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Key managerial measures contributing to construction waste reduction: evidence from construction projects in Ghana

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 MSc. Project 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 or any other university, except where due acknowledgement has been made in the text.

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ABSTRACT

Ghana is overwhelmed with high wastage levels and this is very evident in the sites and communities in the country. Research has shown that, the construction industry plays a significant role in this waste generation. Therefore, the aim of the study is to ascertain the key managerial measures contributing to construction waste reduction in Ghana. With this aim, three (3) objectives were set which were to identify the causes of wastage on construction sites, to identify the key managerial measures contributing to construction waste reduction in Ghana and to identify the challenges impeding the implementation of the managerial measures to waste reduction in Ghana. Establishing the objectives led to the extensive review of literature and subsequently, developing a structured questionnaire to aid in the collection of data from the respondents. Using the convenient non-probability sampling technique, fifty-one (51) questionnaires were retrieved for the analysis. The data were analyzed using RII. With the first objective, poor site management ranked as the most significant cause of wastage on construction sites. A study conducted stated that, waste can occur due to poor construction management on construction sites. Poor planning and scheduling by the contractor were ranked second. Poor planning by the contractor was also identified the most significant cause of waste generation in the construction. Overproduction was ranked third. Overproduction is also a different type of waste which can be associated with over-use of materials and excess input of energy by employees into production. With the second objective, effective supervision was ranked as the most applicable strategy. Supervision is the general direction, coordination and oversight of the processes of a project on-site. Reduce, reuse, recycle was ranked as the second most applicable strategy. Reduce, Reuse and Recycle is a common assertion made in general waste management processes in the construction industry. Development of waste management plan was ranked as the third most applicable strategy. The development of a plan for waste management is also a vital tool in waste reduction. With the third objective, the most severe challenge was inexperience of the contractor. This was followed by lack of funds and time constraints. Lack of experience on the side of the contractor is a significant challenge in the effective implementation of waste management strategies. With these findings, it was recommended that, for public projects, bidders should submit their methods of minimizing waste as part of bid requirements and any bidder who fails to do so can be deemed not responsive. Also, construction firms should enact strict procedures towards waste reduction during the execution of a project. Lastly, construction firms should educate their work personnel on effective ways of waste minimization. This study was limited to only construction firms operating in the Accra metropolis. Further studies can expand the scope to include other areas in the country. The study was also limited to waste generated at the construction phase of project execution. Further studies can expand to include other phase of the construction process. There is also an avenue to study the impact of contactor's waste management strategies on construction project performance.

Key words: construction, waste, managerial, measures, project,management.

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My hearty thanks go to my family.

And finally to all those whose names are not mentioned here, even though their contributions and support are part of this success story, I say a big Thank you.

DEDICATION

This dissertation is dedicated to the Almighty God for his mercies and my family, who laid the foundation for my education.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The construction industry is a very complex sector as it involves the influence of numerous stakeholders at every stage of the construction process. However, Ofori (2012), opined that, the construction industry directly linked to the infrastructural and economic development of the country. Most construction projects involve consultants, main contractors and subcontractors. All these stakeholders have a major role to play in ensuring the project is executed smoothly. The performance of the industry contributes significantly to the country's development. This is because, it employs a wide range of personnel as it is mostly labor intensive (Langford et al., 1995). The Ghana Statistical Service (2015), indicated that, the construction industry in Ghana contributes and average of 14.8% to the country's Gross Domestic Product (GDP). Most importantly, the Ghanaian construction industry is regarded as one of the fastest growing sectors in the country with an annual growth of 7-8%. An even faster rate of growth can be realized if the construction processes are highly expedited.

A major challenge facing construction firms in Ghana is the inability of local contractors to compete with foreign construction firms operating in the country (Abernethy, 1988). This challenge can be attributed to the lack or inadequacies of vital capabilities like capital plants and other managerial technicalities. These are strong pre-requisites for an effective and successful construction project tendering and execution. Another major problem that reduces the effectiveness of construction firms

in Ghana is their wastage levels. Generally, the construction industry is regarded as an environmentally unfriendly industry (Yuan et al., 2011). The industry produces an outrageous level of waste around areas like energy and physical and nonphysical material resources. The generation of construction waste has major effects on both the industry and the country as a whole. The cost of disposing waste on construction sites is a major cost center in the construction industry as wastage levels increases exponentially. Furthermore, the emission of unsafe gases during the construction process and the transportation of contaminated waste are potential hazards to the environment. Also, construction waste generation contributes significantly to the depletion of raw materials used in the construction industry.

Gudigar et al. 2014), opined that, since the construction industry is well-noted for its diverse waste generation, it is very important to ascertain which material mostly generates significant waste on sites. Waste from construction activities are of distinct levels which are mostly obtained from the basis of waste produced (Li et al., 2016). Wang et al., 2008). indicated that, the construction industry generates various types of waste ranging from aluminum, concrete, cement, timber, tiles, brick and steel. Ameh and Itodo (2013) conducted a study on material wastage on construction sites and identified most wasteful building materials during project operation as mortar from plastering (rendering). Chu (2004) conducted a study in Hong Kong and identified the following: concrete, blocks, plastering and waste from screeding, as waste materials generated on construction sites. In supporting this, Gudigar et al. (2014) were of the view that, construction waste materials are of varieties including building debris, steel,

concrete, rubble earth, mixed site clearance materials and timber. Napier (2012) identified numerous waste materials according to their percentage contribution and these are concrete 5%, wood 30%, dry wall 3%, gravels, aggregate and fines, 20%, Asphalt roofing 5%, plastic 1%, ferrous and nonferrous metals 9%, disposal as refuse 5% and cardboard and paper 3%. Looking at the percentages, it means wood is the predominant material wasted on project sites. In support of this, Tam et al., (2007) identified the following percentage wastage of materials: block/brick 8.9%, concrete 8.99%, formwork 20%, reinforcement 7.7%, and tiles 15.58%. The author concluded that, of all these wasted materials woods is the highest generated waste material. These levels of waste are unacceptable and lead to significant monetary losses. Therefore, the study aims at ascertaining the key managerial measures contributing to construction waste reduction in Ghana.

1.2 STATEMENT OF THE PROBLEM

Ghana is overwhelmed with high wastage levels and this is very evident in the sites and communities in the country. Research has shown that, the construction industry plays a significant role in this waste generation. For instances, studies conducted by Craven et al. (1994) showed that, construction activities generate an approximate amount of 20 to 30% of all waste deposited in Australian landfills. Also, Ferguson et al. (1995) indicated that, more than 50% of the waste deposited in a typical landfill in the UK are construction waste. In the Netherlands, waste constitutes a total of 26% of the total amount of waste. These figures give a huge indication of the severity of waste generated by activities in the construction process.

Wahab and Lawal (2011), postulated that, waste may be produced at all the various phases of the construction process like the planning stage, estimating or construction stage. Material waste causes a lot of financial loss to the contractor which is most of the time transferred to the client sometimes leading to litigation. According to Wang et al. (2008) construction waste is a very serious environmental canker in many large cities in China. The authors estimated that, in 1998, an average of 7,030 tonnes (42%) of waste from demolition and construction were disposed as landfill in Hong Kong.This increasing volume of waste have created a bad image for the construction industry (Rameezdeen, 2007). It is not surprising that research studies on construction waste are gaining significance and more public concerns (Yuan et al., 2011). It is very difficult to systematically measure all wastes in construction as it exists in many forms in a typical construction project. In view of this, many researchers from different countries used different measures to quantify waste such as excess consumption of materials (Bossink and Brouwers 1996), quality failure costs (Cnudde, 1991), and maintenance and repair costs, accidents, and non-productive time (Oglesby et al., 1989). These findings bring to bear the need to improve on waste management processes during construction. Therefore, the aim of the study is to ascertain the key managerial measures contributing to construction waste reduction in Ghana.

1.3 AIM OF THE STUDY

The aim of the study is to ascertain the key managerial measures contributing to construction waste reduction in Ghana

1.4 OBJECTIVES OF THE STUDY

The objectives of the study are;

1. To identify the causes of wastage on construction sites;
2. To identify the key managerial measures contributing to construction waste reduction in Ghana; and
3. To identify the challenges impeding the implementation of the managerial measures to waste reduction in Ghana.

