*
C	*Substitute for shortage of skill labour*	*70*	*3.37*	*1.476*	*3rd*
D	*Incentive scheme to inspire private sector*	*70*	*3.34*	*1.443*	*4th*
E	*Piloting of prefab construction method*	*70*	*3.17*	*1.296*	*5th*
F	*Adoption of prefab for future projects*	*70*	*3.06*	*0.961*	*6th*
G	*Government to invest in prefab development*	*70*	*3.00*	*1.049*	*7th*
H	*inclusion into university and tech. training*	*70*	*2.99*	*1.173*	*8th*
I	*Sustainability as the first priority*	*70*	*2.97*	*1.507*	*9th*
J	*Develop prefab Techniques*	*70*	*2.86*	*1.554*	*10th*
K	*Policy to promote prefabrication*	*70*	*2.69*	*1.346*	*11th*

Source: Field survey (August, 2016)

4.6 EXTENT OF USAGE OF PREFABRICATION

4.6.1 Frequency of Prefabricated Element Usage

To determine the most frequently used prefabricated element, nine prefabricated elements were identified for respondents to rank them according to their frequency of use, namely; very frequent, frequent, less frequent and not at all. The elements considered were kerbs, floor slab, beams, girders, columns, wall panels, staircase, lintels and roof trusses.

Considering the use of prefabricated elements by construction firms, the use of roof trusses were ranked first, with a mean score of 2.53. it was noted that metal prefabricated roof trusses were emerging as the predominantly used material for roof works in Tamale, the respondents elaborated in the interview that, metal trusses are more durable, quick and easy to erect has good tensile, compressive and shear stress resistance etc.

This was followed by the use of kerbs which was ranked second, with a mean score of 2.47, kerbs were mostly used for road construction works and landscaping.

The third ranked component of frequency of usage was columns. This was represented by a mean score of 2.43, it was observed that the prefabricated columns used were mostly, concrete and metal columns, these were found mostly in warehouse constructions. Warehouse construction is one of the fast emerging type of construction in the Tamale Metropolis.

The fourth and fifth rankings were beams and lintels, with mean score of 2.30 and 2.29 respectively. Girders and floor slabs were ranked sixth and seventh and in that order.

The least ranked was, staircase which had a mean score of 2.07 and standard deviation of 0.968. It was also observed that most respondents did not use prefabricated elements at all in their construction works.

From the analysis above, it can be conclude that, contractors in Tamale metropolis do not frequently use prefabricated elements, with the exception of roof trusses the rest of the predominantly prefabricated elements used are not quite huge.

Table 4.5 How Frequent Firm Uses Prefabricated Element

item	*Statement of advantage*	*Frequency*	*Mean*	*Std. Deviation*	*Rank*
A	*How frequent your firm uses roof trusses*	*70*	*2.53*	*1.059*	*1st*
B	*How frequent your firm uses roof kerbs*	*70*	*2.47*	*1.315*	*2nd*
C	*How frequent your firm uses roof column*	*70*	*3.37*	*1.476*	*3rd*
D	*How frequent your firm uses roof beams*	*70*	*2.30*	*0.922*	*4th*
E	*How frequent your firm uses roof lintels*	*70*	*2.29*	*1.051*	*5th*
F	*How frequent your firm uses girders*	*70*	*2.27*	*0.961*	*6th*
G	*How frequent your firm uses roof floor slab*	*70*	*2.24*	*0.649*	*7th*
H	*How frequent your firm uses roof wall panels*	*70*	*2.20*	*0.894*	*8th*
I	*How frequent your firm uses roof staircase*	*70*	*2.07*	*0.968*	*9th*

Source: Field survey (August, 2016)

4.6.2 Respondents Intent to Use or Recommend Prefabrication In Future

Figure 4.3 shows the results of respondents who would recommend the usage of prefabricated components in the future. 48 respondents out of 70, (representing 68.57%), said they would recommend the use or use prefabrication method of construction in future when the need arises, 22 out of the 70 respondents would not recommend or use prefabrication in the future. During the interview which was conducted along the administering of the questionnaire, the respondents who said they would not recommend the use of prefabrication in future indicated that, they do not

have adequate equipment and funds to purchase them for their future projects. Those who recommended the use of prefabrication did so because of the numerous benefits associated with the use of prefabrication.

