Operational framework for optimal utilisation of construction resources during the production process.

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Operational Framework for Optimal Utilisation of Construction Resources during the Production Process

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Abstract

The construction industry contributes a significant amount to a nation's Gross Domestic Product and National Income. The industry products are enormously important to other organisational sectors, and provide a considerable amount of employment to the nation's populace. However, the industry is significantly under-achieving in terms of clients' and stakeholders' satisfaction. In addition, the resources in the industry are currently under-utilised. It is affirmed that resources' wastes management in the industry is far behind that obtainable in other organisational sectors. Thus, there is a need for re-assessment of the way in which the industry generates its products towards utilising the scarce and costly resources efficiently.

It is noteworthy that a project could be completed, within the estimated cost, time frame and quality expected, and even satisfying the clients' and stakeholders' implied needs, with lots of resource wastefulness during the construction production process. Despite the lean construction techniques being effective in reducing resources utilisation wastefulness; currently there are difficulties in achieving the approach objectives adequately. Thus, to maximise resources utilisation and avoiding inefficiency, it is paramount to critically evaluate, identify, and establish the several wastage occurrences, occurring either consciously or unconsciously during the project construction process.

This research responded to the need for the construction industry to review the use of resources during production process, and to minimise the "gap" between the construction industry and the other sectors in efficient resources utilisation.

To establish a valid and reliable best practice operational framework, towards utilising construction resources optimally, this research study was triangulated. Both structured and unstructured questionnaires and in-depth interview research surveys were exploited for its data collection. The Statistical Package for the Social Sciences version 13, (SPSS 13), software was used to analyse the data obtained through the questionnaire research survey, while NVivo, (version 8) statistics software was explored to analyse the information collected through the in-depth interview research survey.

This research was grouped into three main studies. The first study evaluated the issues associated with site managers' efficient performance, and causes of site managers' inefficiency in performances established were identified. In this respect, the factors that will enhance site managers to optimally utilise resources were established. Secondly, the scenarios of budgeting for resources' wastes were investigated, and factors that will reduce their effects on optimal resources utilisation were established. Lastly, the causes and modalities of averting resources wastefulness during the production process were investigated and ascertained. The success factor of these studies is the evaluation of the knowledge, attitudes, and perceptions, (KAP), of construction participants on resources utilisation. Based on these three main research studies and their sub studies, an operational framework for optimal utilisation of construction resources during the production process was developed, validated and established.

This research study was conducted within the UK construction Industry. The implementation of the research findings and inferences will not only enhance optimal resources utilisation in the UK construction industry. In respect that the UK construction industry is vast in innovations, research development and construction re-engineering, the established framework is significant for global construction industry adoption.

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The Almighty God should be glorified, for His exceptional and divine favour He always bestows on me, and in particular, during this programme.

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Glossary of Terms and Abbreviations

In relation to this research work, the following notations/definitions hold:

ACRW: Avoidance of Construction Resources Wastefulness.

BWS: Budgeting for Wastes' Syndromes; conscious Allowance for resources wastefulness in beliefs that it is normal, *(see the definition of Syndromes).*

CITB: Construction Industry Training Board.

Conscious: Noticing or realising something, (Aware).

Construction Resources: These are the integrated inputs, (materials, manpower, machinery), towards achieving construction product as an output.

CRU: Construction Resources Utilisation.

CRWM: (Construction Resources' Wastes Management), management of construction resources' wastes. This phrase is synonymous to 'Optimal Utilisation of Construction Resources' in this research work, (see the definition of "Resources' Wastes Management").

CSM: Construction Site Manager. This refers to any management personnel that lead construction project execution.

CSCS: Construction Skills Certification Scheme.

Efficiency: The quality of doing something well and effectively without wasting time, money or energy. That is, the ability to get things done correctly.

Effectiveness: Production of result that was wanted or intended. Or, the ability to do the right things as required.

ERU: Efficient Resources Utilisation.

KAP: Knowledge, Attitudes and Perceptions.

KPIs: The Key Performance Indicators.

(OUR): (Optimal Utilisation of Resources), this phrase is synonymous to 'Construction Resources' Wastes Management', (CRWM) in this research work.

Resources: In this research work, these are limited to Materials, Manpower, and Machinery Resources.

Resources' Wastes Management: Is the way and manner of which project resources/inputs are controlled, monitored and checked for any uneconomical application. This is synonymous to "Wastes Management" in this research work.

SMEP: Site Management Efficiency and Performances.

SWOT: Strengths, Weakness, Opportunities and Threats.

Syndromes: Concepts or Attitudes that are believe to be normal.

Unconscious: Unable to see, move or feel in the normal way, (unaware, or not conscious).

Wastes Management: (Management of wastes); this is the way and manner of which project resources/inputs are controlled, monitored and checked for any uneconomical application.

Wastes Minimisation: reduction of wastes, (materials, manpower and machinery resources' wastes).

Wastes: (used as a noun - resources' wastes), used to describe the project inputs/resources that add no value to the final product output of a project. Or, to use resources more than required. Types of wastes in this research work are Materials, Manpower and machinery wastes.

Waste: (used as a qualifier - waste resources), used to describe a situation that brings forth inefficient use of resources; or, in a way that it is not economical.

CHAPTER ONE

1.0 RESEARCH INTRODUCTION

1.1 CHAPTER INTRODUCTION

This chapter aims to familiarise the reader with the purpose and the subject area of the research study, and to provide the structure of the research thesis. The chapter summarises the phenomena of the research, the overview of the research set up and the necessity for efficient utilisation of construction resources and resources' wastes management framework in the industry.

The problems of resources wastefulness on construction sites have resulted in serious losses of time and cost. These problems are usually caused by lack of effective management, inefficient resources utilisation, bad workmanship, inadequate supervision, lack of proper planning and poor site organisation. On many occasions, resources wastage causes: project cost escalation, poor quality of products, delay in the handing-over date, or even building failure and project abandonment.

This research investigates to what degree resources wastage occurs through the inefficient use of labour, materials, plant and equipment. Also, it establishes how these resources' wastes can be avoided during the construction production process.

The perceptions of wastes on sites are often attached to solid wastes as in Cheremisinoff (2003) and the reports of Department for Environment, Food and Rural Affairs, DEFRA (2007 – 2008), Department of Trade and Industry, DTI (2004) and Strategy Unit (2002). Moreover, waste is a general term used to describe a situation that brings about uselessness or inefficient use of resources. The waste arises through lack of proper planning, inadequate control and monitoring of procedures, (Polat and Ballard, 2003; and Howell, 1999). The construction resources' wastes can be conscious or unconscious in occurrence, avoidable or unavoidable in use, and visible or invisible in sight. It is these aspects on which the research perception is based.

The management of resources' wastes is the way and manner in which these resources are efficiently and effectively controlled, monitored and checked, while several approaches could be adopted to achieve this. However, project management is the art of directing and co-ordinating resources throughout the life of a project, by using several techniques to achieve the predetermined objectives of scope, cost, time, quality, and stakeholders' satisfaction, (Fellows et al., 2002; Griffith and Watson, 2004). In respect of this, project management is a process designed to minimise the risk of failure in terms of cost, time, and product fitness for purpose.

In Egan (1998) report, it was identified that the construction industry as a whole is under achieving, and to achieve its set target, the industry will need to make radical changes in the process through which it delivers its products. These include the utilisation of construction resources efficiently and effectively. Thus, the effective utilisation of materials should be the primary concern of the designers' and construction organisations to prevent resources' wastes, as vast savings would be achieved directly or indirectly during the operation stage.

Despite the involvements of different professionals before and during construction production process, (whose make constructive contributions towards achieving better products), wastage of resources on project sites are still predominant. During the design stage, cost analysis, value analysis, build-ability assessment and other measures are carried out; to avoid unnecessary modifications, alterations and variations that could lead to resources wastage during construction. Egan (1998:15) indicated that *"40-60% of labour is effectively utilised, with not less than 10% of materials being wasted, and up to 30% of construction works being reworked or repeated during the construction production process"*. Also, Fapohunda et al. (2004) stated that, the cost of both plant and labour are proportional to the time expected, while it is important to consider the make up of construction time wastage on site and its effects on productivity and output. These buttress the needs for adequate integration of wastes management with project planning, control and monitoring during construction production process.

In British Standard, BS 6079-1 (2002), Office of Government Commerce, OGC – 02 (2007), and Constructing Excellence (2003a, 2005a), it was emphasised that, the occurrences of resources inefficiency are due to one or a combination of the following: negligence, an incautious attitude, carelessness, indulgence, poor supervision, and project manager's inefficiency or ineffectiveness; in addition to inefficient utilisation of materials and plant, and the predominance of variations and alterations. In Constructing

Excellence (2003a, 2006a), it was explained that wastes due to motion, transportation, repetition, overproduction and defects will never add value to construction products. These issues made the needs, (among other factors), to carry out research on the occurrences of resources' wastes in the construction industry, and the evaluation of wastes' effects on construction cost, time, quality, and client's satisfaction. Thus, it will made possible to ascertain the various causes of resources wastage occurrences due to construction participants, working patterns, techniques for project monitoring and schedule control. However, McGeorge and Palmer (2002) did point that effective project management for construction is more than an academic exercise.

Xiao and Proverbs (2003) state that, construction time, together with cost and quality are key factors that are target during project construction and are used to measure contractors' efficiency. Though, to achieve quality of work and cost effectiveness in a projected period, there is a need to carry along all the construction participants, and the participants are required to know the benefits of resources' wastes minimisation. In addition, the workers must be made to recognise that the benefits accruing from wastes minimisation are not for the clients or the contractors alone, but for all the project executors, (Fapohunda et al., 2006a).

In order for the site management to meet the project objective adequately, the site management needs to perform several significant functions effectively and efficiently. As indicated in much literature, these functions include specification of project objectives and plans, resources utilisation, integration of operations, processes, and management techniques. In addition, the following are also essential: project integration and scope management; time, cost and quality management and risk administration, (Blair, 1993a; Reh, 2005a; Hendrickson, 2009; and in the reports of BS 6079-1, 2002; Project Management Institute, PMI, 2005; Office of Government Commerce, OGC - 03, 2007).

1.2 NEEDS FOR THE RESEARCH

For a nation to be economically power-driven, its infrastructure, industrial, social facilities, health, technology, and manpower development need to be adequately addressed, as indicated in Crosthwaite (1999), and the reports of Department of Indian

Affairs and Northern Development, DIAND (2001) and Strategy Unit (2002). Also, it was highlighted in Egan (1998) and DTI (2004) reports that the importance of the construction sector should be related not only to its size, but also to its roles in economic development. This implies that national environment and infrastructure growth are significantly attributed to the construction industry. However, to Xiao and Proverbs (2002) and Priestley (1994), the expected inputs of the construction industry to the national endowment are being hindered by many factors, which include inadequate resources management.

Teo and Loosemore (2001:271) emphasised in their *"Theory of Waste Behaviour in the Construction Industry"*, that the management of wastes is perceived as a low project priority; also, there is an absence of the appropriate resources and incentives to support the management. McGeorge and Palmer (2002), Griffith and Watson (2004), and Fryer (2004) did point that, for many years the construction industry has been criticised for its inability to innovate, and slow adoption of new technology and management methods. These account for a high percentage of resources lost in the industry by design or by accident. However, these resources are increasing in cost daily and also, becoming relatively scarce, as reported in Consultative Committee for Construction Industry Statistics, CCCIS (1998 – 2003) and EC-Harris Plc Economy Survey Research (2003 - 2005). In addition, Griffith and Watson (2004) emphasise that the principal contracting organisation will only remain a profitable business if it maintains a sustainable competitive advantage over other contractors in undertaking its projects. All these make the need for more systematic and integrated project processes, in which wastes in all forms will be significantly reduced, to achieve an improved quality and efficiency.

The prospective clients and developers need value for the money invested; contractors' reputations and profits are indispensable, while national development is also imperative; while these facts rely on the construction management, procurement and use of construction resources (plant, labour and materials) efficiently. The concerns now are: what are the contributing factors of construction participants in these negligent wastes, and how could these resources be efficiently utilised?

In view of all these issues, the researcher upholds the strategic objectives of the Lean construction principles, among other factors and techniques, (as indicated in the Research Statements, Section 1.6); aim to conduct a robust research, to address resources wastage, and to provide a validated operational framework for resources' wastes minimisation. This framework is to enhance the use of available resources optimally, towards achieving the set goals and objectives of the clients, contractors, and nations.

1.3 RESEARCH AIM AND OBJECTIVES

The aim and objectives of this research work are as follows:

1.3.1 Research Aim

This research work is to establish an operational framework for efficient utilisation of construction resources during the production process.

1.3.2 Research Objectives

In line with the research aim, the objectives of this research are:

a) to evaluate and ascertain site managers' constraints that enhances construction resources wastefulness;
b) to identify and ascertain the rationales of budgeting for resources' wastes in the construction industry;
c) to investigate and establish various sources of resources wastefulness during the construction production process;
d) to ascertain how construction resources could be efficiently utilised, to minimise wastefulness during the production process, based on best practice;
e) to develop and validate an operational framework, that will facilitate optimal utilisation of construction resources during the production process.

These objectives are buttressed in Sub-section 4.5.2; where the relationships of the research objectives and questions are drawn.

The next section highlights the methodology and approaches as to how the aim and objectives of this research study will be achieved.

1.4 RESEARCH METHODOLOGY AND THE STRUCTURE

To achieve the set aim and objectives of this research study, both qualitative and quantitative research surveys were conducted. In summary, this research followed this sequence:

a) Review of literature to obtain existing and current facts in relation to the research topic. These are presented in Chapter Two.
b) Identification of the research variables to develop appropriate research methods, as explained in Chapter Three.
c) Evaluation of different research methodologies and establishing the appropriateness of different research approaches for obtaining viable and reliable research outcomes. These research methodology approaches are presented in Chapter Three
d) Evaluation of research design, and identification of the appropriate instruments to establish the operational framework. The details are presented in Chapter Four.
e) Collection of quantitative and qualitative data. The questionnaires and interview surveys data are analysed by exploring appropriate statistical tools. The details are presented in Chapters Five and Six.
f) Development, establishment and presentation of the research operational framework. The details are presented in Chapter Seven.
g) Validation of the research operational framework. The reports are presented in Chapter Eight.
h) Finally, the research conclusion is drawn, and the areas that require further studies are recommended in Chapter Nine.

Figure 1.1 illustrates the logical sequence of the research methodology and structure.

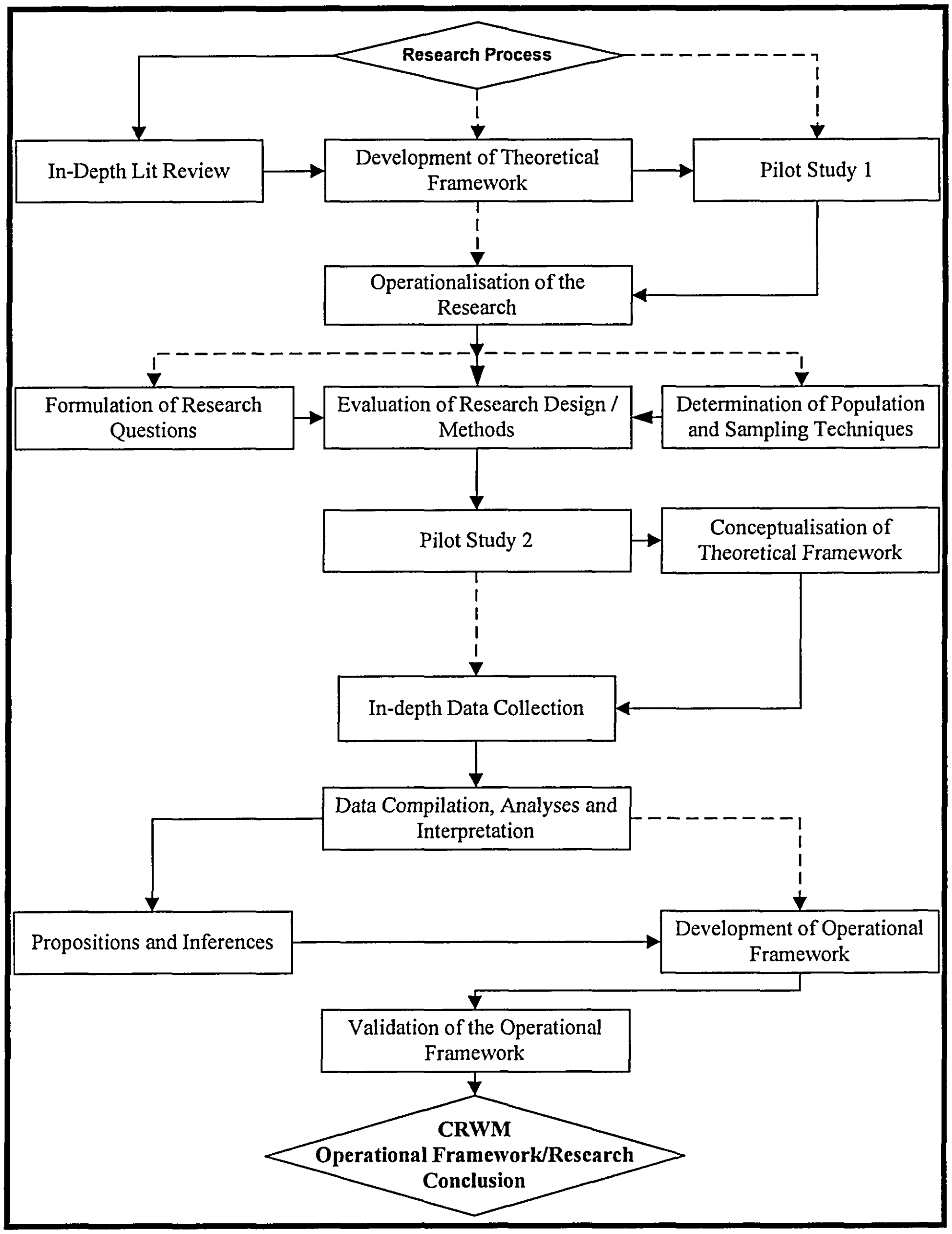


Figure 1.1 CRWM Research Process

Key: Direct Link ⟶ Indirect Link - - - - - ->

1.5 SIGNIFICANCE OF THE RESEARCH STUDY

From much literature, it is evident that the construction industry needs to be re-engineered towards construction resources optimisation that will facilitate cost and time efficiency. These will not only enhance the image of the industry, but also clients' satisfaction with the construction products delivered. Egan (1998) affirmed that the construction production process needs to be re-thought through re-engineering. To address this rethinking process, Lean construction techniques are viable, (Constructing

Excellence, 2006a); though, the practical applications of these techniques are yet to be adequately successful. These emphases indicate the need for a robust research into various construction production processes, resources utilisation and wastefulness that will reveal the causes of occurrences of the resources' inefficiencies during the production process, and to ascertain the avoidance of the resources' wastes. Also, several indications have shown that the construction sector lags behind other industrial sectors, (the manufacturing and knowledge based service sectors), in resources optimal utilisation. Thus, to bridge this gap, critical evaluation of its causes and how resources are really utilised in the construction industry are essential.

The questions at stake are: What are the causes of these predominant resources' wastes during the construction stage after due considerations have been made to avert these wastes during the design stage? When, where, how, and why do resources' wastes often occur? Do site participants envisage that resources misuse are inevitable and why? What are the appropriate resources and incentives to support wastes management on construction sites? Thus, this research addresses the management of resources' wastes, and establishes the causes of the wastes on sites that occur consciously and unconsciously.

The CRWM operational framework that is to be established will be a benchmark for wastes avoidance; also, will serve as a significant indicator for averting these wastes' occurrences during the construction production process. In addition, the outcome of this research will improve resources utilisation sustainability and the construction lean production techniques. In consequence, it will enhance organisations' profit, productivity, and clients' satisfaction.

1.6 RESEARCH STATEMENT

The economic input of the construction industry to a nation's Gross Domestic Product and the provision of employment to a remarkable number of the nation's populace cannot be under-estimated. Findings from literature confirmed that resources are wasted during the construction production process consciously and unconsciously. Though, in Constructing Excellence (2003a, 2003b and 2006a) reports, there are clear indications that Lean principles, techniques and practice will significantly reduce construction resources wastage. However, there are difficulties in achieving the set objectives of the Lean construction consistently, even by many organisations who have tried the utilisation of the techniques and principles. Thus, many construction professionals, scholars and researchers are finding modalities on how the Lean construction principles and techniques could be efficiently and effectively implemented.

In Constructing Excellence (2006a:7), it was emphasised that:

> *"Lean does work, it reduces cost and time, while it simultaneously improves client satisfaction..........But, it's tough, and more importantly, it's tough to keep it going! Perhaps, that is why so many organisations have tried, but so far, few have yet succeeded in making the technique work consistently"*

Thus, Ballard, the Co-founder and research director of the Lean Construction Institute advocated more research on lean construction. Stated that:

> *"Even though testing of theory and development of the production system is done primarily through field experiments, implementation of the Lean Project Delivery System is a research topic in its own right. Various fields of study can help us better understand implementation; particularly organisational development. We are specifically interested in the dynamics of organisational change provoked by initiating change in a single element such as production control".*
>
> *- Ballard (2000: 7).*

In light of these statements, *"initiating change in production control"* (Ballard, 2000:7), in addition with *"yet succeeded in making Lean Construction techniques work consistently", (Constructing Excellence, 2006a:7),* and other concerns, arise the needs of this study. The researcher is convinced that, in order to maximise resources utilisation, the conscious and unconscious occurrences of these wastes during the construction production process need to be critically examined. Also, the researcher contends that several wastages termed to be unavoidable, could be avoided, while the avoidable ones have not be adequately noted by the construction participants and stakeholders. However, the knowledge, attitudes and perceptions of the construction management and participants contribute immensely to these predicaments.

This study evaluates several conscious and unconscious wastes' scenarios, and presents an operational framework that will be effective for optimal utilisation of construction resources during the production process.

The key propositions in consideration, (as the success criteria), to achieve the research objectives are:

a) to re-assess the unconscious and conscious wastefulness of construction resources; and
b) to ascertain the optimal utilisation of construction resources through avoidance of resources' wastes.

1.7 LITERATURE REVIEW OUTLINE

During literature review emphases are placed on resources utilisation. Also, the factors towards achieving optimal utilisation of construction resources during production process are highlighted. The facts obtained in the literature reviewed are presented in Chapter Two. Among the issues evaluated are:

a) construction management principles and practice;
b) the constraints of the site manager in efficient use of construction resources;
c) qualities, skills and attributes required of a site manager for efficient performance of their obligations;
d) the management techniques towards efficient utilisation of construction resources;
e) the issues of budgeting for wastes' syndromes, (BWS) in the construction industry;
f) the current innovations, principles and practice toward efficient utilisation of construction resources in the UK.

Base on the findings deduced from the literature reviewed, the researcher's perception and position are presented, (Section 2.9).

1.8 RESEARCH QUESTION AND SUB QUESTIONS

Many authors, including Bryman (2004), Sarantakos (2001) and Punch (2003) emphasised that research methods determine the research questions and methodological position of the researcher. Also that the research questions are generated to probe the needs for the research work; this is further argued toward what is achievable within the framework of the research. Thus, in the designing of these research questions, the researcher recognises the functions which the questions will perform:

a) to organise the study, and provide a direction to the research methods and designs to be employed;
b) to indicate and provide directions to the research data to be collected to achieve the research set objectives;
c) to delimit the research study and show the research boundaries;
d) to keep the research focused during the study;
e) to help in framework development, and establishment.

1.8.1 Research Question

In respect of the research study aim and objectives; and the stated functions of the research questions, the research into "optimum utilisation of construction resources during the production process" is guided by this main question:

How could construction resources be efficiently utilised during the production process?

This question could be explained as:

a) *What are the circumstances that surround the conscious and unconscious wastefulness of construction resources during the production process?*
b) *What are the factors that enhance the conscious and unconscious wastefulness of construction resources during the production process?*
c) *Why are construction resources being wasted conscious and unconscious during the production process?*

1.8.2 Research Sub Questions

To address this main research question adequately, the following sub-questions are investigated.

a) *What are the constraints on site managers that enhance the wastefulness of construction resources?*

b) *What are the factors that need to be constant towards efficient utilisation of resources?*

c) *Why do construction participants budget for construction resources wastefulness?*

d) *How could construction resources be salvaged toward efficient utilisation?*

These research questions are justified and related to the research objectives in Chapter Four, (the Research Methods, Section 4.5.2).

1.9 RESEARCH SCOPE AND LIMITATION

The research into "Construction Resources' Wastes Management" focuses on the utilisation of resources in the UK building industry. The investigations are on resources management during the construction projects delivery. This research is limited to the procurement and use of resources, (materials, manpower and machinery); other wastes, such as energy and social wastes are not investigated.

Figure 1.2 illustrates the scope and limitation of the research, also, the research variables. This research study is to establish operational framework for optimal resources utilisation. The research dependent variables are materials, manpower and machinery wastes, and the extraneous variables are cost of construction, delivery time expected quality, client's satisfaction and contractors' profit. The independent variable is the construction resources management. The research scope and variables are explicitly explained in Chapter Four, (the Research Methods, Section 4.2).

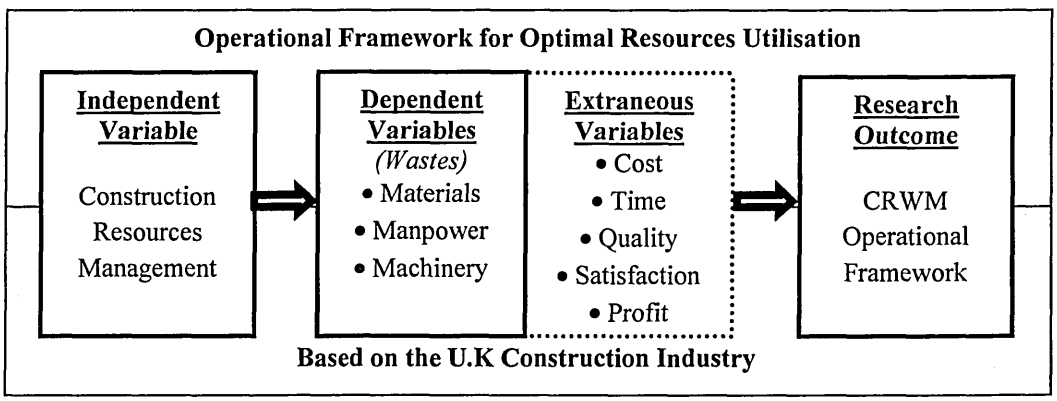


Figure 1.2 Research Scope and Limitation Overview

1.10 CHAPTER ONE SUMMARY

This chapter introduced this research work and indicated the need for the research study. The research aim and objectives are stated. The needs to optimise the use of scarce and costly construction resources are clarified. In the research statement, it was affirmed that resources in the construction industry are under-utilised and under-achieving the stakeholders' satisfaction.

The chapter highlighted the research questions and summarised the methodology approaches that will be useful for adoption to achieve the research objectives. These research questions and objectives are further explained in Chapter Four, (the Research Methods), where their relationships are drawn.

The next chapter, Chapter Two presents the deductions drawn from the literature reviewed, and the researcher position.

CHAPTER TWO

LITERATURE REVIEW

2.0 LITERATURE REVIEW

2.1 CHAPTER INTRODUCTION

This chapter evaluates and presents statements of facts, views of diverse authors, scholars, institutes and organisations; taking into consideration the construction resources utilisation. Management techniques and current innovations in practice towards the enhancement of construction resources utilisation are evaluated. In addition, the chapter highlights the scenarios of "Budgeting for Wastes' Syndromes" and construction resources sustainability. The chapter presents the research position based on the divergence views from the literature evaluated, and concludes by presenting the chapter summary.

2.2 CONSTRUCTION RESOURCES' WASTES PERCEPTIONS

The perceptions of wastes on construction sites are often attached to solid wastes as discussed in much literature including DEFRA (2007 - 2008), DTI (2004a) and Strategy Unit (2002) reports. However, waste is used as a term for a situation that brings forth uselessness or inefficient utilisation of resources; arising from lack of proper planning, inadequate control and monitoring of construction procedures, (Polat and Ballard, 2003; Howell, 1999). In addition, wastes add no value to the construction final product(s).

Management of resources' wastes revolve around efficient and effective controlling, monitoring and checking of resources utilisation, (Formoso et al, 1999). The construction resources' wastes could be conscious or unconscious in occurrences; avoidable or unavoidable in use; and visible or invisible in sight.

The scenarios of resources wastefulness are usually developed from the design stage. Much of the resources' wastes that occur during the production process are built-up during design and specifications writing, bill of quantities preparation, cost estimation, and resources procurement specification; these documents are combined and presented as the construction production information. The production information conveys the project objectives, designers' concepts, and the stakeholders' requirements of the proposed work to be implemented by the construction team. Unless this information is explicit, accurate and properly coordinated, it will be ineffective in use, and will inevitably lead to resources' wastes during the project production phase. Thus, quality production information is fundamental and essential for satisfactory realisation of construction project objectives.

The requirements of construction resources' wastes management are to address the following: the skills, experience, leadership and motivation of workforce; job size and complexity; job site accessibility; and, materials, machinery and labour availability. In addition, the management is needed to address procurement system and work schedule adequately. Other important factors when considering CRWM are: monitoring and controlling of contractual agreements, local climate and local cultural characteristics.

2.3 PROJECT MANAGEMENT OVERVIEW

Project Management is a carefully planned and organised endeavour to accomplish a specific one-time effort. The project management includes the development of a project plan, definition of project goals, objectives, tasks and specifications, and stipulation of how the project goals will be achieved timely, (PMI, 2005). Therefore, project management is the implementation of the project plan, to ensure the project stays on its "critical path" through adequate monitoring and control. That is, to plan and manage the project according to the pre-determined targets at the inception of the project.

Project management usually follows phases with various titles for each phase: feasibility study, planning, implementation, evaluation and maintenance. To achieve the best from a project, the management of projects requires a thorough knowledge of modern management techniques, (Lane, 2002; McGeorge and Palmer, 2002; Haughey, 2009), as well as an understanding of the current design and construction processes, (PMI, 2005).

The management of projects has a specific set of objectives with constraints: delivery of the project within budgeted cost, time frame and quality. While the relevant technology, institutional arrangements or processes differ, the management of all projects has much in common; including the management of projects in specialities or technology domains, (such as in aerospace, pharmaceutical and energy developments). However, project management is distinguished from general management by its mission-oriented nature. The discipline of project management aims at defining and achieving targets, at the same time, optimising the use of financial, human, materials and natural resources. However, project management is generally terminated when the mission is accomplished.

Management of a project is the responsibility of all the construction project personnel working within the project province; striving for the successive and successful achievement of the project objective(s), (Newcombe et al., 2003a, 2003b). Thus, the Project managers strive to maintain the progress and mutual interaction of various parties involved in project initiation and execution to ensure that the risk of failure is reduced.

Project managers can be found in all industries. The numbers of project managers grow rapidly since all industries and organisations realise the immense importance of project managers in project success. As project-based organisations have started to emerge; thus, project management is becoming established as both a professional career path and a way of controlling business, (Haughey, 2009). The rapid growth arises due to the need to execute complex works where high technicalities are required for the success and in the use of scarce resources efficiently.

As highlighted in much literature including Haughey (2009) and APM (2006), the essential features of project management are:

1. Project management is not an easy task.
2. Project management has a definite beginning and end. It is not a continuous process.
3. Project management uses various tools to measure accomplishments and track project tasks. These include Gantt charts, Critical Path Methods, (CPM) and Program Evaluation and Review Techniques, (PERT) charts.
4. Projects frequently need resources on an ad-hoc basis as opposed to organisations that have only dedicated full-time positions.
5. Project management reduces risk and increases the chance of success.

Among the fundamental tasks of a construction project manager indicated in APM (2006), PMI (2005), and OGC - 2 (2007) reports are:

1. specification of project objectives and plans including delineation of scope, budgeting, scheduling, setting performance requirements, and selecting project participants;
2. maximisation of resources utilisation through efficient procurement of labour, materials, and equipment in according to the defined schedule and plan;
3. implementation of various operations through proper co-ordination, monitoring and controlling, planning, designing, estimating, contracting and constructing of the entire process;
4. development of effective communications and mechanisms for resolving conflicts among the various participants.

All construction products require to be delivered (within scope, on time at minimum cost), to meet the project quality objectives. These factors form the classic time, quality, cost triangle as illustrated in Figure 2.1. Thus, a project is deemed to be efficient and effectively implemented when the project is delivered on time, within cost, scope, and meets the customer quality requirements, (where quality is a constant factor). These four factors have to satisfy customers' expectations, (Figure 2.2).

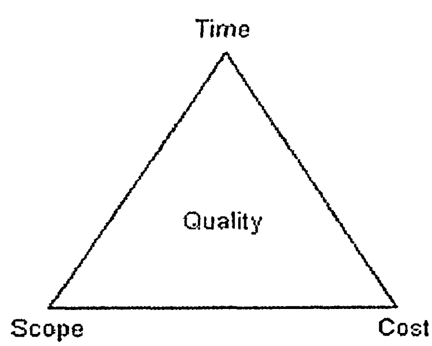


Figure 2.1 Project's Delivery Objectives Triangle, (Haughey, 2009)

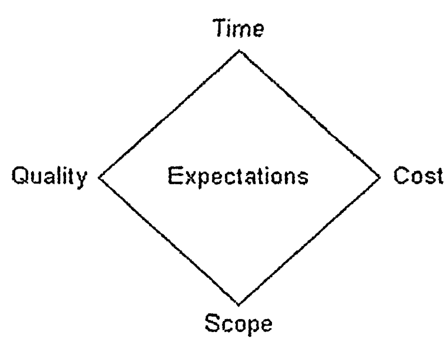


Figure 2.2 Stakeholders' Expectations Diamond, (Haughey, 2009)

However, there are no two customers' expectations that are the same; but, at the point of any project completion, the majority of the customer expectations require to be met.

If there is unlimited money and time for a project, management of the project becomes easier, but several projects have limited time frames and are to be executed within a budgeted cost. Thus, effective and efficient time and cost management are paramount for project success. It is therefore pertinent to implement effective construction site management systems during construction production process.

2.4 CONSTRUCTION SITE MANAGEMENT SYSTEMS

Construction Site Management is the act of carrying out construction processes from inception to completion on site. The management involves planning, co-ordinating, controlling, organising and forecasting a viable operational system for project execution, (Wideman, 1986; Newcombe et al., 1993a). Management of the construction site also involves the act of motivating the participants and maintaining efficient and effective communication between the stakeholders. These functions are manned by the construction site managers, whose responsibility is to execute the project successfully on behalf of the client and/or the organisation.

In practice, a construction project is rigorous and difficult to manage due to the characteristics nature of the industry. Fluctuating workloads, complex and non-unique projects, a mobile workforce, different sub-contractors and suppliers, various regulatory bodies, and changes in government policy pose hindrances in effective implementation of site management principles and techniques. However, the historical dividing line between design practice and the production process is becoming more blurred due to the increase in the use of different new innovative and contract methods. Such methods are managing contracting, construction management in risk, turnkey project arrangements, partnering and the supply chain systems; instead of the old traditional system.

Practically, maximisation of resources utilisation during the construction process is achievable through effective implementation of various management techniques, (Hendrickson, 2009). Thus, towards efficient site management, the major areas requiring site manager's knowledge to Wideman (1986) and Dinsmore (1990), and as stressed in PMI (2005) and APM (2006) are:

a) integration management: this is to ensure that the various project elements are effectively co-ordinated;

b) scope management: this is to ensure that all the work required and only the required work is included;
c) time management: this is to provide an effective project schedule for project delivery;
d) cost management: this is paramount in order to identify needed resources and maintain budget control throughout the construction process;
e) quality management: to ensure functional requirements are met and delineation of construction non-conformances;
f) human resources management: to develop effective project personnel, team work and interactions for construction operation process;
g) communications management: to ensure effective internal and external communications and feedback from all the stakeholders;
h) risk management: to analyse, mitigate and foresee potential risks and change that may arise during the construction process;
i) procurement management: to obtain necessary resources from both internal and external sources as input and convert these resources effectively and efficiently towards output, that is, the construction products.

Other important management systems of which site managers required are materials, machinery and knowledge management systems.

These principal knowledge areas form the basis of the Project Management Institute's certification programmes for any site manager in the construction industry, (PMI, 2005).

2.5 SITE MANAGEMENT TECHNIQUES TOWARDS EFFICIENT RESOURCES UTILISATION

2.5.1 Introduction

There are several significant management techniques towards achieving efficiency and effectiveness in construction products delivery. Some of the most important are: Knowledge Management; Human resources management; Materials management; Plant and machinery management; and Time management. Also, there are Cost management; Quality management; Risk management; Communications management, and Procurement management. This section evaluates these management techniques and relates their importance towards achieving optimal resources utilisation during the construction production process.

2.5.2 Knowledge Management

This management system describes the processes that enable an organisation to exploit knowledge and learn from its people. These results in efficiency, an enhanced project implementation, reduction in wasteful resources and cost, and contribute to greater innovation and more success in winning new business. To Lin and Tserng (2003), knowledge management deals with creating, securing, capturing, coordinating, combining, retrieving and distributing knowledge. Noteworthy, knowledge sharing principles between different projects are essential management tools in gaining competitive advantage over competitors, through avoidance of wastes and advancements in innovation.

During the project construction, among the necessity of a construction site manager is the need to harness the experience of others; which helps to prevent mistakes that had been made in past projects. Re-using experience also avoids problem-solving from scratch, that is, already solved problems which do not need to be solved over and over again.

Lin and Tseng (2003) affirmed five major phases in the knowledge management life cycle; these are: knowledge acquisition, knowledge extraction, knowledge storage, knowledge sharing, and knowledge updating. Figure 2.3 illustrates the generic of the phases of the knowledge management life cycle. The Knowledge to be shared has to be acquired. In construction, most information and knowledge mainly comes from the job site. Therefore, knowledge collection on a job site plays an important role during knowledge acquisition. However, the storage is most done in the main office, where all the information or tacit knowledge sent back from the job site are transferred to explicit knowledge.

Knowledge sharing is the ultimate goal of knowledge management. After a particular knowledge has been acquired and stored, only people who need the related-knowledge for a peculiar project access, select, and reuse the appropriate knowledge. That is, when required, a specific knowledge is adopted to a new project and put to use in solving problem through its re-use.

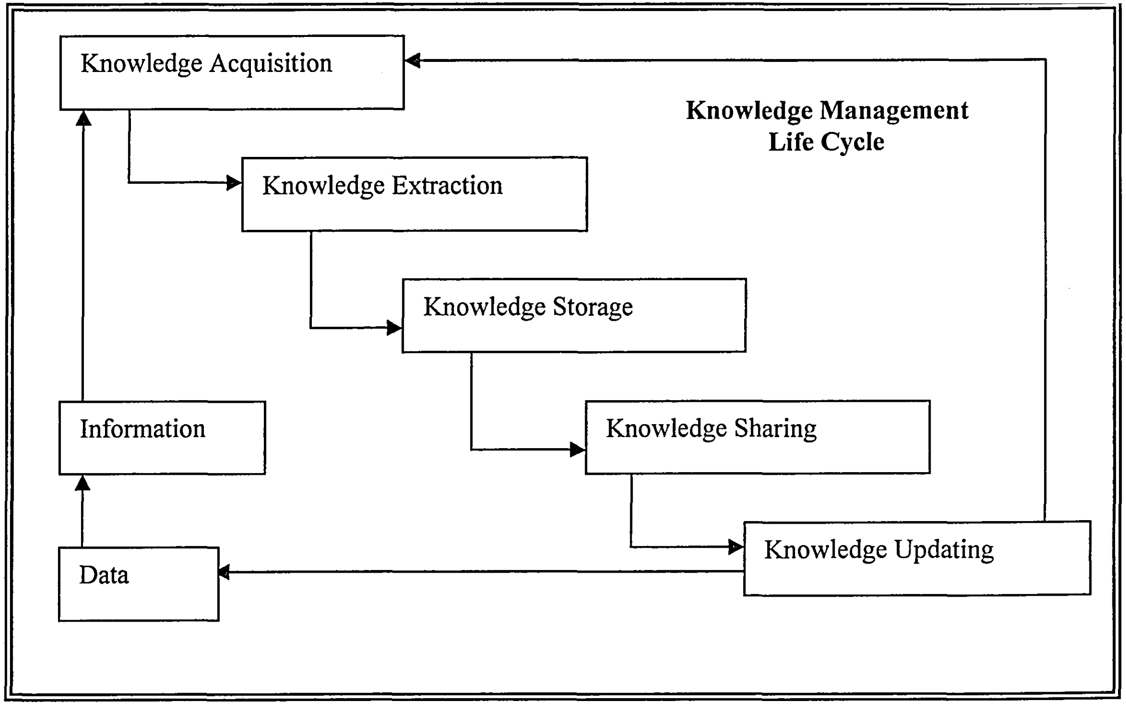


Figure 2.3 Five Phases of Knowledge Management Life Circle,
(Modified from Lin Y. C and Tserng, H. P, 2003)

2.5.3 Human Resources Management

Dinsmore (1990:2) stress that, "*at least fifty percent of the problems that exist in projects are either totally or partially behavioural in nature, while the percentage could be as high as seventy five percent in some project set ups*". This makes human resources management, (HRM), to be paramount in project management systems. Human co-ordinates, manages, delegates, performs, processes, decides, approves, solve problems and carry out all the project activities. Thus, the HRM processes require making effective use of people that are involved in the project.