1.5 RESEARCH QUESTIONS

This study seeks to answer the following questions

1. What are the causes of wastage on construction sites?
2. What are the key managerial measures contributing to construction waste reduction in Ghana?
3. What are the challenges impeding the implementation of the managerial measures to waste reduction in Ghana?

1.6 SIGNFICANCE OF STUDY

The construction industry is very significant in the development of the infrastructural component of the country. However, the industry is well-noted for its underperformance and wastage levels. Therefore, this study is very significant as it will create awareness among construction engineers, developers, professional builders/contractors, and the general public about construction waste and mitigation measures. This will help decrease the occurrence of client dissatisfaction, project delays and cost overrun.

The occurrence of waste in the construction industry forms a major cost center and mostly leads to cost overruns. Waste management can save up to 30% of construction cost (Tam et al. 2007). This study will aid in the realization of this savings by developing practical strategies that can be adopted in that respect. Therefore, this study is very significant as it can aid in the realization of the 30% cost savings as indicated by Tam et al., (2011).

Lastly, this study will contribute to the body of knowledge and literature on waste management and its challenges. This could serve as a basic for policy formulation and benchmarking.

1.7 BRIEF RESEARCH METHODOLOGY

The aim of the study was realized through the review of pertinent literature followed by the development of a structured questionnaire to collect data from the respondents. For this study, only primary data was used. The respondents were construction firms in the Accra metropolis currently executing a construction project in the vicinity. This study adopted the quantitative research method. This is because; only numerical data was utilized in the analysis of the data. Also, mathematical tools were adopted in the analysis of the data collected. The data was analyzed using percentages and the Relative Importance Index (RII). The study adopted the survey research design and the study involved the use of a sample obtained from a population. The research approach was deductive. Details of the methodology is shown in the chapter three (3) of this report.

1.8 SCOPE OF THE STUDY

The scope of the study is categorized under geographical scope and contextual scope. Geographically, this study was limited to construction firms who were currently executing projects in the Accra metropolis. Contextually, the study was limited to waste management practices used by construction managers during construction phase of the project.

1.9 THESIS STRUCTURE

The structure of this report was shown in figure 1.1. The chapter one (1) constitutes the general introduction to the study. The introduction of the study touches on the background of the research, the problem statement, research aim, research objectives, the scope, significance of the study and the methodology. The chapter two (2) involved a comprehensive review of literature pertaining to the study. The chapter three (3) gave an elaborate discussion on the methods, approaches and strategies employed for this study. It also discusses the type, method and processes of collating and analyzing the data. The chapter four (4) provided a report on the analysis of the data collected from the respondents. It establishes the procedures adopted for the analysis and a discussion of the results of the analysis. The chapter five (5) summarized and gave a conclusion to the entire report. This includes a discussion on how the objectives were achieved, the findings and recommendations made.

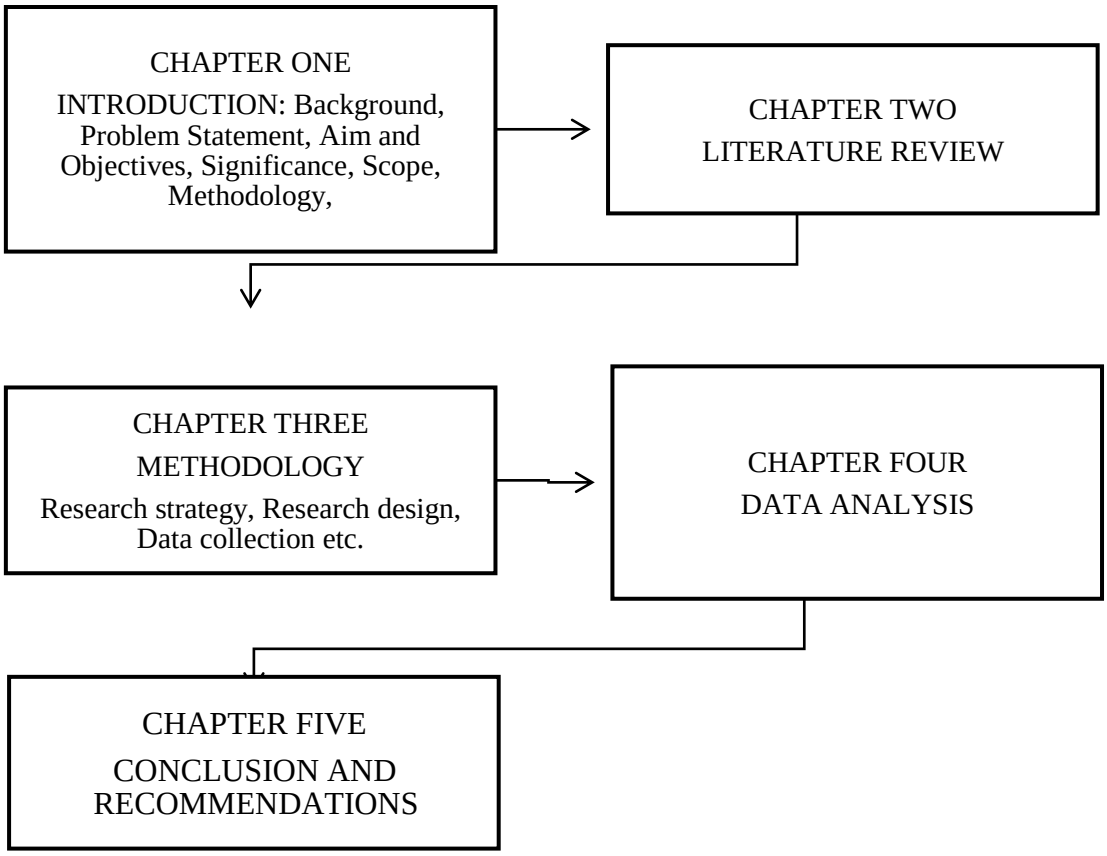

Figure 1.1: Structure of the report

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews literature pertaining to the subject area of the study. This review forms the first step in the achievement of the aim and objectives of the study as it aids in the development of a survey questionnaire to collect data from the respondents. The review is conducted based on the objectives of the study. The study had three objectives which were to identify the causes of wastage on construction sites, to identify the key managerial measures contributing to construction waste reduction in Ghana and to identify the challenges impeding the implementation of the managerial measures to waste reduction in Ghana. The outline of this chapter includes the overview of the construction industry, the concept of construction wastage, causes of wastage, effects of wastage, sources of waste, managerial measures to reduce wastage and the challenges in implementing the measures.

2.2 OVERVIEW OF THE CONSTRUCTION INDUSTRY

The economy of Ghana, a Sub-Saharan country in Africa is rapidly developing at a great pace (Ahmed et al., 2014). The construction industry is a key player in the growth of any economy as its activities are prime importance to the achievement of the socio-economic development goals in the provision of shelter, infrastructure and also as a source of employment (Kutir, 2016; Osei, 2013). The construction industry is huge and a very vital sector in economic development as in other parts of the world. According to Osei (2013), in the improvement of the socio-economic circumstances

and development of the built environment of every country, the construction sector plays a vital and critical role in achieving such success. Mahajan *et. al* (2014) also came to an understanding that the construction industry is a key sector in the economy of almost every country. Physical infrastructure and asset based-lending as a development controls the construction with its accompanying industry complexity and varying nature. In the Ghanaian society, the construction sector contributes foremost to the economy potently by the helping to alleviate the unemployment canker in the country by providing jobs for both the educated and the uneducated as well. Nonetheless there is an ever-increasing demand for housing, commercial as well as industrial space while conversely trying to sustain the physical environment and the social development of the country of which the construction industry is struggling to keep pace leading to huge infrastructural deficit in the country (Ahmed et al., 2014).

Efficient performance measurement is of immense importance to the successful implementation of a project (Ofori-Kuragu et al., 2016). Sanganyi (2016) also noted in agreement that projects like the construction of works in schools today are temporary undertakings to attain a certain set target within a particular duration and a pre-determined cost. Otieno (2000) also asserts that in the third world countries, many projects fail to be successful as a result of many varied reasons.