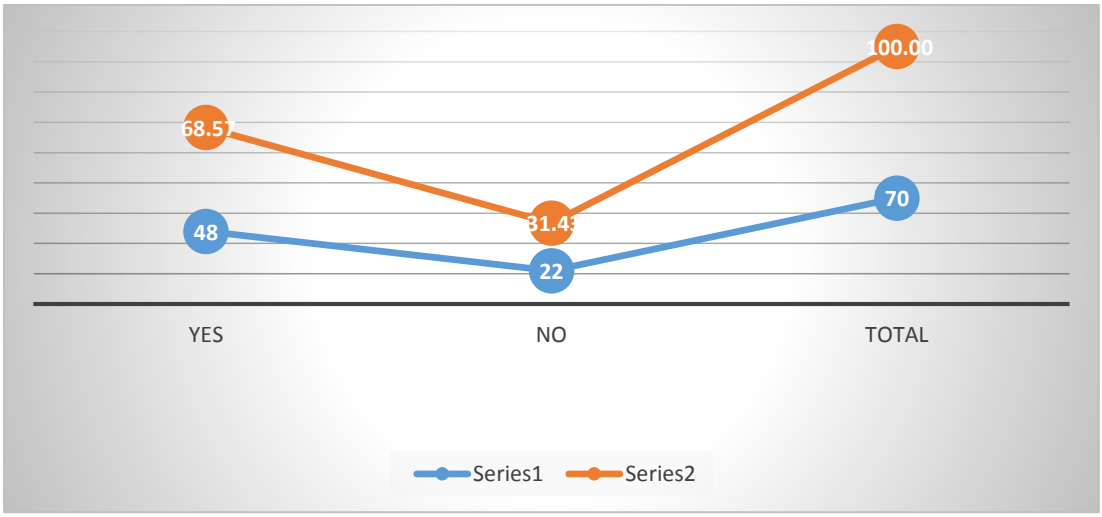

Figure 4.3: Respondents Intent to Use or Recommend Prefabrication In Future

Source: Field survey (August, 2016)

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter presents the final section of the research work and delivers the review of the objectives initially set, draw conclusions and give appropriate recommendations for the promotion and adoption of prefabrication for construction projects in Tamale.

A methodological approach comprising of literature review and subsequent questionnaire survey and desk study of some selected stakeholders in the construction industry were undertaken. The results of the primary data and analysis thereof were presented in the previous chapter. This chapter summarizes the findings of the study in the context of the set objectives and shows how the broader research aim has been achieved.

5.2 REVIEW OF OBJECTIVES

The aim of the research as has been stated earlier, was to investigate how prefabrication can be used a criteria for project success.

To be able to achieve this aim, the following objectives were set:

1. To investigate the benefits in adopting prefabrication;
2. To investigate the difficulties in the adoption of prefabrication;
3. To investigate the measures in adopting prefabrication; and
4. To examine the extent of usage of prefabrication.

This section reviews the study objectives in relation to the findings and highlights the extent to which they have been achieved.

5.2.1 Objective 1: To instigate the benefits in adopting prefabrication.

This objective was addressed by assessing twelve (12) benefits of prefabrication by using a questionnaire survey. This were identified from the literature and respondents ranked them on a five-point scale. The findings of the study identified the following (in descending order) as stated below;

Benefits of applying prefabrication

1. Shorten construction time
2. Reduce construction cost
3. Frozen design at the early stage
4. Better quality
5. More adaptable to hash conditions
6. Achieving green goals
7. Better supervision
8. Reduce construction waste
9. Aesthetic issues
10. Improve environmental performance/sustainability
11. Integrity of the building
12. Fewer onsite resources

5.2.2 Objective 2: To instigate the difficulties/hindrances in adopting prefabrication.

This objective was addressed by assessing twelve (12) difficulties in the adoption of prefabrication by using a questionnaire survey. This were identified from the literature and respondents ranked them on a five-point scale. The findings of the study identified the following (in descending order) as stated below;

Difficulties on applying prefabrication

1. Lack of direct financial grant
2. Higher initial construction cost
3. Development type is not appropriate
4. Lack of practical university/technical training
5. Inadequate suppliers of prefabrication
6. Lack of adequate transport and logistics
7. Proprietor do not want prefabrication
8. Inflexible for design changes
9. Not included in the design
10. No cabinet/policy to promote prefabrication
11. No demand for prefabrication
12. Leakage problems