The questions on how to blend project elements and human behaviours outlined by Dinsmore (1990:64) are:

(a) What is the best way to blend the talents of key project personnel?
(b) How can it be done most effectively to meet project needs?
(c) Who should be involved?
(d) Should the programmes be extended to various project levels and include all major participants and parties?
(e) When should blending be done and who should do it?

In respect of these, the success or failure of project execution depends on the knowledge, skills and ability of the site manager to effectively and efficiently integrate human resources with other construction resources, (materials and machinery). However, since a human resource is a resource that does lead to wastage of other resources, it makes human resources management vital for an efficient project success. Though, in theory, the management of people is not different from the management of other resources in organisations, (Bratton and Gold, 1994); but in practice, the differences are in the nature of the resources, such as: mobility, adaptability and flexibility.

A human being is potentially a complex creature; whose behaviour is influenced by many diverse factors. This originates from either the individual or the surrounding environment. The behaviour and performances of the human resources are functions of at least four variables: ability, motivation, role perspective and situational contingencies, (Bratton and Gold, 1994). Thus, the three principal processes for efficient human resources management, (PMI, 2005) are:

(a) organisational planning: identifying, documenting and assigning project roles, responsibilities and reporting relationships;
(b) staff acquisition: getting the human resources needed to be assigned to projects and working on the project as a team;
(c) team development: the process is to develop individual and group skills that will enhance project performance.

Several managerial problems are technical in nature; many are attributable to human behaviour, while a good number have both technical and behavioural characteristics. However, "man-made" problems can only be solved by man. Therefore, among the major tasks of a site manager is to lead the site personnel adequately; towards achieving the project objectives within the constraints of cost, time, and quality. Thus, adequate integration of the people involved, the systems and the techniques are paramount to achieve efficiency during construction.

2.5.4 Materials' Management

The largest percentage of construction cost goes on materials as input resource, (Hendrickson, 2009). Thus, efficient utilisation of this resource is of great importance in project success. Materials handling, procurement, inventories, fabrication, integration and implementation require special attention. Poor management of materials leads to large and unavoidable extra costs during construction process. However, management of materials is not just a concern during the construction stage or where the construction is taking place; rational decision making about procurement of materials is required during the planning and scheduling stages, (Hendrickson, 2009). To save production time during the construction process, sufficient time has to be scheduled for materials delivery at the initial planning stage. Thus, the availability of materials when require greatly influences the delivery of projects with a very tight time schedule constraint.

Materials purchased early hold capital, and in several cases, these materials deteriorate during storage or are stolen. However, delays and extra expenses are incurred if materials required for a particular activity are not available when needed. Therefore, for effective and efficient use of materials, site managers need to ensure timely flow of materials. The accrued benefits of effective materials' management are:

(a) reduction in material delays;
(b) timely availability of materials consequently leads to an improved productivity; and,
(c) improvement in inventory management that leads to a reduction in interest charges and thereby saves cost.

Thus, for a site manager to be assertive in materials' management, (PMI, 2005; APM, 2006), the following skills have to be developed in addition to other site manager's qualities, (discussed in Section 2.6):

(a) a broad knowledge in materials' procurement and delivery;
(b) skilful in stock control procedures and techniques;
(c) materials' utilisation and wastes control; and,
(d) good inventory control such as purchase costs control, order costs and holding costs;
    i. Purchase cost; this is the unit cost of a material from an external source including transportation and freight costs;
    ii. Order cost: the order cost reflects the administrative expenses of issuing a purchase order to an outside supplier;
    iii. Holding cost: this cost is primarily the result of capital costs, handling, storage, obsolescence, shrinkage, and deterioration.

Wong and Norman (1997) suggest that the site manager needs to introduce efficient construction materials planning systems into management techniques; in order to determine what components are required on the basis of materials' delivery lead time. In addition to this, the manager needs to calculate the periods when a specific component must be available. These will enable the site manager to determine what to order, the quantity to order, time to order, the schedule of delivery and the quality standard. In other words, efficient materials' management system will enhances better handling of raw materials, eliminate project delays and reduces the time activities take, therefore resulting in a reduction in construction cost.

In summary, the main objective of a materials' management system in construction is to ensure that the right materials are available in the right quantity and at the right time; to meet the demand on schedule during construction production process.

2.5.5 Cost Management

Projects could not emerge without finance or cost implications; these make the effective management of cost and finance paramount for any project success. Finance or cash flow can be regarded as an unproductive input by itself, but it enables production to occur. The conversion processes of finance are concerned with evaluating the demands for finance, matching these to the available funds and allocating the most suitable finances to the uses which will serve the organisational objective best.

Management of project cost includes all necessary processes required to ensure that project is completed within an approved budget. It also encompasses effective construction cost planning, cost estimating, cost budgeting and cost control, (APM, 2006). Lack of adequate cost control and management to ensure that sufficient cash is available for project implementation could result in bankruptcy or liquidation during the construction process, in some instances, causing project abandonment.

Cost control is concerned with influencing the factors which create changes to the cost baseline to ensure that changes are beneficial; to determine the cost baseline, and manage the actual changes, when and as the changes occur, (PMI, 2005). Also, cost control includes the searching of the "whys" of both positive and negative variances, while these must be properly integrated with the other control processes such as change control, schedule control, quality control, and risk change control, to enable construction cost management to be efficient. It implies that efficient cost management systems and techniques are essential for a project's success.

2.5.6 Quality Management

Quality management encompasses all activities of management functions that determine the quality policy, objectives, and responsibilities; and implementing these by means of adequate quality plan, control, assurance, and improvement within a predetermined quality system, (PMI, 2005; OGC - 9, 2007; BS 6079 - 1, 2002).

Quality management in construction includes the processes that are required to ensure that the project will satisfy the needs for which is been undertaken or proposed. Yong and Wilkinson (2000), Pheng (1998), Kufida and Vouzas (1998), and Mann and Kehoe (1995) explain the need for total quality management in the construction production processes. It was argued that, whether total quality management is making an impact on an organisation or is just a passing fad, remains a debated issue within construction management circles. Imperatively, an effective and efficient quality management system is an important competitive weapon for any organisation's survival.

The three major quality management processes that require attention, (PMI, 2005), are:

(a) Quality planning: to identify which quality standards are relevant to the project and determining how to satisfy them.

(b) Quality assurance: to evaluate overall project performance on a regular basis during the construction process, in order to assure confidence that the project will satisfy the relevant quality standards stipulated at the onset.

(c) Quality control: to monitor specific project results and to determine that these comply with relevant quality standards set in order to identify ways of eliminating causes of unsatisfactory performance or short-fall of any activities.

Therefore, construction quality management system addresses both the management of the project at stake and the final product expected of the project in process. Failure in the quality requirements required of any project causes negative consequences and dissatisfaction for the project stakeholders.

The project management objectives are to deliver the project on time, to cost and to specification. These are easier, and more efficient if the organisation implements an effective and efficient quality policy, (Somerville and Craig, 2002). Thus, in the project management process, there is a need to continuously balance the time scales, cost and risk without undermining the performance and quality of the project. In addition, the overall objective of quality management within the construction sector is to adopt new business approaches, increase productivity, and reduce costs whilst at the same time improving the overall quality of the finished product.

Since quality is the totality of characteristics of an entity that bear on its ability to satisfy stated or implied need, (PMI, 2005; BS 6079 - 1, 2002); thus, the significance of quality management in the project context is the necessity to turn the implied needs into stated needs through proper management techniques and principles.

2.5.7 Risk Management

Risk management is the process which aims to help organisations to understand, evaluate, and take action on all activities containing risk, (Hillson, 1998); with a view of increasing the probability of success and reducing the likelihood of failure, (PMI, 2005; Institute of Risk Management, IRM, 2003). Thus, effective risk management enhances comfort for project stakeholders and helps the organization confirm its compliance with governance requests. That is, it enhances accountability, performance measurement, reward, and promotes efficiency at all stages of the production process.

Management of risk in project is complex and arises from a wide range of sources and has a broad scope of possible effects on any project, as stressed by Hillson and Murray - Webster (2005), Rafele et al (2005), and in the report of IRM (2003). Managing project work and project risk is a great task that requires a detailed understanding of the organisation and the process involved in the business. The management includes maximising the results of positive events and minimising the consequences of adverse events. Also, an efficient risk management system requires effective risk identification, risk quantification, and risk response development and control, (PMI, 2005). Though, there is no reward without risk. Therefore, the duty of a good management is to take the right risks and the right level of risk at the right time. This implies that strategy and creative approaches to risk management are the key factors of success in any business environment.

2.5.8 Time Management

Time management is about controlling the use of resources, (encompassing planning, monitoring and regular reviewing of production), with minimal waste of efforts to achieve a definite or desire satisfaction, (Blair, 1993c). This involves efficient use of time in achieving important goals; doing the right thing at the right time, (Ferner, 1980; Reh, 2005c). Therefore, the project time management process is to ensure timely completion of the project within the estimated time. Time management is a continuous ongoing process of analysing, planning, re-analysing and re-planning. Thus, an efficient use of time to save costs of the construction satisfies the client interest.

Satisfactory completion of projects in relation to cost, time, and quality could be (but is not absolutely) a yardstick for measuring a successful project. However, it is difficult to weigh the paramount factor. Many construction stakeholders are interested in executing quality project at minimum cost. Conversely, every project has a purpose and the ability to achieve the expected purpose of the project significantly relies on the project delivery time.

Kaming et al. (1997) identify several variables that could lead to construction project delay: inclement weather; inaccuracy of materials' estimates; inaccurate prediction of artisans' production output; inaccurate prediction of equipment production ration; materials' shortages; equipment shortage; inadequate planning; poor labour productivity; design changes and frequent alterations. However, effective time management induces personal fulfilment and self regard for completing the project within the budget period without jeopardising the cost of construction and quality.

To achieve the best outcome through time management, the following aspects are essential, (Fontana, 1993:43 - 47):

(a) plan to handle a group task logically;
(b) efficient and effective delegation of authority, that is, distribution of authority and power among sub-ordinates;
(c) provision of necessary facilities to undertake a task when due;
(d) good record systems via the adoption of a fast tracking record recovery system that suits each project plan and sequence; and,
(e) provision of an effective communication system for both incoming communication and outgoing communication.

In PMI (2005), it was affirmed that an effective project time management requires:

(a) the inclusion of a tasks time frame in the project plan: to identify how long a task will realistically take in advance and to keep with the allotted time;

(b) deadline of a specific task: to concentrate on sticking to the time frame, if possible to finish earlier and the possible provision of incentives for using time productively;
(c) provision of time lag for time loss: to enable a task possible overruns time frame to be planned to make-up the time without delaying successive tasks;
(d) provision of incentives: enabling the construction participants' awareness that there are incentives for effective use of time and completion of tasks within the specified period.

The benefits of effective time management as indicated by Fontana (1993:60 - 62) in relation to construction project delivery are:
(a) increase in effectiveness and efficiency of use of construction resources;
(b) enhancement of productivity of building production;
(c) increase in leisure time while delivering the set target at less time, as expected;
(d) reduction of stress of repetition works aimlessly;
(e) creation of room for forward planning and for long term solution for the next stage of work to be done;
(f) enhanced creativity while saving time gives room for thinking constructively.

Fontana (1993:5) stressed that, *"it is one thing to recognise the importance of time at the theoretical level, quite another to do so at the practical and emotional levels. And.......we are best able to appreciate the value time has in our lives".* Thus, to manage time effectively, construction project participants need to have several significant qualities; such as: clarity of thinking, decisiveness, good memory, and punctuality, calmness, and objective rationality. These factors are achievable through good leadership traits, self-assessment, avoidance of provocation, dynamism, effective delegation, setting goals, priority delegation, follow-up and effective communication of the action plan.

2.5.9 Procurement Management

Procurement Management in construction is the process of acquiring construction resources. Management of project resources procurement is to balance the construction project requirement towards financial accountability, to uphold equality, proximity, fairness, and the project specific objective, (PMI, 2005). This process includes the modality of obtaining goods and services for the production process that is outside organisational performance.

Procurement management involves procurement planning, solicitation planning, source selection, contract administration and contract close up, (PMI, 2005). These processes interact with each other to determine what and when to procure, the documentation of products' requirements and identifying the potential sources. Also, obtaining quotations from different contractors or sub-contractors and comparing different bids offered for the project. In addition, the procurement management process includes selection of tenders to undertake the production process or the supplier for goods and services and involves managing the relationship of the parties involved and resource supply for project production.

Traditionally, project success factors are measured with respect to cost and time. Tools such as cost/schedules control systems have been developed specifically to monitor project performance with respect to cost and time. However, project procurement is equally paramount in the success of any project. Efficient utilisation of construction resources depends on an efficient procurement planning system employed during the design and construction phases. Thus, procurement planning is a process of identifying which project requests could be best met timely by careful selection from various procurement systems for a particular product or service. It involves consideration of: whether to procure, what to procure, how much to procure, what quality to procure and when to procure? Thus, procurement managers need advance knowledge and awareness of the more rigorous management procedures: tried and proven experience in successfully balancing leverage and control techniques and a demonstrated ability to repeat the success.

2.5.10 Section Summary

It becomes evident from these management systems evaluated that efficient utilisation of construction resources depends greatly on efficient integration of several management principles and techniques by the site manager. These make the competency of the construction site manager on resources utilisation crucial for project success. These relationships are illustrated in Figure 2.4; and the figure shows the success factors of a proficient site manager.

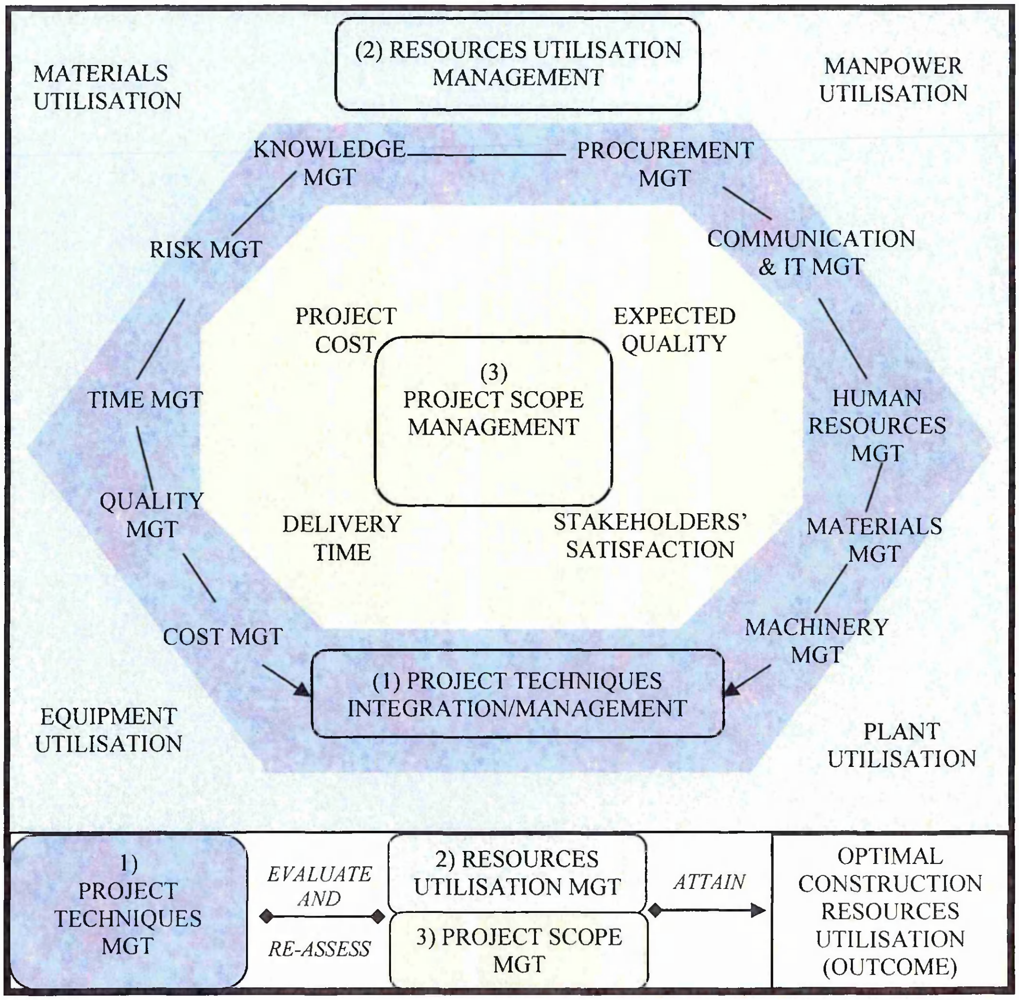


Figure 2.4: Construction Resources Management - Success Factors of a Proficient Site Manager
Key: Management – MGT

During construction production process, site managers are required to be significantly proficient in three groups of management systems as illustrated in Figure 2.4. In this research work, the success factors of a site manager are related to, (Figure 2.4):

1) the ability to integrate all management techniques effectively;
2) the ability to utilise all construction resources, (materials, manpower, plant and equipment) economically; and,
3) the ability to deliver the construction product(s) within the project scope, (the project cost, delivery time, quality and stakeholders' expectation), satisfactorily.

The next section, (Section 2.6) presents the significance of a skilful project manager towards the achievement of optimal resources utilisation and effective resources' wastes management.

2.6 CONSTRUCTION SITE MANAGERS' TRAITS TOWARDS EFFICIENT RESOURCES UTILISATION

2.6.1 Introduction

The unique characteristics of projects require the site managers to have adequate knowledge of construction resources utilisation and management. In addition, the construction site managers require various qualities, skills and attributes, (QSA), to be efficient in implementing the management principles and techniques adequately. This section delineates different types of site managers' qualities, skills and attributes, (QSA) that contribute to construction project management efficiency. Also, it evaluates the relevancies of these traits during production process.

2.6.2 Qualities of Site Managers towards Efficient Resources Utilisation

Site managers need to possess diverse qualities towards achievement of optimal utilisation of construction resources during the production process. These qualities include good leadership traits, effective human management, eloquent communication, negotiation power, articulate planning, contract management and administration, problem solving and conflict resolution ability, and creative thinking, as argued in APM (2006), PMI (2005), Haughey (2009), and Barry (2000).

However, the barriers that directly or indirectly affect utilisation of construction resources are: poor communication, disagreement, misunderstandings, bad weather, union strikes and construction participants' personality conflicts. Therefore, to achieve the predetermined project success, the site managers need to have control over the four principal variables: time, cost, quality and scope; and these are possible through integration of different management techniques as discussed in Section 2.5. In addition, site managers need to possess authoritative and absolute control on the following factors: project plan, staffing and recruitment, training and manpower development, resources scheduling, ordering and procurements, storage of materials, equipments and facilities, security of assets, materials and facilities' requisitions, hoarding and pilferage, and health and safety.

Griffith and Watson (2004) state five distinct stages in which the construction site managers need to monitor and control effectively during construction production process: project initiation, planning, production, monitoring and completion. However, during the management of these stages, several possible rules lead to project failures, (Haughey, 2009). These include:

a) Maintaining a focus on delivery at all times: the project manager focuses on delivering results, ignoring extraneous things like quality assurance, testing, communication, team management and little touch of humanity; assuming that these distract from the main objective for delivering;

a) Assuming that planning is time wasting: assuming that there is no need for adequate administrative, financial and control planning of project, with the pre-assumption that these have been done by the smart system architect or business consultants who have previously produced excellent e-business designs;

b) Stressing the construction team beyond the aptitude of efficient performance: the project manager believing that the secret of delivering a successful project is to overwork the team participants, and being careless about the workers well being. At the same time, not carrying the workers along hoping that s/he has an overwhelming talent to perform all management functions without the contribution of others;

c) Underestimating the importance of communication and feedback: believing that there is no strong need for effective communication system and that any directive can be given anyhow;

d) Avoidance of stage implementation and iterative cycles on project execution: believing that the operational sequence wastes time and adds unnecessary administrative overheads. This means pushing the team participants relentlessly and this often generates deliverables without having any moment to consider the actual performance, while hoping that any error committed can be corrected later;

e) Believing in common sense rules: when a manager refuses to adjust to new innovation and new techniques in delivering a project, believing that the old system works better and is fanatically shackled to an outmoded technology, never bothering to train in new techniques;

f) Believing in satisfying clients at all costs: taking all necessary steps to satisfy clients; not viewing nor weighing the consequence to the project success. That is, when the project manager refocuses resources to suit clients, reassigns the workforce, no matter how illogical or the extent to which the project will be delayed.

Hence, for any project manager to achieve its ultimate objectives during the construction production process, the manager also needs to possess several and significant management skills which are described in the Sub-section 2.6.3.

2.6.3 Skills of Project Managers towards Optimal Resources Utilisation

Towards efficient resources utilisation, site managers require a number of significant skills as explained by Newcombe et al. (1993), Fraser (2000) and Haughey (2009), and in APM (2006) and PMI (2005). Among the skills identified are: inspiration of a shared vision, good communication, integrity, enthusiasm, empathy, competency, and the ability to delegate tasks, being cool under pressure, adept in team-building and possessing problem solving skills.

a) Shared Vision

An effective project leader is often described as someone who has a sense of direction and the ability to express it. Although every leader has different intrinsic leadership styles, (Blair, 1993b); however, a good leader should possess vision, thrive on change and be able to extend boundaries. Visionary leaders enable other people to feel that they possess a real stake in the project's successful outcome. The leader empowers people: to express the vision on their own; offers people opportunities to create their own vision; to explore what the vision will mean to their jobs and their lives, and also to envision their future as part of the vision for the organisation.

b) Communication

Many scholars including Griffith and Watson (2004) highlight that the ability to communicate with people at all levels is an important skill that all team leaders should possess. In addition, project leadership calls for clear communication about goals, responsibility, performance, expectations and feedback, (PMI, 2005; APM, 2006). The project leader serves as a mediator between various organisations and within construction project participants. Therefore, a good leader should possess the ability to negotiate effectively and use persuasion when necessary to ensure a project success.

c) Integrity

A project manager must be conscious of his or her actions, not merely his/her words. Good leadership demands commitment to, and demonstration of, ethical practices. Cunningham (2002) highlights that, integrity depends on: respect for self; respect for others; and responsibility for all actions taken. Hence, it is the responsibility of project leaders to create standards for ethical behaviour and to live by the standards, as well as rewarding those who exemplify these practices.

d) Enthusiasm

Construction workers want leaders with high enthusiasm, confidence and with an optimistic attitude; workers often dislike leaders who are negative. Construction workers are more motivated when they have the conviction that they are part of a stimulating journey, (Blair, 2993d; Haughey, 2009). Thus, workers rationally feel alive and keen to follow a leader with a 'can-do' attitude: not those who have many objectives and goals while few or nothing can be achieved.

e) Sympathy and Empathy

There is usually appreciation by the subordinate when the leader acknowledges them with an apparent and distinct vision that they have a life outside of work. Thus, good leaders need to adopt differing leadership styles with different people, or with the same people, but at different times towards achieving their needs. In The Tea Trust (2007), it was indicated that sympathy is an emotional affinity in which whatever affects one correspondingly affects the other, which is synonymous with compassion; while empathy is the ability to recognise, perceive and envisage the emotional feelings of others. Therefore, it is essential that a good project leader should be able to blend sympathy and empathy towards efficient utilisation of construction resources.

f) Competence

Workers must be made to believe that the leader knows what he or she is doing. Leadership competence does not necessarily refer to the project leader's technical proficiency in the core technology of the project, (Allen, 1998). However, as project management is being recognised as a field in, and of itself; thus, the leader should have the ability to successfully lead others. However, expertise in leadership skills is only a dimension in competency, (APM, 2006); as having a preceding winning track record is another way of considering leadership competency.

g) Delegation of Tasks

Trust is an essential element in the relationship of a project leader and the project team(s), (Allen, 1998). Individual who is unable to trust other people often fail as leader, and could remain simply as a micro-manager; or possibly doing all of the works unaided. A good leader needs to demonstrate trust in others through actions and delegation of duties. Delegation is the downward transfer of formal authority from superior to subordinate, and this could be measured through how the leader checks, controls the subordinate's work, and allows people to participate freely in decisions taken.

h) Handling Pressure

In a perfect project condition, the project will be delivered on time, as budgeted and with no problems or obstacles to overcome. However, there has never been a perfect project. Thus, a manager with a hardy attitude will always take problems in his or her stride. When a good manager encounters a stressful event, the manager needs to consider it as interesting and take it as a challenge or an "adventure" towards discovering new techniques. Thus, a good manager needs to view any problem encountered during the project execution as an opportunity to be creative: out of uncertainty and chaos, changes and innovation emerges, which enhances creativity and skilfulness.

i) Team-Building

A team builder can be defined as a person who provides the substance that holds the team(s) together toward a common purpose and objective(s). In order for a team to progress from a group of strangers to a single cohesive unit, the leader must understand the process and dynamic requirements for the transformations. Thus, a team leader needs to know the appropriate leadership styles to be employed at every stage of team development. Leaders must also have an understanding of the different team players' styles and how to capitalise on the transferable knowledge of each team member at the appropriate time, to resolve a peculiar problem.

j) Problem Solving

Although an effective leader is said to share knowledge; it is equally important to employ joint problem-solving and delegation of responsibilities within a team. Nonetheless, many subordinates expect a leader to have excellent in-built problem-solving skills. In respect of the fact that some subordinates might have high creative ability, they do expect the leader to make a proactive and positive move in problem solving and brain storming.

2.6.4 Section Summary

The requirements for a site manager to be efficient in project execution are proficiencies in decision making, problem handling, and change management. In addition, stress management and systems integration proficiencies are equally essential. As indicated in much literature, system integration is required to propel a project in meeting speculated objectives of cost, time and quality through people. Therefore, an effective project management significantly depends on efficient integration of systems and people. In addition, for a site manager to accomplish a predetermined mission through people, the workers need to work as a team. However, there are several factors confronting site managers, towards efficient resources utilisation, apart from being efficient in implementation of their qualities, skills and abilities, (QSA). These are presented in Section 2.7.

2.7 SITE MANAGERS' CONSTRAINTS ON EFFICENT RESOURCES UTILISATION

This section presents some of the hindrances on site manager's performances and highlights the effects.

2.7.1 Design Team and Production Information

Project design team does envisage that the production information documents presented to the site manager should be adequate to execute the project and perform efficiently. Nonetheless, inaccuracies, errors, and mistakes in construction production information are perpetual, and these factors affect site managers' efficient performances, (Fapohunda et al., 2007). On many occasions, the design team does view the identification of deficiencies in the production information as a challenge to professional competency.

The construction participants; the client, design team and the contractor are often in variance when it involves construction costs adjustment: to effect the cost implication of the change, (modifications, alterations and/or re-design). These cause delay, and affect the efficient utilisation of the construction resources. Thus, site managers need to draw attention to the production information inadequacies logically: for corrections and modifications. This is to avoid confrontation and conflict, between the construction team and the design team that could jeopardise the project objective(s) and/or mutual relationship.

2.7.2 Budgeting for Wastes' Syndromes in the Construction Industry

Another critical factor that hinders construction site managers in efficient resources utilisation is the syndromes of "budgeting for wastes' of construction resources in the industry.

The term "budgeting for resources' wastes" means the provision of resources, (materials, machinery, and/or manpower), for wastage; envisage that wastes will occur during the construction stage. Thus, several construction wastefulness or resources inefficient utilisation occur not only due to bad workmanship, inadequate supervision, improper planning or poor organisation of the project by the site manager, but due to the intrinsic perception of the construction participants on the production information and wastes budgeting scenarios, (Fapohunda et al., 2006b). That is, the belief that wastes has been built-in into the resources' specifications, estimations, and construction costs.

Therefore, this research study, (among other factors), evaluates the rationales for budgeting for wastes. This is to identify the beliefs, attitudes and perceptions that drive the design and construction teams to allow for wastes, which in consequence lead to inefficient resource utilisation and jeopardise the site manger's efficient performance.

2.7.3 Perceptions of Construction Participants towards Resources Utilisation

Human attitudes and perceptions significantly contribute to the scenarios of resources' wastes allowance and constrain the site manager's efficiency. Douglas McGregor's human theory emphasises that, there is an inherent dislike of work by human beings, and in many occasion, there is need to either force, persuade or threaten construction participants towards efficient performance of duty, (Swinton, 2008). Also, Frederick Hertzberg's two-factor hygiene and motivation theories indicate the relationships between the work environment and what the people actually do when working. Frederick Hertzberg human theories placed emphases on a work environment that acts as a "catalyst" and motivates human to work, (Blair, 1993d; Swinton, 2008). However, monetary reward, self-recognition, responsibility assessment, good appraisal, promotion and advancement are important drivers towards the workers industrious attainment, (Fapohunda et al., 2007). Thus, for efficient performance; getting things done through employees and to achieve an enhanced workers' output, there is a need for the construction site managers to be conscious of individual worker's potentials, their weaknesses and interests.

2.7.4 Section Summary

To successfully achieve the set objectives of the construction project and the stakeholders' goals during production process, it is essential to identify the paramount factors that constrain the site manager in optimal resources utilisation. Thus, thorough evaluations of the characteristics and perceptions of the construction participants on resources utilisation in the industry are essential. Hence, the modalities of avoiding the effects of these constraints on resources utilisation during the production process could be established.

2.8 STATES OF CONSTRUCTION INDUSTRY AND INNOVATIONS TOWARDS EFFICIENT CRWM IN THE UK

2.8.1 Introduction

For many years the construction industry globally has been criticised for its perceived inability to innovate and its slow adoption of new technology and management methods, in comparison with manufacturing and service sectors, (McGeorge and Palmer, 2002). These have accounted for a high percentage of resources lost in the industry by design and/or by accident. Moreover, these resources are not only increasing in cost daily, but are becoming relatively scarce, as affirmed in CCCIS (1998 - 2003) and EC-Harris Plc Economy Survey Research (2003 - 2005) reports.

The global awareness of the importance of the construction industry in national development, (the inputs of the industry to all nations Gross Domestic Products; the provision of infrastructure for other organisations' working environments and employment opportunities for a remarkable number of the nations' total population), trigger challenges and innovations in the industry by several committees, organisations, and institutes. These drive the re-engineering of the construction industry towards enhancement its products delivery. However, the expected inputs of the construction industry to the global endowments have not been optimally achieved, which have been hindered by many factors. These issues added to the need of this research work, to evaluate the utilisation of construction resources, and to ascertain the modalities of minimising wastefulness in the construction industry.

The current effective practices in the construction industry include the Lean construction techniques, partnering and the supply chain systems, implementation of knowledge management, benchmarking, and the construction key performance indicators (KPIs). Also, there in practice build-ability assessment, total quality management, integration management system, value engineering and management. Irrespective of these, in Egan (1998) report, it was highlighted that the industry is still under achieving, while it is the requirement of the industry to provide clients' satisfaction at minimum cost, within a reasonable time frame and quality expected.

The next subsections present a review of the current approaches in the UK construction industry towards the enhancement of resources utilisation and CRWM.

2.8.2 States of the Construction Industry in the UK

> *"The UK construction industry provides a tenth of the UK's gross domestic product, and employs about 1.4 million people. UK designers, civil engineers, contractors and construction components and products' manufacturers have a worldwide reputation for working overseas. The UK construction industry is one of the strongest in the world, with output ranked in the global top ten, with the increase in private finance to public sector projects. British consultants and contractors are well positioned to offer skills and experience in PFI projects and also provide high-tech solutions to environmental, transport and building projects".*
>
> *- DTI, (2006:n.p) report, (online, accessed, 21 June, 2006)*

Nigel Griffith M.P, Minister for Construction, 2003, affirmed that;

> *"In the global economy, all UK industry is under pressure to continually improve to maintain competitiveness and attract investment. The construction industry has started to recognise that greater efficiencies are possible"*
>
> *- Constructing Excellence, (2003b:3),*

King (1999) identifies the interesting parallels as well as interesting differences between the problems identified and solutions recommended in Sir Michael Latham's "Constructing the Team" 1994 report, and the state of the U.S. Construction Industry in the mid-1990s. To King (1999), the problems facing the construction industry in utilisation of resources are universal. However, these universal problems differ according to the differing approaches taken by construction organisations from one nation to the other. The early 1990s were a terrible time for the construction industries in the United States and the United Kingdom, (King, 1999), while overbuilt markets, overheated economies, overextended developers and mismanagement led to a significant decline in construction volume.

Egan (1998:18) reported that "*the UK construction industry has two choices: to ignore the belief that construction is so unique that there are no lessons to be learned from previous mistakes; and, the need to seek improvement through re-engineering the construction products*". In the Egan (1998) report, the answers to improving the industry products are stated: to rethink the process through which the industry delivers its projects; and the industry need to aim achieving continuous improvement in its performance. These indicate that there are significant inefficiencies in the UK construction process; and thus, there is potential need for a more systematised and integrated project process in which wastes' reduction in all its forms will be significantly enhanced and both quality and efficiency improved.

In comparison, the manufacturing sectors in the UK have achieved performance improvements by integrating the team process around its product delivery. Thus, performance improvements in the UK construction industry must begin by "bench-marking" the manufacturing integrated project process. More so, integrated project process will enhance the utilisations of the full construction team, and will bring the skills of all the participants together towards efficient use of all the resources. In effect, the bench marking will enhance the delivering of equitable value to the clients and all stakeholders as in the organisation and service sectors. However, this process needs to be explicit and transparent, and should be easily understood by all construction stakeholders.

Egan (1998) outlines the areas in which there is a need for change in the UK construction industry. These areas include change in working conditions, skills and training, design approaches, use of technology and relationships between companies.

Though, in the Consultative Committee for Construction Industry Statistics, (CCCIS, 1998 - 2003 report), it was indicated that, despite a slowdown in the global economy, the UK's construction industry has continued growing at a steady rate. Also, the UK construction industry is still competing favourably with other developed nations, as affirmed in the reports of Latham (1994), Priestly (1994) and DTI (2006).

These relationships and arguments indicate the needs to stabilise the UK construction industry output; to meet the emergence of the importance of national endowment; while efficient and effective utilisation of the construction resources are paramount.

Another critical area that requires improvement in the UK construction industry is the issue of health and safety,

> *"Approximately 2.2 Million workers engaged in Britain construction industry, this make the industry the biggest among all the UK industrial sectors. However, the sector is also the most dangerous one. Record shown that, in the last 25 years, over 2,800 workers have died from injuries sustain from construction sites, while many have been made disabled",* -
>
> - *Health and Safety Executive, HSE, (2008:n.p), (online), accessed on 06/05/2008).*

To Egan (1998:25), the heath and safety of the UK construction sector is the second worst in compare with other organisational sectors; and several accidents occur when the site workers are not properly trained and working out of process. Thus, the industry needs to reflect not only on the purely welfare consequences of the poor health and safety record, but to consider as well its cost in terms of lost work days, potential prosecutions and, in extreme cases, the enforced closure of the construction site

Based on the need to minimise the construction industry predicament in the UK and globally, this research study evaluates and identifies the causes of under-utilisation of construction resources, (materials, manpower, and machinery), and establishes the modalities of achieving an improved productivity, and an enhanced stakeholders' satisfaction.

2.8.3 Innovations and Techniques towards CRWM in the UK Construction Industry

Section 2.8.2 makes it clear that the UK construction industry is notable, both in terms of economy output and employment provision. This Section 2.8.3 appraises the developments towards efficient utilisation of construction resources in the UK, based on current practice; that is, the innovations, principles and techniques. In addition, the significances of these innovations towards resources utilisation and efficiency are outlined.

2.8.3.1 Rethinking Construction

Rethinking construction reflects the recommendations made in a report as a title, produced by a taskforce led by Sir John Egan in 1998. This was commissioned by the Deputy Prime Minister John Prescott to assess the efficiency of the UK construction industry. The report acknowledged that the construction industry in UK is on a par with any other in the world, but pointed that there is a need for the industry to increase its performances towards client's satisfaction.

Egan (1998: 18) advised that the UK construction organisations need to endeavour:

a) to ignore the belief that construction is so unique that there are no lessons to be learned from previous projects undertaken;
b) to improve, through re-engineering, all the traditional ways in the construction process which are restrictive and confrontational;
c) to address the needs and expectations of the end-user more closely;
d) to aim to achieve targets through reductions in costs, time, accidents and defects;
e) to increase its predictability of cost and time, productivity and profitability.

It was affirmed by Egan (1998) that the answer for improvement in the construction industry is to rethink the process through which it delivers its projects, with the aim of achieving continuous improvement in its performance and products. These indicated that there are significant inefficiencies in the construction process and that there is potential need for a much more systematised and integrated project processes in which wastes in all forms are significantly reduced and both quality and efficiency improved.

In the Egan (1998:25) report, the areas of need for improvement in the UK construction industry were affirmed, and these are: working conditions, construction skills and training, approaches to design, use of technology and relationships between companies. It was further stressed that the industry should strive towards enabling construction sites to serve as an advert for the industry and the subsidiary firms working in collaboration with the industry. Also, Egan advised that the industry and the government should liaise with clients towards performing construction process in ways that are distinct from those of previous traditional systems:

> *"What we are proposing is a radical change in the way we build. We wish to see, within five years, the construction industry deliver its products to its customers in the same way as the customer - lead manufacturing and service industry. To achieve the dramatic increases in efficiency and quality that are both possible and necessary we must all rethink construction".* - *Egan, (1998:37)*

This report energises the construction industry domain in the UK towards innovation and change. Also, it serves as a standard in which construction participants and the government work collaboratively to improve the industry performances. The initiative ideas suggested by the Rethinking Construction team for construction industry improvement are beneficial towards reductions in the cost of construction, a reduction in project delivery time, better healthy and safe environment, an increase in productivity, fewer defects and an efficient application of construction resources.

2.8.3.2 The Construction Key Performance Indicators, (KPIs)

The purpose of the Construction Key Performance Indicators (KPIs) is to standardise measurement of project and organisational performance throughout the construction industry, (KPIs, 2000). While individual organisations have been measuring their performance for many years, there has been little consistency in the way their data are published. KPIs are frameworks for performance measurement, and are adaptable techniques for rectifying deficiency in construction industry.

> *"Sir John Egan's report, Rethinking Construction, challenged the industry to measure its performance over a range of its activities and to meet a set of ambitious improvement targets..........This is the KPI Working Group's answer to that challenge. It sets out a comprehensive framework which construction enterprises can use to measure their performance against the rest of the industry, and has been designed to be used by organisations, large or small, specialist or supplier, designers or constructors".*
>
> *- Nick Raynsford, Minister for Construction in 2000, (KPIs, 2000: 5).*

These KPIs improvise standard formats with which construction organisations will be able to measure the efficiency of resources, and to ascertain the performance of each activity.

2.8.3.3 Construction Best Practice, (Now Constructing Excellence)

Construction Best Practice, (CPB) is a "no-profit" organisation established in 1998. It was instituted to provide support for individuals, companies and organisations in the construction industry; seeking to improve operational systems and product delivery techniques. In the year 2002, CPB merged with other innovations, which included Rethinking Construction, to form "the Constructing Excellence", (Constructing Excellence, 2003a).

The vision of constructing excellence established is similar to that of construction best practice. The constructing excellence aspirations are centred on the construction industry: to maximise the project products' values for the end users and stakeholders, and to achieve consistent delivery of world-class products and services. In addition, to enhance the attainment of all construction stakeholders' expectations,

Constructing excellence roles include driving improvement by disseminating knowledge of good practice, innovations and modalities of efficient projects delivery. This is to boost performance through targeting inefficiencies on site operations and other related activities.

Constructing Excellence is also established to implement strategic objectives such as:

a) improving performance through increased productivity and competitiveness;
b) improving the industry's image by taking action to create steps to change culture, development of people, enhanced engagement with the community and customers;
c) engaging and taking action with individuals, businesses, organisations and industry associations.

The Constructing Excellence organisation set up core activities that will significantly enhance efficient resources utilisation in the industry, and these are: innovation and research, measurements and diagnostics, leadership and influence, showcasing and exemplars, and tailor services for business and improvement. These activities are to enhance the achievement of the clients and all stakeholders' set strategic objectives, and the expected construction products' values,

2.8.3.4 Accelerating Change

"Accelerating Change" is an industrial forum report, which was launched in 2002. This forum comprises representatives across the construction industry, government and the unions, working together with Sir John Egan, (the Chairman). This was a significant event for the construction industry as "Accelerating Change" set an improved agenda for all stakeholders in the industry, (the report of SFfC, 2005 - 2006)a. The forum four principal concerns are: client(s) engagement; integrating teams and supply chains; people issues, and enhancing the value of construction products. To achieve these, the six key areas that the Strategic Forum for Construction (SFfC) is focusing on are: procurement and integration, commitment to people, client leadership, sustainability design quality, and health and safety, as stated in the report of SFfC (2005 - 2006)b.