Asamoah and Decardi-Nelson (2014) conjectured that even though the construction sector in Ghana aids the progress of the economy particularly social development, it is cripples with practices that are alien to the industry which are highly unprofessional.

Ofori-Kuragu et al. (2016) distinguished that the Ghanaian construction sector does not reflect the great strides in the execution of construction projects as it's the case in many developing countries. It is for these reasons that Callistus and Clinton (2016) posits that to achieve the set targets and aims of a construction project, there is the need for monitoring and evaluation in the project delivery process. It is then that the prevalent ideology of bad performance and performing below accepted norms and practices amidst the Ghanaian construction professionals leading high rate of delayed construction, deserted as well as stopped projects due to contractor non-performance (Ofori-Kuragu et al., 2016) can be stopped. However, it is an undisputed fact that the construction sector has colossal future benefits as it stands a great capacity to employ a wide range of people, increase the country's capital base and technological enhancement (Nhabinde et al., 2012). Kutir (2016) postulates that it becomes of a prime significance to know the probable causes of unsuccessful projects which includes failure to monitor and evaluate construction activities and the strategies embraced by the fast-developing ones. If such acts of failure are not checked, through their investigation revealed that these activities lead to long standing and perilous problems to the construction industry inclusive time and cost overrun, waste generation, conspicuous negative impact on the environment and colossal intake of resources. It is also observed that issues of litigation and time overruns leading to projects absolute abandoned are some of the delays in construction (Fugar and Agyakwah 2010). Ofori-Kuragu et al. (2016) finally affirms that in Ghana, the full achievement of project targets and objectives are alien to most construction clients.

2.3 OVERVIEW OF CONSTRUCTION PERFORMANCE

The three (3) most significant performance criteria as identified in literature are cost, time and quality. They are popularly known as the iron triangle. Chan and Chan (2004) described construction schedule as the duration for completing a project. The schedule of a project is normally arranged to allow the building to be used by a date determined by the client. Time is one of the major factors that is used to measure the success of a project (Swan and Khalfan, 2007). Thus, the component of time may suggest to project managers and all stakeholders that the project was completed smoothly and on schedule. Therefore, project managers prefer contracts with reasonable amount of time to execute completely. The timely completion of a construction project is seen as the hallmark of the design and built industry. However, construction delays have become a major component of construction projects as projects continue to experience delays even with the vast advancement in technology and management understanding (Stumpf, 2000). The duration of a construction project is affected by various factors which include post award-negotiations, pre-tender proceedings and poor schedule planning by the contractor (Westring, 1997). Also, bureaucratic interference and availability of resources as planned affects the timely completion of a construction project.

According to Egemen and Mohamed (2005), completing a project to meet the required quality standards is one of the major criteria in measuring project success. Quality is achieved when the legal, aesthetic and functional requirements of a project of the

customers/client is achieved (Tang et al., 2005). Quality involves meeting or exceeding the expectations of clients. According to

Ling et al., (2009), quality is the output of the service provided or work done. Arditi and Lee (2004) defined quality as the ability to conform with a quality plan designed to satisfy customer needs. Thus, in the construction industry, quality is determined by the ability to conform to set standards. From the definitions above, it can be deduced that, quality can be described from two main perspectives. The first being the perspective of the finished project (Ling et al., 2009). The second perspective as adopted by Arditi and Lee (2004). It should be noted that, low cost and speedy construction should not be highly focused on at the expense of quality of the construction project. The three (3) significant components of quality management on a construction project are quality planning, quality assurance and quality control (Project Management Institute, 2000). Quality planning can be defined as the process of setting quality objectives and specifying necessary operational processes and related resources to fulfil the quality objectives. Quality assurance also describes the process of providing the confidence that quality requirements can be achieved while quality control describes the process of monitoring specific project results to determine whether they comply with relevant quality standards or not. These components aid in the achievement of high-quality performance in construction when they are properly executed.

The performance of a construction project gives an indication of how successful the project was executed. How construction project's stakeholders determine the success of a project varies from each party (Zoltan, 2017). However, according to Agarwal and Rathod (2006), for a project to be successful, it must be delivered on time, budget and specifications. Since the emergence of this description, various researchers have broadened the scope of project success over the years. For instance, Atkinson et al., (1997) incorporated the performance of the stakeholders, assessing their contributions and understanding their expectations. Wateridge (1998) indicated that, the benchmarks for a successful construction project are very broad and it integrates the performance of the stakeholders, assessing their contributions and coming to terms with their expectations.

Despite all these advancements in the description of the concept of project success, cost performance is regarded by many researchers as the most important success criteria (Olawlae and Sun, 2010). Gido and Clements (2003) indicated that, cost performance is an effective method in project management effort expended and it is generally recognized in literature and industry. Furthermore, Salter and Torbett (2003), indicated that, the use of cost performance is one common means to measure project success with ease. Apart from the tender sum, the cost from inception to completion makes up the cost of project. A comprehensive site investigation helps in proper planning which aids to get a clear scope for the project and later results in project cost performance. By Georgy et al. (2005), the cost variance of project results from the difference between the actual cost and the budgeted cost and a good way of measuring project success.

2.4 THE CONCEPT OF CONSTRUCTION WASTAGE

Waste can be described as all the material different from the minimum quantity of resources (materials, equipment, manpower) needed in the creation of a product (Alarcon, 1995). From the description of waste provided, it can be concluded that, waste is any resource that do not add to the value of a product. Another description of waste provided by Rameezdeen (2007) was that, waste is an unused material left onsite. Further descriptions by Westerveld (2003), viewed waste as an unwanted material from the execution of construction activities. From all the descriptions of waste above, it can be ascertained that, waste is unwanted and should be avoided as much as possible.

Therefore, many governments have taken initiatives with the goal of waste minimization. For example, the government of Wales proposed to achieve a 60% reduction in waste by the year 2000 by amending their existing Waste Disposal Act (Waste Reforms, 1995). Details of the existing Waste disposal Act enacted in 1970 concentrated on the storage, collection, treatment and disposal of wastes. The reforms were based on waste management hierarchy that prioritizes avoidance and reuse of waste.

Formoso et al. (2002) opined that, most construction stakeholders have the general idea that, waste is directly connected with debris removed from the site and disposed at landfills. This common assertion of the nature of waste can be attributed to the fact that, it makes the quantification of waste very easy. However, there is more to waste than that, and thus it has been heavily criticized by researchers. Gudigar et al. (2014) opined that waste includes

all inputs that are heavily criticized. According to Gudigar et al. (2014), at every stage of construction, the inputs gets deformed, discarded, discouraged, discounted, disgraced, diseased, disfigured, disintegrated and hence categorized as waste.

Waste was categorized by Skoyles (1976), as direct waste and indirect waste. The direct waste was described as the loss of material, because they are damaged or cannot be used again and thus need to be removed from site. On the other hand, indirect waste occurs when materials are not physically lost but there is some form of monetary loss. For instance, there is no physical loss occurs when a concrete slab thickness is larger than specified in a structural design. There is only monetary loss as more money than required was pumped into its construction.

There are numerous activities executed by construction firms that do not add any value to the construction project during its execution (Ekanayake and Ofori, 2000). These activities that do not add value has initially been described as waste in this review. Therefore, it can be confidently postulated that, construction waste is not only concentrated on the quantity of wasted materials on site, but also, several other activities and occurrences like overproduction, waiting time, material handling, processing, inventories and movement of workers (Alarcon 1994). Various causes of waste generation on site are discussed in the next section.

2.4.1 Causes of wastage

The causes of waste include poor planning and scheduling, variations during construction, mistakes during construction, unnecessary movement of materials and human personnel, poor site management and overproduction. These factors are discussed into details as follows;

2.4.1.1 Poor planning and scheduling by the contractor

Ekanayke and Ofori (2000) identified poor planning by the contractor as the most significant cause of waste generation in the construction. Polat and Ballard (2004), had a similar assertion about poor planning and scheduling by the contractor. He opined that, it could be significant cause of wastage during the execution of construction projects. With regards to the nature of construction, planning of work items is a key component of the construction process. Improper planning and scheduling forms a big contributor to waste generation as opined by the researchers above.