5.2.3 Objective 3: To instigate the measures in adopting prefabrication.

This objective was addressed by assessing eleven (11) difficulties in the adoption of prefabrication by using a questionnaire survey. This were identified from the literature and respondents ranked them on a five-point scale. The findings of the study identified the following (in descending order) as stated below;

Future development for prefabrication applications

1. Provision of direct financial grant
2. Advancement in prefab skills in workers
3. Substitute for shortage of skill labour
4. Incentive scheme to inspire private sector
5. Piloting prefab Construction method
6. Adopting prefabrication to the future projects
7. Government/stakeholder to invest in prefab development
8. Inclusion into university/technical training
9. Environment/sustainability as the first priority
10. Develop technique and
11. Policy to promote prefabrication

5.2.4 Objective 4: To examine the extent of usage of prefabrication

The fourth objective was attained through a four-point likert question on the extent of usage of prefabrication in Tamale (1 being very frequent, 2 being frequent, 3 less frequent and 4 being not at all). Nine (9) prefabricated building components were identified and respondents rated their usage level as stated below in descending order.

How frequent firms uses prefabricated elements

1. Roof trusses
2. Kerbs
3. Columns
4. Beams
5. Lintels
6. Girders
7. Floor slabs
8. Wall panels
9. Staircase

Also majority of respondents who do not currently use prefabrication highly recommended the adoption of prefabrication in future projects.

5.3 CONCLUSION

Prefabrication is economical when compared to other conventional methods of construction which are being used for centuries now. Prefabrication is a cost and time saving construction method which assures high quality of construction to its maximum extent. The productivity of construction is high and wastes are minimum in the use of prefabrication. Even though prefabrication is established to be very economical, it has its own challenges as the system has not been fully implemented in Ghana and there is less practical knowledge about this method in the construction sector of Ghana.

At present Ghana has just little skilled labour. To introduce prefabrication in Ghana, this percentage should be increased which can help in meeting the huge housing demand using prefabrication. The government needs to come up with smart incentives to facilitate the establishment of prefabrication production plants to avoid any kind of productivity delay (for example one in the coastal areas, one in the middle belt and another one for the northern zone). Even on-site management is crucial for enhanced construction speed and ensuring quality and exact specification. The need for adoption of such a methodology also needs a guaranteed market to function and thus contractors, suppliers and managers also need to be made aware of the potential of such a technology in Ghana. A study conducted on the perception of clients, contractors and consultants towards prefabrication method of construction, reveals the acceptability and knowledge of this method in Ghana.

5.4 RECOMMENDATIONS

The following recommendations were made after a critical look at the literature review and the findings of this study;

1. The government through the Ministry of Water Resources Works and Housing should come out with a deliberate policy to encourage and empower professionals in the built environment to adopt the usage of prefabrication as a criteria for project success in Ghana. This should be a gradual process but not an event, According to Kamar el al. (2009b), the Malaysian government showed deliberate efforts to ensure that prefabricated elements were adopted for use, this was given a strong cabinet backing by an endorsed blueprint document to use prefabrication method of construction for the industrialization of the Malaysian construction sector;

2. Government should also take steps to support the construction industry by either providing them with direct financial grant or incentives to support professionals acquire equipment or buy, and make them available for stakeholders in the construction industry to easily assess them for use. The survey showed that, one of the major hindrances to the adoption and use of prefabrication is higher initial cost of equipment. According to Virendra Vyas International Journal of Engineering and Technical Research (IJETR) Mumbai, India, financial incentives were offered by the government to initial investors in prefabrication construction because the initial cost is higher, making it difficult for new investors in the sector to make it, and this helped promote and improve the use of prefabrication;

3. The Ministry of Education should ensure and encourage, technical and university education to not just be theoretical, but also practical oriented to ensure that students are equipped with both theoretical and practical knowledge, since the survey indicated that majority of the respondents had more theoretical knowledge but lacked practical knowledge in prefabrication and;

4. Finally, government being the bigger provision of infrastructure in the country, should adopt standardisation and prefabrication in all sectors of the economy to allow the use of prefab method of construction to be adopted, for example in the educational sector classrooms, dormitories, and libraries can be standardised across the country. In the health sector for instance, CHPS compounds and hospitals can also be standardised to allow for the adoption of prefab as a method of construction to enjoy the benefits that prefabrication has.