In the SFfC (2005 - 2006)c report second page, the headline targets of Strategic Forum for Construction are stated as follows:

a) by end of 2004, 20% of construction projects, (by value), should be undertaken by integrated teams, and supply chains should rise to 50% by end of 2007;
b) by end of 2004, 20% of clients should have embraced the principles of Clients' Charter and targeted a 50% increase by the end 2007;
c) by the end of 2004, approximately 500 fully completed projects could have exploited Design Quality Indicators, (DQIs);
d) by end of 2006, approximately 300,000 qualified people could have being recruited and trained in the industry;
e) by the end of 2007, 60% of all publicly-funded/PFI projects (having a value in excess of £1m) could have exploited Design Quality Indicators, (DQIs), and 20% of all projects (having a value in excess of £1m) might have been found to have utilised DQIs;
f) by end of 2007, there will be a 50% increase in student applications to built environment tertiary education courses and by end of 2010, an increase in the annual rate of construction trades apprentice completions, in total approximation, amount to 13,500;
g) by end of 2010, a significant quantity of fully trained, qualified and competent workforce will engage in all construction projects.

The principal roles of the SFfC are to co-ordinate, monitor, measure, and report construction progress. Though, the SFfC does not act as an operational body; its strategy is being implemented through several institutions. The operating institutions are: Constructing Excellence; Construction Skills; the Construction Umbrella Bodies; Construction Research and Innovation Strategy Panel, and other construction related institutes.

2.8.3.5 Lean Construction

Lean Construction, (LC), is a production management-based approach to project delivery; a new way to design and build that was established towards changing the way in which work is being done during construction production process, (Constructing Excellence, 2006a). Lean Construction extends from the objectives of a lean production system by structuring production process, to maximise value and minimise wastes through specific techniques. In addition, to apply the lean techniques on the project delivery processes. The project and delivery processes are designed uniquely to enhance clients' satisfactions. The lean construction techniques also enhance positive iteration within the process while negative iteration is reduced,

Lean construction is based on the following principles:

a) to reduce wastes;
b) to specify value from the perspective of the ultimate clients;
c) to clearly identify the process that delivers what the clients will value;
d) to reduce all non-value added steps and activities;
e) to ensure that value adding steps and activities flow, without interruption in the process of managing the interfaces between steps and activities;
f) to ensure that client halt and agree to accelerate the rate of activities when required;
g) to pursue perfection by continuous improvement.

The Lean construction efforts to manage and improve performance, and aimed at improving total project performance which could lead to reduction of the construction cost and enhance the speed of production activities achievement.

Viewing the robustness of these principles, there emerge various innovations through diverse organisations, sectors, and research institutes to foster the better achievement of the strategic objectives of the lean principles in the industry. A few of these groups and innovations are:

(a) International Group for Lean Construction, (IGLC)

The International Group for Lean Construction, (IGLC), founded in 1993, comprises a network of professionals and researchers in Architecture, Engineering, and

Construction, (AEC), with the notions that the practice, education, and research of AEC have to be radically renewed in order to respond to future challenges.

The IGLC clarifies the distinction between lean construction and other forms of project management. The characteristics of IGLC, (Howell and Ballard, 2004; Constructing Excellence report, 2006b), are:

a) control is redefined from "monitoring results" to "making things happen". Planning performance is measured and improved to assure progression of workflow and a predictable project outcome;
b) performance is measured through maximising value and minimising wastes at the project level. Current practice attempts to optimise each activity of a project which often reduces total performance.
c) project delivery by simultaneous design project facility in cognisance to its production process. This is in the form of concurrent engineering the current practice through buildability reviews to prevent resource wastefulness.
d) value to the customer is defined, created and delivered throughout the life of the project. In current practice, the owner is expected to completely define the project requirements that will be delivered at the end at the outset; irrespective of the uncertain changes in markets, technology and business practices.
e) co-ordinating action through pulling and continuous flow. This is in opposition to the traditional schedule-driven push with its over-reliance on central authority and project schedules to manage resources and co-ordinate work.
f) decentralising decision making through transparency and empowerment.

The principles and practice of IGLC provide project participants with sufficient information on the state of the production systems and also empower them to take action.

(b) Lean Construction Institute Research Agenda

The Lean Construction Institute Research Agenda was established in 2000 after conducting research to develop knowledge regarding the management of "project-based production systems" in the construction industry. The establishment identifies three primary research areas which will significantly enhance construction output and production process; these are: (i) theory of project-based production systems; (ii) the production system itself; and (iii) implementation of the system. Consequently Research Agenda was developed to the Lean Project Delivery System, (LPDS).

(c) Lean Project Delivery System, (LPDS)

Lean Project Delivery System, (LPDS), applies principles pioneered in manufacturing to construction. The LPDS is developed as a philosophy, a set of interdependent functions, the systems level, rules for decision making, procedures for execution of functions, and as implementation aids and tools, (Ballard, 2000). Based on the basic principles of LCI, the LPDS tools facilitate planning and control, and maximise value by minimising wastes throughout the construction processes. The tools and techniques developed by the LCI in the form of LPDS remove wastes from design and construction processes, and lead the organisation that practice it to an enhanced competitiveness, as well as profitability.

Ballard (2000:3) outlined the essential features of LPDS, and these include:

a) the project is structured and managed as a value generating process;
b) downstream stakeholders are involved in front end planning and design through cross functional teams;
c) project control during the job execution as oppose to reliance on after-the-fact variance detection;
d) optimisation efforts are focused on enabling work flow to be reliable, as oppose to improving productivity;
e) pull techniques are used to govern the flow of materials and information through networks of co-operating specialists;
f) capacity and inventory buffers are used to absorb variability;
g) feedback loops are incorporated at each level; dedicated to rapid system adjustment and learning.

The effective operations of these LPDS features are driving tools to enhance efficient utilisation of construction resources in the industry, and equally a driver towards clients' satisfaction and contractors' profitability enhancement.

(d) Construction Lean Improvement Programme, (CLIP)

CLIP is based on the theory of Lean Construction. It was instituted in 2003, and helped to focus companies' activities towards achieving high levels of client's satisfaction; by improving the quality at reduced project cost, delivering products and services at higher efficiency, (Building Research Establishment, BRE, 2006).

CLIP is a practical step towards an enhanced profit and greater productivity. The programme adapts lean tools and techniques in the construction industry. These allow construction companies to take the highly theoretical topic of lean construction and turn it into a practical tool that can be effectively implemented.

This programme philosophy is based on the concept of process, values, and wastes in the industry. By focussing on these three areas, the construction industry will be able to remove/reduce wasteful activities, and minimise non-value adding activities. In Constructing Excellence (2003a) report, it was ascertained that, to achieve the full benefits of implementing CLIP, the industry should intensify on:

a) Processes: this is to transform the form, fit and function of construction resources and information in order to meet the clients' requirements through attaching cost to each process.
b) Values: the applications of the resources needed, which will be of value to the project. These resources have to be applied or integrated optimally during the production process.
c) Wastes: ensuring resources waste reduction. Wastes in generality are activities or resources that do not add significant value to the project output.

Further, in the Constructing excellence (2003a, 2003b), the classifications of wastes that would not add value to any construction process and product were outlined. These are wastes due to: motion, transportation, waiting, defects, and over-production, as well as unnecessary envisaged. The approaches highlighted in the Constructing excellence (2003a, 2003b) for continuous improvement in the construction industry to minimise resources' wastes are:

a) Clear out: that is, to separate the essentials from the non - essentials.
b) Configure: to maintain a place for everything and everything in its place
c) Clean and Check: to assess the current condition of the environment
d) Conformity: to ensure that standards are easily maintained
e) Custom and Practice: to ensure that everything follows the laid down rules.

Based on these factors, Ballard, the Co-founder and research director of the Lean Construction Institute (LCI), encourages more research studies in lean construction direction, (Ballard, 2000:7). Also, the needs for more studies in lean construction direction were emphasised in Construction Excellence reports (2006a:7), (as cited in Section 1.6).

2.8.4 Construction Resources Utilisation Sustainability Practice in the UK

Sustainability is the form of development, an approach to production process, to enable the products deliver to meet the needs of the present situation without compromising the ability of meeting future generation needs. The objectives are to improve resources efficiencies, overall effectiveness, and the social responsibility of a country business. The concept is based on improving the quality of life for all without increasing the use of natural resources beyond the capacity of the environment to supply the resource indefinitely, (Brundtland, 1987 report). Also, in the OGC (2007) and BERR (2007) reports, it was further clarified that the concept involves the creation of a better quality of life presently and ensure that sufficient resources remain for future generations.

In BERR (2007) report, the strategy key areas for sustainable construction are:

a) reduction of the carbon footprint of activities within the construction sector;
b) production of Zero net waste at construction sites;
c) developing voluntary agreements and initiatives between the construction industry and its clients; with the aims of reducing the carbon footprint and the use of resources with the built environment;
d) creating a safer industry by improving skills; boosting the numbers of workers taking part in training programmes and retaining more skilled workers.

However, sustainability as a concept has different meanings from one sector to another, and means different things to different people, also, the approach differs. Thus, towards achieving sustainability in the construction industry, the industry has to improve on environmental responsibility, social awareness, and economical profitability, as explained by Fapohunda et al., (2008) and Arthur (1997), and reported in BERR (2007), CIOB (2006), OGC (2007) and DEFRA (2001). These significant factors, (environmental responsibility, social awareness, and economical profitability), are "The Three Pillars of Sustainability", (Construction Skills, 2007), which cut across all sectors sustainable decision, towards balancing the conflict of demands and the human needs.

Thus, the construction industry is addressing sustainability by asking questions such as, "What? Where? Why? How and when to build? Also, in decision taking, the industry takes into considerations, the three pillars of sustainability: the social, economic, and environmental sustainability.

DTI (2004b:20) report outlines the guiding objectives to sustainable development which construction industry adopted, and these are:

a) putting people at the centre so that they can enjoy a better quality of life now and in the future;
b) taking a long term preparation through radical improvements from now to safeguard the interest of future generations;
c) placing accounts of cost and benefits including those that cannot be easily valued in monetary terms; and,
d) creating an open and supportive economic system that supports economic growth.

Sustainable in construction does not only help the environment, but also improves economic profitability and the relationship of stakeholders. The practice is to identify: what is current good practice within the industry; and how to improve this current practice, bearing in mind, what the future priority should be.

Towards achieving sustainability in resources utilisation, construction organisations have to recognise the importance of design to minimise resources wastefulness and achieving targeted quality while optimising resources utilisation, (Fapohunda et al., 2008). Additionally, there is a need to give due consideration to people in construction localities through avoidance of environmental pollution. The organisations also need to set resources waste targets and work towards achieving the best. It is of paramount importance to improve performance by setting the project KPIs; formulating modalities to reduce alterations and modifications during construction process and re-engineering the current practice towards best practice, (Fapohunda et al., 2008).

Based on the need of Sustainable and Lean Constructions techniques, it is imperative to recognise the immense benefits of Modern Methods of Construction.

2.8.5 Modern Methods of Construction towards Construction Resources Sustainability

Modern Methods of Construction, (MMC) is the initiation and execution of projects from inception to completion considering economy of production, towards achieving better quality in minimum delivery time, (National Audit Office report, NAO, 2005). That is, it is an effort towards improvement of business efficiency, attainment of high quality, and customers' satisfaction. The additional benefits are effective and efficient environmental performance of construction products, construction sustainability and predictable delivery time scales and cost effectiveness. Among Modern Methods of Construction practices is the lean construction, (discussed in Section 2.8.2.5), in addition are partnering and the supply chain systems.

Partnering and the supply chain systems are practices in which organisations co-operate, and find ways of working together that serve the interest of each party. These are terms that describe individual stakeholder's involvements in a construction project, mutually agreeing on objectives that the parties will fully committed to achieve, as indicated by Peace and Bennett (2006), and in CIOB (2006), OGC - 2 (2007) and CIC (2005) reports. The advantages of these systems are: achieving good performance in respect of quality, time, cost and specific improvement over the normal performance. More so, the parties tend to co-operate together over a series of projects to achieve improvements in performance that lead to efficient resources utilisation, enhanced profit and greater productivity.

Based on these innovations and approaches discussed in these Sections 2.8.2 to 2.8.4, the construction organisations could significantly deliver their products more efficiently, cheaper and faster; achievable by enhancing the use of construction resources.

2.9 CONSTRUCTION RESOURCES' WASTES MANAGEMENT - THE RESEARCHER'S PERCEPTIONS AND POSITION

From the diverse scholarly views and literature reviewed, it was found that the construction industry is confronting several challenges; ranging from the achievement of clients satisfaction, the delivery of construction products promptly at minimum cost, and contractors' profit, to construction resources utilisation sustainability. In addition, construction resources are not only scarce, but the resources are continuing to increase in cost. It was established that for the industry to meet its implied objectives, the industry needs to utilise its resources efficiently, by re-assessing the current construction resources management processes. However, in the recent study carried out by Lean Construction Institute, (LCI); and the Constructing Excellence, there are apparent indications that lean construction principles will significantly reduce construction resources wastage during production process. Also, it is evidence that there are significant difficulties in achieving the set objectives of the LCI approaches or achievement of consistent success by the organisations that have tried the techniques and principles.

In view of these statements of facts: *"provoked by initiating change in production control",* (Ballard, 2000:7); *"succeeding in making Lean Construction techniques work consistently",* (Constructing Excellence, 2006a:7), and "*what we are proposing is a radical change in the way we build*", (Egan, 1998: 37) drive the needs of this CRWM research study. The researcher is convinced that, to maximise resources utilisation, there is a requirement to scrutinise the conscious and unconscious occurrences of wastage during the construction production process. In addition, the researcher is of the opinion that the wasting of several resources that are believed to be unavoidable could be avoided; whereas, it has not been foreseen that the avoidance are possible by the construction participants and stakeholders. The construction management and the participant's knowledge, attitudes and perceptions contribute greatly to these predicaments.

The Construction Innovations Forum, (CIF), was established in 1987 in response to the "lack of innovations". This "lack of innovations" problem was highlighted in the Construction Industry Cost Effectiveness survey report that was conducted by the Business Roundtable in early 1980's, (CIF report, 2005). The CIF was inaugurated to enhance the image of the construction industry, also to foster and encourage innovations in the industry by working towards meeting challenges of declining productivity, shortage of skilled workers, rising costs, and fragmentation of project design and construction. Apart from CIF, other organisations that advocate the need for improvement in the construction industry and its products are International Lean Construction Organisation, Constructing Excellence, and Construction Users Roundtable.

Irrespective of these several current practices, innovations, established Institutions and organisations in the construction industry,

> *"Several projects are still completed within the estimated cost, time frame, quality expectation, and even meeting the stakeholders' implied needs with lots of resources' wastes".*
>
> *- The CRWM Research Perspective*

Thus, these made the need to investigate the rationales for several resources' wastes that occur during the construction production process from the Knowledge, Attitudes and Perceptions (KAP) viewpoints. This study sets out to identify, classify, and evaluate the occurrences of different conscious and unconscious resources' wastes scenarios; and aim to develop a validated CRWM best practice operational framework. This framework will not only enhance cost and time effectiveness, but will also improve the stakeholders' satisfaction and contractors' profit.

2.10 CHAPTER TWO SUMMARY

The chapter presented the literature reviewed, current facts and an overview of construction project management in relation to resources utilisation during the production process.

This literature review chapter presented the needs for the project management team to recognise the value of collaborated efforts and a close relationship between the design and construction teams, while the process are viewed as an integrated system. Therefore, for an effective integration of design and construction process, diverse operational tasks must be performed with a variety of precedence. However, the separations of design and production in the industry, and the consequent difficulties that arise during construction projects have been the subject of several construction industry reports. There have been trends towards using enhanced integrated procurement approaches such as design and build, construction management, construction management at risk and partnering. However, the dominant procurement system is still the traditional system, (design-tender-build process), which perpetuates the separation of sequential operation of production from design.

The Literature reviewed reveals that there is a need to re-shape and re-engineer the industry; these energise several organisations, sectors, governments, institutions and establishments in innovating different approaches, techniques, practices and procedures on the construction production process and project delivery. These were geared toward an improvement in productivity, reduction of cost, timely delivery, and enhanced quality and clients' satisfaction.

This chapter also summarised several principles, practices and innovations that emerged towards the efficient utilisation of construction resources in the UK construction industry. There is a clear indication, from the literature reviewed, that all construction resource utilisation processes need to be re-engineered, since resources' wastes management in the industry globally is far behind that applicable in other organisation sectors. To reduce the resources utilisation gap of the construction sector with these other sectors, lean construction techniques are effective; but currently, there are difficulties in achieving its set objectives adequately. It was also established from much literature that, to achieve enhanced sustainable construction, there is a need for efficient and effective management of construction resources utilisation; which will be achieved considerably through effective implementation of modern methods of construction, partnering, and the supply chain techniques.

This chapter presented the researcher's perception and position that establishes the need to carry out research into construction resources' wastes management, prior to this section, (the chapter summary).

The next chapter, (Chapter Three), presents the research methodology.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 RESEARCH METHODOLOGY

3.1 CHAPTER INTRODUCTION

In this chapter, there are identifications and evaluations of the different research methodology in the social scientific world. The comparative importance and demerits of deferent research strategies and approaches were highlighted; these include deduction and induction research approaches, qualitative, quantitative, and exploratory research surveys. Among literature reviewed to achieve these are Arksey and Knight (1999), Bryman (2004), Burns (2000), Clough and Nutbrown (2002), Silverman (2005) and Sapsford (1999). By identifying merits and demerits of different research methodology, the most appropriate research methods that are suitable for this CRWM research work were established.

3.2 RESEARCH STRATEGIES

Construction resources wastefulness and the efficient utilisation of construction resources are vast in phenomenon. To achieve realistic results, critical evaluation of different research methodology and types of research strategies in the social scientific world are paramount; to identify the appropriate methods that will ensure reliable and valid research findings.

To social scientists, theory is essential towards achievement of scientific understandings of research. Thus, from divergent views concerning the measuring and the structure of theory, including Frankfort-Nachmias and Nachmias (1996), the four levels of systems to generate theory are:

a) Ad-hoc classification systems: these are arbitrary categories constructed in order to organise and summarise empirical observations.
b) Taxonomy: this system is termed to be a categorical system; a system of categories constructed to fit empirical observation.
c) Conceptual framework: in this, descriptive categories are systematically placed in a broad structure of explicit propositions, statements of relationships between two or more empirical properties to be accepted or rejected.

d) Theoretical system: this combines taxonomies, conceptual explanations and predictions in a systematic manner.

Based on the differential importance of these theories (concepts), this research is to adopt an ad-hoc classification and taxonomy to achieve the research "theoretical framework". In addition, a theoretical theory system is explored to achieve this research "operational framework"; while this will make possible to conceptual explanations and the predictions of viable outcomes in a systematic manner from data collected and analysed.

3.3 SURVEY RESEARCH AND THE APPROACHES

In social scientific research, an adoption of a specific research method depends on the objectives of the particular research study. Thus, these sections explain different approaches that are significantly suitable for various research studies, where applicable and the rationale of their adoption. The understanding of the merits and demerits of these approaches assisted in the adoption of the most appropriate research methods for this CRWM research data collection.

3.3.1 Survey Research Approaches

Frankfort-Nachmias and Nachmias (1996), Punch (1998) and Sapsford (1999) explain that a survey research approach enhances details and quantifies descriptions of information and data. This makes survey research methods to be significant and frequently use for data collection in the social scientific world. It involves data collection in which information is gathered through qualitative interview survey, quantitative questionnaires survey or mixed methods.

This research explores three different types of survey research: mail questionnaires, personal interviews, and direct observation research. The consideration of these survey research methods is primarily based on the objectives of this research work, and secondly on scope and geographical coverage that would provide valid and reliable findings.

Trochim (2006) stress that the adequate construction of a survey needs to be considered as an important factor for research study, as the research instrument itself is an art. Hence, appropriate decisions have to be made before undertaking a survey research in respect to the survey content, wording, format and placement. These decisions are considered as important consequences during this study. Therefore, in carrying out this research work, there were critical examinations of several significant issues and questions as evaluated and specified by Trochim (2006). Table 3.1 presents summary of factors considered significant, and that are carefully applied during this research study.

Table 3.1 Factors that Enhances the Research Instrument Administration, (Trochim, 2006)

(1) Population Issues	(2) Sampling issues	(3) Questions issues
a) Can the population be enumerated? b) Is the population literate to interpret the questions to be administered? c) Is there any language issue that will involve multiple versions and interpretation for data collection? d) Will the population envisaged co-operate with the researcher? e) What will be the geographical restrictions of the sample population?	a) What data are already available? b) Can respondents be found, located or be accessible easily? c) Who are the respondents? d) Can all members of population be sampled? e) Will response rates be a problem?	a) What types of questions will be asked, and what details will be required? b) How easy will the questions be or are sub-questions required? c) Will screen questions be needed to determine whether the respondents can answer the questions? d) Can the questions sequence be controlled? e) Will lengthy questions be asked to give detailed background? f) Will long response scales be used to simplify the questions provided?
(4) Content issues	**(5) Bias issues**	**(6) Administration issues**
a) Do the respondents know the issue or have acquaintance with trends of events at stake? b) Will respondents need to consult records for accurate answers?	a) Can social desirability be avoided to avoid the respondent having bias? b) Can interview distribution and subversion be controlled? c) Can false respondents be avoided so that actual respondents answer the questions?	a) What cost is available for the survey method? b) Does this survey require any peculiar facilities or equipment for the survey? c) Is there sufficient time for the survey response or research work to obtain reliable and viable findings?

There are two distinct of surveys research approaches, and these are the quantitative and qualitative research surveys.

3.3.1.1 Quantitative Questionnaires Research Survey

This is an appropriate method of gathering data from different geographical zones, in substantial and sizeable number with minimum cost. The researcher is aware that questionnaire design and construction have direct influences on the quality of response. The questionnaire for this research is structured in a way that the questions administered, the content and the format will not influence the respondents to react negatively. However, the questionnaire is firstly piloted to ensure questions adequacy and subsequently modified to avoid low response. (The rationales and importance of pilots studies carried out are reported in Section 4.9).

Questionnaires surveys are in the form of mail, group administered questionnaire and household drop-off.

a) Mail survey: There are many advantages to mail surveys. These types of survey are relatively inexpensive to administer and make it possible to send the exact same instrument to a wide number of people. Also, mail questionnaire surveys allow the respondent to fill the questionnaire at a time convenient to the respondent. However, the response rates from mail surveys are often very low, and are not the best vehicles for asking for detailed written responses.

b) Household drop-off: This is a less familiar type of questionnaire survey. In this approach, a researcher goes to the respondent's home or business and hands the respondent the instrument. The respondent is asked to mail it back or the researcher returns to pick it up. This approach attempts to blend the advantages of the mail survey and the group administered questionnaire. The blended advantage of the Household drop-off are: the respondent can work on the instrument in private, when it's convenient and also it make it possible to have personal contact with the respondent, while the respondent can ask questions about the study and get clarification on what is to be done.

c) Group administered questionnaire: This type of questionnaires survey is not explored during this research work. In this type of survey, a sample of respondents is often brought together and asked to respond to a structured sequence of questions.

Traditionally, questionnaires were administered in group settings for convenience. The questionnaires are given to those who were present and the researcher can be fairly sure that there would be a high response rate. One of the main advantages of this survey is that, if the respondents are unclear about the meaning of a question, clarification can be asked from the administrator.

3.3.1.2 Qualitative Interview Research Survey

At a basic level, interviews are often regarded as conversations, but in the scientific world, qualitative research interviews are attempts to understand the world from the subjects' point of view. Also, to reveal the meaning of peoples' experiences, to discover the respondent's lived experience through scientific explanations, (Silverman, 2005; Sapsford, 1999). Therefore, exploration of interview survey enhances understanding and emphasises intellectual understanding, rather than producing personal change. Thus, the researcher viewed the substantial importance of employing interview in social scientific research and decided to exploit these advantages.

The major types of the interview survey are personal contact, video conferencing, and telephone interviews.

a) Personal interview: This type of interviews survey is more in personal in form, (direct contact), in comparison with questionnaires which are dispatched. In the personal interview survey, the interviewer works directly with the respondents. In addition, the respondents and the interviewer have direct contact for dialogue and rapport within a close environment.

b) Telephone interview: Telephone interviews enable a researcher to gather information rapidly. In similarity with personal interviews, a telephone interview allows personal contact between the interviewer and the respondents, and also allows the interviewer to ask follow-up questions. The Telephone interview allow information to be obtained conveniently at disperse, and eliminates the cost of travel. However, many respondents often dislike the intrusion of a call at their homes; hence telephone interviews' durations need to be short and concise.

c) Video Conferencing: The facilities to conduct this type of interview research are costly, and not generally available for use. This type of research approach is more convenient than the personal interview. It enables information to be sought at a distance apart, while the interviewer and respondent could have a contact through audio visual means.

Irrespective of any type of interview methods adopted for information collection, the interviewer has the opportunity to probe or ask follow-up questions. Also, interviews are generally easier for the respondents, especially to seek opinions or impressions, in comparison with questionnaires' surveys. However, interview surveys are more time consuming and resource intensive.

Several merits and demerits of interview research are identified by many authors; including Silverman (2005), Denzin and Lincoln (2005), Bryman (2004), Punch (2003), Sarantakos (2001) and Frankfort-Nachmias and Nachmias (1996). The merits and demerits of interview survey are:

A) Merits of Qualitative Interview Survey Research

The merits attributed to qualitative interview research are:

a) The on-going one-to-one dialogue enables a relationship to be developed and significantly enables the parties to feel confidence and relax with each other.
b) The interview helps in engagement on discussion that could clarify ideas and experiences.
c) The interview helps to gain a definite understanding of the research work and the respondent expectations.
d) It helps to evaluate the research study that aimed at examining individual respondent.
e) It helps to explore individual differences between participants' experiences and outcomes.
f) It helps to evaluate, capture, and describe research processes that are dynamic and evolving.
g) It helps to present the significance of the research study to the participants.
h) It helps to document variations in research program implementation at different sites.

B) Demerits of Qualitative Survey Research

The demerits of qualitative interview survey are:

a) It is more intrusive than quantitative approaches. The participants may say more than they intended to say, and later regret having done so.
b) It is more reactive to personalities, moods, and interpersonal dynamics between the interviewer and the interviewee than the quantitative method.
c) Conducting interviews is expensive and time-consuming, thus to achieve a robust qualitative interviewing requires considerable skill and experience.
d) Analysing and interpreting qualitative interviews is much more time-consuming than analysing and interpreting quantitative interviews.
e) It is more subjective than quantitative interviews and prone to problems on the part of the researcher in terms of decisions about relevant quotes and specific examples to report.

3.3.1.3 Qualitative Interviewer Attributes and Establishment of Rapport

During qualitative research, the interviewer needs to demonstrate the following qualities and attributes, to establish pleasant rapports; so that the support of the interviewees could be gained. Such characteristics are:

a) Practical: characterising the image of constructive person, engaging in an important task.
b) Sincerity: enabling the respondent to enjoy discussions with the interviewer.
c) Appear harmless to enable the interviewer to develop trust, mutual respect, and realise that interviewee is not a mischievous person.
d) Speak and act in ways that are non-threatening.
e) Cultivates a relatively neutral role, is compassionate or sympathetic towards the interviewee when such cases arises.
f) Prompt: endeavour to interview respondents at a time and place convenient to them and as scheduled.
g) Keeps one's word and strives not to promise anything that cannot be accomplished.
h) Remains neutral throughout the interview period.

3.3.1.4 Structure of Qualitative Interview Research

The different structures of interview research are:

a) Structured interviews: By structured interview, the Interviewer, (researcher) has 'control' of questions and cultivates the habit of been 'neutral' in acknowledging responses. The structured interview contains closed-end questions with alternative answers for the respondent to choose from, to pass comment and vend opinion. In this research study, majority of the interview questions are structured from the results obtained through a questionnaire survey and pilot studies carried out.

b) Unstructured and Semi-Structured Interviews: Apart from the structured questions, a few questions were semi-unstructured, while a few are unstructured. These methods enable the researcher to gain an overview on and to explore specific areas of interest. The semi-structured questions are open-ended types, where opinions are sought from the respondents. These enable the respondents to respond more freely and flexibly than the structured question ones.

3.3.2 Mixed Method Research Approach

The adoption of both qualitative and quantitative research methods for research work is defined as, the exploitation of mixed or multiple methods research approach for data collection. In this research study, multiple methods are significant towards achieving "grounded results". Creswell (2008) argued that the use of a mixed methods approach is important for research so that the demerits of a method will be cancelled by the merits of the other method. Also, the results from one method could be useful to develop or infer the ones that are generated from another. That is, greater insight is achievable from approaching a topic from a different perspective.

Creswell (2008) explains three important strategies for using a multiple methods approach in research. These explanations enhance the researcher's understanding to adopt the most appropriate strategies for this research work. These strategies are:

a) Sequential strategy: This is predominantly used where there is a need to elaborate on or expand the findings of one method with another method. In this research study, qualitative interview research study will be conducted after exploration of quantitative research approach.

b) Transformational strategy: This strategy involves the use of theoretical views to provide a framework for the study and research design, and is inclusive of both qualitative and quantitative research methods for data collection.

c) Concurrent strategy: This involves the conduction of both qualitative and quantitative research and data being collected at the same time and construed together for inferences.

During this research, both sequential strategy and a transformational strategy were fully explored, while research theoretical frameworks were developed and research questions were divided to diverse sub-questions; while each sub-question were investigated independently by employing qualitative and quantitative research methods.

The researcher recognised that research findings are often affected by the nature of the data collection techniques, as each of the data collection methods has advantages as well as intrinsic limitations, (Frankfort-Nachmias and Nachmias, 1996). Thus, to avoid the inadequacies of a specific method, to explore the advantages of a different research method, and for triangulation purposes, a mixed-methods research approach was fully employed for the information and data collection.

Facts from Punch (1998) on the exploitation of mixed or multiple methods approach for research work are also found useful. These factors are:
a) The logic of triangulation: Enables findings from one type of approach to be checkable against the findings which derive from another type.

b) A research method facilitates other methods: Quantitative research helps to provide background information on research concepts and assist in research interview questions formulation and construction. While qualitative research helps to bridge the deficiency of quantitative study.

c) The structure and process: Quantitative research is efficient in information about structural features of social life while qualitative is stronger in procedural aspects.

d) The researcher and subject perspectives: The mixed-method approach is used to annul the bureaucratic perspective of the research study. Qualitative research is driven by the researcher's concerns while quantitative addresses the subject's perspective as the point of departure.

e) The problem of generality: The inherent limitation of qualitative study is its inability to generalise its findings due to limited geographical coverage, time, and cost; although its findings are significantly rich. To reduce this effect, quantitative research is explored to obtain information or data from a wider scope at lower cost. Hence, findings from the two approaches enhance the reliability and validity of this research work.

f) The interpretation and relationship variables: Quantitative research readily allows the easy establishment of relationships between variables but is often weak in exploring the reasons for the relationships; while, qualitative helps to explain the factors underlying the broad relationships that were established from the quantitative research method

The advantages obtainable from the exploration of the mixed methods research survey drive the consideration of the Quantitative and Qualitative research surveys for this CRWM study data collection. Also, Sarantakos (2001) drew a relationship of the two research approaches, which further enhances the use of this mixed methods. Quantitative research adheres to the standards of strict research design that are developed before the research begins, employs quantitative measurement, and eases the use of numeric statistics. Conversely, the Qualitative research is a methodological principle based on social interactions, by employing methods of data collection and analysis non-quantitatively, while aiming towards exploration of social relations and thereby describing reality as experienced by the respondents.

In summary, the general assessments of different types of research survey methods as identified by Trochim (2006) are presented in Table 3.2.

3.3.3 Inductive and Deductive Research Approaches

The researcher evaluates inductive and deductive research methods' approaches, (principles and practice), and the exploitation of these approaches to deduce inferences and robust findings. These are two broad methods of reasoning in Social scientific world.

Table 3.2 General Assessments of different Types of Survey Research Methods, (Trochim, 2006)

Issues	Questionnaire Survey			Interview Survey	
	Group	Mail	Drop-Off	Personal	Phone
Are visual presentations possible?	Yes	Yes	Yes	Yes	No
Are long response categories possible?	Yes	Yes	Yes	???	No
Is privacy a feature?	No	Yes	No	Yes	???
Is the method flexible?	No	No	No	Yes	Yes
Are open-ended questions feasible?	No	No	No	Yes	Yes
Is reading & writing needed?	???	Yes	Yes	No	No
Can you judge quality of response?	Yes	No	???	Yes	???
Are high response rates likely?	Yes	No	Yes	Yes	No
Can you explain study in person?	Yes	No	Yes	Yes	???
Is it low cost?	Yes	Yes	No	No	No
Are staff and facilities needs low?	Yes	Yes	No	No	No
Does it give access to dispersed samples?	No	Yes	No	No	No
Does respondent have time to formulate answers?	No	Yes	Yes	No	No
Is there personal contact?	Yes	No	Yes	Yes	No
Is a long survey feasible?	No	No	No	Yes	No
Is there quick turnaround?	No	Yes	No	No	Yes

A) Inductive Approach

In an inductive research approach, a conclusion is drawn based on literature search and findings obtained through exploratory study. This approach is suitable when there are insufficient theories to predict types of responses expected from the research work. Frankfort-Nachmias and Nachmias (1998) and Trochim (2006) explain that, among the significance of the inductive research is its flexibility and richness. In addition, the approach often enables the researcher to generate viable explanations from practical deductions from the analysed data or information obtained.

The inductive approach in social research enables the researcher to move from a specific observation to broader generalisation and development of theory thereafter. This approach is found to be suitable for this research work which is exploratory in nature. It enables the researcher to commence the study with observations and measures, followed by detection of patterns and regularities. Research questions are formulated and conclusions are drawn from empirical findings. Another approach is the deductive approach.

B) Deductive Approach

This approach was found not significantly appropriate for this particular research works. In this type of approach, the reasoning work is from the more general to the more specific, which is concerned with testing or confirming hypotheses from the theory formulated from the outset. In contrast, the researcher intends to develop propositions to construct response categories before administration of research instruments to respondents.

Trochim (2006) affirms that, the two methods of reasoning have a very different believe when conducting research. Inductive reasoning, by its very nature, is more open-ended and exploratory, especially at the beginning. Deductive reasoning is narrower in nature and is concerned with testing or confirming hypotheses. Though a particular study may look like it is purely deductive, however, most social research involves both inductive and deductive reasoning processes at same time in the project.

3.3.4 Other Types of Qualitative Research Approaches

Other approaches to the qualitative survey as stated by many authors including Trochim (2006), Silverman (2005) and Sapsford (1999) are:

A) Qualitative ethnographic research methods

The ethnographic approach to qualitative research comes largely from the field of anthropology. The emphasis in ethnography is on studying an entire culture. This idea of a culture was previously tied to the notion of ethnicity and geographic. However, it has been broadened to include virtually any group or organization. Ethnography is an extremely broad area with a great variety of practitioners and methods. The most common ethnographic approach is Participant Observation as a part of field research. The ethnographer becomes immersed in the culture as an active participant and records extensive field notes. As in grounded theory, there is no preset limiting of what will be observed and no real ending point in an ethnographic study.

B) Qualitative phenomenological research methods

Phenomenology is a school of thought that focuses on people's subjective experiences and interpretations of circumstances, and the approach tend to interpret and understand the relationship between situations and occurrences.

C) Participant Observation Research

In this approach, the researcher often becomes a participant in the culture or context being observed. This participatory observation survey requires months of intensive work because there is need for the researcher be accepted as a natural member of the construction participants in order to assure that the observations are of natural phenomenon.

D) Direct observation

Direct observation is distinguished from participant observation in several ways. A direct observer does not typically try to become a participant in the context. However, the direct observer does strive to be as unobtrusive as possible so as not to be bias in the observations. Also, direct observation suggests a more detached perspective. The researcher is watching rather than taking part. In addition, direct observation tends to be more focused than participant observation. The researcher observes the sample, situations or people rather than trying to become immersed in the entire context. Finally, direct observation tends to be briefed and shorter in duration in comparison with the participant observation.

E) Case studies

A case study is an intensive study of a specific individual or specific context. There is no single way to conduct a case study, and a combination of methods, (such as, unstructured interviewing, direct observation), can be used.

The details of the typical research methods explored are distinctly presented in Chapter Four.

3.4 CHAPTER THREE SUMMARY

This chapter evaluated different types of research methodology, and presented the merits and demerits of each research survey. The chapter identified and explained the rationales of the research methods to be adopted for the CRWM study. The chapter explained the need for adopting a mixed research methods approaches, (Quantitative and Qualitative research approaches), for data collection; to ascertain valid and reliable findings.

The next chapter, (Chapter Four), presents the research design that is to be employed for the research data collection, and also analyses techniques to be adopted. Also the sampling techniques, sample population and statistical methods to be employed towards achievement of viable and reliable CRWM best approach framework are detailed.

CHAPTER FOUR

RESEARCH METHODS

4.0 RESEARCH METHODS

4.1 CHAPTER INTRODUCTION

In the preceding chapter, (Chapter Three), different approaches for research work were evaluated. In this chapter, the most appropriate ones to be adopted for this research study are explicitly referenced. The merits and demerits of each method enabled the researcher to choose the most appropriate methods, (these factors are explained in Chapter Three)

In addition, in Chapter Three the necessity to explore inductive research principle, and multiple methods of survey approaches for data collections were clearly identified. The logical sequence to obtain valid and reliable data, information and research outcome is explicitly explained in this chapter. The main research variables, the research planning process, theoretical frameworks, and the research questions in relation to the research objectives are highlighted, and conclude with the chapter summary.

4.2 RESEARCH VARIABLES

Research variables mean the attributes in terms of which considered cases and factors varies. Trochim (2006) explains that, a variable is any entity that can take on different values. That is, variable is an empirical property that takes one or more values and can change in quality and quantity. There are four types of variables, and these are: the independent, dependent, descriptive and extraneous variables. These research variables are illustrated in Figure 4.1.

A) Descriptive Variables

These are variables to be reported on, with no conclusion drawn about influencing or causing effect. The research descriptive variable is the building, (construction) production process. This research is based on a conviction that the current construction production process needs to be re-assessed to improve its product delivery in relation to cost and time effectiveness that will enhance the stakeholders' intended objectives.

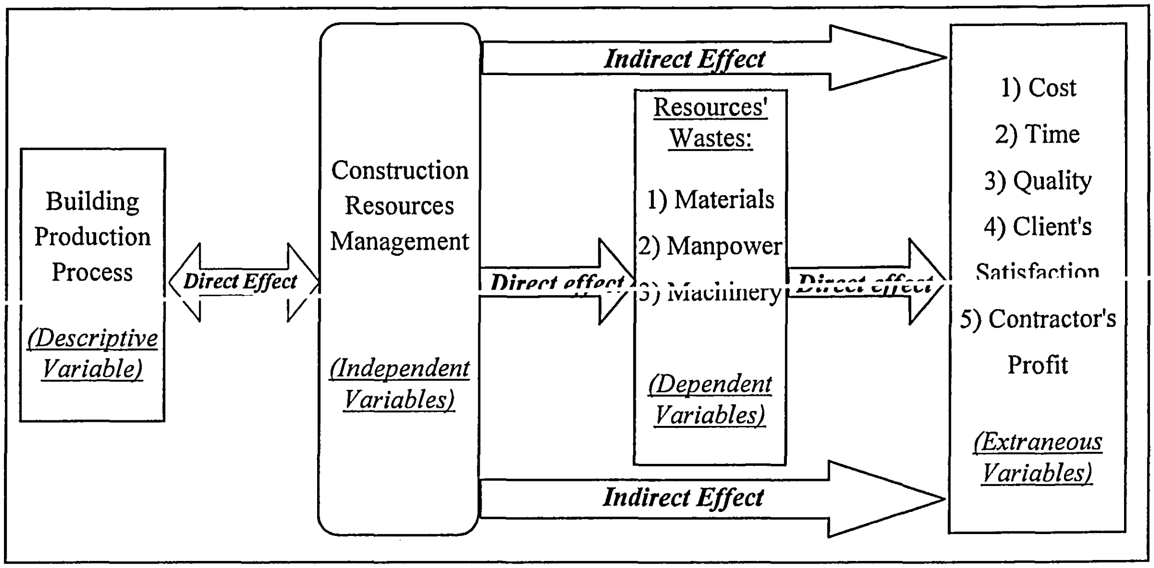


Figure 4.1: Research Variables

B) Independent Variable

The independent variable is what nature or research manipulates, threat, program or causes. These are the variables that influence the dependent variable. The independent variable of this research is the construction resources management. The causal-effect of construction resources management is resources utilisation efficiencies, (efficient and inefficient utilisations). This variable has a direct effect on dependent variables

C) Dependent Variables

The dependent variables are what are affected by the independent variable: the effects or outcomes. That is, dependent variables are affected, caused, or influenced by other variables. The dependent variables of this research are the resources' wastes: materials waste, manpower waste, and machinery waste.

D) Extraneous Variables

These are the types of variables that provide alternative causal explanation and so cast doubt on the dependent variables. For this research, the Extraneous Variables are project cost and time, clients' satisfaction and contractors' profits.

Based on the identification of the research variables, this research theoretical framework was established.

4.3 RESEARCH THEORETICAL FRAMEWORKS

These research theoretical frameworks are developed base on critical appraisal of much literature, evaluations of both research problems and strategies, and the preliminary pilot study conducted. These theoretical frameworks are to assist in concentrating and to pave the direction on what to be investigated towards achieving the research objectives.