2.4.1.2 Variations during construction

Variations can be described as changes that are made to the initial scope of a construction project. A research conducted in China by Zhao and Chua (2003), concluded that, reworks caused by changes to the scope of works forms a significant waste generation during project execution. Reworks include demolition and re-construction which may involve additional materials and labor and disposal of damaged materials on landfills as a result of demolition. Variations in it can lead to demolitions and reconstructions. Wan et al. (2009), had a similar assertion about

variations. They indicated that, variations form a major aspect of waste as errors and mistakes that lead to design changes may result in major alterations like relocation of stairwells.

2.4.1.3 Mistakes during construction

Pheng and Tan (1998), opined that, mistakes made during the construction of a project can hugely stimulate the generation of waste during construction. Mistake that happens during the course of project execution can be described as occurrences variant from the default procedure (Wang et al., 2008). If a contractor lacks the technical capabilities in the execution of a project, there is the tendency to increase the cost of the project from around 6-10% of the total project cost due to the mistakes the contractor may commit (Koskela, 1992).

2.4.1.4 Unnecessary movement of materials and human personnel

According to Ohno (1988), there are two categories of operations and movement on a construction site. These are waste and actual work. Waste is the movement that does not add value and is not needed basically termed as unproductive time. Work includes both non-value adding and value-adding work. Again, unnecessary transports of goods on site which may arise due to improper site layout have significant effect on time and cost. Unnecessary movement of people can therefore be considered as a major source of waste in the execution of construction projects.

2.4.1.5 Poor site management

A study conducted by Lu et al. (2011), stated that, waste can occur due to poor construction management on construction sites. Similarly, Jayawardane (1998) indicated that, waste can be generated due to improper management and supervision of sties. Thus, poor site management and supervision is a major cause of construction wastage on site. This was elaborated in Wang et al. (2008) research in China. The authors stipulated that, lack of management skills and lack of supervision is a key reason of substantial amount of waste generation on construction sites. Furthermore, in Chile, it was identified by Serpell et al. (1995) that, poor or lack of supervision causes waste generation in the construction industry mainly on-site.

2.4.1.6 Overproduction

Overproduction is also a different type of waste which can be associated with over-use of materials and excess input of energy by employees into production. Skoyles (1976) categorize this type of waste as indirect waste where materials are not physically lost but causing only a monetary loss and increasing cost of production. For example, waste due to concrete slab thickness larger than specified by the structural design. This over-design structurally does not have any impact on the structure but can have significant impact on cost.

2.4.2 Sources of material waste

Dania et al. (2007) indicated that construction waste materials are of different varieties. These include building debris, steel, concrete, rubble earth, mixed site clearance materials and timber. Napier (2012), identified numerous waste materials according to their percentage contribution and these are concrete 5%, wood 30%, dry wall 3%, gravels, aggregate and fines, 20%, Asphalt roofing 5%, plastic 1%, ferrous and non-ferrous metals 9%, disposal as refuse 5% and cardboard and paper 3%.

These percentages mean that, wood is the predominant material wasted on project sites. In support of this, Tam et al. (2007), identified the following percentage wastage of materials: block/brick 8.9%, concrete 8.99%, formwork 20%, reinforcement 7.7%, and tiles 15.58%. The author concluded that, of all these wasted materials woods is the highest generated waste material. Contrarily, Perry and Kristy, (2007) in their study concluded that waste from brick is the highest waste by weight generated on domestic construction site in Australia as cited in (Ameh and Itodo, 2013). It is of this that Agyekum et al. (2012) stated that the construction industry is highly responsible for producing numerous varieties of wastage owing to its factors of production, stages of construction, the kind of construction task and practices on project site.

Based on this, Li et al. (2016) concluded in their report that construction waste is the amalgamation of waste from all work packages at site. The five (5) major building materials associated with excessive waste generation are concrete, reinforcement, brick and block, formwork and tile (Tam et al., 2016). These are further discussed below.

2.4.2.1 Concrete

Concrete is the most widely used material for construction projects (Bossink and Brouwers 1996). Concrete is generally a mixture of fine aggregates, coarse aggregate and cement. According to Tam et al., (2016), waste in concrete basically results from excess quantity of ready-mix concrete which result from changes and errors in calculating the quantity of needed concrete due to improper planning or inefficient communication. He also identified a quantum of concrete waste generation during transportation. He stated that, concrete may settle over a long period of transportation and cannot be used for construction activities. A project manager interviewed in Hong Kong stated that, due to congested traffic in Hong Kong, concrete wastage due to the settlement over long transportation time affects around 1.5% of the total mixed concrete materials. However, just like in Ghana, it is impossible to control the transportation system in Hong Kong. Other causes of wastage in concrete may include poor formwork and concrete handling processes.

2.4.2.2 Reinforcement

Steel bars are mostly used in construction projects as reinforcements. According to Tam et al., (2016), steel wastage mostly results from cutting. Damages and rusting during storage also form a major part of steel wastage.

2.4.2.3 Formwork

Timber boards used for formwork are another major material used on construction sites. The major causes of wastage in timber are rots and cutting waste and are very difficult to avoid (Tam et al., 2016). According to Shen et al., (2013), timber materials

wastage can be as high as 20 percent of the total materials during substructure works. Thus, timber wastage can be significant without proper management.

2.4.2.4 Brick and block

Bricks and blocks are the most common materials used in walling. Cutting of bricks and blocks for joints or small spaces is the main cause of their wastage. Due to the fragile nature of bricks and blocks, they can be damaged during transportation and unloading (Tam et al., 2016). Unused bricks and blocks can also go waste and such wastes can be imperative in projects where material planning is poor.

2.4.2.5 Tiles

Tiles are normally wasted in a non-consequent process, affected by different stages of construction sequence (Tam et al., 2016). The sizes of the materials may not match specifications in the design because of poor coordination and communication. In some cases, wastes have to occur in the application to these specific sized areas. Also, during transportation, tiles can be easily cracked.

2.5 MANAGERIAL MEASURES TO REDUCE WASTAGE

Construction managers have a significant role to play in ensuring that, wastage on construction sites are reduced to the bearest minimum. The roles that they play includes effective supervision, development of waste management plan, monitoring and evaluation, reduce, reuse and recycle, thorough study of the design and client requirements, effective motivation of employees, proper work methods, proper site

layout, education and training and implementation of sanctions. These factors are discussed below.

2.5.1 Effective supervision

Supervision is the general direction, coordination and oversight of the processes of a project onsite (Mustapha, 1990). It is the duty of the contractor to provide effective supervision on sites mainly through delegation or self-supervision. In order to effectively supervise on-site, the supervisor must clearly delegate responsibilities and make prompt decisions on behalf of the client. The site supervisor plays the most significant role in site supervision. Improper site supervision can lead to numerous problems that generates waste on sites.

2.5.2 Development of waste management plan

The development of a plan for waste management is also a vital tool in waste reduction. According to Gudigar et al. (2014), the plan for the management of construction waste management should be divided into phases. The authors concluded in their study that, waste management needs its due importance in projects and that the management area needs to be developed as any other management knowledge area and the benefits of this area towards environment, sustainability, cost-benefits, speed of construction, and needs distribution (Gudigar et al., 2014).

2.5.3 Monitoring and evaluation

Shihemi (2016), described monitoring and evaluation as the practice that helps in assessing the performance and achievements of project success. Monitoring and evaluation is directed to the effective use of project resources (Callistus and Clinton, 2016). It is the managerial duty of the construction manager to monitor and evaluate the processes used in the execution of construction projects. This aids in the reduction of waste through reworks and mistakes in construction (Callistus and Clinton, 2016).

2.5.4 Reduce, Reuse and Recycle

Reduce, Reuse and Recycle is a common assertion made in general waste management processes in the construction industry. It is the duty of the construction manager to establish mechanisms that can aid in the process. The process was a proposed reform in Wales in a Waste Disposal Act (Waste Reforms, 1995). This process reduces the tendency of completely discarding materials as waste and creates material usage effectiveness. Figure 2.1 shows a waste management hierarchy involving reduce, reuse and recycle.