5.4.1 Recommendations for further studies

1. It is recommended that, since prefabrication method of construction is a new method of construction in the Ghanaian construction industry, future research into the concept of prefabrication should be conducted, in order to solve the misunderstanding of the concept to make stakeholders accept it.
2. Further studies to derive prefabrication models for the Ghanaian construction especially in the field of Real Estate developers and the public sector where majority of the projects are repetitive by their design concept, this can facilitate the effort toward the adoption of prefabrication.
3. Further studies should be conducted in other cities of Ghana, to obtain generalized findings in Ghana.

5.5 Limitation of the study

1. Due to the sample used, the findings of the study cannot be generalized to other cities in Ghana, it is recommended that further studies should include more cities in other to generalize the results in respect of Ghana.
2. The type of analytical tool used, thus descriptive statistics were limited in inferring to other populations. Hence, the study recommends that, further studies could use inferential statistics such as structural equation modelling.

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APPENDIX

QUESTIONNAIRE

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

COLLEGE OF ART AND BUILT ENVIRONMENT

DEPARTMENT OF BUILDING TECHNOLOGY

INTRODUCTION

A study is being conducted to assess the knowledge, attitude and practice of people on how to use prefabrication as a criteria for construction project success in Tamale. The results of this survey would be used to draw strategies aimed at promoting the use of prefabricated building components to ensure project success of construction works in the construction industry with reference to Tamale metropolis. Your cooperation is needed in answering the questionnaire. Every piece of information you give would be treated confidentially and would be used for only academic purposes

Please select with a tick [√] and comment where appropriate.

Demographic

13. Please which of the following does your company belong;

a. Builder/ constructor [ ]

b. Architectural/engineering/consultancy [ ]

c. Client/developer/government agency [ ]

d. Others specify [ ]

14. Please indicate the academic qualification you hold

a) Basic [ ]

b) Secondary [ ]

c) Tertiary [ ]

d) Others specify…….

15. Years of working experience

a) 0-5 year

b) 6-10 years

c) 11-15 years

d) 16-20 years

e) Over 20 years

16. Investigate the Benefits in Adopting Prefabrication

Benefits of prefabrication	Least relevant	Fairly relevant	relevant	Very relevant	Extremely relevant
Better quality					
More adaptable to hash conditions					
Reduce construction waste					
Fewer onsite resources					
Achieving green goals					
Frozen design at the early stage					
Better supervision					
Reduce construction cost					
Shorten construction time					
Improve environmental performance/sustainability					
Integrity of the building					
Aesthetic issues					
Achieving green goals					

17. Investigate the Difficulties in Adopting Prefabrication

Difficulties of prefabrication	Least relevant	Fairly relevant	Relevant	Very relevant	Extremely relevant
Not included in the design					
Development type is not appropriate					
Proprietor do not want prefabrication					
Inadequate suppliers of prefabrication					
Lack of adequate transport and logistics					
Inflexible for design changes					
Higher initial construction cost					
Lack of direct financial grant					
Lack of practical university/technical training					
Limited site space					
Leakage problems					
No cabinet/policy to promote prefabrication					
No demand for prefabrication					

18. Investigate the Measures in Adopting Prefabrication

Future development	Least relevant	Fairly relevant	Relevant	Very relevant	Extremely relevant
Cabinet/regulation/policy to promote prefab					
Government/stakeholder to invest in prefab development					
Inclusion into university/technical training					
Provision of direct financial grant					
Advancement in prefab skills in workers					
Incentive scheme to inspire private sector					
substitute for shortage of skill labour					
Adopting prefabrication to the future projects					
Piloting prefab Construction method					
Environment/sustainability as the first priority					
Develop techniques					

To investigate the Extent of Usage of Prefabrication in The Study Area?

8. Please indicate how frequent your firm uses the following prefabricated elements

Please use: 1 = very frequent; 2 = frequent; 3 = less frequent; 4 = not at all

No	Component	1	2	3	4
1	Kerbs				
2	Floor slab				
3	Beams				
4	Girders				
5	Columns				
6	Walls panels				
7	Staircase				
8	Lintels				
9	Roof trusses				

9. If your company do not use any of the above prefabricated components please state why……

……

10. If your company is not currently using prefabricated components, do you intend to use them in future or recommend for its use

a) Yes [ ]

b) No [ ]

THANK YOU FOR PARTICIPATING