Figure 4.2 presents a theoretical concept that illustrates the relationship of the construction resources, (Materials, Manpower, and Machinery), which are the inputs towards construction products production, and the resources' wastes envelope that often occurs. This Figure 4.2 also presents the resources' wastes that have direct effect on stakeholders' expectations, the construction industry and the national endowment. The resources' interactions envelope in Figure 4.2 illustrates the forms of waste resources that are often being generated during the production process through inefficient resources utilisation by the construction participants.

To achieve optimal construction resources utilisation and efficient wastes management during the construction production process, several factors need to be evaluated. Among these are the factors that often hinder the site managers in efficient implementations of different management skills and attributes. Figure 4.3 illustrates the roles of site managers within the construction industry with emphasis on efficient resources utilisation, vis-à-vis wastes management during the production process. In addition, the Figure 4.3 presents the scenarios of the site managers' inefficient implementation of functions and attributes. In consequence, these inefficiencies often perpetuate inefficient utilisation of construction resources. These scenarios influence the construction production cost, delivery time and quality expected.

In respect to the circumstances presented in the Figures 4.2 and 4.3, Figure 4.4 illustrates the CRWM theoretical framework, taking into consideration the research proposition; "A project could be completed within a budgeted cost, time frame, expected quality, and to clients' satisfaction, with lots of resources wastefulness. Hence, during this research data collection, the CRWM was view based on these identified factors presented in the Figure 4.4.

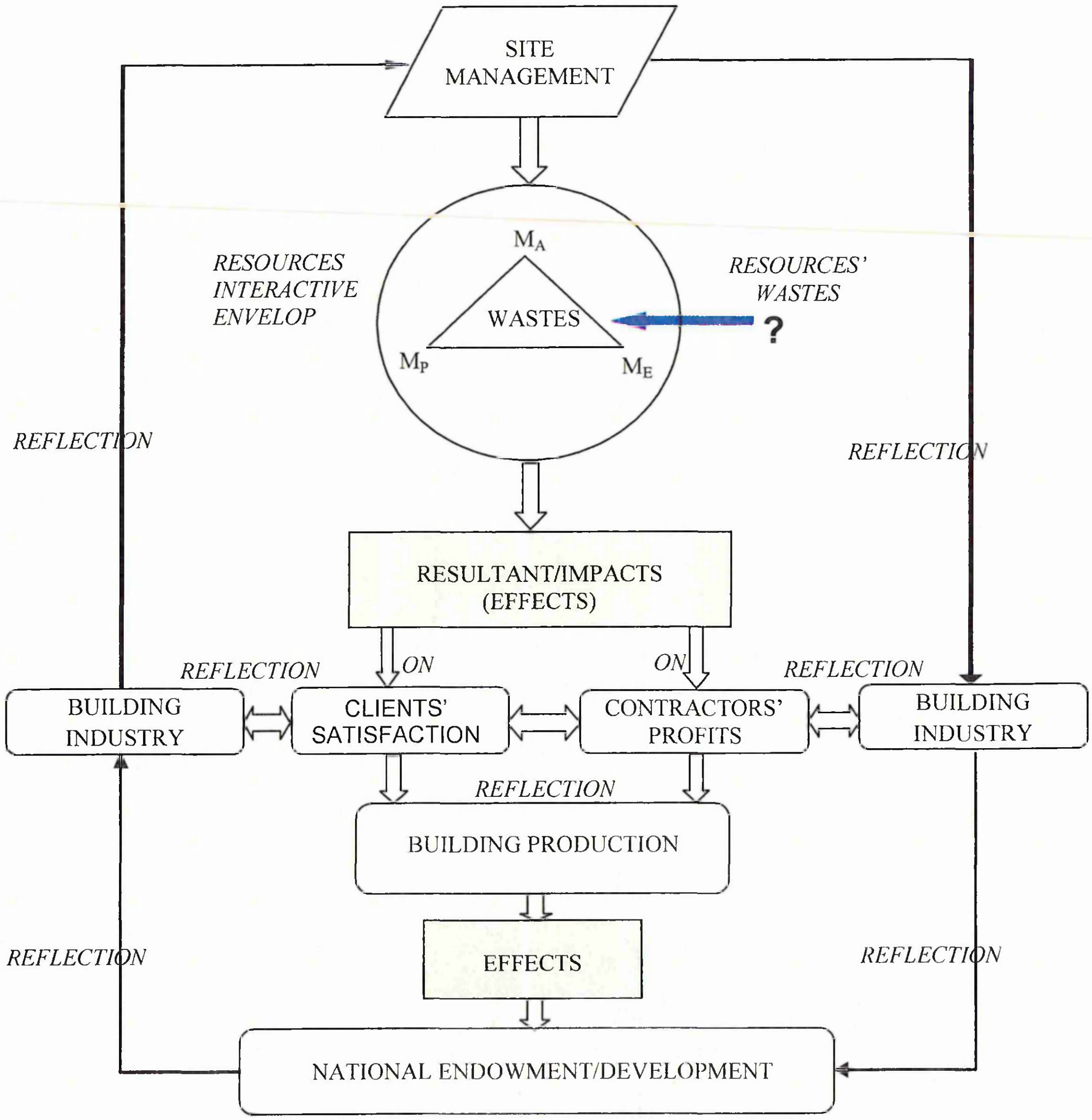


Figure 4.2 Construction Resources' Wastes Generation Envelop and the Effects

Key: Materials, Ma; Manpower, Mp; Machinery, Me.

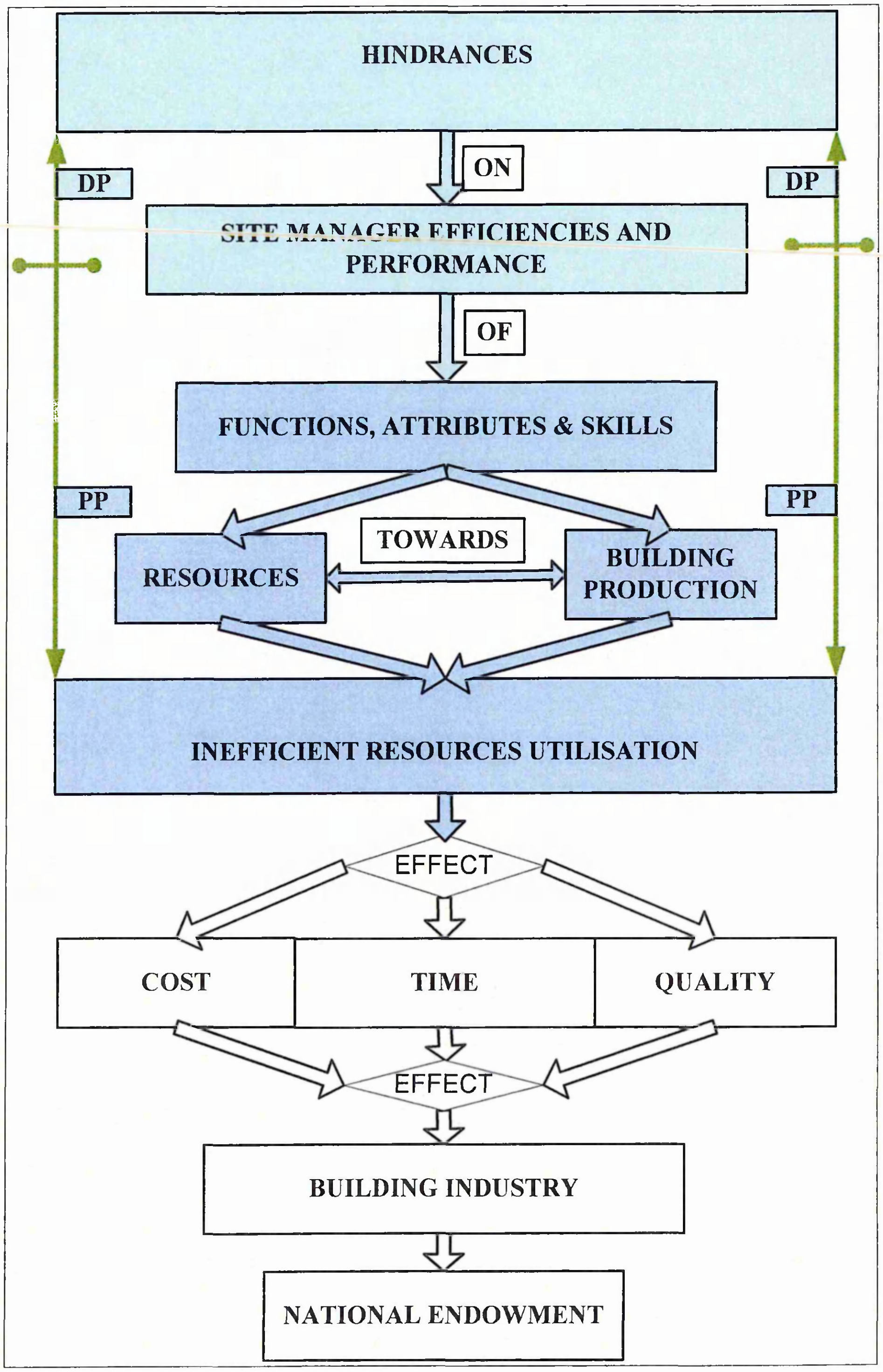


Figure 4.3: Resources Utilisation and Wastes' Management Conceptual Framework

Key: DP - Design Phase; PP - Production Phase

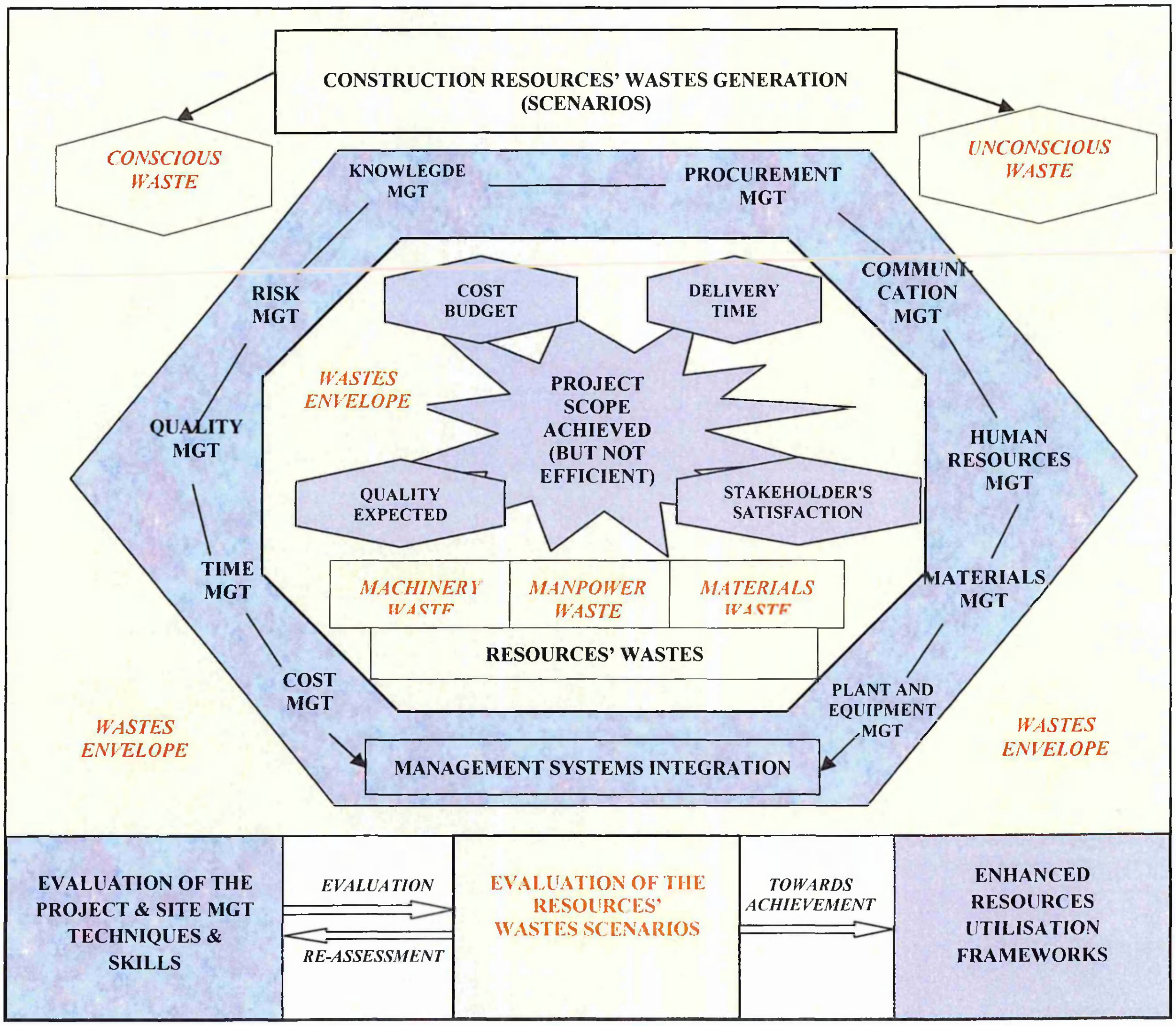


Figure 4.4 CRWM Theoretical Framework

Key: Management - MGT

The sequence of achieving optimal resources utilisation in the construction industry is illustrated in the framework Figure 4.5, in logical order, (A to H). To achieve optimal resources utilisation operational framework, several CRWM concepts need to be investigated within the current resources utilisation system and process in the construction industry or organisation. Therefore, identification of inefficiencies in any factor objective(s) or goal(s) would require the re-evaluation of the preceding factor. This figure presents the research design approach in loops of concepts, systems and process towards achieving optimal resources utilisation and resources' wastes management during the production process.

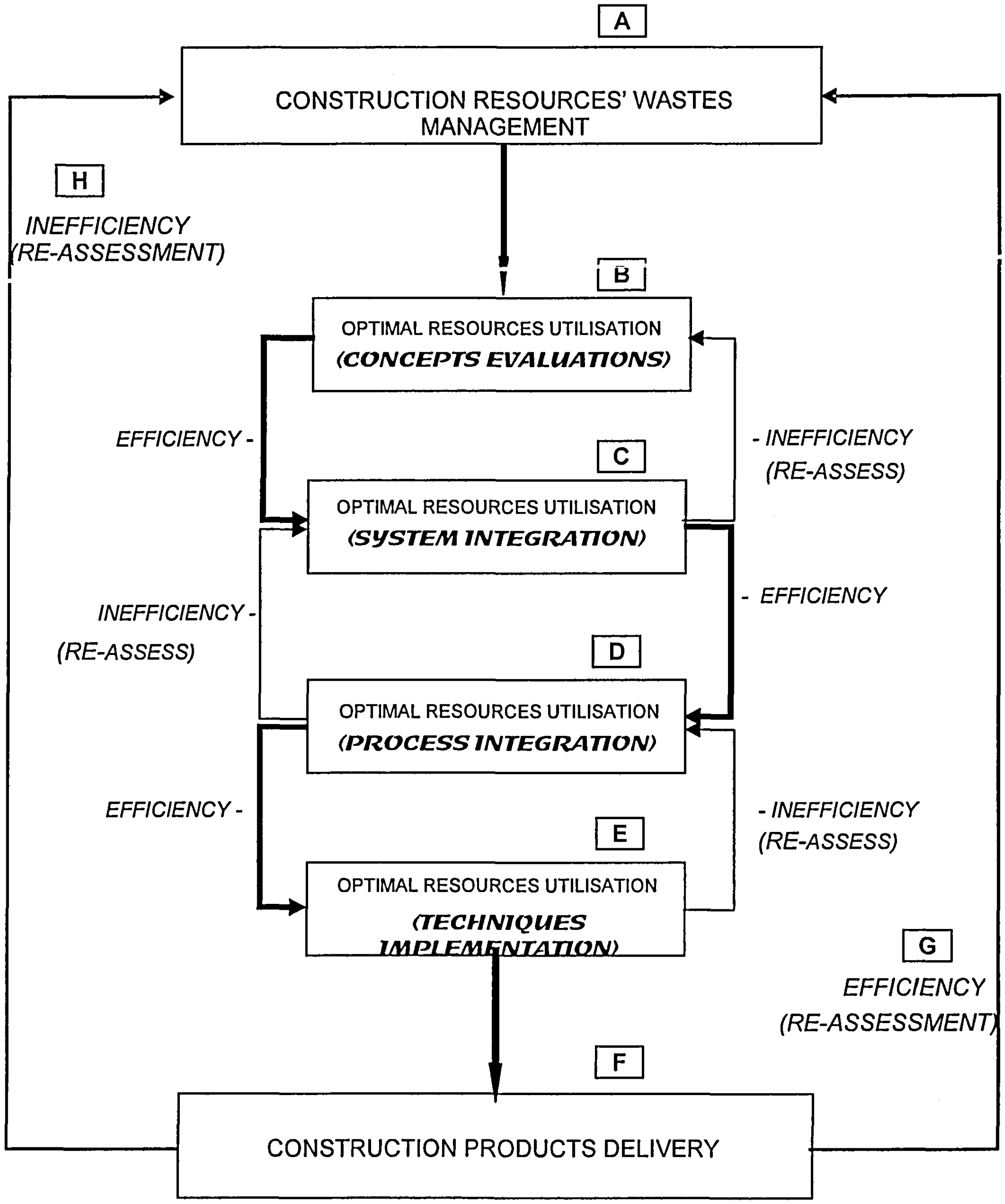


Figure 4.5 CRWM Current Practice Evaluation Sequence towards Best Practice

4.4 SURVEY RESEARCH PLANNING TECHNIQUES

The four principal elements that are involved in the planning of a robust research in the social scientific world, as identified by many scholars, were found useful and implemented. These elements are problem definition, sample selection, design of measurement, and questions and ethical responsibility, (the concern for respondents), (Sapsford and Jupp, 1996). These factors are illustrated in Figure 4.6.

The interactive links that show the relationship of these factors, (Figure 4.6) indicate that any of these factors could be the starting point of a process and the decision made within any of the factors seldom have a consequent effect on others. The initial planning of this research work involves the critical definition of the research variables, followed by the formulation of feasible research theoretical frameworks, a review of the research questions and sequential procedure for the implementation of the research methods.

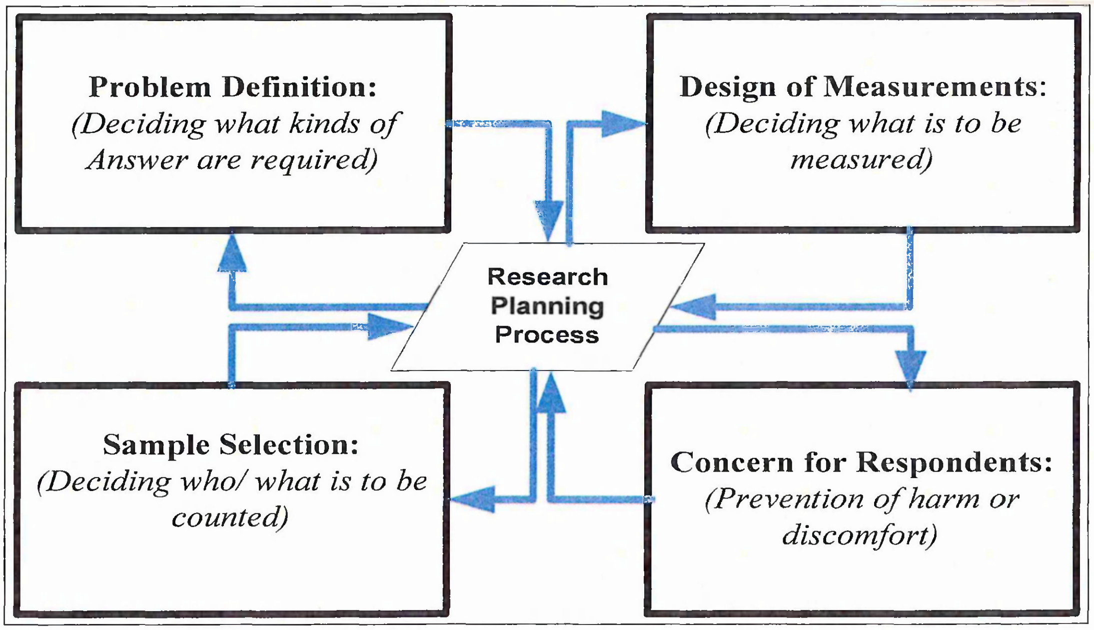


Figure 4.6 Interrelationships between the Research Planning Processes

4.5 CRWM RESEARCH QUESTIONS AND THE ASSOCIATED RESEARCH OBJECTIVES

This section presents in detail the CRWM research questions and relates these questions to the research objectives. Towards the development of these research questions, there is a critical consideration of the views of Trochim (2006), Bryman (2004), Sarantakos (2001) and Punch (2003).

As affirmed by many authors, the three basic types of questions that research projects often address are:

a) Descriptive questions: when a study is designed primarily to describe what is going on or what exists, such as public opinion polls that seek only to describe the proportion of people who hold various opinions are primarily descriptive in nature. Thus, this research is designed to investigate construction resources inefficiencies and to ascertain how the resources wastefulness could be minimised in the construction sector by sampling the opinion of construction site managers in the UK construction industry.

b) Causal questions: when a study is designed to determine whether one or more variables cause or affect one or more outcome variables. In respect, this research is designed to verify and ascertain the effect of Construction Resources Management on resources utilisation which will perpetuate cost, time, quality stakeholders' satisfaction and contractors' profit.

c) Relational questions: when a study is designed to look at the relationships between two or more variables. In contrast, this research is not designed to compare individual variables, rather to investigate the causal-effect of the research variables.

However, these three question types in many occasions are often interwoven in a research study, (Trochim, 2006). That is, a relational study can be explored first to describe, (by measuring or observing), each of the variables that the research is trying to relate; a causal study can help to describe both the cause and effect variables, and finally these variables can be verified to relate to each other.

4.5.1 Practical Importance of CRWM Research Questions

This study research questions set targets for the research work toward what is achievable within the research framework In addition to this, the questions:

1. enable the researcher to organise the study, tailor a coherent research direction and determine the most appropriate research methods and design to be employed;
2. limit the research work and the boundaries that will keep the research focus towards its objectives;
3. help to streamline the significant research data required for collection;
4. enhance the theoretical framework development toward achieving valid and reliable findings.

4.5.2 CRWM Study Research Questions and the Corresponding Research Objectives

This sub-section relates each research question to its corresponding objective, and presents their significant towards achieving the research aim. This CRWM study is an exploratory and descriptive survey to investigate the causal-effect of the research variables illustrated in Figure 4.1.

The following are the research questions and their associated research objectives

Research Question 1: What are the constraints on site managers that enhance the wastefulness of construction resources?

This question 1 is set to investigate various constraints on site managers that augment inefficient utilisation of resources.

Research Question 2: What are the factors that need to be constant towards efficient utilisation of resources?

This question 2 is set to identify and evaluate various factors, (internally within the construction organisations and external environmental factors), that are required to sustain efficient utilisation of resources during production process.

Research Question 3: Why do construction participants budget for construction resources wastefulness?

This question 3 is set to identify and ascertain the rationales for provision for resources' wastes, and the attitudinal behaviour of construction participants towards waste resources during production process.

Research Question 4: How could construction resources be salvaged from wastefulness and be efficiently utilised during the production process?

This question 4 is set to establish CRWM operational framework for optimal utilisation of construction resources, and effective construction resources' wastes management during the production process.

4.6 CRWM STUDY RESEARCH PROCESS AND DATA COLLECTION

The logical sequence of achieving the CRWM research objectives was illustrated in Figure 1.1, however, this research process flowchart, (Figure 1.1) is further simplified in

Figure 4.7 to clarify the elements in the research process. The main elements in this research process are explained thus:

4.6.1 Secondary Research Study

Secondary research study is the review of literature. It is an overview to combine divergent opinions, facts, principles, techniques and the emergent innovations which are fundamental to efficient and effective utilisation of construction resources during the production process. Secondary research provided the background information for this research work, and this is the first stage of this research study.

Among the issues evaluated during the secondary research survey were: the constraints of the site manager in efficient use of construction resources, and the attributes, potential, and skills required of a site manager for efficient performance of duties. Also there was a critical evaluation of several management techniques towards efficient utilisation of construction resources and the rationales for budgeting for wastes, and the syndromes in the industry. In addition, the current innovations towards efficient utilisation of construction resources in the UK were overviewed, and relevant factors towards sustainable construction resources utilisation were also evaluated. These were presented in Chapter Two.

From the secondary research, the appropriate research methods for primary research data and information collection were identified, (presented in Chapter Three).

The secondary research, and the findings obtained from the first research pilot study provides substantial information for the conceptualisation of research theoretical framework and for the administration of questionnaires and interview surveys, (the primary data collection techniques).

4.6.2 Primary Research Study

This is the second stage of information collection for this research study. Field surveys were carried out to obtain primary data and information. The fundamental rationales to explore primary research studies, (the qualitative and quantitative research methods) have been identified and explained in Chapter Three.

In summary, the primary research study helps to achieve the following:

(a) It was explored to provide substantial information and data that significantly clarified or affirmed the facts obtained during the literature review.

(b) It provides data on behavioural patterns of construction participants toward utilisation of construction resources.

(c) Helped to evaluate the respondents' perceptions on conscious and unconscious construction resources' wastes.

(d) It was explored to obtained information from respondents on how construction resources wastefulness could be effectively minimised.

(e) It provides substantial information for the formation and establishment of the research operational frameworks.

4.6.3 Survey Research Data Collection

The sequence and approach adopted for data collection are presented in this section. That is, there are explicit clarifications of the logical approach for data collection and the appropriate research methods that will provide robust outcome. Mixed methods survey research approach was adopted for the data collection. That is, the exploitations and administrations of both quantitative questionnaires and qualitative interview research techniques. The sequence of the data collection is presented in Figures 4.8 and 4.9, and the following sub-sections outline the operationalisation.

4.6.3.1 Data Collection Sequence

A quantitative method of data collection was carried out to obtain substantial descriptive statements. Consequently, a qualitative method of data collection method was employed which enabled the experience and perceptions of the construction site managers to be explored. During the qualitative interview data collection, direct observations were carried out, and a diary was used to note vital information on resources utilisation on some construction project sites. The rationales for choosing each technique and distinctive strengths and weaknesses have been discussed in Chapter Three.

The logistic sequences for the research data collection are illustrated in Figures 4.8 and 4.9. Figure 4.8 shows the detailed sequence for the research data collection through the three main research surveys explored, while Figure 4.8 buttressed Figure 4.7 and outlined the operationalisation sequence of the research methodology. That is, the sequence of data collection from the quantitative and qualitative research surveys.

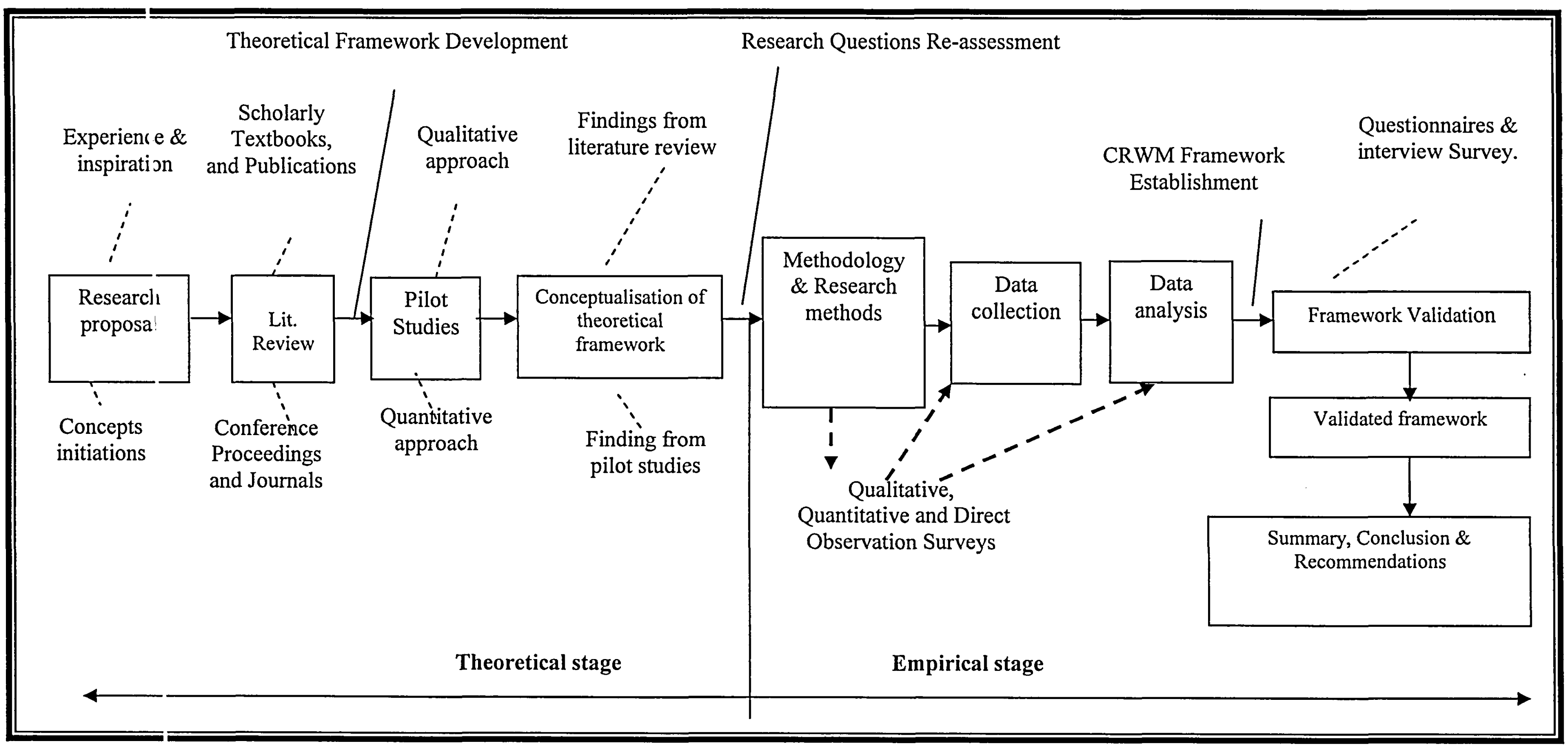


Figure 4.7 Simplified Research Process

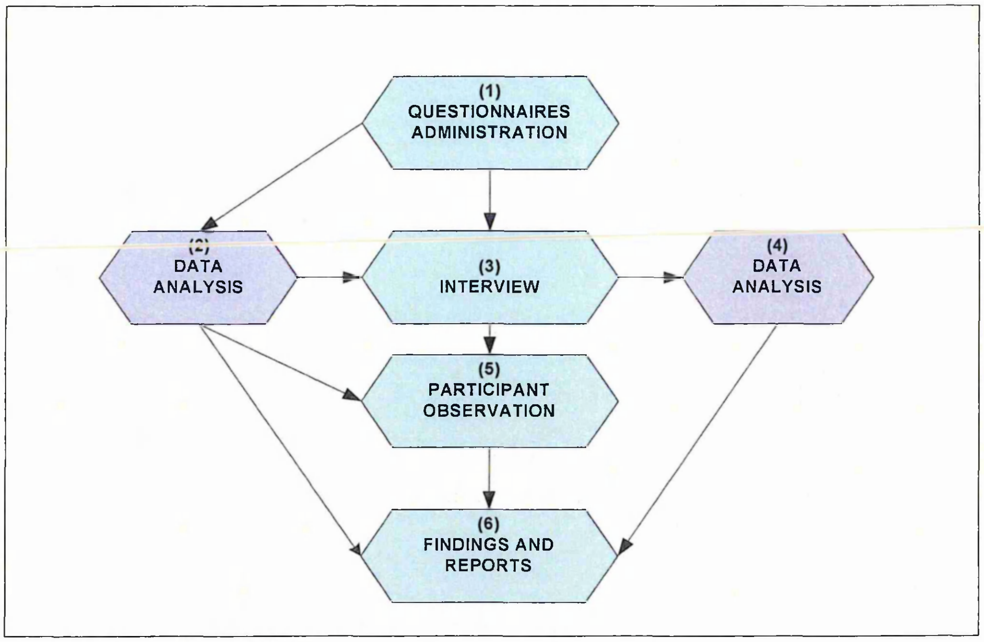


Figure 4.8 Data Collection Sequence

A questionnaire research survey was firstly carried out before the interview survey research for the following reasoning:

a) To ascertain the respondents that will be interested in the interview data collection process.
b) To allow pre-analyses and inferences that the interview survey will be based upon, also to enable the researcher to have pre-knowledge of what is to be studied and viewed during the direct observation survey.
c) To make any respondent interested in the interview survey to have foreknowledge of the possible questions or issues that will be addressed during the interview.
d) To allow the interview research survey bridged the disadvantages and limitations of the questionnaire research survey.

4.6.3.2 Sample Frame, Sampling Techniques and Population

A) Sample Frame and Sampling Techniques

Sampling is a feasible method of obtaining data; it saves time and cost of data collection, and provides a good representation of elements in the population. Also, apart from saving time and effort, sampling allows the possibility of consistency and unbiased estimates of the population, (Sapsford and Jupp, 1996).

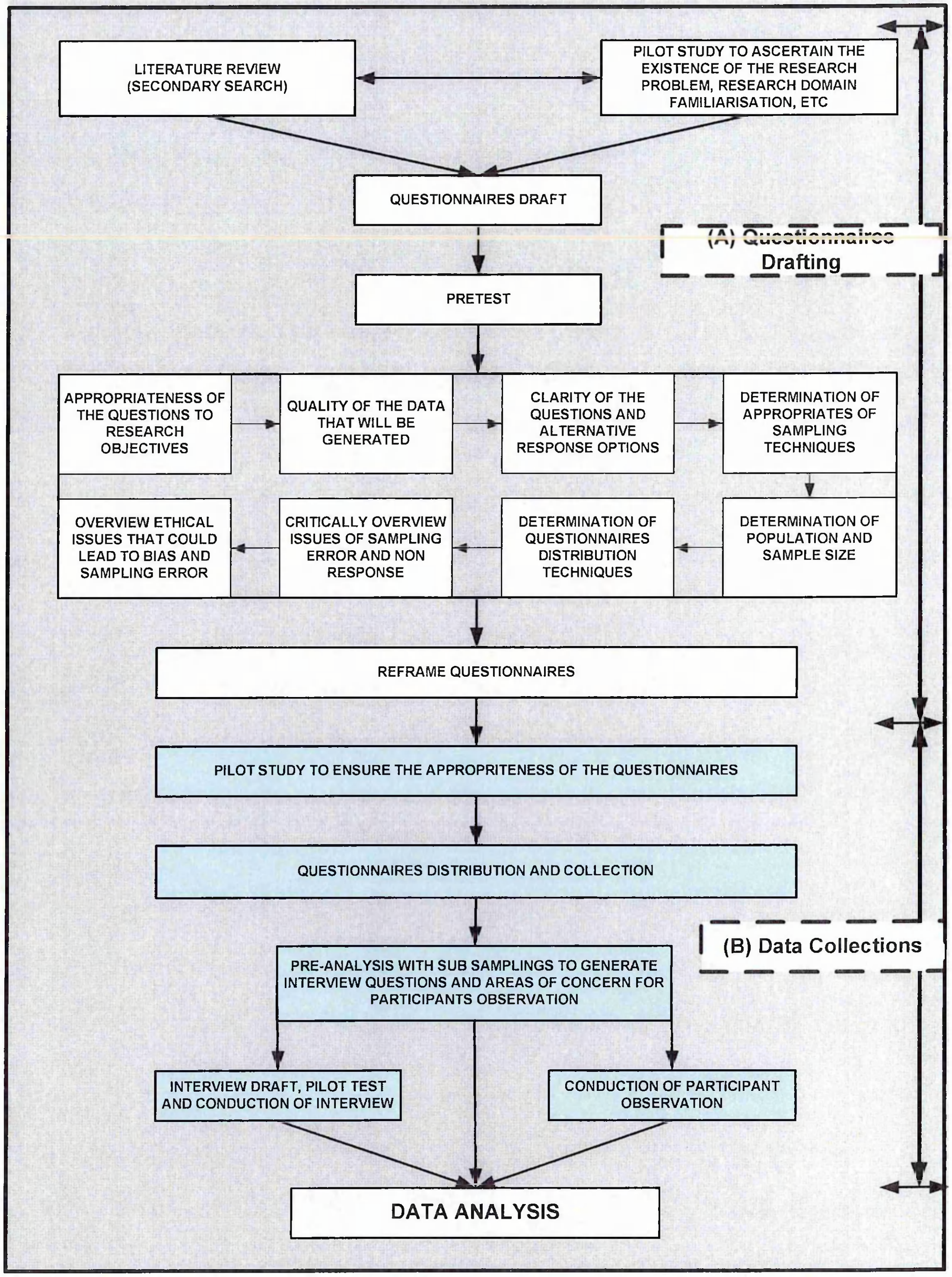


Figure 4.9 Operationalisation of the Research Methodology - Mixed Methods Research Survey Approach

From the literature searched, the researcher was aware that the two principal types of sampling techniques are probabilistic sampling and non-probabilistic sampling, (Czaja and Blair, 2005; Oppenheim, 1992; Sapsford and Jupp, 1996). Thus, the researcher found it significant to exploit probabilistic sampling techniques, and to combine simple random sampling with stratified random sampling. This is to balance sample adequacy with cost and feasibility. With simple random sampling, it implies that any construction project manager in the sample frame is having an equal opportunity and independent chance of being chosen.

The population from which the samples were drawn is that of construction site managers in the UK. Construction site managers in this research imply the personnel that are directly involved in the management of the construction production process at the construction project sites.

However, it is obvious that, validity and reliability of data collection greatly depends on the characteristics of samples and the population from which the samples are drawn. Thus, during the data collection planning stage, the sample validity was critically viewed to ensure that population will be able to provide the information that will adequately address the research objectives.

B) Sample Population

A sample population is the total collection of the elements actually available for the sampling and this will be the representation of all those that fall within the category of the sample frame, (Oppenheim, 1992). There are approximately 27,500 construction companies in the UK, (Financial Analysis Made Easy, (FAME); the free financial database website, accessed on 22/10/2006). These comprise indigenous, multinational, small, and medium enterprises. Within these organisations, there are 32,701 and 13,624 registered members of CIOB and Association Project Management, (APM), respectively in the UK, (obtained from CIOB and APM Record, September 21, 2006), while some construction site managers have acquired other allied professional background. These indicated that the research population, (the Construction site managers in the UK), is large. Thus, to achieve a valid and reliable outcome the researcher explored both simple and random stratified sampling techniques.

This research samples were drawn randomly from selected and stratified construction organisations. The majority of construction organisations selected have multinational status with a significant number of employees covering many geographical zones, (regions), in the UK. It is believed that the managers selected in these organisations will possess seasoned construction knowledge from diverse countries or environment from which the organisation operates. Secondly, the managers would have possessed adequate managerial experience before been appointed as a manager in a multinational organisation. The demography of the questionnaire respondents is presented in Chapter Five, Tables 5.1 and 5.2 and the interview research survey demography is presented in Chapter Six, Table 6.1.

The research data collection is limited to the UK construction organisations due to: (i) the UK is one of the developed countries in which there is up dated research and advancement in innovation, especially in the construction industry, and (ii) several countries adopted or modified British Standards for their code of practice. Conceiving these facts, there is a conviction that, the research outcome will be significant for global construction industry adoption.

4.6.4 Quantitative Questionnaires Survey Research Data Collection

This is the first part of the primary data collection. The questionnaires administered were structured to explore Knowledge, Attitude, and Perception, (KAP), of construction site managers in the industry. Closed ended questions dominated the questionnaires, while the respondents were requested to choose from alternative options provided. Also, some open-ended questions for opinion expression were set to bridge possible inadequacies of options provided. A copy of this questionnaire is attached as Appendix (B). The researcher developed the self-administered questionnaires based on personal experience in construction works, information gathered from secondary literature and pilot studies undertaken.

A) Questionnaires Administration, Avoidance of Sampling Errors and Non-Response

The questionnaire data collection covered all the UK geographical zones. The questionnaires were randomly distributed amongst the construction site managers working in construction organisations; organisations that are having good reputations in respect of numbers of employees and turnover. Also, the types of construction projects undertaken, and the extent of geographical coverage within the UK were significantly considered. These facts and information of the organisations were obtained from Financial Analysis Made Easy 2006 report.

The questionnaires were used to collect standardised descriptive information on the use of construction resources during the building production process. The information collected was analysed using the SPSS statistical software. The analysed data produced descriptive patterns and trends, and the findings obtained from the quantitative study are presented in Chapter Five.

As has been explained in Chapter Three, the choice in use of self-administered questionnaires among the other facts was to obtain information from a relatively large number of people who are widely dispersed geographically.

Practically, the validity and reliability of study does not solely depend on the number of samples taken or the number of respondents, but the possibility of obtaining sufficient relevant information from the respondents that could address the research aim and objectives. To obtain valid and reliable responses from the respondents, the questions were made explicit, clear, and logical to capture the interest of the respondents, (Czaja and Blair, 2005). Also, to guide against "non-response and sample errors", and to ensure that questions and corresponding alternatives were simplified enough and clearly stated, pre-test and pilot studies were carried out. The questionnaires questions were piloted with some research colleagues, and construction site managers to ascertain the appropriateness and ambiguity of the questionnaire wording and layout. The relevancies and information obtained in these research pilot studies are presented in Section 4.9.