2.5.5 Thorough study of the design and client requirements

Client requirement depicts the targets, desires, expectations or constraints imposed by the client on the execution of a construction project (Gilb, 2005). In order to realize a satisfactory result of the project, the construction manager must clearly understand the scope and aspirations of the client (Chan et al., 2002). The contractor must liaise with the design team to ensure that, the requirements of the client are clearly understood. Chan et al. (2002) opined that, this is a crucial step as it guides against excessive scope changes and reworks which are major causes of wastage on construction sites.

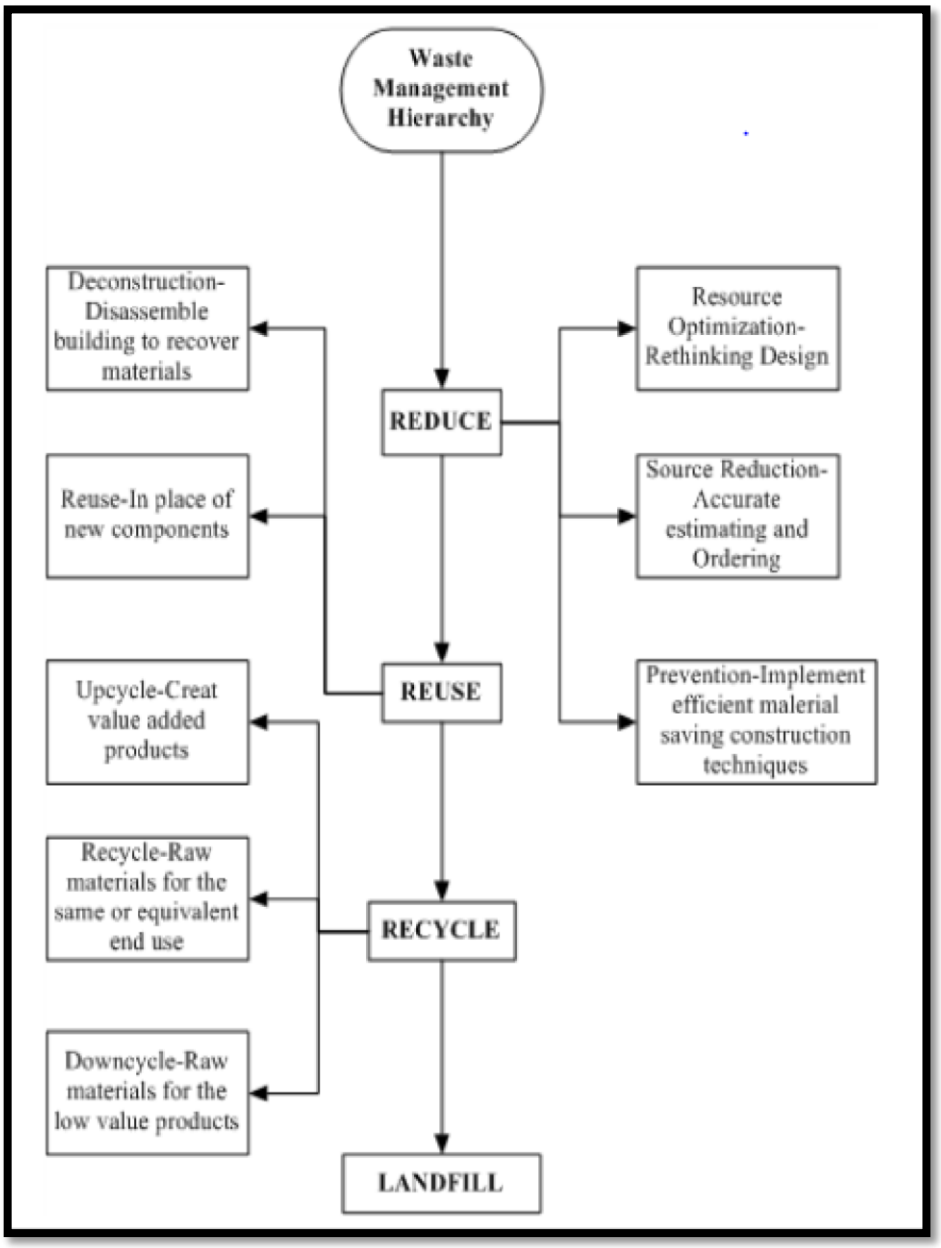

Figure 2.1: Waste Management Hierarchy

Source: Gudigar et al., (2014).

2.5.6 Effective motivation of employees

Motivating employees can increase their willingness to work extra hard to achieve a particular aim. According to Kerzner (2013), construction projects fails because of poor morale and inadequate motivation. Thus, poor motivation can consequently lead to the inability of project managers to meet targets set by him and the client makes the project unsuccessful. Therefore, it is very necessary to have motivated individuals who will work extra hard to achieve a particular set of goals or aim. Motivating employees can raise their level of work and reduce the amount of waste they generate especially in unnecessary movement of work personnel.

2.5.7 Proper work methods

The selection of a proper construction method has a significant impact of construction productivity (Thomas et al., 1990). Serpell (2002), indicated that, the selection of an inappropriate construction method for a project can cause imperative losses to the productivity on site. The method statement is a document that specifies the processes and steps in the execution of a construction project. It also gives an indication of the human and plant resources needed for the work item. If the method statement is not properly done, it can cause wastage on the site as it creates the tendency for excessive mistakes and reworks.

2.5.8 Proper site layout

Many researchers believe that, the working environment of employees affects their morale, willingness to engage in site activities and productivity (Chandrasekar, 2011;

Kim and Dear, 2013). The working environment surrounding construction work personnel have a significant impact on how these employees approach site activities. Quality working environment promotes job satisfaction and efficient team collaboration at the work place which reduces wastage on site. The main aim of a site layout is to identify the required temporary facilities, its size and shape and also stipulates an appropriate location for it placement (Sanad et al., 2006). Their appropriate location eliminates the occurrence of excessive handling of materials and unnecessary personnel movement. Other managerial roles that reduce wastage are education and training and Implementation of sanctions.

2.6 CHALLENGES IN IMPLEMENTING THE MEASURES

This section discusses the challenges that hinder the implementation of measures in waste reduction. The challenges include lack of management support, lack of funds, uncompleted designs, time constraints, inexperienced construction manager, site size constraints, complex designs and excessive change orders.

Lack of experience on the side of the contractor is a significant challenge in the effective implementation of waste management strategies. This assertion was buttressed by researchers in South China who studied the work of steel benders. They mentioned that reinforcement works handled by inexperienced steel benders is the main cause of reinforcement waste (Lu et al., 2011). The substantial amounts of waste they cause also have significant effect on the productivity and progress of work. Lee and Sivananthiran (1996) also agreed on the assertion and they stated that a substantial

percentage of foreign contract labor has little or no experience in construction. Furthermore, inexperienced foremen add to more defective works in Hong Kong construction industry (Wan et. al. 2009). Nazech and Trigunarsyah (2008) also believed that a lot of waste generated is due to the inexperienced field supervisor. The lack of funds is also regarded as a major challenge. Contractor's financial challenges hinder the ability of the contractor to implement strategies that can help reduce waste creation. For instance, recycling requires financial commitments. Time limitations also lead to an increase in speed of project delivery. This has the tendency to cause mistakes that can lead to reworks.

CHAPTER THREE

RESEARCH METHODOLGY

3.1 INTRODUCTION

This chapter discusses the research methodology adopted for the study. The research methodology provides the researcher the directions and approaches that can be adopted in order to successfully achieve the research aim and objectives. The objectives of this study were to identify the causes of wastage on construction sites, to identify the key managerial measures contributing to construction waste reduction in Ghana and to identify the challenges impeding the implementation of the managerial measures to waste reduction in Ghana. This chapter discussed the research strategy, research design, research approach, research method, data collection, questionnaire development, questionnaire administration and data analysis.