To Sapsford and Jupp (1996), the major sources of "non-sampling errors" are often due to sampling frame defects, non-response, inaccurate or incomplete response details, defects in measuring instruments and defects in data collection or management. Therefore, these effects were minimised through proper planning and randomisation of sampling. Hence, it was found necessary to employ both simple and stratified random sampling techniques so that every prospective site managers, (sample) in the population had an equal opportunity of being sampled.

However, self-completion questionnaire surveys do sometimes suffer low response rates that often cause sampling errors (as explained previously). Hence, to maximise the questionnaires response rates, the researcher included with the questionnaires, a letter which explained the purpose of the research, the significance of each sample to the research outcome, and included a prepaid envelope for the completed questionnaire feedback postage. Reminder letters were sent a week after distribution of the questionnaires. Also, telephone contacts were made and emails sent to those who could be reached through these means.

B) Accessing and Sampling the Research Quantitative Data

For the questionnaires to be efficient and to cover a wide geographical spread of construction site management personnel in the UK, the database of construction industry in the UK was found through Financial Analyses Made Easy, (FAME) website. Through this means, the directory and addresses of construction organisations and their regional offices' locations were obtained. Consequently, letters were sent to various organisations' regional project directors explaining the objectives of the research and solicit assistance by providing information on how the construction site managers in the region could be contacted. Apart from posted mailing of the questionnaires, several questionnaires were handed to construction site managers in person.

Fifty construction organisations' regional, (principal) officers of construction operations were contacted, solicited, and helped with the distribution of questionnaires randomly to the regional construction site managers. Also, contacts were made personally to some construction site managers, through postal mails and telephone. Approximately one thousand questionnaires were distributed to site management personnel within different geographical zones in the UK. Reminders were made at intervals through telephone, emails and/or personal contact to solicit quick responses and emphasis was placed on the importance of every respondent contributing to the research outcome.

Chapter Five presents the data analyses and findings obtained through the quantitative questionnaires research survey.

4.6.5 Qualitative Interview Research Survey

Interview Research Survey is the second part of the primary data collection technique adopted for this research work. This section describes the method employed for qualitative data collection and explains the rationales of chosen the respondents for the interview. The analyses of data collected and the discussion of findings obtained are presented in Chapter Six.

The interview guiding questions comprised structured and semi-structured types. These guiding questions are based on the results obtained through the questionnaires survey Exploratory Data Analyses, (EDA), and preliminary findings from literature searched.

4.6.5.1 Rationales for Qualitative Data Collection

The Qualitative research approach was found appropriate to explore and probe the questionnaire results. Also, the Qualitative interview survey was designed to obtain information on issues in relation to "how and why" construction resources were being wasted either consciously or unconsciously during construction production process.

In summary, the principal objectives of interview survey are:

a) to validate the results obtained through questionnaires survey;
b) to provide answer(s) to "how and why" questions on some findings obtained through the questionnaires survey;
c) to address some questions about which clarity could not be properly obtained in questionnaires survey, and
d) for triangulation purpose in order to enhance the research validity and reliability.

The comparative importance, advantages, and the weaknesses of the interview research survey with other types of research methodology were presented in Chapter Three.

4.6.5.2 Interview Survey Stages

The following outline presents the stages by which the interview research survey was explored:

Stage 1: Interview planning: This involves:

a) preparation of interview questions;
b) selection of interviewees;
c) interview pilot study.

Stage 2: The interview and its recording;

Stage 3: Interview information transcription;

Stage 4: Analysing and creation of individual profile, nodes, codes and themes: These are achievable through employing the NVivo statistical software. This involves:

a) creation of "Nodes";
b) identifying similarities and differences in wordings and "Coding";

c) identifying and evaluating "Tree Codes" into to why, how, and related explanation
d) creating table of "Nodes" and central "Themes";
e) checking the necessity and sufficiency of each "Node";
f) clustering and grouping "Nodes" together;
g) writing a succinct and explanation to the "Themes" and "Nodes".

Stage 5: Identifying general and unique "Themes" from the interview transcribed.

Stage 6: Presentation of findings in logical order of understanding based on the research objectives

The following sequence presents the detail explanations on how the interview survey was actualised.

A) Interview Planning

The interview planning includes determination of sample size, preparation of interview guiding questions, piloting the guiding questions and re-framing the guiding questions.

The process of planning for interview commenced from the outset of this research work. To achieve robust valid and reliable research outcome, there are needs for adequate and effective planning. Thus, at early stage of this research work, a pilot study was carried out to familiarise the researcher with the research environment from which data will be collected, and also to ascertain the significance of the research study in the construction industry. These pilot studies also strengthened the researcher on the modalities of carrying out research work and gave insight into exploring different research methods and approaches that could generate viable findings. The findings from the literature review with the previous experience of the researcher were used to structure semi-structured interviews based on the research aim, objectives and proposition. The outcome of this pilot study and how it was carried out were explained in Section 4.9. All possible essential factors required to conduct good interviews were followed, these factors have been explained in Chapter 3, Section 3.3.1.3.

B) Sample size and Selection of Interviewees

Qualitative interviews were conducted with a sub-sample of the site managers who participated in the questionnaires survey. The decisions to interview those respondents who voluntarily indicated interest to participate in the interview survey rather than interviewing a new set of personnel were based on the following rationales:

a) The respondents to be interviewed would have had prior knowledge of the research proposition and the likely issues that would be discussed.
b) The respondents will be able to provide adequate explanations to affirm or change their opinions on options selected or information provided during the questionnaires survey.
c) Since the respondents have participated in the previous questionnaires survey, it will be possible to clarify vividly either in support or contrast the questionnaires' findings.
d) Since the conclusions drawn from the questionnaires survey are based on several opinion polls, thus, there is a likelihood of not being biased in responding to the interview questions.
e) In addition, since the respondents voluntarily indicate interest to be interviewed, the respondents would be able to provide adequate time for the interview.

As indicated in the case of questionnaires survey, the validity and reliability of research findings do not depend absolutely on the numbers of participants in the survey, but also depend on the experience and possibility of interviewees providing valid and reliable information that addresses the research objectives. However, logical sequence and procedures were followed to obtain robust and valid interview findings, and these have been explained in Chapter Three and earlier sections of this Chapter Four.

C) Appointment and Meeting with the Interviewees

a) The research interview was formally introduced to the respondents through letters, followed by telephone and emails; through the email addresses and telephone numbers that were provided by the respondents in the completed questionnaires survey.
b) The introductory letter to the interviewees includes the research objectives, the interview objectives, the research proposition, and the interview proposed date and duration. Also, they were solicited to ascertain the most suitable date and time convenient for them to be interviewed.
c) Through the introductory letter, the researcher assured the personnel that ethical principles and practice will be maintained and the information provided by each respondent will remained anonymous.

d) After the date and time had been fixed, the researcher sent the interview questions, which served as a guide for the interview. This was done a few days after the agreed interview day. This enabled the personnel to prepare for the likely questions to be asked, and provided necessary document(s) that could enhance, affirm, and support the interviewer's responses viewpoint.

e) A reminder was sent to each personnel to be interviewed two days prior to the meeting day.

D) Accessing and Sampling the Interview Survey Research data

The Interviews were conducted after questionnaire survey responses had been analysed. The interviews were conducted from a sub-sample of those that participated in the questionnaires survey. That is, with the questionnaires survey respondents who had voluntarily shown an interest in being interviewed and included contact details in the questionnaires survey feedback.

Before each interview day, detailed explanations of the interview survey were sent to the interviewees and the researcher stressed further the confidentiality of the information and all ethical principles that would be maintained in this research work. Permissions were sought in advance to the use of an audio tape recorder which eased information retrieval and the transcription, while all the interviewees agreed.

The interview questions were in structured and semi-structured in form, and the questions were loosely defined to enable the interviewee to raise issues and generate new topics during the interview.

Further, the same themes were covered with every interviewee with few variations from one interviewee to another; the important variation on idea provided, (significant issue during discussion), were noted for "follow up" interview. The "follow up" interview conducted bridged the discrepancies of the emergent themes and information obtained from one respondent to the other. The set of themes and questions used for the interview were based on findings obtained from the questionnaires survey conducted, the researcher personal experience, and the literature reviewed.

E) Structure of the Interview Survey Questions

As discussed previously, the interview questions were drawn from facts deducted from literature reviewed, results obtained through research pilot studies and findings from questionnaires research survey. The interview survey questions were divided into four major parts; each part representing different research propositions and tailored towards the aim and objectives of the research work. The patterns of the interview research guide questions are:

a) questions to probe the obtained questionnaires' results on "site manager's efficient performance";
b) further questions to explore the obtained questionnaires' results on "effect of budgeting for wastes' syndromes";
c) questions to validate the obtained questionnaires' results on "avoidance of construction resources wastefulness";
d) general questions on radical approaches that could enhance efficient utilisation of construction resources and CRWM.

During the interview, some topical issues emerged which required a follow-up interview to seek clarifications from others respondents that had be interviewed before the issues become known.

The guide questions for the main and follow-up interviews are presented as Appendix C1 and C2. The duration of the main interview with each respondent was approximately ninety minutes, while the follow-up one was within thirty to forty five minutes.

F) Piloting the Interview Research Survey

A pilot study was conducted for the interview research survey. This helped to determine the adequacy and robustness of the guide questions. It also helped to ascertain clarity and the appropriateness of the interview duration proposed. The research supervisors assisted in confirming the robustness and adequacy of the questions. The clarity and duration were ascertained through the conduction of a preliminary interview with two of the site managers who had shown interest to be interviewed. After completing the pilot study, additional questions were generated, which were significant to the research problems, and thus enhanced the quality of the interview.

Necessary modifications were made to the initially-proposed interview questions. The interview-guiding questions were not dogmatic, reflective questions and modifications were made to the questions during the interviewing process. These warranted a follow-up interview that was conducted, to bridge the gap of the variance in the questions posed to the previous interviewees.

G) Interview Survey Data Collection

The guided questions were formulated and modified after been piloted to suit the research objectives, proposition and the realistic time frame of which adequate information could be achieved without over-stressing the interviewees. On a few occasions, during the interview, there were some divergences in responses and some important discussion generated which was further explored, however, the researcher was focused to achieve the main objective of each question.

Eight construction site personnel's were interviewed and the demography of the respondents, information collected and findings deduced are presented in Chapter Six

4.6.6 Direct Observation Research Survey

To be more in-depth in the study inferences, a direct observation research study was conducted concurrently with the interview research. This was to see and ascertain how construction resources are been utilised during project execution. The information obtained helped to affirm the data obtained during the research interview survey.

The major advantages of this direct observation survey have been explained in Sub-section 3.3.4, part (D).

To gain access to the site, the researcher wrote comprehensive information about the objectives and importance of the research in advance to the construction site managers interviewed. Hence, the permission to enter the construction sites was sought in advance. In addition, the resume of the researcher were sent to construction site managers to convince the interviewees that the researcher had significant experience on construction sites, construction works, and heath and safety issues on construction sites. Accesses were gained to six construction project sites. The observed construction resources utilisation and management lapses and credibility were noted, which formed part and enhanced the interview data obtained.

4.7 DATA ANALYSES TECHNIQUES - QUANTITATIVE AND QUALITATIVE RESEARCH SURVEYS

This section describes how the data collected by means of questionnaires and interviews research surveys were analysed by using the appropriate statistical software.

4.7.1 Analyses of Quantitative Questionnaires Survey Data

The data collected by this method was analysed using SPSS, (a statistical package for the social sciences), for windows version 13. The raw data were cleaned, coded and inputted manually and analysed. The information obtained was presented in tabular form to show frequencies and relationships between variables and/or factors. This is explicitly detailed in Chapter Five under quantitative data analyses and discussion of findings.

4.7.2 Analyses of Qualitative Interview Survey Data

The information and data generated through the qualitative survey were interpreted through Thematic Analysis approach. This is a proactive approach for analysing data in order to develop a grounded theory. In this research data collection, there was positive consideration of the view of Punch (1998) among other scholars: the grounded theory is a research strategy purposely to generate theory from data. Thus, grounded theory aims directly at generating abstract theory to explain what is central in the data. There was also recognition of the logistical view of Frankfort-Nachmias and Nachmias (1996) on thematic analysis and grounded theory. Both Punch (1998) and Frankfort-Nachmias and Nachmias (1996) stressed that the process of collecting information to be analysed for generating significant inferences based on the data; while the attempt to develop theory from data is called analytic induction. The researcher found this analytic induction process useful during the research data collection and analyses. NVivo statistics software was used for coding and collation of the themes emerged from the transcribed interview.

4.7.3 Adoption of Grounded Theory

The importance of grounded theory as identified by Sarantakos (2001), Punch (1998), and Frankfort-Nachmias and Nachmias (1996) are:

a) An autonomous unit: this means that a case required to be considered is not amorphous, (defined) of its own; structure, boundaries and history and should be treated as a case and reconstructed as a case, not as an element of something else.

b) Relation of reality: this is creation of reality in an unbiased manner.

c) Everyday thinking: there is continuity between everyday thinking and scientific thinking. This research study is close to everyday behaviour and action. Everyday knowledge is an un-redeemable resource and primary experience which are highly significant for this research reliability.

d) Developments of concepts: theory is consistently developed, refined, and tested in a continuous and unending process till final valid findings were obtained.

e) Flexibility: a grounded theory approach allows flexibility by taking an iterative approach in which the data collection is processed. Thus, throughout the research work, the researcher remained flexible in the course of data collection and analysis in order to gain adequate insight into the research problems

f) Practically: the channel of grounded theory is often from induction to deduction and then to verification.

Based on the significance of adoption of the thematic analysis to develop the grounded theory, the interview transcripts were coded and list of codes and categories were developed. These allowed data to be disintegrated, conceptualised and re-organised into new perspectives. This research qualitative data analyses and discussion of findings are presented in Chapter Six.

4.8 VALIDITY AND RELIABILITY ASSURANCE OF THE RESEARCH OUTCOME

These sub-sections outline validity and reliability issues, and present how the robust research findings that addressed the research problems were achieved. That is, the achievement of valid and reliable research outcome.

4.8.1 Validity

Validity is the term used to describe how the research instrument measures what it is supposed to measure, (Punch, 1998). That is, measurement of validity means the extent to which an instrument measures what it is claimed to measure.

The issue of validity in research is related to available approximation to the truth of a given proposition, inference or conclusion.

The three basic types of validity expressed by many scholars including Sarantakos (2001) and Trochim (2006) which were significantly taken into consideration during this research work are:

a) Context validity: ensuring that the instrument is appropriate, and total population is adequately sampled with the measuring instrument adopted.
b) Empirical validity: ensuring that the relationship between measuring instruments and the measurement outcomes exists and the relationship is strong.
c) Construct validity: the researcher established construct validity by relating a measuring instrument to a general theoretical framework, the instrument affixed to the concepts and theoretical assumptions that were employed.

4.8.2 Reliability

Reliability is ability of an instrument to produce consistent results when repeated by another researcher. Simply, reliability means consistency, (Sarantakos, 2001; Punch, 1998). Additionally, Trochim (2006) claimed that reliability has to do with the quality of measurement. In its everyday sense, reliability is the "consistency" or "repeatability" of what was measured.

Therefore, the considerations of reliability in this research study are twofold:

a) Consistency over time: ensuring the stability of measurement over time; that is, if the same instrument is given to similar respondents under the same circumstances at different time, similar results will be achieved.
b) Internal consistency: ensuring that research proposition and questions addressed by respondents is consistent.

4.8.3 Validity and Reliability Assurance

Trochim (2006) emphasises that:

> *"We, (the researchers) are concerned with whether we are measuring what we intend to measure or with how our observations are influenced by the circumstances in which they are made. We reach conclusions about the quality of our measures; the conclusions that will play an important role in addressing the broader substantive issues of our study. When we talk about the validity of*

research, we are often referring to these to the many conclusions we reach about the quality of different parts of our research methodology".
- Trochim, William M. (2006:n.p), (Online). e-book, (accessed on 02 May, 2007)

Therefore, during this research work, the researcher carefully envisaged errors that could affect the achievement of valid research inferences, findings and conclusion. The researcher endeavoured to avoid errors due to poor sample selection, respondent's bias, sample coding, conduct of research, and miss-interpretation of questions by the respondents. Also there were avoidance of unnecessarily leading questions, unconscious non-verbal prompts on good answers. In addition, the researcher critically evaluates all the appropriate approaches to analyse the raw data.

To ensure that this research outcome is valid and reliable, the following steps were taken into consideration:

a) Variables: the variables were clearly defined and matched the research questions with attributed variables. (Sections 4.2 and 4.5).
b) Population: efforts were made to obtain a large size of population among experienced and skilled personnel in wider geographical zones in the UK construction industry. (Section 4.6.3.2).
c) Participants: the participants are experienced professionals within the construction industry. (Sections 4.6.3.2, 5.3, and 6.5).
d) Time: sufficient time was created for data collection, collation, analyses, and report, (approximately eighteen months).
e) Instruments: appropriate research instruments were adopted, and were enhanced through pilot studies to ascertain their adequacies. (Sections 4.6 and 4.9).
f) Pilot study: pilot studies were carried out twice to ascertain the research methods and techniques adopted data collections were adequate. (Section 4.9).
g) Triangulation: multiple research techniques and approaches were explored for data and information collections. This enabled the demerits of one approach to be corrected by the merits of other method. (Chapters 5.0 and 6.0).
h) Mechanical recording and Statistical Software Analyses: mechanical recording systems were adopted, and the use of audio tape recorder for interview. Also appropriate instruments were used for data analyses, SPSS 13 and NVivo 8.0. (Chapters 5.0 and 6.0).

i) Participant information: the accuracies of the methods and sequence of information collection were checked with other research fellows and experienced site managers during pilot studies. (Section 4.9).

j) Operational framework validation: finally the research findings were two-tier validated. These were achieved by conducting structured questionnaires and in-depth interviews with site managers who appraised and passed comments, observation, and contribution. The feedbacks obtained were used to re-assess the CRWM operational framework developed. (Chapter Eight).

4.9 CRWM RESEARCH PILOT STUDIES

In research, the structure and purpose of pilot studies vary from case to case. It also depends on the type of research and the structure of the methodology adopted. For this research work, pilot studies served the following purposes:

a) familiarisation of the researcher with the environment where the research took place;
b) estimation of costs and duration of the research methods adopted;
c) testing the research methods and research instruments and their suitability;
d) determination of the sampling frame adequacy;
e) gaining information on survey population diversity and homogeneity;
f) testing the response rate of the sampled respondents and determining the adequacy of the structure questions;
g) gaining first hand information and insight on construction organisations' resources utilisation in the UK;
h) preliminary discovery of weaknesses, inadequacies, ambiguities, and problems in all aspect of the research and made corrections before main research data collections.

Based on these intentions, two pilot studies were conducted at different occasions for different purposes.

4.9.1 Initial Research Pilot Study, (Pilot Study One) - Approach and Significance

The first pilot study carried out familiarised the researcher with the research environment in which the research took place, and secondly it allowed the researcher to obtain some principal information, issues and clarifications on the study's research problems. It was carried out at a micro level within few construction site personnel by exploring the research methods and instruments assumed to be appropriate for the macro research data collections. The information obtained from the first pilot study helped to redress the research objectives, questions, and final methods adopted for the research data collections.

(a) Approach adopted for the Pilot Study One

The researcher explored structured and semi-structured questions. The questions administered were based on information collected from literature reviewed and experience of the researcher on utilisation of construction resources. Twelve construction personnel participated in this first pilot study, comprising site managers, project managers, and quantity surveyors.

The researchers followed all the modus-operandi of carrying out effective questionnaires and interview surveys, and probed the participants' knowledge, perceptions, and attitudes on efficient utilisation of construction resources during the production process. Some issues of interest that were addressed by the researcher during the pilot study one were:

a) The constraints on site managers that enhance efficient utilisation of resources.
b) The identification and categorical classification of construction resources wastefulness to conscious and unconscious wastes, avoidable and unavoidable wastes.
c) The issue of "budgeting for wastes' syndromes" in construction industry.
d) Motivators and facilitators for efficient resources utilisation.
e) The impacts of construction resources wastage on cost, time, and quality of construction products.

(b) Significance of the Pilot Study One

After completing the first pilot study, the researcher achieved the following:

a) The study intensified and ascertained that there are needs for the research with a view to enhancing resources utilisation and resources' wastes management.
b) The study assisted in the development of substantial research problems and sub problems.

c) The study ascertained that participants are ready to help and contribute at any time to the success of the research study.
d) The study gave the researcher self confidence to practise research in a real situation within the environment, (the UK) in which the research was carried out.
e) The study ascertained the appropriateness of the research approaches and instruments to be adopted for the main research information collection.
f) The information, data, and findings obtained were presented at four international conferences and also published in the respective conference proceedings. The abstracts of the published papers are attached as Appendixes F1, F2, F3 and F4.

In addition, the following were also achieved during this pilot study one:

a) Probable time duration for the main research study data collection.
b) The modalities towards an effective research data collection and organisation.
c) It assisted in ascertaining the appropriateness of the research questions administration.
d) It helped to ensure that the research design and instruments will provide substantial and valid answers to the research problems.
e) The study helped in development and conceptualisation of the theoretical framework for the research study.

4.9.2 Pilot Study Two - Approach and Significance

The primary objective of the pilot study two was to ascertain the suitability and adequacy of the interview research questions and design that were employed for the research data and information collections.

The participants of this pilot study two comprised the researcher's colleagues, and two of the site managers who participated in questionnaires survey. Semi structured interview and questionnaires were administered, and the respondents:

a) commented on the clarity of the instructions;
b) commented on the clarity and ambiguity of the interview research questions;
c) raised objections and problems encountered in answering the questions;
d) helped to check and advised on any major topics or issues unrealised, and
e) helped to check the appropriateness of the questions' sections layout.

The comments and observations of the respondents were carefully considered for modification of the actual interview research questions which were tailored from questionnaires' survey findings. That is, the pilot study two assisted the researcher to modify the questions, structures, and time duration for effective conduction of the research interview survey.

4.10 CHAPTER FOUR SUMMARY

This chapter presents detailed explanations on the sequence and process in which this research was carried out: the research design and the instrument. The approaches that were adopted for the information and data collections for the research study were outlined.

This chapter further explicitly presented the rationales for adopting mixed methods research approach for data collection, and the importance, and the achievement of pilot studies carried out on the research instruments and the research questions were highlighted.

This chapter also classified types of validity and reliability, and the approaches that enhanced valid and reliable findings, (outcome), from the research instrument were clearly stated.

The subsequent chapters, (Chapters Five and Six) present the quantitative and qualitative surveys data collected, analysed and discussed the deduced findings.

CHAPTER FIVE

QUANTITATIVE DATA ANALYSES AND DISCUSSION OF FINDINGS

5.0 QUANTITATIVE DATA ANALYSES, DEDUCTIONS AND DISCUSSION OF FINDINGS

5.1 CHAPTER INTRODUCTION

The methods and approaches adopted for this research data collection have been described in Chapters Three and Four. In addition, Chapter Four presented the methods for data treatment, and the statistical tool explored for the analyses of both questionnaires and interview surveys data. The research objectives guided the questionnaires' questions and its administration, as explained in Section 4.5. The methods adopted towards achieving robust, valid, and reliable findings have also been explained in Section 4.8. The research instruments were pilot studied, to ascertain the instruments appropriateness, and the outcomes of the pilot studies conducted were presented in Section 4.9.

In this chapter, the importance of the statistical tests employed is detailed. The chapter clearly presents the analysed data of the questionnaires administered, and the findings obtained; also the inferential deductions are detailed. The questionnaires survey is divided into four main headings: the demography of the respondents; the issues towards enhancing Site Managers' Efficiency and Performances, (SMEP); the Budgeting for Wastes' Syndromes, (BWS) in the construction industry, and factors towards Avoidance of Construction Resources Wastefulness, (ACRW). Several findings were obtained and presented in form of tables, charts, figures, and frameworks. For triangulation purpose, and to affirm the questionnaires' research findings, interviews were conducted and the findings obtained from the interview survey are presented in Chapter Six.

The data obtained from questionnaires survey were analysed by using Statistical Package for the Social Sciences, (SPSS 13), software. The selections of the statistics analyses and tests were governed by the research questions, and nature of the data collected. Also, the views of Field (2005), Black (1999), Coakes and Steed (2006), Einspruch (1998), Kinnear and Gray (1997), Green and Salkind (2005), and Bryman and Cramer (2005) guided the descriptive, inferential, validity and reliability tests' statistics and the analyses. Also, the appropriateness and reliability of the instruments explored for the quantitative survey data collection were ascertained.

The descriptive statistics, the frequencies and mean percentages calculated are used to draw the descriptive relationships, (causal-effect) of the variables, samples, items and population distributions. Also, the statistical association and likelihood of relatedness between and within the variables were calculated by exploring validity and reliability tests' statistics; to ascertain the quality and the consistencies of the respondents' responses on each factor, (item) and all the items as a whole.

5.2 RELIABILITY AND VALIDITY TESTS' STATISTICS

5.2.1 Reliability Tests

These are statistics tests conducted to quantify the respondents characteristics and traits. The reliability coefficient values obtained indicate the consistency of the items in the test and the contributions of each item to the final overall score of all the variables, and the alpha coefficient is expressed as an indicative likelihood of effect.

The reliability tests are to ascertain the internal consistencies of the data collected. This is achievable through calculating Cronbach's alpha coefficient of all items and comparing these with overall total coefficient alpha. These enable the interpretation of internal consistencies of the instrument. Cronbach's alpha coefficient is found to be significantly appropriate being perceptions and attitudes studies, and the questionnaires are rated, (Likert scaled). The coefficient provides the average value of several correlation coefficients obtainable when the set of data are combined into pairs, (two) in all possible ways. The significant factors of validity and reliability tests' statistics are:

a) Cronbach's Alpha coefficient: The Cronbach's alpha coefficient values ranges from 0 to1, and the reliability of the "overall total item coefficient" increases from 0 to 1. These values depend greatly on the number of items on the scale, the more the number of the items, the greater the alpha coefficient. However, Cronbach's Alpha coefficient value is significant between 0.7 and 0.9, (Field, 2005; Coakes and Steed, 2006).

b) Alpha if item deleted: One of the most important factors for questionnaires findings validity and reliability interpretations are "Alpha if item deleted" values; these provide the coefficient values for each item. This is the value of Cronbach's Alpha coefficient if the particular item is not included in the calculation. At significant level, and to affirm the reliability of an item, the item "alpha if item deleted" value should be less than or approximately equal to the "overall total-alpha coefficient" value. Thus, if the value of any item 'alpha if item deleted' is greater than 'overall alpha', such item requires to be deleted to improve the reliability of the data set.

c) Corrected Item total correlation: In ascertaining that an item is related properly with others, the value of each item 'corrected item total correlation' value should not less than 0.3; if the value is less than 0.3, such an item needs to be deleted to improve the data set reliability.

5.2.2 Chi-Square

Chi-square test is explored to ascertain item validity. The test statistics compares the frequencies observed in certain categories to the frequencies expected to be obtained in those categories by chance. The Chi-square test detects whether there is a significant association between variables, (Field, 2005). It is used to compare two or more related samples, and this test is equivalent to the 'repeated measure' or within subject ANOVA, (Coakes and Steed, 2006). Friedman chi - square is used for scale items, while Cochran chi - square is used for nominal items. Item chi - square is significant at values less than 0.05 (5%) standard degree of freedom.

5.2.3 Analysis of Variance, (ANOVA)

ANOVA compares the central tendency of different items tested. That is, it is used to conduct a one-way repeated measure analysis of variance on the item selected, (Field, 2005; Coakes and Steed, 2006). ANOVA is explored to verify and determine if three or more samples shared a common trait of likelihood. ANOVA compares the sample means of the data characteristics indirectly using estimates of population variances, (Black, 1999; Kinnear and Gray, 1997 and Field, 2005). Unlike t-test which is used to explore the relationship between two set of variables, ANOVA produces F-ratio that compares the amount of systematic variance in the data to the amount of unsystematic variance, which can be used to explain the experimental effect of several variable interaction. Thus, an "F-ratio" test value is significant when the value is less than or approximately equal to 0.05, (5%).

5.3.1 DEMOGRAPHY OF QUESTIONNAIRES' SURVEY RESPONDENTS

This section presents the demography of the respondents that returned complete questionnaires, and the analysed data are illustrated in Tables 5.1 and 5.2, and Figures 5.1 to 5.3

5.3.1 Managerial Status of the Participants and the Years of Experience

Table 5.1 shows that representatives from 9 distinct construction managerial levels participated in the questionnaires survey. As presented in Figure 5.1, the total respondents that had more than five years' managerial experience in the construction industry are 84%; of these, 57% have more than 15 years managerial work experience and 27% have between 5 - 15 years. Only 16% have less than 5 years' managerial experience, though this does not indicate their unawareness in the problems associated with resources utilisation in the industry.

Table 5.1 and Figure 5.2, illustrate that, the percentage of project site managers /senior site managers in the respondents is 40%, the site managers and contract managers/senior contract mangers are 29% and 10% respectively. All the project directors, planning managers, design managers, and senior building managers in the survey have not less than 15 years' managerial experience in the construction industry.

These results indicate that the respondents are significantly experienced and rationally have wide knowledge in the construction industry.

Table 5.1 Respondents "Site Management Positions"; on, the "Years of Experience of the Respondents as a Manager" in the Construction Industry.

		Years of Experience as a Manager in Construction Industry				Total	%	Cumulative %
		Less than 5	5 – 10	11 - 15	Above 15			
Site Management Position of the Respondents	1. Project Managers/ Senior Project Managers	0	6	8	27	41	40	40
	2. Site managers	12	2	7	9	30	29	69
	3. Contract Managers/ Senior Contract Managers	0	2	0	8	10	10	79
	4. Quantity Surveyors/ Senior Quantity Surveyors	2	2	0	2	6	6	85
	5. Project Directors	0	0	0	5	5	5	90
	6. Planning Managers	0	0	0	4	4	4	94
	7. Section Managers	2	0	0	0	2	2	96
	8. Design Managers	0	0	0	2	2	2	98
	9. Senior Building Managers	0	0	0	2	2	2	100
Total		16	12	15	59	102	100	
%		16	12	15	57	100		
Cumulative %		16	28	43	100			
		16%	84%					

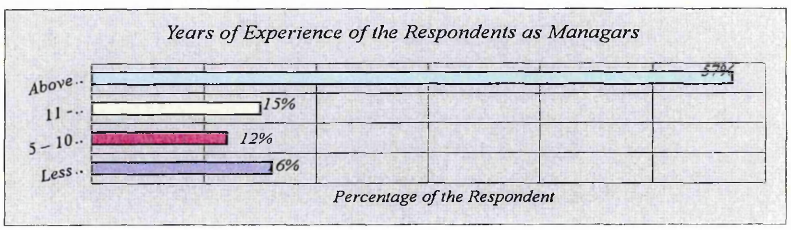


Figure 5.1 Years of experience of the Respondents as Managers in the Construction sector

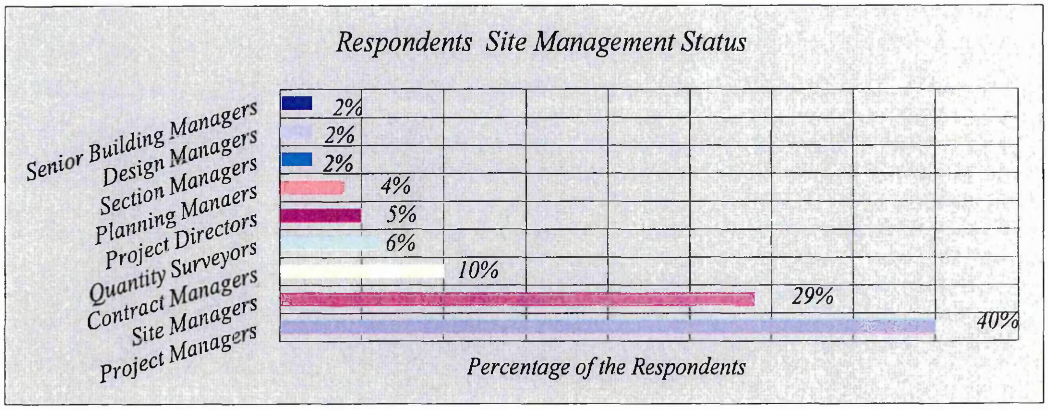


Figure 5.2 Respondents Site Management Status

5.3.2 Participants that shown Interest for further Enquiries and Investigations

Figure 5.3 illustrates the respondents that indicated their interest in further enquiries from the total questionnaires' respondents. Fifteen percent indicated interest in being contacted for further investigation, explanations, and enquiries. These assisted the researcher towards collection of information from these personnel by means of interview survey. The reasons for adopting mixed methods have been explained in Section 3.3.2.

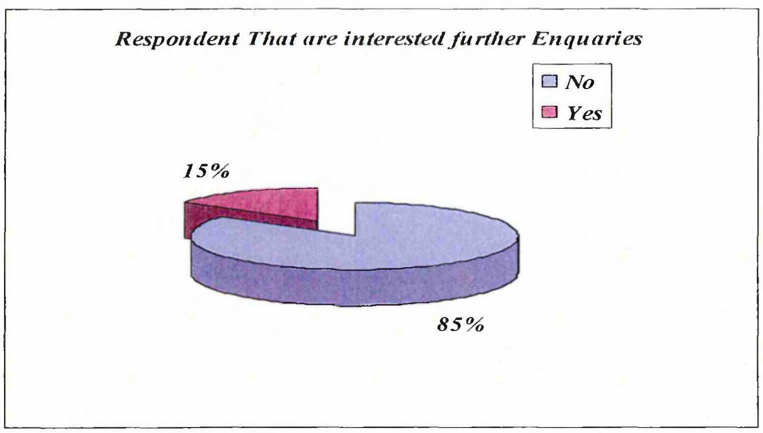


Figure 5.3 Respondents that showed Interest in being contacted for further Enquiries

5.3.3 Geographical Zones covered and the Number of Employees in the Respondents' Organisations

(i) Coverage: Table 5.2 indicates the geographical zones which the respondents' organisations operate in the UK. 84% of the organisations are in 8 or more geographical zones. The majority of the organisations are in 10 – 11 geographical zones, 66%, (28%, + 38%), while only 16% have construction sites in less than 8 geographical zones.

(ii) Numbers of Employees: Based on the results obtained as shown in Table 5.2, 85% of the respondents' organisations have more than 400 employees, while only 15% have below 400 employees.

These results in Table 5.2 show that the respondents are representation of several organisations in different geographical zones in UK, and the majority of the construction organisations had above 400 permanent employees.

Table 5.2: Numbers of Employees in the Respondents' Organisation" Currently Working in the UK; and "Numbers of the Regions which each Respondent Organisation Operates" in the UK.

		Geographical Zones Of Which The Respondents Organisation are located In UK										Total No.	%	Cum %
		Four	Five	Six	Seven	Eight	Nine	Ten	Eleven	Twelve	Thirteen			
No. Of Employees In The Organisation Presently In UK	101-150	0	0	0	0	0	2	0	0	0	0	2	2	2
	151-200	0	0	0	0	2	0	0	0	0	0	2	2	4
	201-250	0	0	0	0	0	0	2	0	0	0	2	2	6
	251-300	0	0	0	3	2	2	0	0	0	0	7	7	13
	350-400	0	0	0	0	0	0	2	0	0	0	2	2	15
	Over 400	1	3	2	7	1	0	25	39	5	4	87	85	100
Total		1	3	2	10	5	4	29	39	5	4	102	100	
Percent		1	3	2	10	5	4	28	38	5	4	100		
Cumulative Percent		1	4	6	16	21	25	53	91	96	100			
		16%				84%								

Sections 5.4, 5.5 and 5.6 present the findings obtained from the questionnaire survey based on the research objectives. There are three main studies in respect to the research objectives:

Study One: "Enhancement of Site Managers' Efficiency and Performances", (SMEP) on Resources Utilisation, (Section 5.4);

Study Two: "Budgeting for Wastes' Syndromes", (BWS) in the construction industry, (Section 5.5);

Study Three: "Avoidance of Construction Resources Wastefulness" (ACRW) during the production process, (Section 5.6).

The collective findings of these three main studies are summarised to establish "An Operational Framework for Optimal Utilisation of Construction Resources during the production process.

Waste resources are non-value added resources, (physical, or latent in nature). That is, "wastes" are construction resources that significantly add no value to the overall outcome of an operation; arises through inefficient utilisation of the resources, (Materials, Manpower, and Machinery). The occurrences of these resources' wastes are either conscious or unconscious in perception, which could be avoided either during the design or construction production phase.

5.4 QUANTITATIVE RESEARCH SURVEY STUDY ONE: ENHANCEMENT OF SITE MANAGERS' EFFICIENCY AND PERFORMANCES, (SMEP) ON RESOURCES UTILISATION

This Study One is to establish the framework that will improve the Site Managers' Efficiency and Performances, (SMEP) during the production process. This goal is achievable through employing strengths, weaknesses, opportunities, and threats (SWOT) techniques. That is, to identify and ascertain the factors that will significantly strengthen the site manager's, as well as the opportunities that will evidently guard against the opposing threats on, and the weaknesses of the site manager(s), towards efficient construction resources utilisation achievement during the production process.

This Study One is sub-divided into four sections as illustrated in Figure 5.4

This study one helped to establish the following:

a) Ranking the factors (attributes) investigated in order of significance, (Table 5.3). To establish the factors that site managers require to emphasised towards achieving efficiency on resources utilisation. (Table 5.4). That is, the essential and desirable factors, "the Strengths"; (Section 5.4.1);
b) Ascertaining the factors that needed improvement towards efficient utilisation of construction resources, "the weaknesses" (Section 5.4.2);
c) Establishing the factors that hinders the site managers' efficient performance, "the threats"; (Section 5.4.3) and.

d) Determining the "opportunities" to be embraced; the factors that will rationally contribute to the site managers' efficient resources utilisation; (Section 5.4.4)

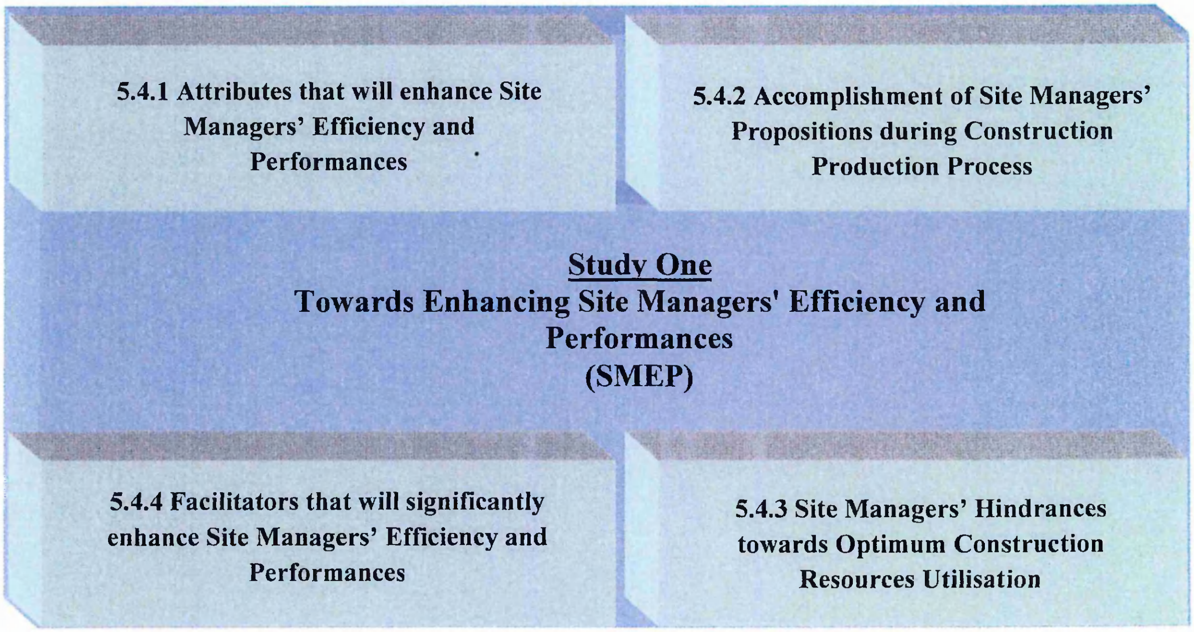


Figure 5.4 Concepts towards Enhancement of Site Managers' Efficiency and Performances

5.4.1 Attributes that will enhance the Site Managers' Efficiency and Performances

This section evaluates and ascertains the management skills, abilities, and traits that will significantly enhance site managers' performances and efficient resources utilisation. Also, those factors that are essential towards resources' wastes minimisation are established.

To achieve this objective, questions were set on a significant number of site managers' attributes: skills, traits, potentials and awareness, and the respondents ranked these factors in scale 1 to 5, where 1 indicates "Not important" and 5 indicates "highly important. Also, from the factors listed, the respondents indicated the essential and the desirable factors towards resources' wastes minimisation.

5.4.1.1 Importance of the Site Manager's Attributes

The groups of attributes that enhance Site managers were identified, data obtained were analysed and the frequency of the importance in percentage, (%) were calculated: The mean values of each group are: Traits, 80%; Skills, 72%; Potentials, 72%; and Awareness 67%, (figure 5.5).

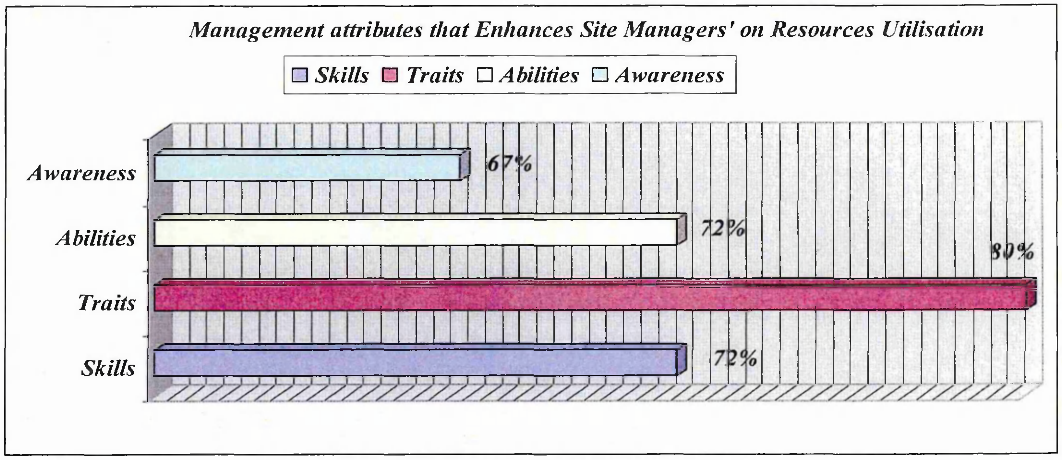


Figure 5.5 Mean Values of the Attributes that Enhances Site Managers' Efficiency

Table 5.3 shows all the Site Manager's attributes evaluated in order of importance. It was found that the four principal attributes, (highest percentage from each group), towards efficient resources utilisation are Leadership Trait and Quality, Risk Management Skill, Decisiveness Potential and Ability, and Health and Safety Regulation Awareness. The least of these are Empathy and Compassion Quality, Negotiation Power Skill, Energy Management Potential and Law and Aberration Awareness. More so, it could be deduced that all these factors have a positive contributing effect and are important towards enhancing efficient resources utilisation; however, the least are Negotiation Power skill, Empathy and Compassion trait, energy management ability, and law and arbitration awareness.

5.4.1.2 Essential and Desirable Site Manager's Attributes towards Efficient Resources Utilisation

Further investigations were made to ascertain the essential and desirable attributes that site managers require to emphasise on, towards efficient resources utilisation during construction production process. These essential and desirable factors are presented in rank order of importance in Table 5.4.

Table 5.3 Attributes that will enhance Site Managers' Performances in order of Importance

Order of Importance	A) SKILLS	Mean 72%		B) TRAITS	Mean 80%		C) ABILITIES	Mean 72%		D) AWARENESS	Mean 67%
1.	Risk management	80%	1	Leadership	90%	1	Decisiveness	81%	1	Health and Safety regulations	82%
2.	Time management	79%	2	Competency	89%	2	Team building	79%	2	Performance measurement	75%
3.	Procurement management	78%	3	Enthusiasm in achievement	82%	3	Objective setting	75%	3	Contract forms & strategies	64%
4.	Knowledge management	76%	4	Cool under pressure	81%	4	Assertiveness	75%	4	Whole Life Costing	64%
5.	Problem solving	76%	5	Integrity	79%	5	Delegation of responsibilities	73%	5	Tendering strategies	63%
6.	Quality management	76%	6	Creative thinking	77%	6	Dispute resolutions	70%	6	Brief writing	62%
7.	Contract mgt & administration	73%	7	Challenging	75%	7	Concurrent project evaluation	67%	7	Law and arbitration	61%
8.	Cost management	72%	8	Empathy and compassion	68%	8	Facilitation	66%			
9.	Staffing and recruitment	71%				9	Energy management	59%			
10.	Materials management	71%									
11.	Suppliers & sub contractors management	71%									
12.	Human resources management	70%									
13.	Client interest management	68%									
14.	Change management	65%									
15.	Motivation strategies	61%									
16.	Negotiation power	61%									

Table 5.4: Essential and Desirable Factors towards Achieving Efficient Resources Utilisation in Order of Importance

Key: Skills/Expertise, (SE); Traits/Qualities, (TQ); Abilities/Potential, (AP); Awareness, (AW)

Essential and Desirable Site Managers' Attributes in order of Importance			
(i) The Essential Attributes	**%**	**(ii) The Desirable Attributes**	**%**
1. Supplier and Sub-Contractor Mgt (SE)	92	1. Empathy and Compassion (TQ)	77
2. Quality Management (SE)	87	2. Facilitation (AP)	77
3. Leadership (TQ)	85	3. Contract forms & strategies (AW)	77
4. Competency (TQ)	82	4. Negotiation Power (SE)	76
5. Energy Management (AP)	82	5. Tendering strategies (AW)	73
6. Risk Management (SE)	81	6. Brief Writing (AW)	70
7. Enthusiasm in achievement(TQ)	81	7. Change Management SE)	68
8. Health & Safety Regulation (AW)	79	8. Motivation Strategies (SE)	67
9. Knowledge Mgt & Shearing (SE)	78	9. Laws and Arbitration (AW)	65
10. Cost Management (SE)	77	10.Contract Mgt & Admin (SE)	63
11. Materials Mgt (SE)	71	11.Concurrent Project Evaluation (AP)	57
12. Integrity (TQ)	71	12.Whole Life Costing (AW)	56
13. Team Building(AP)	68	13.Challenging (TQ)	52
14. Cool Under Pressure(TQ)	62		
15. Delegation of Duty(AP)	59		
16. Performance Measurement (AW)	59		
17. Client Interest management (SE)	59		
18. Procurement Management (SE)	57		
19. Problem Solving (SE)	57		
20. Time Management (SE)	56		
21. Objective Setting (AP)	55		
22. Decisiveness(AP)	55		
23. Assertiveness (AP)	55		
24. Dispute Resolutions (AP)	54		
25. Staffing And Recruitment (SE)	54		
26. Creative Thinking (TQ)	52		
27. Human Resources Mgt (SE)	52		

These essential factors are the attributes which site managers could emphasise as the "strengths" (strong points) towards guarding against the opposing "weaknesses and threats" on achieving optimal resources utilisation during the construction production process. Forty factors were identified and evaluated, among these, thirteen are found to be desirable, while the rest are essential. This implies that, majority of these factors are essential towards achieving maximum utilisation of construction resources.

Further investigations were made during the interview survey, (presented in Chapter Six); to validate these findings and to identify how these factors could be improved.

5.4.1.3 Reliability and Validity Test Statistics

Tables 5.5(a, b, c and d) show the reliability and validity tests' statistics of samples obtained on attributes that will significantly enhance site managers towards efficient utilisation of construction resources. Viewing the characteristics of the scale, the following facts are deduced:

a) The "corrected item of total correlation coefficients" of all individual factors > 0.3, thus, these values will be termed significant.

b) The "overall Cronbach's alpha coefficient" > is greater than all individual items "Cronbach's alpha if the item is deleted" value.

These (a) and (b) indicate that there exist internal consistencies between the values of data collected.

The value of Cronbach's alpha coefficient of factors considered on site managers' Skills is 0.899; traits, 0.862 and Ability is 0.907, also the respective Individual value of "Corrected item-total Correlations" is greater than 0.3, thus it can be said that the results are reliable. The Awareness "overall alpha coefficient" value is 0.805, however, if 'Health and Safety Regulation' item is deleted the overall reliability will be improved, and the value will be 0.845, (Table 5.5d).

An ANOVA test was carried out to find the difference in mean value of the samples, and the value obtained indicates a strong agreement between the respondents' responses, and that the samples share a common trait, (sig. < 0.05).

The validity of the results were confirmed when all the samples chi-square results (table 5.5) registered ($p < 0.05$). This shows that there is strong significant association between the variables. These validity and ANOVA deductions also applied to items on traits, abilities, and awareness responses obtained, (Tables 5.5a – 5.5d).

5.4.2 Accomplishment of Site Managers' Propositions

This section evaluates and ascertains the possibilities of accomplishing the site managers' propositions, (visions and missions), on resources utilisation during construction production process. The factors are grouped into: Materials, Manpower, Machinery, Quality in Construction, Construction Resources Cost, Time management, Risk in Construction, Resources Procurement, Project Scope Determination, Delegation of Authority, Nominated Suppliers Control and Sub Contractors Monitoring and Control.

Table 5.5(a) Reliability and Validity Tests' Statistics of all the Variables – Skills/Expertise Attributes of Site Managers

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Overall Cronbach's Alpha Coefficient	Chi-Square (Sig.)	ANOVA (Sig.)
Knowledge management	.390	.899	.899	.001	.001
Human resources management	.413	.898		.001	
Materials management	.401	.898		.001	
Cost management	.450	.897		.001	
Quality management	.566	.894		.001	
Risk management	.696	.888		.001	
Time management	.585	.893		.001	
Procurement management	.649	.892		.001	
Staffing and recruitment	.671	.889		.001	
Negotiation power	.656	.890		.001	
Problem solving	.673	.890		.001	
Contract mgt and administration	.736	.887		.001	
Client interest management	.560	.894		.017	
Suppliers and sub - contractors management	.567	.893		.001	
Motivation strategies	.642	.890		.001	
Change management	.522	.898		.001	

5.5(b) Reliability and Validity Tests' Statistics of all the Variables – Traits/Qualities Attributes of Site Managers

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Overall total Cronbach's Alpha coefficient	Chi-Square (Sig.)	ANOVA F-test (Sig.)
Leadership	0.653	0.843	0.862	.001	.001
Integrity	0.612	0.845		.001	
Enthusiasm in achievement	0.683	0.838		.074	
Empathy and Compassion	0.563	0.854		.025	
Competency	0.481	0.859		.001	
Cool Under Pressure	0.664	0.840		.001	
Challenging	0.722	0.832		.001	
Creative Thinking	0.563	0.852		.001	

5.5(c) Reliability and Validity Tests' Statistics of all the Variables – Abilities/Potential Attributes of Site Managers

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Overall total Cronbach's Alpha coefficient	Chi - Square (Sig.)	ANOVA F-test (Sig.)
Delegation of Task and Responsibilities	.622	.901		.001	
Assertiveness	.794	.890		.001	
Objective Setting	.735	.893		.001	
Decisiveness	.767	.892		.001	
Team Building	.792	.889	0.907	.001	.001
Facilitation	.692	.896		.001	
Concurrent Project Evaluation	.530	.909		.001	
Energy Mgt	.693	.897		.001	
Dispute Resolutions	.604	.902		.001	

5.6(d) Reliability and Validity Tests' Statistics of all the Variables - Awareness Attributes of Site Managers

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Overall total Cronbach's Alpha coefficient	Chi-Square (Sig.)	ANOVA F-test (Sig.)
Performance Measurement	.577	.776	0.805	.001	
Contract forms & Strategies	.587	.773	*0.846 - The Alpha Value when "Heath and Safety Regulation" Item is deleted*	.001	
Tendering Strategies	.656	.758		.001	
Law and Arbitration	.616	.765		.001	.001
Whole Life Costing	.621	.765		.001	
Brief Writing	.617	.765		.001	
Health & Safety Regulations	.208	.846		.001	

The respondents rated the "ease of accomplishment" of these factors during building production process in Likert scales, rated from "very high accomplishable" (4) to "not accomplishable" (0). Further, the respondents categorised these factors as either "desirable or essential" towards efficient utilisation of construction resources during the production process.

This study assisted towards achieving the following:

a) ranking the factors in order of significance;

b) helped to assess, evaluates and ascertains the factors that need more attention;

c) helped to determine factors that impair resources wastes reduction during production process;

d) helped to ascertain and propose factors that need to be improved towards efficient performances;

e) made possible to determine the possible weaknesses (deficiencies) of site managers on efficient construction resources utilisation.

5.4.2.1 Ease of Accomplishment of Site Managers' Propositions

The ease of accomplishment of these factors are grouped, rated, and ranked as illustrated in Table 5.6, and Figure 5.6. It was found that the accomplishments of all these factors are possible as shown in Table 5.6; all factors rates are above average.

Table 5.6: Ease of Accomplishment of Site Managers' Propositions in order of Possibilities

a) Manpower Accomplishment	%	b) Materials Accomplishment	%	c) Machinery Accomplishment	%	d) Cost Control	%	e) Quality Management	%
Manpower as Planned	73	Procurement of Materials as Planned	79	Control of Machinery	71	Order Cost Control	77	Adequate Quality Control	79
Staff Acquisition ----- Skilled	72	Adequate Materials Control Strategies	72	Efficient Machinery Procurement	70	Purchase Cost Control	76	Achieving Quality Predicted	76
Staff Acquisition ----- Unskilled	71	Adequate Stock/Store Control	71	Efficient Organisation of Machinery	69	Resources Cost Control	74		
Team Selections and Combinations	68	Efficient Materials' Organisation	71	Plant Output Prediction	68	Construction Cost as Planned	73		
Labour Productivity Prediction	66	Efficient Co-ordination of Materials	70			Resources Cost Budgeted	72		
Manpower Control	66					Holding Cost Control	68		
Labour Motivation Strategies	64								

f) Time Management	%	g) Risk in Construction	%	i) Resources Procurement	%	Other Factors Considered (J, k, l & m)	%
Time Control And Sequence	73	Risk Assessment and Quantification	82	Integration of Materials, Manpower & Machinery Procurements	74	j) Project Scope Determinant	75
Adequate Activities Control	71	Efficient Risk Features Identification	81	Resources Source Selection	68	k) Delegation Of Authority	73
Activities Duration Scheduled	68	Adequate Risk Response Against Threat	73	Resources Evaluations And Assessments	67	l) Sub-Contractors' Control	71
Time as Planned and Defined	66	Risk Alternative Strategies	68	Prediction Of Procurements' Constraints	66	m) Nominated Suppliers' Control	66
Activities Duration Estimated	66	Emergency Cover-up Planned	66	Market Conditions Prediction	65		

In respect of high proposition accomplishment of all these factors evaluated, however, inferences can be made, (from the mean of the grouped factors calculated), that site managers' are least efficient in control of Nominated Suppliers, (the least mean value rated 12th), Manpower efficiency, (rated 11th), and Efficient Time Management, (rated 10th), in order of "weakness". Thus, there are significant needs for Site Manager to take cognisance of these factors, (among others), towards achievement of optimum efficient resources utilisation during the construction production process.

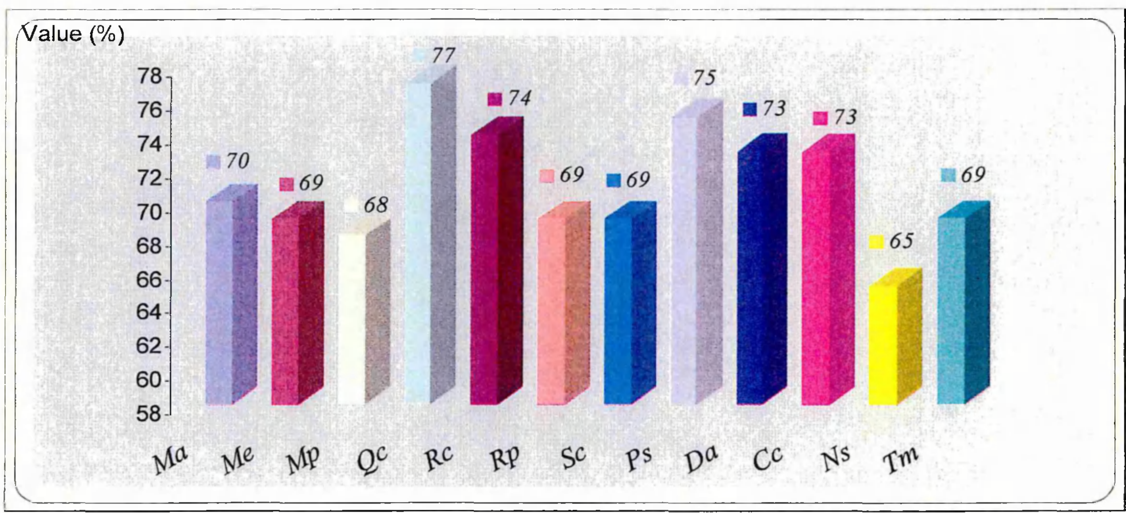


Figure 5.6 Grouped Factors evaluated on Ease of Accomplishment of the Site Managers' Propositions during the Production Process

Key: (The Factors' Groups)

Quality in Construction (Qc)	Sub-Contractors' Control (Sc)	Project Scope Determinant (Ps)
Machinery Efficiency (Mp)	Risk in Construction (Rc)	Resources Procurement (Rp)
Delegation of Authority (Da)	Time Management (Tm)	Construction Cost (Cc)
Manpower Efficiency (Me)	Materials Efficiency (Ma)	Nominated suppliers Control (Ns)

5.4.2.2 Essential and Desirable factors towards Efficient Resources Utilisation

Investigations were made to ascertain the essential factors towards accomplishment of efficient resources utilisation. It was found that out of 43 factors considered, 28 factors are essential, while 15 factors are desirable. Table 5.7 shows the order of importance of the factors with their corresponding group abbreviated.

It is important that site managers' be proficient in these essential factors in order to be efficient in resources utilisation during the production process. Therefore, the ability to possess authority and control over these essential factors will enhance construction resources utilisation, and ultimately, minimise the effects of factors that could be threats on optimal resources utilisation during production processes.

Based on the findings obtained, "high accomplishment rates" of factors evaluated, (illustrated in Figure 5.6 and as detailed in Table 5.6), it could be deduced that resources wastefulness is remotely related to the achievement of site manager's proposition, thus, this scenario supports the research proposition, that:

> *"A project could be completed with high accomplishment of site manager's proposition with lots of resources wastefulness."*

These facts among others drove further investigation, to verify and ascertain other latent factors that cause construction resources' inefficiencies, and the question posed is:

> *"Why resources wastage are high when achievement of the site managers' propositions are high during construction production process."*

The findings obtained are presented in Section 6.6.6 of the interview research survey.

5.4.2.3 Reliability and Validity Tests' Statistics on "Accomplishment of the Site Managers' Propositions"

Table 5.8 shows the reliability and validity tests' statistics of samples obtained on accomplishment of site managers' proposition towards efficient utilisation of construction resources. Viewing the characteristics of the scale, the following facts could be deduced:

ANOVA test was carried out to find the difference in mean value of the samples, and the value obtained indicates a strong agreement between the respondents that the samples share a common trait, (sig. < 0.05).

Table 5.7 Essential and Desirable Factors towards Accomplishment of Efficient Resources Utilisation, in order of Importance

Key: (The Factors' Groups)

Quality in Construction (Qc)	Sub-Contractors Control (Sc)	Project Scope Determinant (Ps)
Machinery Efficiency (Mp)	Risk in Construction (Rc)	Resources Procurement (Rp)
Delegation of Authority (Da)	Time Management (Tm)	Construction Cost (Cc)
Manpower Efficiency (Me)	Materials Efficiency (Ma)	Nominated suppliers Control (Ns)

(A) Essential Factors to be Accomplished in Order of Importance	(B) Desirable Factors to be Accomplished in Order of Importance
1. Construction Cost as Planned (Cc)	1. Market Conditions Prediction (Rp)
2. Efficient Risk Features Identification (Rc)	2. Staff Acquisition -----Unskilled (Mp)
3. Staff Acquisition -----Skilled (Mp)	3. Resources Evaluations and Assessments (Rp)
4. Resources Cost Control (Cc)	4. Labour Motivation Strategies (Mp)
5. Manpower as Planned (Mp)	5. Plant Output Prediction (Me)
6. Procurement of Materials as Planned (Ma)	6. Efficient Organisation of Machinery (Me)
7. Risk Assessments and Quantifications (Rc)	7. Emergency cover-ups Planned (Rc)
8. Sub. Contractors' Control (Sc)	8. Resources Source Selection (Rp)
9. Adequate Quality Control (Qc)	9. Efficient Machinery Procurement (Me)
10. Achieving Quality Predicted (Qc)	10. Prediction of Resources Constraints (Rp)
11. Order Cost Control (Cc)	11. Activities Duration Estimation (Tm)
12. Purchase Cost Control (Cc)	12. Labour productivity Prediction (Mp)
13. Manpower Control (Mp)	13. Efficient Materials Organisation (Ma)
14. Time Control and Sequence (Tm)	14. Adequate Activities Control (Tm)
15. Team Selection and Combination (Mp)	15. Nominated Suppliers Control. (Ns)
16. Efficient Co-ordination of Materials (Ma)	
17. Resources Cost Budgeted (Cc)	
18. Adequate Risk Response against Threat (Rc)	
19. Holding Cost Control - to avoid wastes (Cc)	
20. Adequate Materials Control Strategies (Ma)	
21. Integration of Resources Procurement (Rp)	
22. Project Scope Determinant, (Ps)	
23. Adequate Stock/Store Control (Ma)	
24. Control of Machinery (Me)	
25. Time as Planned and Defined (Tm)	
26. Delegate of Authority, (Da)	
27. Activities Duration Scheduled (Tm)	
28. Risk Alternative Strategy (Rc)	

The validity of the results were confirmed when all the samples chi-square results (Table 5.8) registered ($p < 0.05$). This shows that there is strong significant association between the variables.

The validity and ANOVA tests deductions also applied to items traits, abilities, and awareness responses obtained on site managers' traits, abilities, and awareness as shown in Tables 5.8(a - h), and are explained as follows:

a) Skills of Site Managers' Variables: (Table 5.8a)

(i) The "corrected item of total correlation coefficients" of each factor > 0.3, thus, the values of these items is significant.

(ii) The "overall Cronbach's alpha coefficient" is 0.899 > greater than all individual items Cronbach's alpha if the item is deleted.

These indicate that there are internal consistencies between the values of samples, (data), collected.

The value of Cronbach's alpha coefficient of factors considered on accomplishment of Site Manager's proposition on Manpower (all variables) is 0.726; however, if "Manpower as planned Staff acquisition – unskilled" item is deleted, the reliability will be improved to 0.856 (Table 5.8a). The materials rate of accomplishment "total Cronbach's alpha coefficient value is 0.798, though if "Adequate stock control" item is deleted the value becomes 0.803, (Table 5.8b).

The total Cronbach's alpha coefficient values of other factors are found reliable, also the values of individual of "Corrected item-total Correlations" are greater than 0.3, (Tables 5.8c to 5.8h).

Table 5.8(a) Reliability and Validity Tests' Statistics of all the Variables - Manpower Utilisation

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi-Square (Sig.)	ANOVA F-test (Sig.)
Manpower as planned	.625	.656	.726	.001	.001
Staff acquisition ----- skilled	.464	.694	Total Cronbach's Alpha coefficient value will be 0.856 if "Staff Acquisition" item is deleted.	.001	
Staff acquisition ----- unskilled	-.298	.856		.001	
Team selections and combinations	.761	.608		.001	
Manpower control	.689	.621		.001	
Labour productivity prediction	.523	.676		.001	
Labour motivation strategies	.597	.651		.001	

Table 5.8(b) Reliability and Validity Tests' Statistics of all the Variables - Materials Utilisation

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi- Square (Sig.)	ANOVA F-test (Sig.)
Adequate materials control strategies	.563	.765	.798	.001	.001
Adequate stock/store control	.451	.803	0.803 Total Alpha coefficient when Stock control item is deleted	.001	
Procurement of materials as planned	.690	.721		.001	
Efficient materials organisation	.624	.745		.001	
Efficient co-ordination of materials	.600	.757		.001	

Table 5.8(c) Reliability and Validity Tests' Statistics of all the Variables - Quality in Construction

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi- Square (Sig.)	ANOVA F-test (Sig.)
Adequate quality control	.518	664	.676	.001	.009
Achieving quality predicted	.518	.671		.001	

Table 5.8(d) Reliability and Validity Tests' Statistics of all the Variables - Machinery Utilisation

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi-Square (Sig.)	ANOVA F-test (Sig.)
Plant output predictions	.589	.635		.001	
Control of machinery	.497	.690		.001	
Efficient machinery procurement	.590	.635	.734	.001	0.304
Efficient organisation of machinery	.441	.720		.001	

Table 5.8(e) Reliability and Validity Tests' Statistics of all the Variables - Cost Control

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi- Square (Sig.)	ANOVA F-test (Sig.)
Construction cost as planned	.771	.869		.001	
Resources cost control	.776	.866		.001	
Resources cost budgeted	.765	.868	.894	.001	0.304
Purchase cost control	.713	.878		.001	
Order cost control	.710	.879		.001	
Holding cost control - (to avoid wastes)	.612	.891		.001	

Table 5.8(f) Reliability and Validity Tests' Statistics of all the Variables - Time Management

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi- Square (Sig.)	ANOVA F-test (Sig.)
Time as planned and defined	.721	.801		.001	
Time control and sequence	.629	.825		.001	
Activities duration estimation	.652	.823	.848	.001	.001
Activities duration scheduled	.648	.822		.001	
Adequate activities control	.668	.814		.001	

Table 5.8g: Reliability and Validity Statistics Tests Statistics of All the Variables - Risk in Construction

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi- Square (Sig.)	ANOVA F-test (Sig.)
Efficient risk features identification	.627	.837		.001	
Risk assessments and quantifications	.573	.850		.001	
Adequate risk response against threat	.854	.777	.856	.001	.001
Risk alternative strategies	.761	.805		.001	
Emergency cover-up planned	.592	.857		.001	

Table 5.8h Reliability and Validity Statistics Tests Result of All the Variables - Resources Procurement

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi- Square (Sig.)	ANOVA F-test (Sig.)
Integration of procurement ----	.510	.712		.001	
Resources source selection	.575	.688		.001	
Resources evaluations and assessments	.523	.704	.751	.001	.001
Market conditions prediction	.582	.681		.001	
Prediction of procurements' constraints	.423	.748		.001	

5.4.3 Site Managers' Hindrances towards Optimum Construction Resources Utilisation

The research study further investigates site managers' constraints and hindrances towards optimum utilisation of construction resources. Therefore, this section evaluates, and ascertains the site managers' hindrances towards achievement of effective utilisation of construction resources, and ascertains possible solutions to minimise these constraints. The factors were rated from (0) indicating "No Hindrance" to (5), Very High Hindrance.

The objectives of this section among others are:

a) to rank the factors in order of significance;
b) to assess and evaluate factors that pose threats to wastes minimisation;

c) to determine areas which managers need to place more attention on, to avoid construction operational "threat";

d) to assess and ascertain the factors that hinders the easy operation of the construction production process.

5.4.3.1 Order of Significance of Site Managers' Hindrances

Based on results obtained, the frequencies of several site managers' hindrances on optimal utilisation of construction resources are presented in Figure 5.7. The majority of these factors hinder site managers' efficiency. The factors that causes a significant "threat" to site managers' efficiency and performances are "time lapse to approve changes due to specification inadequacies", "sub contractors and suppliers' performances", "materials availability" and "skilled labour availability". Other factors' effects followed as rated in Figure 5.7. It was found that, "unskilled labour availability" and "skilled plant operators' availability" create less threat to site managers' efficiency and performances.

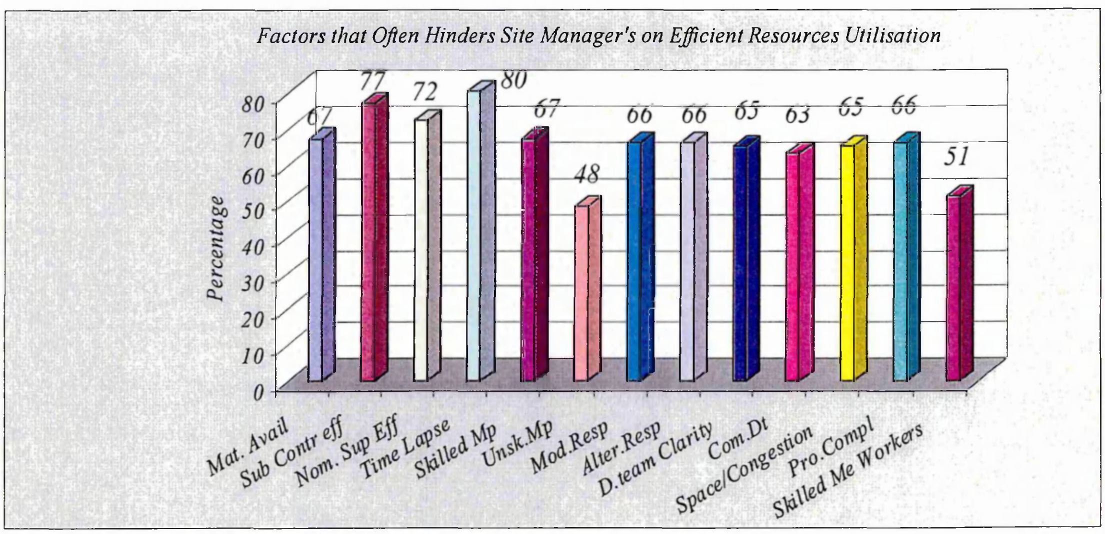


Figure 5.7: Factors that Hinders the Site Managers' Efficient Performances

Key and intensity of Hindrance in Descending order:

1. Time Lapse in Approval of Change Due to Spec. error *(Time Lapse)*
2. Sub- Contractors Efficient Performance *(Sub-Contr. Off)*
3. Nominated Suppliers Efficient Performance *(Nom Sup Eff.)*
4. Materials availability *(Mat Avail)*
5. Skilled Labour availability *(Skill Mp)*
6. Project Complexity Subject to Clarification *(Pro Compl)*
7. Modification Response to Effect Change *(Mod Resp)*
8. Alteration Response to Effect Change *(Alter Resp)*
9. Design Team Drawings and/or Specifications clarity. *(D Team Clarity)*
10. Working/Operation Space and Congestion *(Space/Congestion)*
11. Communication with Design Team *(Com. Dt)*
12. Skill Plant Workers Availability *(Skilled Me Workers)*
13. Unskilled Labour availability. *(Unskilled Mp)*

5.4.3.2 Reliability and Validity Tests' Statistics on "Accomplishment of the Site Managers' Propositions"

Reliability and Validity tests' statistics show that the samples collected are reliable and significantly valid, (Table 5.9). The value of the entire items "Total Cronbach's Alpha Coefficient" is greater than the individual "Corrected Item Total Correlation". Also, the ANOVA and chi-square values are both less than 0.05, the standard significant level.

Table 5.9 Reliability and Validity Statistics Tests Result of All the Variables - Site Manager's Hindrances

Factors Considered	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi- Square (Sig.)	ANOVA F-test (Sig.)
1) Communication with Design Team					
1a) Architects	.802	.952		.001	
1b) Structural Engineer	.860	.951		.001	
1c) Mechanical Engineer	.766	.952		.001	
1d) Electrical Engineer	.712	.953		.001	
1e) Estimator	.639	.954		.001	
1f) Quantity Surveyor	.553	.955		.001	
1g) Project Manager	.682	.953		.001	
1h) Client	.428	.956		.001	
2) Alteration Response To Effects Change	.546	.955		.001	
3) Modification Response To Effect Change	.522	.955		.001	
4) Time Lapse in Approval of Change Due to Spec. error	.488	.955		.001	
5) Material availability	.693	.953		.001	
6) Skilled Labour availability	.635	.954	.955	.001	.001
7) Unskilled Labour availability.	.723	.953		.001	
8) Project Complexity Subject To Clarification	.713	.953		.001	
9) Working/Operation Space And Congestion	.631	.954		.001	
10) Skill Plant availability	.580	.954		.001	
11) Production Information Clarity				.001	
11a) Architects	.757	.953		.001	
11b) Structural Engineer	.839	.951		.001	
11c) Mechanical Engineer	.765	.952		.001	
11d) Electrical Engineer	.817	.952		.001	
11e) Estimator	.789	.952		.001	
12) Sub- Contractor Performance	.713	.953		.001	
13) Nominated Suppliers Performance	.570	.954		.001	

5.4.4 Facilitators that will enhance Site Managers' Efficiency and Performances

Several facilitators that will contribute to achievement of efficient resources utilisation were itemised. The respondents rated these facilitators in order of importance. The rate ranges from 0, denoting "No importance", to 4, "Very high importance". Also, the respondents classified either these factors are essential or desirable towards optimum resources utilisation.

This section helped to achieve the following:

a) ranking the factors in order of importance;
b) assessing and ascertaining the factors that could easily facilitate project operation;
c) to evaluate and ascertain the "opportunity" factors that will enhance site managers' towards utilising construction resources efficiently;
d) to ascertain the factors that needed more attention during the construction production process;
e) to ascertain the factors that needed improvement towards the site manager' efficiency and performances, SMEP framework.

5.4.4.1 Order of Significance of the Facilitators that will enhance the Site Managers' Efficiencies

The relative importance of the facilitators towards Optimum Utilisation of Resources was rated. The rank order is presented in Table 5.10.

It was found that all the factors are important towards efficient resources utilisation while some of these factors are highly important. However, the main factors that were identified as a significant facilitators towards effective operation of construction project are "production information simplicity and clarity", followed by communication effectiveness, resources availability, alterations and modification minimisation and variation control and minimisation respectively. The least facilitator is found to be Technological change during work in progress.

Thus, the Site managers will perform efficiently if these highlighted facilitators are taken into cognisance before commencement of construction work. However, it is noteworthy that, deficiencies of these facilitators will significantly affect construction cost and delivery time.

Table 5.10 Factors that will Facilitates Optimum Resources Utilisation in order of Importance

FACILITATORS	RATE (%)
1. Production Information Simplicity and Clarity	89
2. Communication effectiveness	87
3. Resources Availability	80
4. Alterations & Modifications Minimisation	80
5. Variation control and Minimisation	78
6. Project Participants Skill and Knowledge	77
7. Efficient Cost Control	77
8. Site Manager's Experience on similar Work	76
9. Resources Procurement System	75
10. Efficient Cost Analysis	75
11. Expressive Process Integration	71
12. Weather Condition - Summer	70
13. Project In-Built Morale & Motivation	69
14. Job Satisfaction	69
15. Weather Condition - Winter	68
16. Friendly Project Locality and Environment	66
17. Legal And Local Authority Regulations	64
18. Technological Change during Work in Progress	61

5.4.4.2 Essential and Desirable Facilitators towards Site Managers' Efficient Performances

Investigation was made to ascertain the essential and desirable facilitators. The findings are presented in Table 5.11 in order of importance. The principal essential facilitators are communication effectiveness, production information simplicity and explicitness, resources availability, efficient cost analysis and variation control and minimisation. Other factors were found to be desirable for efficient project operation.

These essentials factors are those factors that will enhance site managers' construction resources utilisation during project production process. Among the 18 factors considered, 5 are found to be essential, while others are desirable. However, these inferences do not mean that all factors are not important towards efficient resources utilisation. Further investigations were carried out during the interview research study, (Chapter Six, Sections 6.6.7 and 6.6.8), to affirm these findings.

Table 5.11 Essential and Desirable Facilitators in order of Importance

Essential Facilitators	Desirable Facilitators
1. Communication effectiveness	1. Weather condition...summer
2. Production information simplicity and explicitly	2. Technological change during work in progress
3. Resources availability	3. Weather condition ... Winter
4. Efficient cost analysis	4. Legal and local authority regulations
5. Variation control and minimisation	5. Resources procurement system
	6. Project in-built morale & motivation
	7. Friendly project locality and environment
	8. Alterations and modification minimisation
	9. Job satisfaction
	10. Expressive process integration
	11. Site manager's experience on similar work
	12. Project participants skill and knowledge
	13. Efficient cost control

Table 5.12 Reliability and Validity Tests' Statistics Result of All the Variables – Facilitators towards Efficiency

Facilitators	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi-Square (Sig.)	ANOVA F-test (Sig.)
Production information simplicity and explicitly	.502	.855	0.862	.000	.000
Communication effectiveness	.651	.849		.000	
Efficient cost analysis	.357	.861		.000	
Efficient cost control	.412	.858		.000	
Expressive process integration	.458	.856		.000	
Alterations & modification minimisation	.525	.853		.007	
Variation control and minimisation	.459	.856		.000	
Resources availability	.531	.853		.000	
Resources procurement system	.354	.860		.000	
Site manager's experience on similar work	.531	.853		.000	
Project participants skill and knowledge	.518	.854		.000	
Project in-built morale & motivation	.667	.846		.000	
Job satisfaction	.564	.851		.000	
Technological change during work in progress	.253	.864		.000	
Friendly project locality and environment	.584	.850		.000	
Legal and local authority regulations	.479	.855		.000	
Weather - winter	.339	.861		.000	
Weather - summer	.329	.862		.000	

5.4.4.3 Reliability and Validity Tests' Statistics

Reliability and validity tests statistics were calculated to verify the consistencies of the data obtained, respondent characteristics, and strengths of relationships of the items considered. Results in Table 5.12 shows that "total Cronbach's alpha coefficient (0.862) is greater than the individual "corrected item - total correlation" value, and the chi-square and ANOVA value are both less than 0.05. Therefore the results are significantly valid and reliable.

5.4.5 Summary of Research Study One

This first part of the CRWM research study critically evaluates and identifies the site managers' potentials, functions, skills, and knowledge towards achievement of efficient construction resources utilisation. Based on the identified problems and the causes, propositions are made which will enhance site managers' performances and lead to efficient resources utilisation. Figure 5.8 illustrates the study one framework. This is a scenarios building framework that leads to investigating the rationales for wastefulness in construction industry.

SPSS was used to analyse the data collected and the findings are presented in tables and figures. Initially pilot studies were carried out to assure the questionnaires' questions clarity and adequacy In addition, to ascertain the reliability and validity of the data collected, tests' analyses were carry out. These confirmed the consistency, and quality of the respondents' responses of all the items considered in this study.

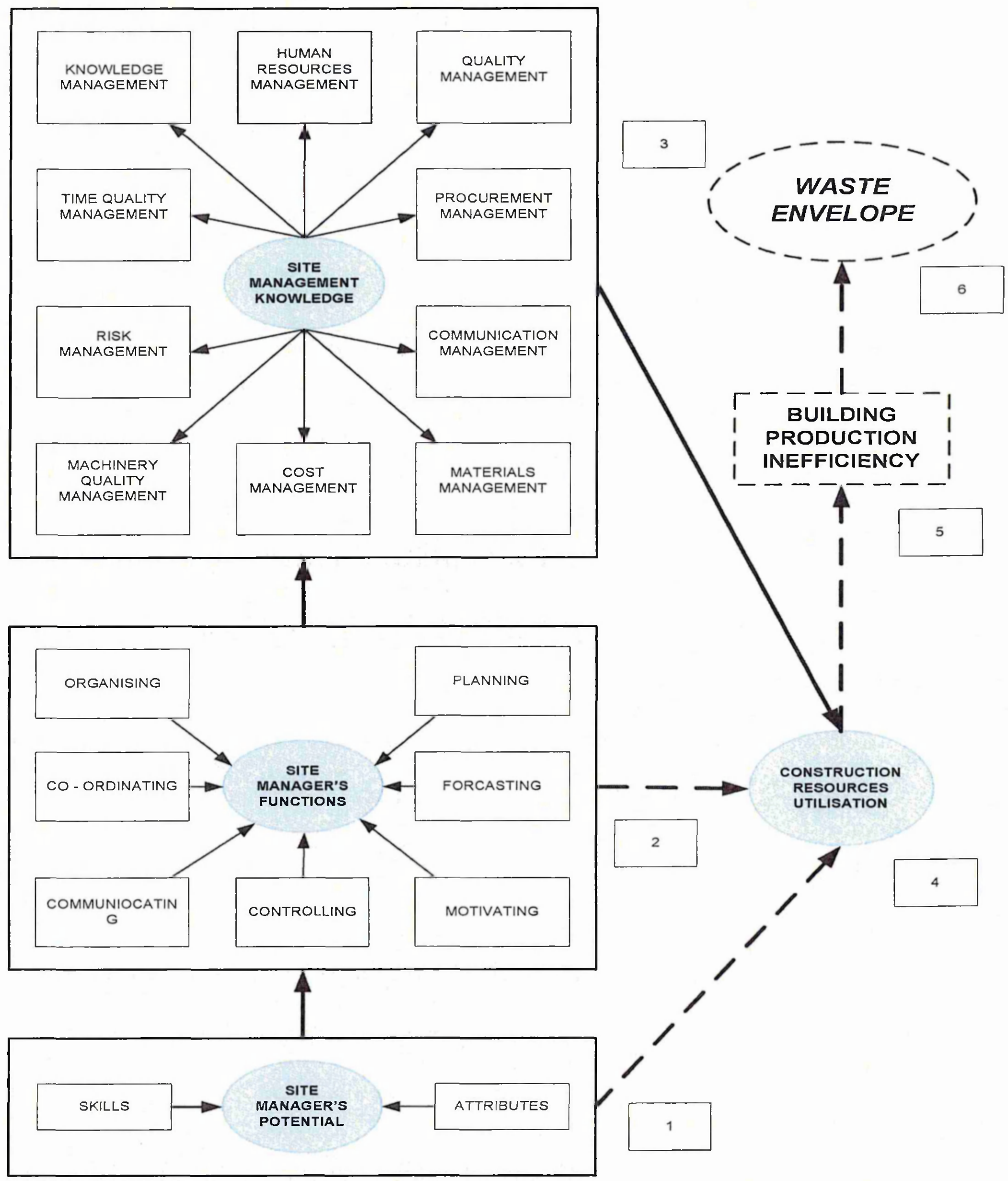


Figure 5.8 Site Managers' Potentials, Functions, and Knowledge towards Efficient Construction Resources Utilisation

As illustrated in Figure 5.8, this part of the research work, (the research study one) made possible the achievement of the following:

a) Attainment of the site manager's skills, attributes and potential; those that are significantly important towards being efficient in resources utilisation, and highlighted factors that are essentials towards achievement of the site managers' propositions.

b) Made possible the clear understanding of the site manager's paramount functions and attributes that are significant towards efficient resources utilisation. Several management principles were evaluated and the major ones that will contribute to efficient resources utilisation were itemised.

c) Identification of several site managers' essential knowledge that will lead to efficient construction resources utilisation during production process. These are recognised as 'The Strengths' that will enhance site manager's efficient performance.

d) Circumstances of the construction resources wastefulness due to the site manager's deficiency were identified. These are referred as 'The Weaknesses' of the site managers that cause inefficiencies in resources utilisation.

e) Establishment of the factors that hinder the site managers from performing efficiently. These are acknowledged as 'The Threats' to site manager's efficient performance.

f) Ascertaining several facilitators that will enhance the site manager's performances, and minimise resources wastefulness. These are signified as 'The Opportunities' available towards the site manager's efficient performance.