3.2 RESEARCH STRATEGY

The research strategy adopted for this study is purely quantitative. Bryman (2004), indicated that, the quantitative research is concerned with the measurement and collection and analysis of data. Quantitative research normally deals with numerical data. The nature of quantitative research strategy in terms of its epistemological and ontological features makes is more than a mere presentation of numbers. The quantitative research strategy can also be described as a situation where the researcher employs a post-positivist claim in an investigation to develop knowledge and explore relationships among variables in terms of hypothesis or research questions, postulating objectivity as a hallmark requiring validity, reliability and exclusion of bias (Creswell,

2003). The quantitative research strategy best fits for this study as it mainly involves providing answers to questions relating to what, how much, how many etc., which involves measurement (Bryman, 2004). The study aimed at ascertaining the key managerial measures contributing to construction waste reduction in Ghana.

3.3 RESEARCH DESIGN

Creswell (2009), described research design as the logical procedures adopted in order to accomplish the aim and objectives by answering the research questions. Also, Creswell (2009) indicated that, the type of research design adopted is affected by the philosophical views, strategy or procedures adopted by the study to arrive at a valid conclusion. There are basically two (2) forms of research design. These are the explanatory research design and the descriptive research design. The explanatory research design provides the causal relationship between one concept and the other whiles the descriptive research design gives a vivid description of a phenomenon. The aim of this study is to ascertain the key managerial measures contributing to construction waste reduction in Ghana. With the aim of this study, the descriptive research design was deemed more appropriate as an accurate description of waste reduction strategies was provided in the study.

3.4 RESEARCH APPROACH

Creswell (2013), defined a research approach as the procedures adopted for a research from the stage of general assumption to the stage of data interpretation. There are basically two forms of research approach. These are the deductive research approach and the inductive

research approach. The deductive research approach concentrates on what is known already. They include existing theories or ideas about a concept through identification and testing of a theory through observation to confirm the theory (Ofori-Kuragu, 2013). The deductive research approach involves a top-down approach in the formulation of the theory and testing of hypothesis with no influence from the researcher.

On the other hand, the inductive research approach is basically adopted in theory building. Theory building begins with the study of specific instances of issues through the identification and development of patterns from the analysis of data gathered (Ofori-Kuragu, 2013). The inductive research approach adopted the down-up approach where the study concentrates on specific issues to the broad generalization of specific situation. In most situations, the qualitative research strategy is employed for such studies.

3.5 DATA COLLETION

Data collection is a very important of aspect of a social research. It aids the researcher to make inferences by comparing the opinion of the respondents to that of literature. This section discusses the data collection process by introducing the population of the study, the sample size and the sampling technique. This section also discusses the nature of the questionnaire and how it was distributed.

3.5.1 Population, sample size and sampling technique

The population for this study was construction firms who were currently executing projects in the Accra metropolis. A definite population number could not be ascertained therefore, the convenient non-probability sampling technique was utilized for the study. The convenient sampling technique is a non-probability sampling technique where respondents are selected because of their convenient accessibility and proximity to the researcher. Thus, this sampling technique was deemed most appropriate for the research. Using this technique, sixty-eight (68) questionnaires were distributed. However, fifty-one (51) was retrieved representing 75% response rate.

3.5.2 Questionnaire development and administration

Questionnaire aids in the collection of data from the various respondents. Structured questionnaire was developed using Microsoft Word 2016. The questionnaire was divided into two (2) sections. The section A concentrated on the background of the respondents whiles the section B concentrated on the three (3) objectives of the study.

With the background of the respondents, the participants were asked to indicate their category in the construction industry, their years of experience, level of education and the number of projects they have being involved in. The section B was made up of three questions. Each question covered one objective. The first question in the section B wanted the respondents to rate how significant the causes of wastage are in the Ghanaian construction industry. They were to rate using the scale of 1 = Not significant 2 = Slightly significant 3 = Moderate 4 = Significant 5 = Very significant. With the second question, the respondents were asked to indicate the applicability of the strategies in waste reduction in the Ghanaian construction industry using the scale of 1 = Not applicable 2 =

Slightly applicable 3 = Moderately applicable 4 = Applicable 5 = Highly applicable. With the last question of the section B, the respondents were asked to rate the severity of the challenges in the Ghanaian construction industry using the scale of 1 = Not severe 2 = Slightly severe 3 = Moderately severe 4 = Severe 5 = Very severe. The questionnaire was self-administered by the researcher. The questionnaire administration took two (2) weeks. Using the convenient no-probability sampling technique, sixty-eight (68) questionnaires were distributed. However, fifty-one (51) was retrieved representing 75% response rate.

3.6 DATA ANALYSIS

The collected data was subsequently analyzed after going through the retrieved questionnaire. Afterwards the questionnaire was coded and entered into the Statistical Package for Social Science (SPSS) version 20. From there, the data was analyzed using percentages and Relative Importance Index (RII). The formula for RII is given below. The Microsoft Excel version 2016 was also used in the analysis of the data.

$$RII = \frac{\sum W}{A \, X \, N}$$

Where; **W = weightings**

A = highest rating

N = sample size

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

This chapter analyzes the data collected from the respondents in order to accomplish the three (3) objectives of the study. The objectives were to identify the causes of wastage on construction sites, to identify the key managerial measures contributing to construction waste reduction in Ghana and to identify the challenges impeding the implementation of the managerial measures to waste reduction in Ghana. The initial aspect of achieving the objectives involved the review of literature which was used to develop a questionnaire to collect data from the respondents. The next part of achieving the objectives is the analysis of data collected. The data was analyzed using the Relative Importance Index. Prior to the analysis of the objectives, the background of the respondents was analyzed using percentages. The outcome of the analysis is discussed in this chapter.

4.2 BACKGROUND OF THE RESPONDENTS

The background of the respondents is summarized in table 4.1. The first question of the demographics wanted to ascertain the category of the respondents. In Ghana, construction firms are categorized based on their financial capabilities and personnel holdings. The options were D1K1, D2K2, D3K3 and D4K4. From the responses, the majority of the respondents were D2K2 construction firms which formed 60.78%. However, none of the respondents were D4K4 construction firms.

The second question was designed to ascertain the number of years of experience of the respondents. The years of experience of respondents gives an indication of his familiarity and knowledge of the processes of the firm. From the responses, majority of the respondents had more than six (6) years of experience. They formed more than 90% of the respondents. This gives an indication of the high reliability of the responses given by the respondents.

Table 4.1: Background of the respondents

DESCRIPTION	FREQUENCY	PERCENTAGE
Category of construction firm		
D1K1	15	29.41
D2K2	31	60.78
D3K3	5	9.80
D4K4	0	0.00
Years of experience		
Below 5 years	3	5.88
6-10 years	19	37.25
11-15 years	22	43.14
16-20 years	6	11.76
Above 20 years	1	1.96
Education Level		
HND	4	7.84
BSc	33	64.71
Post graduate	14	27.45
Number of projects		
Below 5	2	3.92
6-10	17	33.33
11-15	9	17.65
16-20	20	39.22
Above 20	3	5..88

Source: Field survey, (2018).

The third question asked the respondents to indicate their highest level of education. This also gives an indication of the knowledge level of respondents. Majority of the respondents had Bsc degree forming 64.71% of the respondents. The least had HND forming just 7.84% of the respondents. The last question under the background of the respondents wanted to ascertain the number of construction projects the participant has being involved in. The options were below 5, 6-10, 1115, 16-20 and above 20. The majority of the respondents indicated that they had executed 16-20 projects forming 39.22% of the respondents.

4.3 CAUSES OF WASTAGE

Construction waste is not only concentrated on the quantity of wasted materials on site, but also, several other activities and occurrences like overproduction, waiting time, material handling, processing, inventories and movement of workers (Alarcon 1994). In achieving objective one of the studies, the respondents were asked to rate the significant causes of waste construction sites. Their responses were analyzed using RII. A summary of the findings is shown in table 4.2.