Many facts obtained in this questionnaires research survey were concluded. However for validity and reliability purposes, further investigations were made on the quantitative research survey findings by conducting interviews. The findings from the qualitative interview research survey are reported in the Chapter Six, including the outcome of other issues evaluated.

5.5 QUANTITATIVE RESEARCH SURVEY STUDY TWO - BUDGETING FOR RESOURCES' WASTES SYNDROMES, (BWS) IN THE CONSTRUCTION INDUSTRY

Research Study One addressed issues that are directly related to site managers' in respect to efficient resources utilisation and resources' wastes management. However this part (Study Two), evaluates beyond internal factors that are directly associated with site managers. Thus, this study investigates the issues that are distantly connected to site managers' knowledge, attitudes and perceptions, but which are essential towards efficient resources utilisation, such issues as "allowance for resources wastefulness", "effect of motivation and incentives towards resources utilisation", and "the Knowledge, Attitudes and Perception, (KAP) of site participants towards resources utilisation and wastes".

The term BWS in this study implies the allowance, provision or pre-notion for resources wastefulness occurrence either consciously or unconsciously. That is, setting aside or over-estimation of resources in envisaging that wastes will occur during construction production process. In this research study, the term "Syndromes" mean the concepts or attitudes that are believe to be normal. This study is technically sub-divided into five main sub-headings:

5.5.1 Factors that Contributes to "Budgeting for Resources' Wastes Syndromes" The factors evaluated are grouped under:

(a) Materials, (b) Manpower, (c) Machinery, (d) Production Information,

(e) Design Team, and (f), Site Management;

5.5.2 Allowance for Wastes of different types of Construction Resources;

5.5.3 Resources' Wastes in-built in different Production Information;

5.5.4 Knowledge, Attitudes, and Perceptions, (KAP) of Construction Project Participants on Construction Resources Utilisation and Wastes. Such issues as:

(a) The beliefs of site participants on construction resources;

(b) The attitudes of site workers towards resources' wastes;

(c) The behaviour of site operatives towards resources' wastes;

5.5.5 Motivators and Incentives towards the Reduction of BWS.

5.5.1 Factors that Contributes to "Budgeting for Resources' Wastes Syndromes"

This part evaluates, and ascertains the factors that contribute to budgeting for resources wastefulness in the construction industry. Several factors were outlined for consideration, and respondents rated these factors between Very High Contribution, (5) and No Contribution, (0)

This section establishes the following:

a) a rank order of the factors in order of significance;
b) factors that lead to BWS;
c) ascertaining factors that need to be avoided toward resources' wastes minimisation;
d) ascertaining the factors that need attention towards resources' wastes reduction during construction production process.

5.5.1.1 Discussion of Findings on Factors that Contributes to "Budgeting for Resources Wastefulness"

The results obtained from the analysed data are presented in Table 5.13. The data outcome shows that the contributions of all the factors considered are significant, having values above average. Also, there are indications that resources wastefulness largely occur through several means of allowances and provisions. However, the contributions of the design team in resources' wastes assumption and allowances are paramount in comparison with other factors evaluated, (the contributions due to materials, manpower, machinery, production information, and site management).

The details in Table 5.13 show the ranked order of the factors considered in each group. The results indicate that all the nine factors considered under plant and equipment, (Table 13e), have a lesser tendency for budgeting for their wastefulness. The factors' values have ranges from 46% to 55%. However, the factors due to production information (Seven factors - Table 13d) and Design team (Five factors - Table 13a) are 61% and above apart from a factor in each group. Therefore, it could be deduced from these scenarios that, budgeting for resources wastefulness is significantly predominant during construction production process due to the design team and their production information provided for construction works. However, these findings are further verified in the interview research survey, (Section 6.7). The Section 6.7 presents the interview findings on:

"What are the rationales for budgeting for resources wastefulness in the construction industry, and how could these predicaments be minimised to ensure optimal resources utilisation and significant wastes management?"

Table 5.13 Factors that Contributes to Budgeting for Resources Wastefulness

Table 5.13(a) Due to Design Team (Mean)	% 63
1. Variation order delay - that may affect other works	69
2. Waiting time for alteration order	67
3. Communication gap between design & construction teams	65
4. Predominant meeting on variations/alterations/modifications	61
5. Delay in inspection to proceed to another stage of work	54

Table 5.13(b) Due to Materials (Mean)	% 58
1. Design not to manufacturers' standard – materials off cut	66
2. Irregular shapes - off-cut	66
3. Materials damage on stock piling	64
4. Specifications uncertainty	59
5. Ordering of materials for usage - unreturned to store	58
6. Adverse weather - drying shrinkage	58
6. Design engineers' faults	57
7. Weather conditions - materials spoilage	55
7. Pilferage – security lapses	55
8. Residual and spillage during work in progress	55
8. Planning error(s)	54
9. Transit wastes - brake & spillage	52
10. Quantity surveyor(s) mistakes	49

Table 5.13(c) Due to Manpower (Mean)	% 57
1. Double handling	65
2. Rework due to mistake(s)	64
3. Unskilled operation - increasing the time of completion	60
4. Wrong construction method - leading to delay /time lapse	58
5. Waiting time for materials to use - Redundancy period	56
6. Lack of co-ordination within or among gang(s)	56
7. Right operation for wrong work - leading to delay or rework	54
8. Weather conditions – leading to delay	54
9. Insufficient tools and equipment to use - waiting time	52
10. Traffic between plant position to operation place	51

Table 5.13(d) Due to Site Management (Mean)	% 55
1. Poor site organisation	62
2. Inadequate project/site planning	57
3. Poor communication system - that leads to time lag	56
4. Delay in decision making and operation order - time lag	56
5. Poor selection of materials and labour procurement systems	56
6. Inexperience technicality types required for the project	55
7. Poor operation control- leading to delay or rework	55
8. Inadequate monitory system	55
9. Poor project planning And Schedule that leads to wastage	54
10. Lack of sufficient motivation - to boast operative morale	52
11. Poor schedule of resources	51

Table 5.13(e) Due to Production Information (Mean)	% 62
1. Inadequacy of architectural specifications	65
2. Architectural drawings complexity-interpretation time lag	65
3. Ambiguity of structural drawings - interpretation time lag	64
4. Inadequacy of structural engineering specifications	61
5. Inadequacy of electrical engineering specifications	61
6. Inadequacy of mechanical engineering specifications	61
7. Inadequacy of estimator/quantity surveyor specifications	55

Table 5.13(f) Due to Plant and Equipment (Mean)	% 50
1. Long break/position/stationary Un-used/redundancy - rental cost	55
2. Poor communication system within or between gang(s) - time lag	51
3. Lack of co-ordination within or between gang(s) - redundancy/inefficiency	51
4. Breakdown during work in progress - materials/labour wastes	50
5. Possible repeated work for plant	49
6. Operation and plant position, traffic - materials. & labour wastes	49
7. Delivery time & redundancy period	48
8. Un-experience operator - minimal efficiency/productivity	47
9. Uncoordinated skills between plant operator and the controller	46

5.5.1.2 Reliability and Validity Tests' Statistics

The reliability and validity tests' statistics calculated, (Tables 5.14(a - f)) revealed that the responses collected and items considered on issues of "budgeting for resources wastefulness" are valid and reliable, apart from items "design not to manufacturers standard - materials off cut", (Table 5.14a), and "weather condition - work delay" (Table 5.14b). However, this fact does not absolutely indicate that these factors do not contribute to budgeting for resources wastefulness. These results are further investigated during the interview research survey, (Chapter 6, Section 6.7), among other issues.

Table 5.14(a) Reliability and Validity Tests' Statistics of all the Variables - Budgeting for Materials' Wastes

Factors Considered	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi- Square (Sig.)	ANOVA F-test (Sig.)
Specifications uncertainty	.434	.847	.851	.001	.001
Design not to manufacturer's standard - materials off cut	.134	.865		.001	
Quantity surveyor mistake(s)	.671	.829	.865	.001	
Design Engineers' faults	.566	.837	Alpha Value when "Design not to manufacturer standard - materials off cut" is Deleted	.001	
Materials damage on stock piling	.485	.842		.001	
Planning error(s)	.596	.835		.001	
Adverse weather - Drying shrinkage	.711	.827		.001	
Irregular shapes - Off-cut	.555	.838		.001	
Pilferage - Security lapse	.588	.835		.001	
Ordering of materials for usage unreturned to store	.404	.847		.001	
Residual and spillage during work in progress	.536	.840		.001	
Transit wastes - Brake & Spillage	.530	.840		.001	
Weather condition - materials spoilage	.433	.845		.001	

Table 5.14(b) Reliability and Validity Tests' Statistics of all the Variables - Budgeting for Manpower Wastes

Factors Considered	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi-Square (Sig.)	ANOVA F-test (Sig.)
Waiting time for materials to be used - Redundancy period	.487	.888	.889	.001	.001
Double handling	.580	.882		.001	
Insufficient tools and equipment to use - waiting time	.718	.872	.895 The Alpha Value when "Weather condition - work delay" is deleted	.001	
Unskilled operation - increasing the time of completion	.736	.870		.001	
Rework due to mistake(s)	.648	.877		.001	
Lack of coordination among gang	.802	.865		.001	
Wrong construction method - leading to delay /time lapse	.665	.876		.001	
Weather condition - work delay	.385	.895		.001	
Right operation for wrong work - delay or rework	.672	.875		.001	
Traffic between plant position to operation place	.568	.883		.001	

Table 5.14(c) Reliability and Validity Tests' Statistics of all the Variables - Budgeting for Machinery Utilisation Wastes

Factors Considered	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi- Square (Sig.)	ANOVA F-test (Sig.)
Delivery time & redundancy period	.686	.909	.917	.001	.001
Un-experience operator - minimal efficiency/productivity	.771	.903		.001	
Breakdown during work in progress - material/labour waste	.647	.912		.001	
Lack of coordination among gang(s) - redundancy/inefficiency	.667	.910		.001	
Operation and plant position, traffic - materials. and labour wastes	.807	.901		.001	
Uncoordinated skills among plant operator and controller	.737	.906		.001	
Possible repeated work for plant	.700	.908		.241	
Poor communication among gang(s) - time lag	.730	.906		.049	
Long break or position/stationary un-used - rental cost	.633	.913		.001	

Table 5.14(d) Reliability and Validity Tests' Statistics of all the Variables - Budgeting for Resources' Wastes due to Production Information

Factors Considered	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi- Square (Sig.)	ANOVA F-test (Sig.)
Architectural drawings complexity - interpretation time lag	.738	.948	.949	.001	.001
Ambiguity of structural drawing s - interpretation time lag	.823	.942		.001	
Inadequacy of Architectural specifications	.784	.945		.001	
Inadequacy of Mechanical Engineering specifications	.873	.937		.001	
Inadequacy of Electrical Engineering specifications	.879	.937		.001	
Inadequacy of Structural Engineering specifications	.872	.937		.001	
Inadequacy of Estimator/Quantity Surveyor(s) specifications	.832	.941		.001	

Table 5.14(e) Reliability and Validity Tests' Statistics of all the Variables

- Budgeting for Wastes due to Possible Inefficiencies of Site Management

Factors Considered	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi-Square (Sig.)	ANOVA F-test (Sig.)
Inadequate project/site planning	.682	.939	.942	.001	.001
Inadequate monitory systems	.790	.935		.001	
Lack of sufficient motivation - to boast operative morale	.800	.934		.001	
Poor materials and labour procurement systems	.660	.940		.001	
Poor site organisation - leading to wastage	.788	.935		.001	
Delay in decision making and operation order - time lag	.745	.937		.001	
Poor communication system - leading to time lag	.810	.934		.001	
Inexperience technicality required for the project	.724	.937		.001	
Poor project planning and Schedule - leading to wastes	.773	.936		.001	
Poor schedule of resources - leading to wastes	.678	.939		.001	
Poor project/site operation control	.782	.935		.001	

Table 5.14(f) Reliability and Validity Tests' Statistics of all the Variables

- Budgeting for Wastes due to Inefficiencies of Design Team.

Factors Considered	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi-Square (Sig.)	ANOVA F-test (Sig.)
Variation order delay that may affect other work in progression	.817	.844		.001	
Waiting time for alteration order	.882	.827	,889	.001	.001
Delay in inspection to proceed to another stage of work	.602	.884		.001	
Communication gap between design and construction teams	.542	.902		.001	
Predominant meetings on variations/alterations/modifications	.821	.842		.001	

5.5.2 Allowance for Wastes of different types of Construction Resources

This section verifies and differentiates the magnitude of physical or visible resources wastes that are allowed for in various construction resources. The results show that less solid or visible wastes' assumptions are often made for plant and equipment utilisation with combined "strongly agreed and agreed rate of 22%. In comparison, materials are rated highest, 68% followed by manpower, 44%, (Table 5.15).

Table 5.15 Budgeting for Wastes of different types of Resources, (%)

	a) Materials, (Ma)		b) Manpower, (Mp)		c) Machinery, (Me)	
Strongly Agreed	17	68	07	44	02	22
Agreed	51		37		20	

The results presented in Table 5.15 show that the allowance of materials' wastes is approximately half the total resources' wastes allowance for construction works. Comparing the ratio of occurrence, the ratio is approximately 1:2:3, (Me: Mp: Me). The interactive charts of the occurrences illustrated in Figure 5.9 and Figures 5.10(a-c) present the details of the respondents' agreement. Figure 5.10a shows the higher agreement to wastes due to materials, while the wastes due to machinery utilisation have a lower agreement percentage.

Though, allowance of materials' wastes is the highest in percentage of occurrence; however, the majority of the occurrences are highly possible due to utilisation of other construction resources: manpower, machinery and other factors such as design team and production information as illustrated in Section 5.5.1

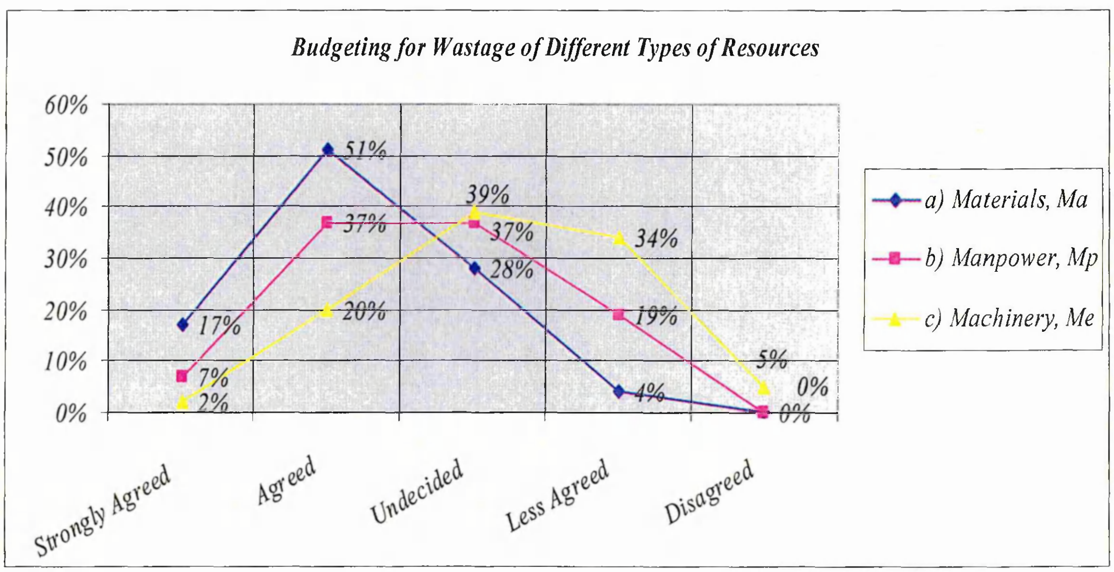
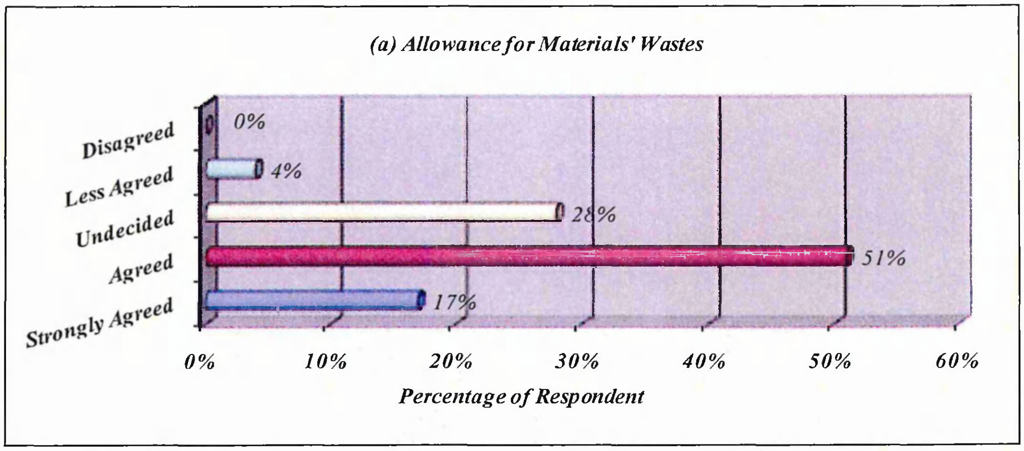
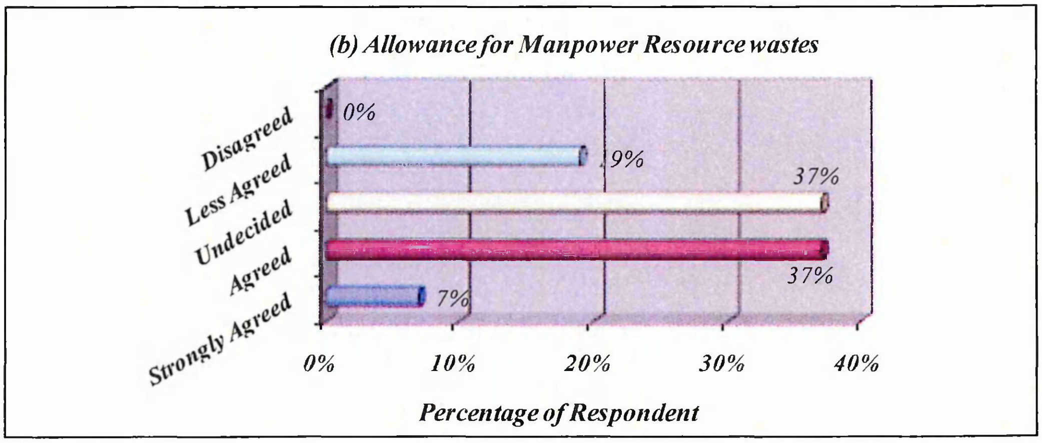
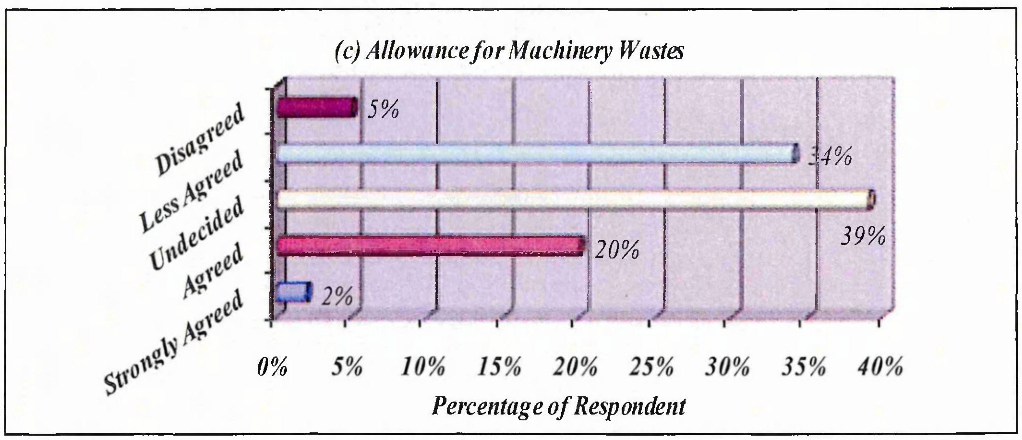


Figure 5.9 Budgeting for Wastes of different types of Resources

(Summation of Strongly agreed and agreed percentages)







Figures 5.10(a-c) Respondents' Agreement on Budgeting for Wastes of different types of Resources

5.5.3 Resources' Wastes in-built of different Production Information

This section evaluates and ascertains the level of contribution of every package of production information towards budgeting for resources' wastes. From the analysed data, the percentages of "strongly agreed" and "agreed" were summed together. The results show that, "Architectural Drawings and Specifications" has maximum allowance for resources wastefulness with a respondents' rate of 56%. This is followed by:

Structural Drawings and Specifications, 53%; Bill of Quantities, 52%; Mechanical Drawings and Specifications, 50%. The production information of which resources wastefulness is least envisaged to occur is "Electrical Drawings and Specifications", with rate of 45%. These results are presented in Table 5.16

Table 5.16 Allowance of wastefulness in deferent Production Information

	a) Architectural Drawings and Spec		b) Structural Drawings and Spec.		c) B. O. Q		d) Mech. Drawings and Spec.		e) Elect. Drawings and Spec.	
Strongly Agreed	02	56	05	53	03	52	08	50	05	45
Agreed	54		48		49		42.		40	
Undecided	26		20		23		23		27	
Less Agreed	16		25		22		25		27	
Disagreed	02		02		03		02		01	
Total	100		100		100		100		100	

5.5.4 Knowledge, Attitudes, and Perceptions, (KAP) of Construction Project Participants on Construction Resources

This part investigates and establishes the Knowledge, Attitudes, and Perceptions, (KAP) of construction project participants towards resources' wastes during the construction production process. The respondents chose from alternative answers provided. The rationales for this section are:

a) to rank these factors in order of significance;
b) to evaluate the KAP of construction participants towards BWS;
c) to ascertain the conformity of estimated construction resources to actual utilisation; and
d) to assist in establishing the measures towards minimisation of budgeting for resources' wastes syndromes.

To gain better insight into the KAP of construction participants, this section was sub-divided into three main headings and the following issues were addressed:

5.5.4.1: Beliefs of Site Participants on Construction Resources Procurement and Utilisations;

5.5.4.2: Attitudes of Site Workers towards Resources' Wastes; and

5.5.4.3: Behaviour of Site Operatives towards Wastes

5.5.4.1 Beliefs of Construction Participants on Resources' Procurement and Utilisations

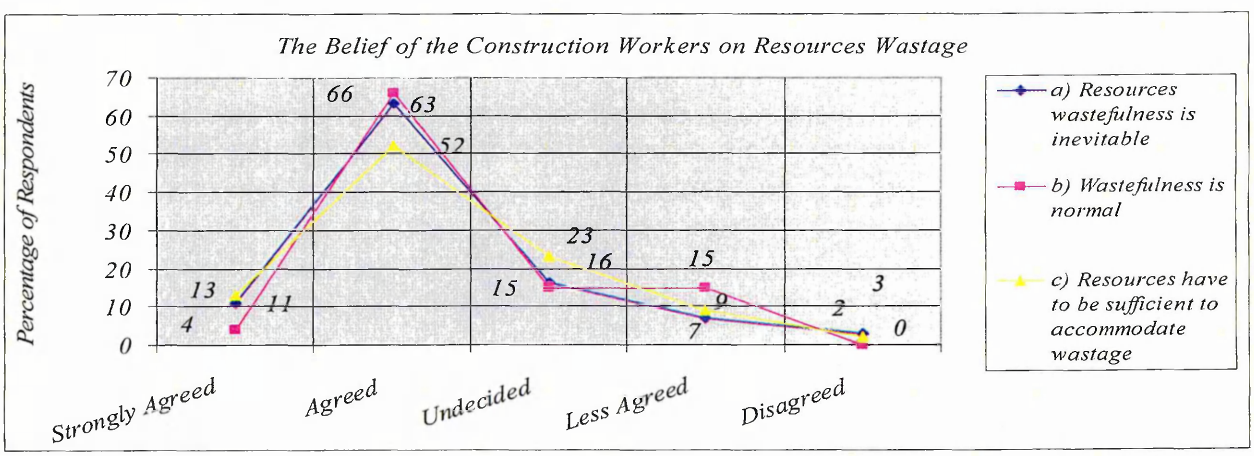
This section is based on agreement of respondents on "beliefs" of site workers. The respondents' chose from alternatives provided, ranging from 'Strongly Agree' (5) to 'Disagreed' (0). The summation of 'Strongly Agreed' and 'Agreed' percentages of "resources wastefulness is inevitable" is 74%; "resources wastage is normal" is 71% and "Resources have to be sufficient to accommodate wastage" is 67%. These are presented in Table 5.17 and interactive Figure 5.11.

These results indicate that, the agreement positions on all the factors and resources' wastes are viewed in diverse perspectives by construction participants. In comparison, the belief that "resources wastefulness is inevitable" is rated highest. This fact also indicates that the construction participants view resources wastefulness as unavoidable.

These findings are further investigated in the interview survey and the interview survey findings are presented in Section 6.7.1. This Section 6.7.1 clarifies and ascertains the rationales for these construction participants' beliefs and possible ways to reduce the beliefs towards resources efficient utilisations.

Table 5.17 Beliefs of the Construction Participants on Resources Wastage.

		A) Resources wastefulness is inevitable, (%)		B) Wastefulness is normal, (%)		C) Resources have to be sufficient to accommodate wastage, (%)	
Valid	Strongly Agreed	11	74	04	71	14	67
	Agreed	63		67		53	



Figures 5.11 Beliefs of the Construction Participants on Resources Wastage

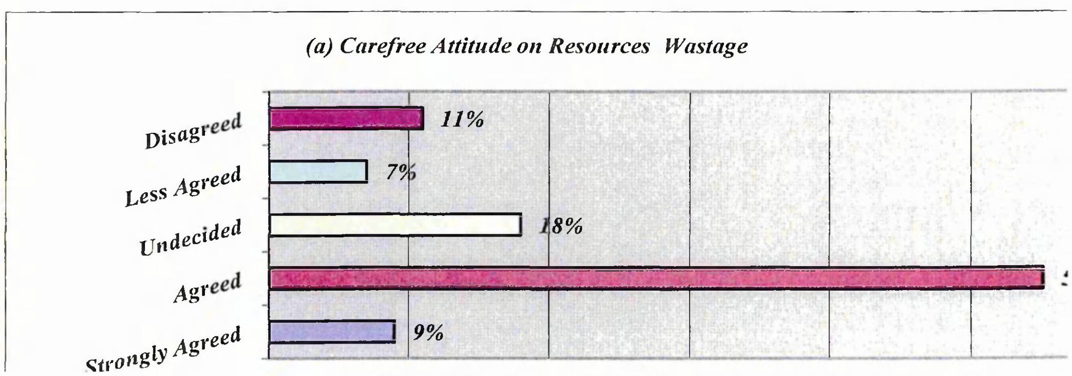
5.5.4.2 Attitudes of Site Workers towards Resources Wastage

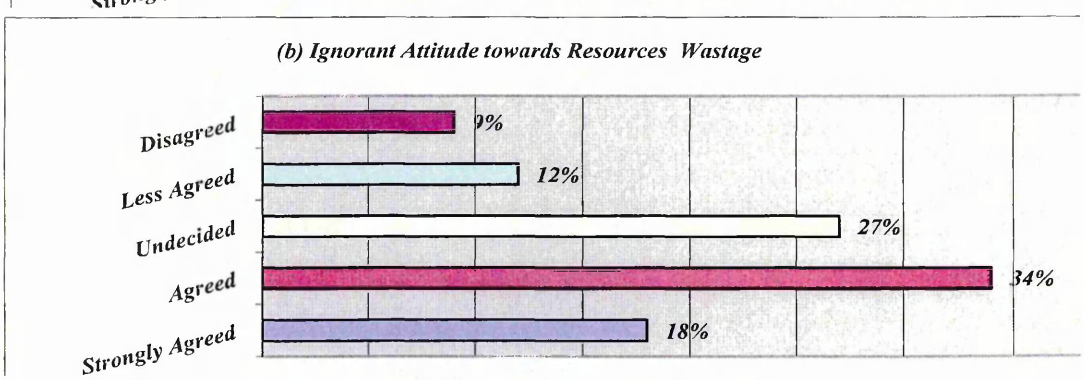
This section evaluates the concerns and reactions of site participants towards resources utilisation and wastefulness during the production process, and ascertains the construction workers' feelings towards resources inefficient utilisation. From the survey, majorities of site participants are carefree in regard to resources minimisation, 64% out the respondents agreed with this fact, followed by an ignorant and nonchalant attitudes with 52% each. Normal reaction is 46%, while the least are those workers whose will be displeased, 31%. The sum of "strongly agreed" and "agreed" percentages is tabulated in Table 5.18, while the detailed are presented in Figures 5.12 (a - e)

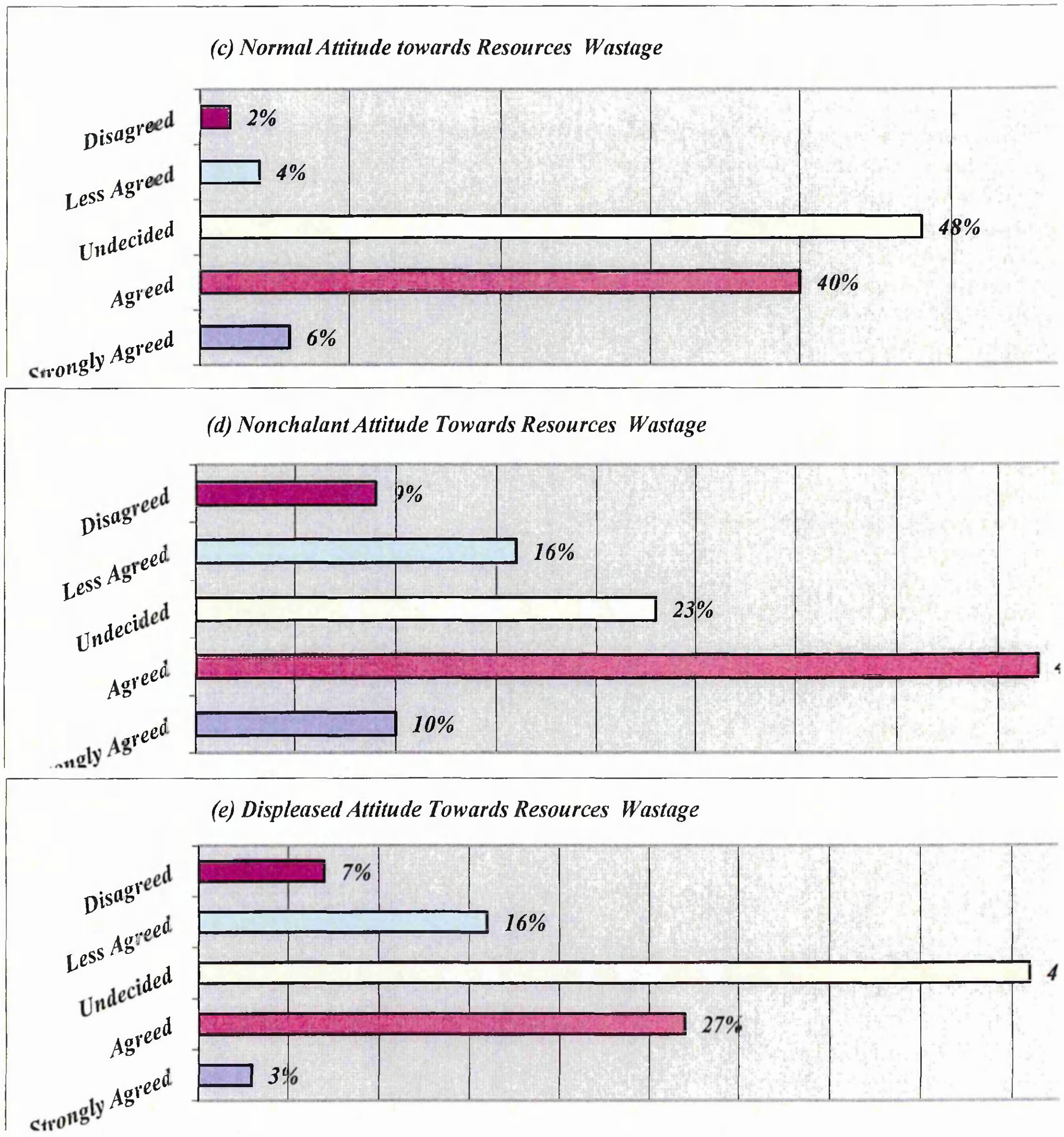
Table 5.18: Site Participants' Attitudes towards Resources Wastage.

	a) Carefree		b) Ignorant		c) Nonchalant		d) Normal		e) Displeased	
Strongly Agreed	09	64	18	52	10	52	06	46	03	31
Agreed	55		34		42		40		28	

The results obtained in this Section 5.5.4.2, the "Carefree attitude" of site participants buttress the fact established in Section 5.5.4.1, that construction participants view resources wastefulness as unavoidable and inevitable during construction production process.







Figures 5.12(a - e) Site participants' Attitudes towards Resources Wastage

5.5.4.3 Behaviour of Site Operatives towards Resources Wastage

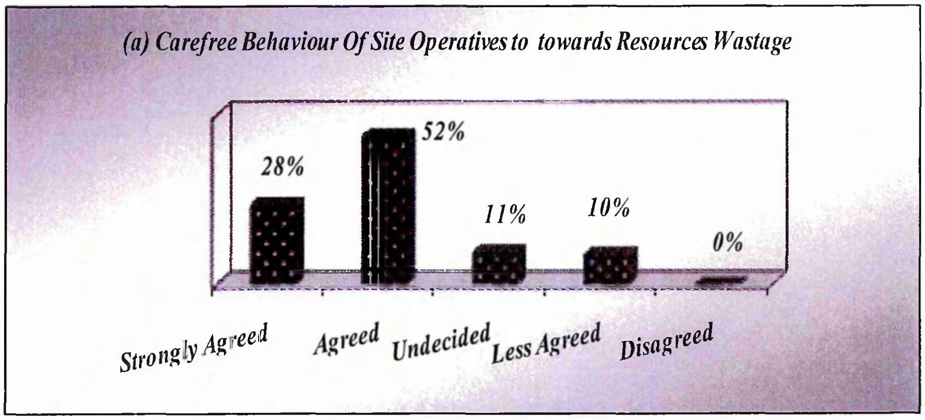
This sub-section establishes the conduct of site workers towards efficient resources utilisation and strengthens the facts obtained on beliefs of construction workers during construction process. The facts obtained are presented in Table 5.19 and Figure 5.13(a - d). The findings indicate that the site operatives show less concern on resources utilisation, wastage, or minimisation. .

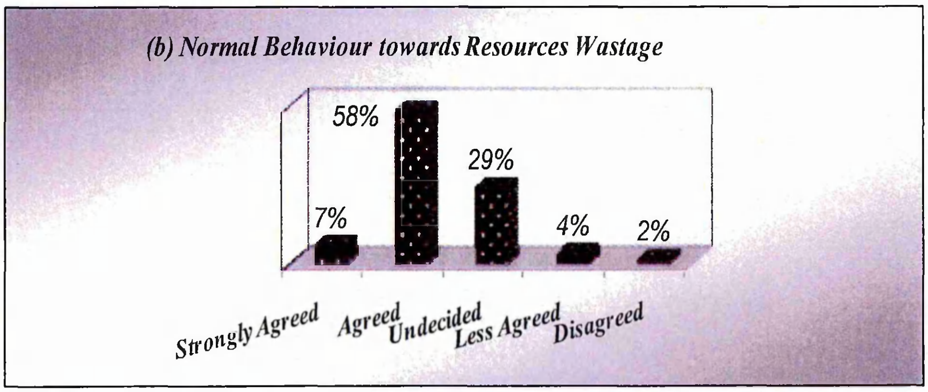
Based on these scenarios, further investigations were conducted through interview survey, (presented in Section 6.8.7), to evaluate, and establish facts on this topical issue:

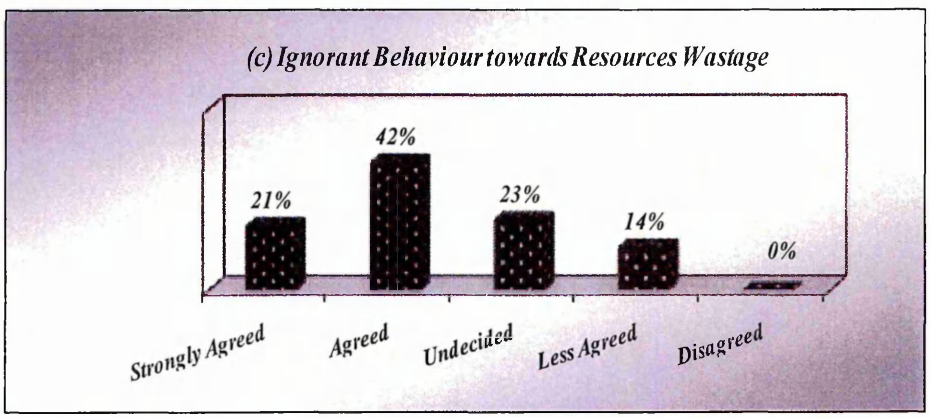
"Manpower is a resource that leads to wastefulness of other resources".