From the table, poor site management ranked as the most significant cause of wastage on construction sites. A study conducted by Lu et al. (2011), stated that, waste can occur due to poor construction management on construction sites. Similarly, Jayawardane (1998), indicated that, waste can be generated due to improper management and supervision of sties. Thus, poor site management and supervision is a major cause of construction wastage on site. This was elaborated in Wang et al. (2008) research in China. The authors stipulated that, lack of management skills and lack of

supervision is a key reason of substantial amount of waste generation on construction sites. Furthermore, in Chile, it was identified by Serpell et al. (1995) that poor or lack of supervision causes waste generation in the construction industry mainly on-site.

Poor planning and scheduling by the contractor were ranked second. Ekanayke and Ofori (2000) identified poor planning by the contractor as the most significant cause of waste generation in the construction. Polat and Ballard (2004), had a similar assertion about poor planning and scheduling by the contractor. He opined that, it could be significant cause wastage during the execution of construction projects. With regards to the nature of construction, planning of work items is a key component of the construction process. Improper planning and scheduling forms a big contributor to waste generation as opined by the researchers above.

Overproduction was ranked third. Overproduction is also a different type of waste which can be associated with over-use of materials and excess input of energy by employees into production. Skoyles (1976) categorize this type of waste as indirect waste where materials are not physically lost but causing only a monetary loss and increasing cost of production. For example, waste due to concrete slab thickness larger than specified by the structural design. This over-design structurally does not have any impact on the structure but can have significant impact on cost.

Table 4.2: Causes of wastage

DESCRIPTION	∑W	RII	RANK
Poor site management	200	0.784	1ST
Poor planning and scheduling by the contractor	196	0.769	2ND
Overproduction	183	0.718	3RD
Mistakes during construction	180	0.706	4TH
Unnecessary movement of materials and human personnel	179	0.702	5TH
Variations during construction	168	0.659	6TH

Source: Field survey, (2018).

4.4 KEY MANAGERIAL MEASURES CONTRIBUTING TO WASTE REDUCTION

Construction managers have a significant role to play in ensuring that, wastage on construction sites is reduced. In achieving objective two of the studies, the respondents were asked to rate the applicability of the strategies in waste reduction in the Ghanaian construction industry. Their responses were analyzed using RII. A summary of the findings is shown in table 4.3.

Effective supervision was ranked as the most applicable strategy. Supervision is the general direction, coordination and oversight of the processes of a project on-site (Mustapha, 1990). It is the duty of the contractor to provide effective supervision on sites mainly through delegation or self-supervision. In order to effectively supervise on-site, the supervisor must clearly delegate responsibilities and make prompt decisions on behalf of the client. The site supervisor plays the most significant role in site supervision. Improper site supervision can lead to numerous problems that generate waste on sites.

Reduce, reuse, recycle was ranked as the second most applicable strategy. Reduce, Reuse and Recycle is a common assertion made in general waste management

processes in the construction industry. It is the duty of the construction manager to establish mechanisms that can aid in the process. The process was a proposed reform in Wales in a Waste Disposal Act (Waste Reforms, 1995). This process reduces the tendency of completely discarding materials as waste and creates material usage effectiveness.

Development of waste management plan was ranked as the third most applicable strategy. The development of a plan for waste management is also a vital tool in waste reduction. According to (Gudigar et al. 2014), the plan for the management of construction waste management should be divided into phases. The authors concluded in their study that, waste management needs its due importance in projects and that the management area needs to be developed as any other management knowledge area and the benefits of this area towards environment, sustainability, cost-benefits, speed of construction, and needs distribution (Gudigar et al., 2014).

Table 4.3: Key managerial measures contributing to waste reduction

DESCRIPTION	**∑W**	**RII**	**RANK**
Effective supervision	216	0.847	1ST
Reduce, reuse, recycle	215	0.843	2ND
Waste management plan	204	0.800	3RD
Proper work methods	200	0.784	4TH
Monitoring and evaluation	190	0.745	5TH
Thorough study of design and client requirements	187	0.733	6TH
Sanctions	185	0.725	7TH
Proper site layout	183	0.718	8TH
Education and training	182	0.714	9TH
Employees motivation	175	0.686	10TH

Source: Field survey, (2018).

4.5 CHALLENGES TO THE IMPELMENTATION OF MANANGERIAL MEASURES CONTRIBUTING TO WASTE REDUCTION

In achieving objective three of the studies, the respondents were asked to rate the severity of the challenges in waste reduction in the Ghanaian construction industry. Their responses were analyzed using RII. A summary of the findings is shown in table 4.3. The most severe challenge was inexperience of the contractor. This was followed by lack of funds and time constraints. Lack of experience on the side of the contractor is a significant challenge in the effective implementation of waste management strategies. This assertion was buttressed by researchers in South China who studied the work of steel benders. They mentioned that reinforcement works handled by inexperienced steel benders is the main cause of reinforcement waste (Lu et al., 2011). The substantial amount of waste they cause also have significant effect on the productivity and progress of work. Lee and Sivananthiran (1996) also agreed on the assertion and they stated that a substantial percentage of foreign contract labor has little or no experience in construction. Furthermore, inexperienced foremen add to more defective works in Hong Kong construction industry (Wan et. al. 2009). Nazech et al. (2008) also believed that a lot of waste generated is due to the inexperience field supervisor.

Table 4.4: Challenges to the implementation of managerial measures contributing to waste reduction

DESCRIPTION	∑W	RII	RANK
Inexperience of the contractor	210	0.824	1ST
Lack of funds	201	0.788	2ND
Time constraints	198	0.776	3RD
Lack of support	194	0.761	4TH
Excessive change orders	184	0.722	5TH
Incomplete designs	183	0.718	6TH
Complex designs	179	0.702	7TH
Site size constraints	177	0.694	8TH

Source: Field survey, (2018).

The lack of funds is also regarded as a major challenge. Contractor's financial challenges hinder the ability of the contractor to implement strategies that can help reduce waste creation. For instance, recycling requires financial commitments. Time limitations also lead to an increase in speed of project delivery. This has the tendency to cause mistakes that can lead to reworks.

4.6 CHAPTER SUMMARY

This chapter analyzed the data collected with the aid of a survey questionnaire. The data collected were analyzed using RII. With the first objective, poor site management ranked as the most significant cause of wastage on construction sites. A study conducted by Lu et al. (2011), stated that, waste can occur due to poor construction management on construction sites. Poor planning and scheduling by the contractor were ranked second. Ekanayke and Ofori (2000) identified poor planning by the contractor as the most significant cause of waste generation in the construction.

Overproduction was ranked third. Overproduction is also a different type of waste which can be associated with over-use of materials and excess input of energy by employees into production. With the second objective, effective supervision was ranked as the most applicable strategy. Supervision is the general direction, coordination and oversight of the processes of a project on-site (Mustapha, 1990). Reduce, reuse, recycle was ranked as the second most applicable strategy. Reduce, Reuse and Recycle is a common assertion made in general waste management processes in the construction industry. Development of waste management plan was ranked as the third most applicable strategy. The development of a plan for waste management is also a vital tool in waste reduction. With the third objective, the most severe challenge was inexperience of the contractor. These was followed by lack of funds and time constraints. Lack of experience on the side of the contractor is a significant challenge in the effective implementation of waste management strategies.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION, RECOMMENDATIONS

5.1 INTRODUCTION

This chapter is the last chapter on the study and it concentrates on discussing the summary of findings, conclusions and making recommendations. The study was aimed at ascertaining the key managerial measures contributing to construction waste reduction in Ghana. With this aim, three (3) objectives were set in order to attain the aim of the study. They were to identify the causes of wastage on construction sites, to identify the key managerial measures contributing to construction waste reduction in Ghana and to identify the challenges impeding the implementation of the managerial measures to waste reduction in Ghana. Establishing the objectives led to the extensive review of literature and subsequently, developing a structured questionnaire to aid in the collection of data from the respondents. Using the convenient nonprobability sampling technique, fifty-one (51) questionnaires were retrieved for the analysis. The data were analyzed using RII. The findings are discussed in subsequent sections.

5.2 SUMMARY OF FINDINGS

A summary of the findings from the first objective indicate that, poor site management ranked as the most significant cause of wastage on construction sites. A study conducted by Lu et al. (2011), stated that, waste can occur due to poor construction management on construction sites. Similarly, Jayawardane (1998), indicated that, waste can be generated due to improper management and supervision of sties. Thus, poor site management and supervision is a major cause of construction wastage on site.

This was elaborated in Wang et al. (2008) research in China. The authors stipulated that, lack of management skills and lack of supervision is a key reason of substantial amount of waste generation on construction sites. Furthermore, in Chile, it was identified by Serpell et al. (1995) that poor or lack of supervision causes waste generation in the construction industry mainly on-site. Poor planning and scheduling by the contractor were ranked second. Ekanayke and Ofori (2000) identified poor planning by the contractor as the most significant cause of waste generation in the construction. Polat and Ballard (2004), had a similar assertion about poor planning and scheduling by the contractor. He opined that, it could be significant cause wastage during the execution of construction projects. With regards to the nature of construction, planning of work items is a key component of the construction process. Improper planning and scheduling forms a big contributor to waste generation as opined by the researchers above.

Overproduction was ranked third. Overproduction is also a different type of waste which can be associated with over-use of materials and excess input of energy by employees into production. Skoyles (1976) categorize this type of waste as indirect waste where materials are not physically lost but causing only a monetary loss and increasing cost of production. For example, waste due to concrete slab thickness larger than specified by the structural design. This over-design structurally does not have any impact on the structure but can have significant impact on cost

The second objective also indicated that Effective supervision was ranked as the most applicable strategy. Supervision is the general direction, coordination and oversight of

the processes of a project on-site (Mustapha, 1990). It is the duty of the contractor to provide effective supervision on sites mainly through delegation or self-supervision. In order to effectively supervise on-site, the supervisor must clearly delegate responsibilities and make prompt decisions on behalf of the client. The site supervisor plays the most significant role in site supervision. Improper site supervision can lead to numerous problems that generate waste on sites. Reduce, reuse, recycle was ranked as the second most applicable strategy. Reduce, Reuse and Recycle is a common assertion made in general waste management processes in the construction industry. It is the duty of the construction manager to establish mechanisms that can aid in the process. The process was a proposed reform in Wales in a Waste Disposal Act (Waste Reforms, 1995). This process reduces the tendency of completely discarding materials as waste and creates material usage effectiveness.

Development of waste management plan was ranked as the third most applicable strategy. The development of a plan for waste management is also a vital tool in waste reduction. According to (Gudigar et al. 2014), the plan for the management of construction waste management should be divided into phases. The authors concluded in their study that, waste management needs its due importance in projects and that the management area needs to be developed as any other management knowledge area and the benefits of this area towards environment, sustainability, cost-benefits, speed of construction, and needs distribution (Gudigar et al., 2014).

The Third objectives also explained the most severe challenge was inexperience of the contractor. This was followed by lack of funds and time constraints. Lack of

experience on the side of the contractor is a significant challenge in the effective implementation of waste management strategies. This assertion was buttressed by researchers in South China who studied the work of steel benders. They mentioned that reinforcement works handled by inexperienced steel benders is the main cause of reinforcement waste (Lu et al., 2011). The substantial amount of waste they cause also have significant effect on the productivity and progress of work. Lee and Sivananthiran (1996) also agreed on the assertion and they stated that a substantial percentage of foreign contract labor has little or no experience in construction. Furthermore, inexperienced foremen add to more defective works in Hong Kong construction industry (Wan et. al. 2009). Nazech et al. (2008) also believed that a lot of waste generated is due to the inexperience field supervisor. Contractor's financial challenges hinder the ability of the contractor to implement strategies that can help reduce waste creation. For instance, recycling requires financial commitments. Time limitations also lead to an increase in speed of project delivery. This has the tendency to cause mistakes that can lead to reworks.

5.3 CONCLUSIONS

The construction industry is very important in the socio-economic development of the country. It is therefore very crucial to expedite the processes involved in construction so as to reduce was and consequently eliminate unnecessary financial losses. The study demonstrated that, the construction manager has a huge role to play in ensuring the waste is minimized in construction sites. However, a number of causes of wastage on sites can be traced to the inadequacies of the construction manager. It is therefore very

significant to engage a construction firm with enough expertise to execute the project at hand. The study further demonstrated that, there are barriers that inhibit the construction manager's abilities to effectively implement waste reduction strategies on site. Some of the severe challenges identified in this study were unavailability of funds and time constraints. Generally, construction wastage is a menace to all the stakeholders involved in the construction process. It is therefore very necessary to adopt strategic measures to eliminate or reduce the quantum of waste in the construction industry.

5.4 LIMITIATIONS

This study was limited to only construction firms operating in the Accra metropolis and also to waste generated at the construction phase of project execution.

5.5 FURTHER STUDIES

Further studies can expand to include other phase of the construction process and also can expand the scope to include other areas in the country. There is also an avenue to study the impact of contactor's waste management strategies on construction project performance.

5.6 RECOMMENDATIONS

With the findings of the study, the following recommendations were made;

- For public projects, bidders should submit their methods of minimizing waste as part of bid requirements and any bidder who fails to do so can be deemed not responsive.

- Construction firms should enact strict procedures towards waste reduction during the execution of a project
- Construction firms should educate their work personnel on effective ways of waste minimization.
- Construction firms should organize training activities for their personnel on proper ways of minimizing waste.

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APPENDIX

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ART AND BUILT ENVIRONMENT

DEPARTMENT OF CONSTRUCTION TECHNOLOGY AND MANAGEMENT

SURVEY QUESTIONNAIRE

KEY MANAGERIAL MEASURES CONTRIBUTING TO CONSTRUCTION WASTE REDUCTION: EVIDENCE FROM CONSTRUCTION PROJECTS IN GHANA

SECTION A

RESPONDENT'S PROFILE

1. Please indicate your category in the Construction industry?

[ ] D1K1

[ ] D2K2

[ ] D3K3

[ ] D4K4

2. Please indicate your years of experience in your profession?

[ ] Below 5 years

[ ] 6-10 years

[ ] 11-15 years

[ ] 16-20 years

[ ] Above 20 years

3. What is your highest level of education?

[ ] HND

[ ] BSc

[ ] Post Graduate

Other; Please specify…….

4. Please indicate the number of projects you have handled?

[ ] Below 5

[ ] 6-10

[ ] 11-15

[ ] 16-20

[ ] Above 20

SECTION B

CAUSES OF WASTAGE

1. Please indicate how significant the following causes of wastage are in the Ghanaian construction industry. Please use the response scale below:

1 = Not significant 2 = Slightly significant 3 = Moderate 4 = Significant 5 = Very significant

No.	Variables	1	2	3	4	5
1	Poor planning and scheduling by the contractor					
2	Variations during construction					
3	Mistakes during construction					
4	Unnecessary movement of materials and human personnel					
5	Poor site management					
6	Overproduction					
	If other, please specify					

KEY MANANGERIAL MEASURES CONTRIBUTING TO WASTE REDUCTION

2. Please indicate the applicability of the following strategies in waste reduction in the Ghanaian construction industry. Please use the response scale below:

1 = Not applicable 2 = Slightly applicable 3 = Moderately applicable 4 = Applicable 5 = Highly applicable

No.	Variables	1	2	3	4	5
1	Effective supervision					
2	Waste management plan					
3	Monitoring and evaluation					
4	Reduce, reuse, recycle					
5	Thorough study of design and client requirements					
6	Employees motivation					
7	Proper work methods					
8	Proper site layout					
9	Education and training					
10	Sanctions					

CHALLENGES TO THE IMPELMENTATION OF MANANGERIAL MEASURES CONTRIBUTING TO WASTE REDUCTION

3. Please rate the severity of the following challenges in the Ghanaian construction industry using the scale below. Please use the response scale below:

1 = Not severe 2 = Slightly severe 3 = Moderately severe 4 = Severe 5 = Very severe

No.	Variables	1	2	3	4	5
1	Lack of support					
2	Lack of funds					
3	Uncomplete designs					
4	Time constraints					
5	Inexperience of the contractor					
6	Excessive change orders					
7	Site size constraints					
8	Complex designs					