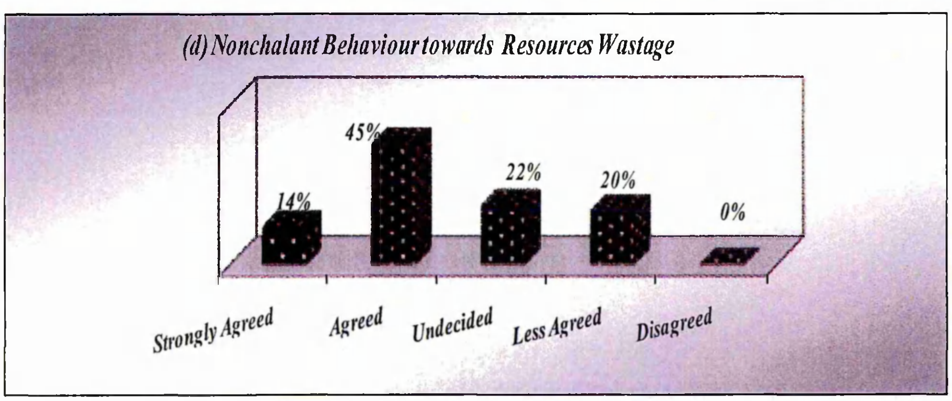
Table 5.19 Behaviour of Site Operatives towards Resources Wastage

	a) Carefree		b) Normal		c) Ignorant		d) Nonchalant	
Strongly Agreed	28	80	7	65	21	63	14	49
Agreed	52		58		42		45	









Figures 5.13(a - d) Behaviour of Site Operatives towards Resources Wastage

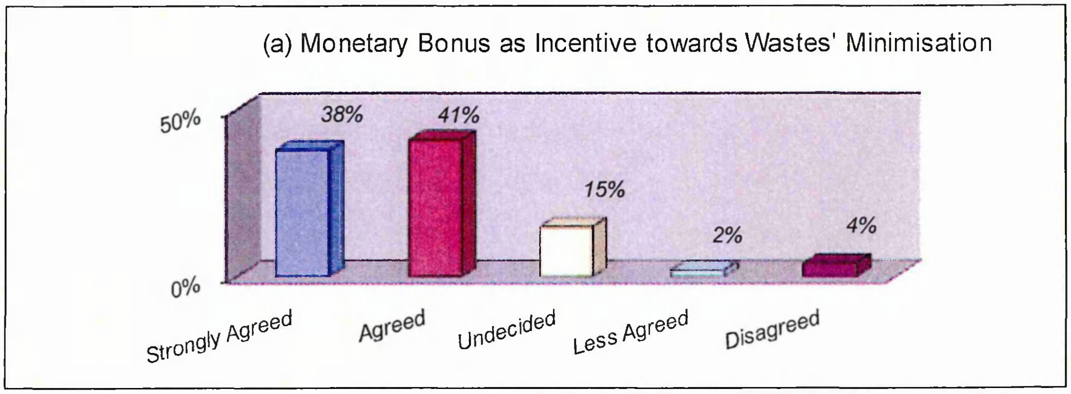
5.5.5 Motivators and Incentives towards Reduction of Resources Wastefulness and BWS

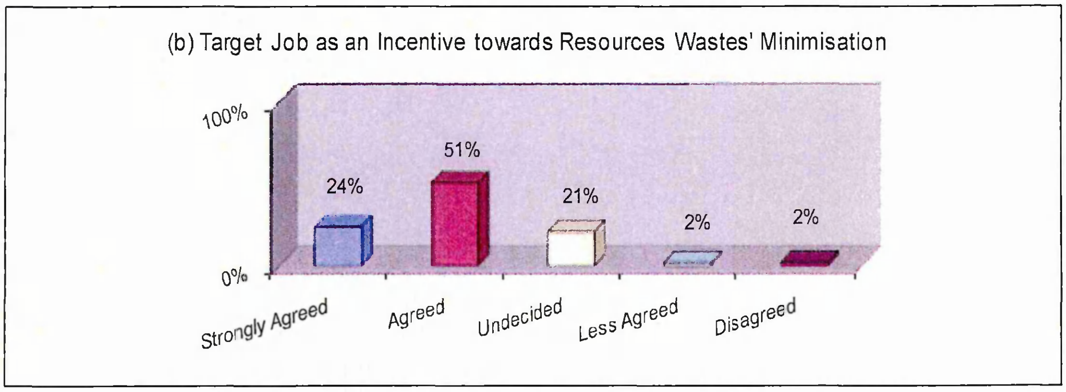
Five factors were evaluated as incentives or means towards efficient resources utilisation, (wastes minimisation). Respondents rated these factors on agreement, ranging from (0) to (5), where (0) indicates disagreed' and (5) represents 'strongly agreed'. The results obtained are: "Monetary Bonus for Wastes Minimisation", 79%, "Target job and Resources Saving Scheme", 74%, "Payment in Relation to Sensitivity of the Resources", 71%, "Damage Free Incentive Package", 67%, and "Wastes' awareness awards", 56%. Also, the agreement to "Carefulness Awards" is, 45%, which is the lowest. These results are presented in Table 5.20

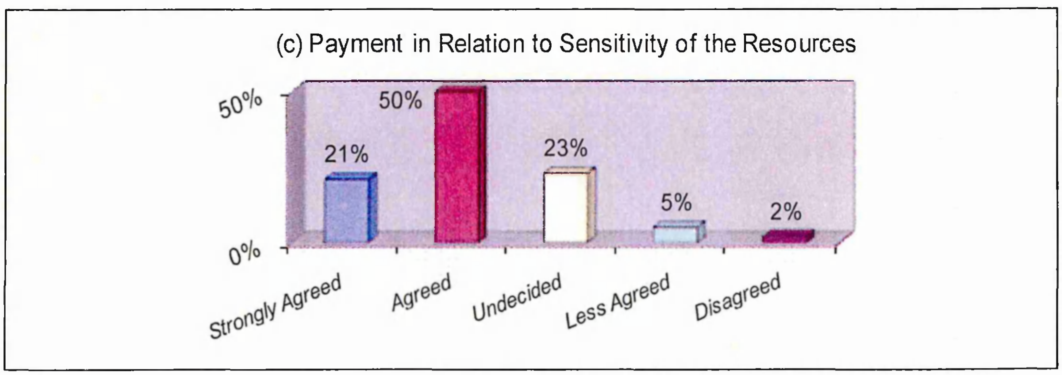
Table 5.20 Possible Motivators and Incentives towards Reduction of Resources Wastefulness and BWS

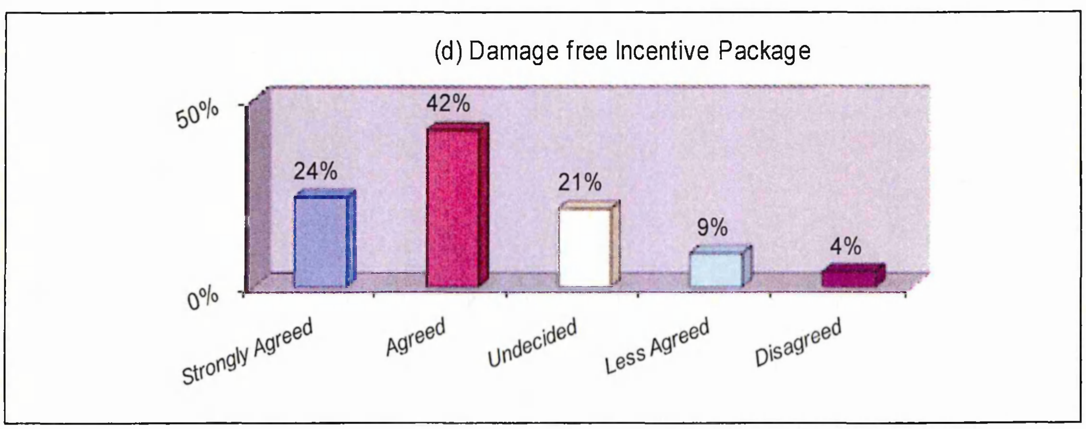
	a) Monetary Bonus towards waste minimisation		b) Target job and resources saving scheme		c) Payment in relation to sensitivity of the resources		d) Damage free incentive package		e) Wastes' awareness awards		f) Carefulness awards	
Strongly Agreed	38	79	24	75	21	71	24	66	16	56	11	45
Agreed	41		51		50		42		40		34	

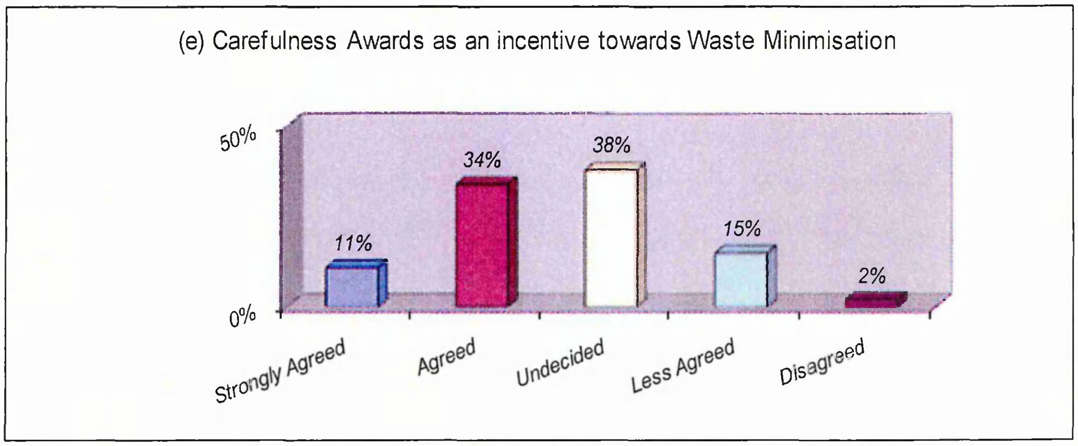
From the data obtained and presented in Table 5.20 and Figure 5.14, it is found that all the factors considered are significantly important towards the reduction of construction resources inefficiencies apart from "carefree awards" which is below average in percentage, (45%). In comparison, "Monetary Bonus" is the most acceptable factor to motivate workers towards efficiency, (79%), followed by "Target Job" (75%). However, to validate and establish the rationales behind these motivates and modalities of providing significant incentives to the site operatives, further investigations were conducted on these deductions through exploration of interview research survey. The interview research survey results are presented in Section 6.8.8.


(a) Monetary Bonus as Incentive towards Wastes' Minimisation
50%
0%
38%
41%
15%
2%
4%
Strongly Agreed
Agreed
Undecided
Less Agreed
Disagreed


(b) Target Job as an Incentive towards Resources Wastes' Minimisation
100%
0%
24%
51%
21%
2%
2%
Strongly Agreed
Agreed
Undecided
Less Agreed
Disagreed


(c) Payment in Relation to Sensitivity of the Resources
50%
0%
21%
50%
23%
5%
2%
Strongly Agreed
Agreed
Undecided
Less Agreed
Disagreed


(d) Damage free Incentive Package
50%
0%
24%
42%
21%
9%
4%
Strongly Agreed
Agreed
Undecided
Less Agreed
Disagreed



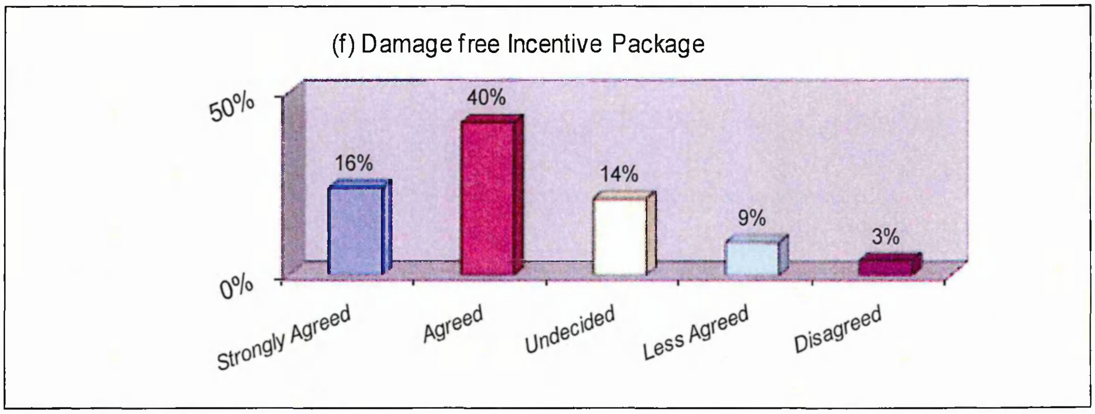


Figure 5.14 (a -f) Motivators or Incentives towards Reduction of Resources Wastefulness and BWS

5.5.6 Summary of the Research Study Two

This research study evaluated the scenarios of budgeting for resources wastefulness that perpetuate resources inefficiencies during construction production process. The study critically investigates this BWS concept from the perspective of the construction participants' Knowledge, Attitudes, and Perceptions based on the beliefs, attitudes, and the behaviour of the construction workers towards construction resources utilisation and wastes.

Study Two critically assessed the factors, grouped under five categories. These groups are materials, manpower, machinery, production information, design team, and site management. In this study, the circumstances and scope of different types of construction resources; wastes; and resources; wastes in-built of different production information were affirmed.

Several significant facts emerged which are presented in tables, figures and interactive charts that made possible the establishment of the "beliefs of site participants on construction resources"; "the attitudes of the site workers towards resources wastage"; and, "the behaviour of the construction operatives towards resources' wastes".

Among the facts deduced are: the site operatives believe that the construction resources wastage is normal and wastes have to be budgeted for during production information preparation. Thus, these facts influence the workers in showing a carefree attitude towards resources utilisation. Further findings confirmed that the majority of these wastes stem from the design team, and could be avoided by the provisions of adequate and explicit production information for construction works. Also the provisions of adequate motivators and incentives will enhance the reduction of BWS. Several probable motivators and incentives that will be effective towards minimisation of BWS include: bonus for wastes reduction, and wastes target achievement; and appraisal for a job well done. These factors will not only significantly enhance efficient resources utilisation, but also reduce wastage during production process.

The data and results validity and reliability were confirmed with tests' statistics. In addition, further investigations were carried out through an interview research study, to establish the modalities of the avoidance or reduction of BWS, before or during construction works.

5.6 QUANTITATIVE RESEARCH SURVEY STUDY THREE - AVOIDANCE OF CONSTRUCTION RESOURCES' WASTES, (ACRW)

The third part of this quantitative research survey is sub-divided into three main categories. Firstly, the study evaluates several modes of wastes' occurrences: the wastes due to materials, manpower, machinery, production information, design team, and site management. Secondly, the study ascertains the resources' wastes that often occur consciously and unconsciously during the construction production process, and finally, it establishes the avoidable and unavoidable resources' wastes.

The respondents classified construction resources wastefulness into conscious or unconscious in relation to occurrence, and avoidable or unavoidable in relation to avoidance during utilisation. The respondents were solicited to choose the most appropriate conditions. That is, to classify each waste, either the occurrence is conscious or unconscious in nature; also, to indicate either the occurrence is avoidable or unavoidable. The frequency of the occurrence was rated from "very high occurrence", (5) to "very low occurrence", (1).

The rationales for this Study Three are:

a) to rank the construction resources wastefulness in order of significance;
b) to assess and evaluate the predominance of conscious, unconscious, avoidable and unavoidable wastes;
c) to rank the frequency of conscious, unconscious, avoidable, and unavoidable resources' wastes;
d) to ascertain factors that need emphasis towards efficient resources utilisation; and
e) to establish the unconscious and conscious occurrence of wastes that could be avoided during construction production process.

The findings from this Study Three are presented in form of tables, figures, and interactive charts to draw the relationships between the factors considered. The reliability and validity of the items data collected were verified with ANOVA, and chi-square statistics tests; these ascertained the consistencies of the respondents' responses, and the items data correlations.

5.6.1 Discussion of Findings from "Avoidance of Construction Resources Wastefulness", (ACRW) - Wastes due to Materials' Circumstances

a) Sources of Occurrence

Frequency of the occurrence of thirteen distinct factors that causes materials' wastes are presented in Table 5.18. It is found that materials' wastes due to "damage on stock piling," "materials off-cut" and "specification error(s)" are significant during construction works, while the least-occurring ones are "transit wastes – spillage and breaking" and wastes due to "planning mistakes". The percentages of all the factors, (Table 5.21), are approximately average, ranges from 46% to 59%. However, the CRWM research study is on "avoidance or minimisation of resources wastefulness". Thus, there is a significant need to evaluate and ascertain the modalities of averting the occurrence of these wastes. The interview research study ascertained the several possible solutions, and these solutions are presented in Section 6.8.

Table 5.21 Frequency of Occurrence - Wastes due to Materials

Wastes due to Materials	Factors' Notations	% Freq. of Occurrence
1) Materials damage on stock piling.	Ma 1	59
2) Off-cut due to irregular shapes.	Ma 2	55
3) Design not to manufacturer(s) standard - materials off cut.	Ma 3	55
4) Specification error(s).	Ma 4	51
5) Over ordering due to quantity surveyor mistake.	Ma 5	50
6) Pilferage.	Ma 6	50
7) Weather condition - materials spoilage.	Ma 7	49
8) Over ordering due to Design engineers faults.	Ma 8	49
9) Residual and spillage during work in progress.	Ma 9	48
10) Drying shrinkage due adverse weather.	Ma 10	48
11) Excess ordering of materials. For usage, (unreturned to store).	Ma 11	47
12) Transit waste - braking and spillage.	Ma 12	47
13) Planning mistake.	Ma 13	46

b) Modes of Occurrence and the Avoidance

Figure 5.15 presents the conscious and unconscious modes of occurrence of all the factors considered on materials' wastes. Figure 5.16 presents the occurrence of these factors in relation to whether they are avoidable or unavoidable during resources utilisation.

The interactive chart, Figure 5.15, indicates that approximately 50% of these factors occur consciously, while the other 50% occur unconsciously. However, Figure 5.16 shows that the majority of these factors considered are avoidable; Eleven (11) out of thirteen factors have a very high percentage, rated above 63%. Therefore, this affirmed that the modes of occurrence of the majority of materials' wastes are avoidable during construction production process. In respect of this, further investigations were made through interview research survey, (Chapter 6, Section 6.8), which established the possible modalities of averting and/or minimising these predicaments.

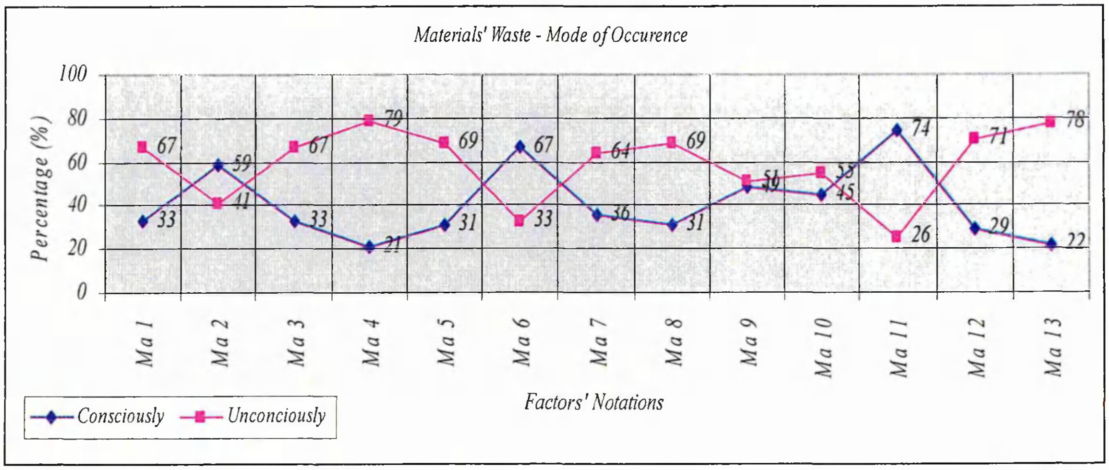


Figure 5.15 Modes of occurrence – Wastes due to Materials,

(Ma1 - Ma13 notations in Table 5.21)

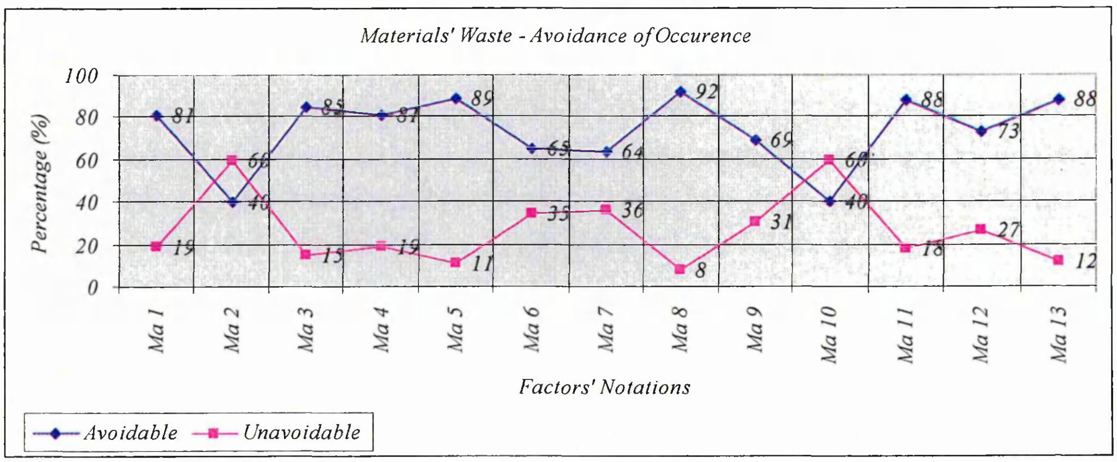


Figure 5.16 Avoidance of the Occurrence –Wastes due to Materials

(Ma1 - Ma13 notations in Table 5.21)

Based on reliability and validity tests' statistics conducted on all variables obtained on "wastes due to materials", deductions could be made that the items data obtained are consistent and valid, (Table 5.22), apart from materials' wastes due to "specification error(s)" in which "Cronbach's Alpha Coefficient" is greater than the "Total Overall Alpha Coefficient", indicating that if this item "specification error(s)" is deleted from the calculation, the overall total will be 0.893 instead of 0.883.

Table 5.22 Reliability Statistics and validity Tests' Statistics of all the Variables - Wastes due to Materials

Factors Considered	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi- Square (Sig.)	ANOVA F-test (Sig.)
1) Specification error	.288	.893	.883	.001	.001
2) Design not to manufacturer standard - materials off cut	.544	.876		.001	
3) over ordering due to quantity surveyor mistake	.632	.872		.001	
4) Over Ordering Due To Engineers faults	.649	.871	.893 Alpha value when "Specification Error" Item is deleted.	.001	
5) material damage on stock piling	.664	.869		.001	
6) Planning error	.632	.871		.001	
7) drying shrinkage due adverse weather	.544	.876		.001	
8) Off-cut due to irregular shape	.631	.871		.001	
9) pilferage	.648	.870		.001	
10) Excess ordering of materials for usage unreturned to store	.617	.872		.001	
11) Residual and spillage during work in progress	.616	.873		.001	
12) Transit waste - braking and spillage	.718	.868		.001	
13) Weather condition - materials spoilage	.327	.885		.001	

5.6.2 Discussion of Findings from Avoidance of Construction Resources Wastefulness, (ACRW) - Wastes due to Labour Circumstances

a) Sources of Occurrence

The frequency of occurrence of wastes due to labour circumstances is presented in Table 5.23. The main identify factors of the resource wastefulness are due to "double handling" and "rework due to mistake(s)". The least factor that causes wastes is "over staffing for a particular work operation". All these factors are further investigated to ascertain the modes and causes of the occurrence, and to establish the possible modalities of reducing the occurrence. These facts are presented in Chapter Six, Section 6.8 of interview research survey report.

Table 5.23 Frequency of Occurrence - Wastes due to Labour Resource Utilisation, (Mp) and The Notations used in the figures

Wastes due to labour	Factors' Notations	Freq of occurrence %
1) Double handling.	Mp 1	60
2) Rework due to mistakes.	Mp 2	58
3) Unskilled operation - increasing completion time.	Mp 3	54
4) Waiting time for the resources to be used - redundancy period.	Mp 4	54
5) Lack of coordination among gang.	Mp 5	51
6) Weather condition - work delay.	Mp 6	51
7) Insufficient tools and equipment for use - waiting time.	Mp 7	50
8) Wrong construction method - leading to time delay	Mp 8	49
9) Less work apportionment.	Mp 9	48
10) Right operation for wrong work – leading to delay or rework.	Mp 10	48
11) Traffic between plant positions to operation place.	Mp 11	48
12) Over staffing for a particular work operation.	Mp 12	46

b) Modes of Occurrence and the Avoidance

The modes of conscious and unconscious occurrence of labour wastes are presented in an interactive chart, Figure 5.17. This chart shows that majority of labour wastes occur unconsciously; only three (3) out of the twelve factors considered occur consciously.

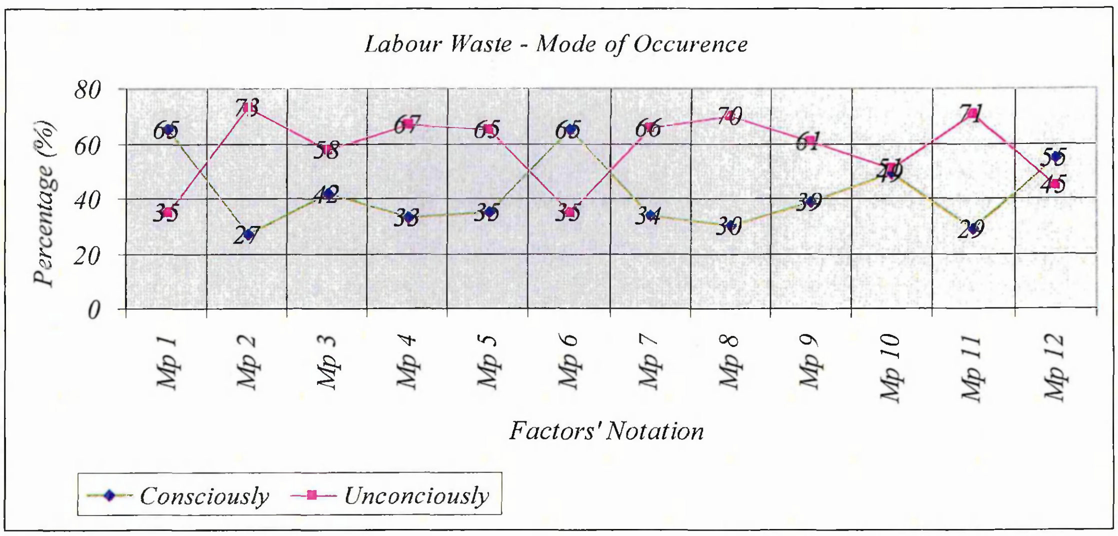


Figure 5.17: Modes of the Occurrence – Wastes due to Labour Resource, (Mp1 to Mp12),

However, Figure 5.18 indicates that, the majority of these items wastefulness could be averted, (avoidance percentage above 70). Only one factor is found to be unavoidable, (Mp6, Weather condition that delays work operation). These findings prompted further investigations to ascertain the rationales for these circumstances and to establish the modalities of enabling these unconscious wastes' scenarios being conscious and be averted; to minimise resources wastefulness during production process. The findings obtained from the interview research survey conducted are presented in Section 6.8

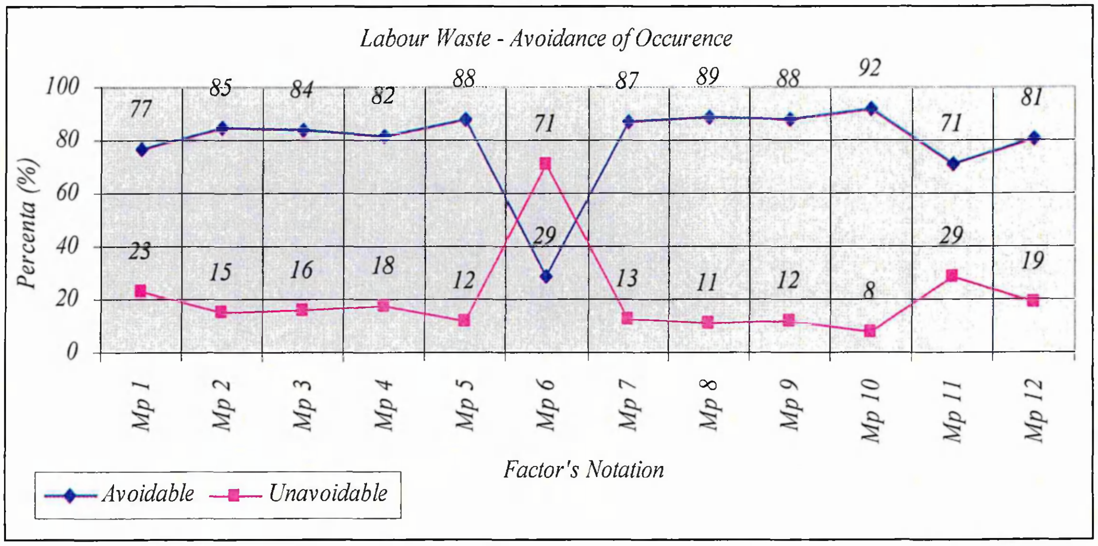


Figure 5.18 Avoidance of the Occurrence – Wastes due to Labour Resource, (Mp1 to Mp12)

Reliability and validity Tests' Statistics of all the variables considered on wastes due to Labour circumstances are verified, and presented in Table 5.24. Inferences could be drawn that the data obtained from the respondents on these items are reliable, apart from that obtained on "weather condition - work delay" having "corrected item – total correlation less than significant value of 0.3 and the Cronbach's Alpha if deleted of 0.917. This alpha coefficient indicates that, if the item is deleted "Total Cronbach's Alpha coefficient" will be 0.917 instead of 0.637. Further, the Chi-Square and ANOVA tests' statistics values indicate that there are significant relationships between the items, (value < 0.05).

5.6.3 Discussion of Findings - Avoidance of Construction Resources Wastefulness, (ACRW) - Wastes due to Plant and Equipment Circumstances

a) Sources of Occurrence

As defined in this research work, resources' wastes refer to utilisation of construction inputs that do not add value to the outcome of the product(s). These arise through inefficient utilisation of resources, (Materials, Manpower, and Machinery), and these wastes could be solid, (physical) or latent, (not physical), in nature.

Table 5.24 Reliability and Validity Tests' Statistics of all the Variables - Wastes due to Labour Circumstances

Factors Considered	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi-Square (Sig.)	ANOVA F-test (Sig.)
1) Waiting time for materials to be used - Redundancy period	.603	.596	0.637	.001	.001
2) Double handling	.519	.608		.001	
3) Over staffing for a particular project execution	.365	.620		.001	
4) Insufficient tools & equipment to use - waiting time	.574	.596		.001	
5) Unskilled operation - increasing the time of completion	.374	.615		.001	
6) Rework due to mistakes	.533	.603		.001	
7) Less work apportionment	.651	.596		.001	
8) Lack of coordination among gang	.656	.587	(.971) Alpha Value when Weather condition is deleted	.001	
9) Wrong construction method - leading to delay or time delay	.681	.581		.001	
10) Weather condition - work delay	.166	.917		.001	
11) Right operation for wrong work - causing delay or rework	.694	.588		.001	
12)Traffic between plant position to operation place	.405	.613		.001	

The frequency of occurrence of wastes due to plant and equipment circumstances is presented in Table 5.25. From this table, the occurrence of wastes of the considered factors are significant, (49% and above). Though, the occurrence of wastes due to "low out capacity than require of the gang in operation" rate is the highest, (56%). Each factor considered contributed to construction plant and equipment inefficiencies during production process. Further investigations to ascertain these findings and to establish the modalities of reducing these predicaments are verified and presented in interview research survey Chapter Six.

Table 5.25 Frequency of Occurrence - Wastes due Plant and Equipment Circumstances

Wastes due Plant and Equipment	Notations	Frequency (%)
1) Low output capacity than required of the gang in operation.	Me 1	56
2) Operation and plant position, traffic – materials and labour waste.	Me 2	54
3) Position/stationary un-used, rental cost.	Me 3	53
4) Breakdown during work in progress - material/labour waste.	Me 4	53
5) Early delivery time and redundancy period.	Me 5	52
6) Uncoordinated skill of plant operator and controller.	Me 6	50
7) Lack of coordination within gang - redundancy/inefficiency.	Me 7	50
8) Wrong construction method and repeated work for plant.	Me 8	50
9) Un-experience operator - minimal efficiency/productivity.	Me 9	49
10) Poor communication system within the gang - time lag.	Me 10	49

b) Modes of Occurrence and the Avoidance

Comparing the mean percentages of the different modes, the occurrence of wastes due to plant and equipment utilisation is more unconscious in nature with a mean percentage of 56%, (Table 5.26).

Table 5.26 Mode of Occurrence - Wastes due Plant and Equipment

Waste due Plant and Equipments	Conscious	Unconscious	Avoidable	Unavoidable
Mean of Occurrence (%)	44	56	83	17

As illustrated in Figure 5.19, it shows that 50%, (ten out of twenty) of the considered factors on wastes due to machinery scenarios occur consciously, while others occur unconsciously.

However, by relating these consciousness occurrences to avoidance of the occurrences, Figure 5.20 shows that all the wastefulness are avoidable, with very high avoidance rates (above 70%), apart from one factor with a rate of 52%. These findings ascertained that resources' wastes due to machinery utilisation are avoidable, (Mean value is 83%), during construction process; these made the needs to ascertain the rationales of the occurrences. Further investigations were carried out to establish these facts and modalities of averting the occurrences, (Section 6.8).

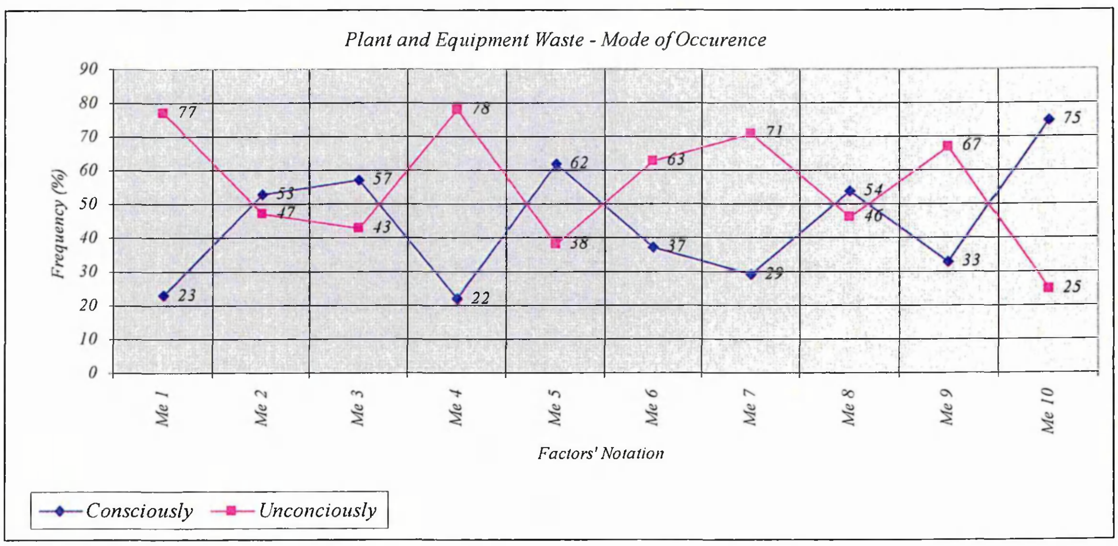


Figure 5.19 Mode of occurrence – Wastes due to Plant and Equipment (Me1 to Me10)

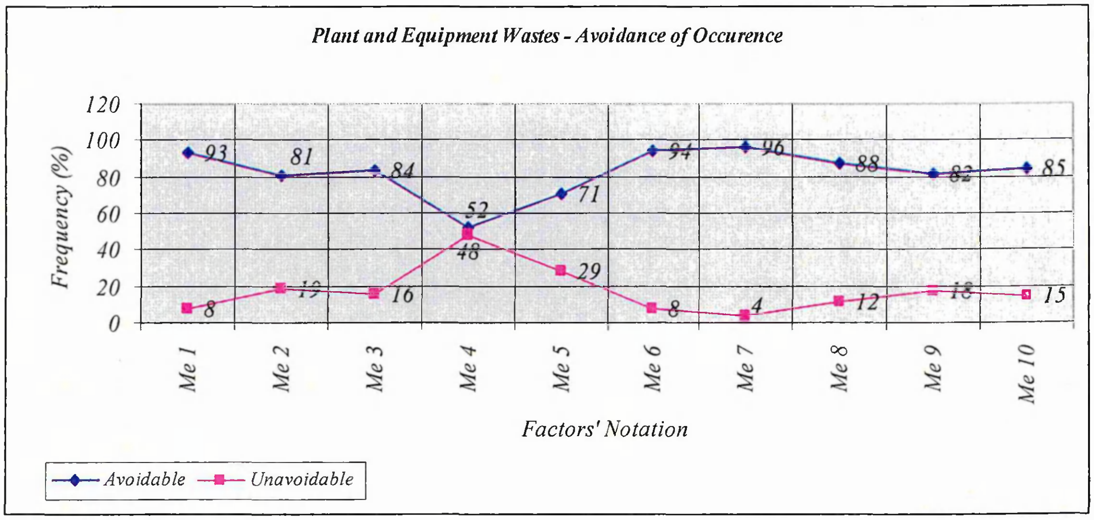


Figure 5.20 Avoidance of the Occurrence - Wastes due to Plant and Equipment - (Me1 to Me10)

The data collected reliability and validity tests were calculated to check the consistency and strengths of relationship of the data set, items and respondents' responses, through employing reliability tests' statistics; ANOVA (F-test), and Chi-square test for goodness of fit.

The "Corrected Item-Total Correlation" of individual factors is greater than the acceptable value of 0.03, and the corresponding "Cronbach's Alpha Coefficient if Item is Deleted" values are all less than the "Total Cronbach's Coefficient" value, (0.941), These indicate that the items respondents' responses are significantly consistent and reliable, (Table 5.27).

Also, the statistics results show that, the ANOVA and the chi-square values of individual factors are less than standard significance level of 0.05. These indicate that there is strong concordance between the items.

Table 5.27 Reliability Statistics and validity Tests' Statistics of all Variables - Wastes due to Plant and Equipment Circumstances

Factors Considered	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi- Square (Sig.)	ANOVA F-test (Sig.)
1) Early delivery time and redundancy period	.614	.941	.941	.000	.000
2) Low output capacity than required for the gang in operation	.695	.938		.000	
3) Un-experience operator - minimal efficiency/productivity	.881	.928		.000	
4) Breakdown during work in progress - material/labour waste	.715	.937		.000	
5) Lack of coordination within gang - redundancy/inefficiency	.805	.933		.000	
6) Operation and plant position, traffic - mat. and labour waste	.774	.934		.008	
7) Uncoordinated skill of plant operator and controller	.675	.938		.009	
8) Wrong construction method and repeated work for plant	.821	.931		.001	
9) Poor communication system within the gang - time lag	.839	.931		.000	
10) Long break/position/stationary un-used , rental cost	.753	.935		.000	

5.6.4 Discussion of Findings from "Avoidance of Construction Resources Wastefulness", (ACRW) - Wastes due to Production Information Circumstances

The frequency of occurrence of wastes due to production information is presented in Table 5.28. The occurrence of wastes due to "Inadequacy of architectural specification(s)" is the highest, (60%), followed by "Design error", (57%). From the results obtained on the eleven factors considered, it shows that the occurrence of wastes due to production information is significant, (the minimum rate of occurrence is 51%).

Table 5.28 Frequency of Occurrence - Wastes due to Production Information

Wastes Due To Production Information	Notations	Freq.
1) Inadequacy of Architectural specifications.	Pi 1	60
2) Design errors.	Pi 2	57
3) Architectural drawings complexity and interpretation time lag.	Pi 3	56
4) Variation order and implementation approval delay.	Pi 4	55
5) Modifications subjected to due process for implementation.	Pi 5	55
6) Inadequacy of Electrical Engineering specifications.	Pi 6	53
7) Inadequacy of Structural Engineering specifications.	Pi 7	53
8) Ambiguity of Structural Drawings and interpretation time lag.	Pi 8	53
9) Inadequacy of Mechanical Engineering specifications.	Pi 9	52
10) Alterations subjected to due process for implementation.	Pi 10	51
11) Inadequacy of Estimator/Quantity Surveyor specifications.	Pi 11	51

The modes of occurrence of wastes, (both conscious and unconscious), due to production information are presented in Table 5.29; while the details of occurrence are shown in interactive chart Figure 5.20. Also, Figure 5.21 shows the possibility of avoiding these types of resources' wastes during construction process.

Table 5.29 Average Mode of Occurrence of the all factors Considered - Wastes due to Production Information

Wastes Due To Production Information	Conscious	Unconscious	Avoidable	Unavoidable
Mean of Occurrence (%)	38	62	80	20

From the Figure 5.21, it could be observed that the majority of the wastes due to production information occur unconsciously with occurrence rates above 60% and the average percentage of unconsciousness is 62% (Table 5.29). Also, the occurrences of these factors are easily avoidable; several factors are rated above 70%, (Figure 5.22), and the average avoidance rate is 80%, (Table 5.29).

Based on the results presented in Figures 5.21 and 5.22, a deduction could be inferred that the majority of the wastes due to production information occur unconsciously and the occurrence could be avoided. However, further investigations were made to validate these findings and to establish how these predicaments could be minimised towards achieving optimal utilisation of the construction resource during production process. These possible solutions are presented in Chapter Six in interview research survey report.

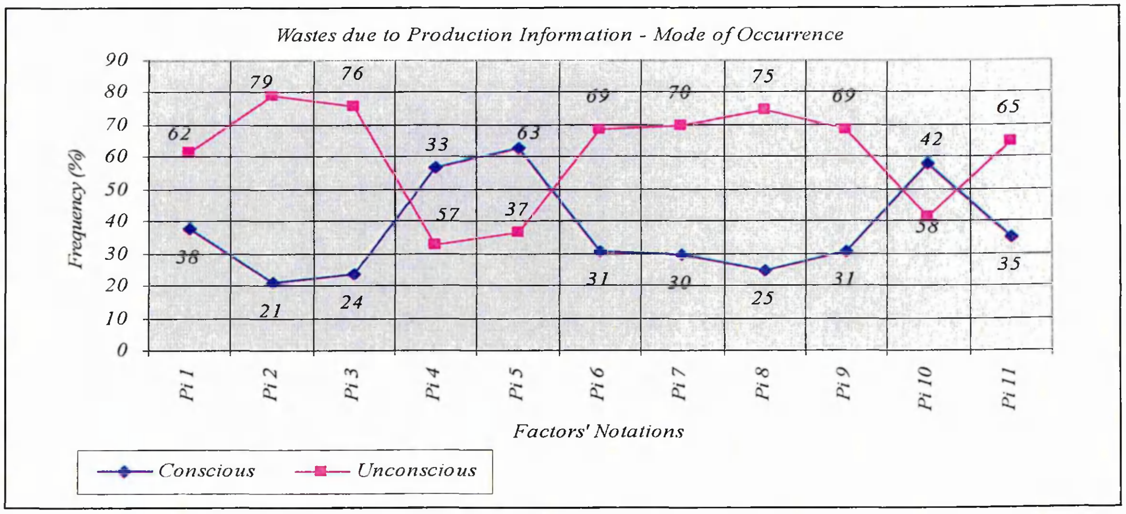


Figure 5.21 Modes of Occurrence - Wastes due to Production Information

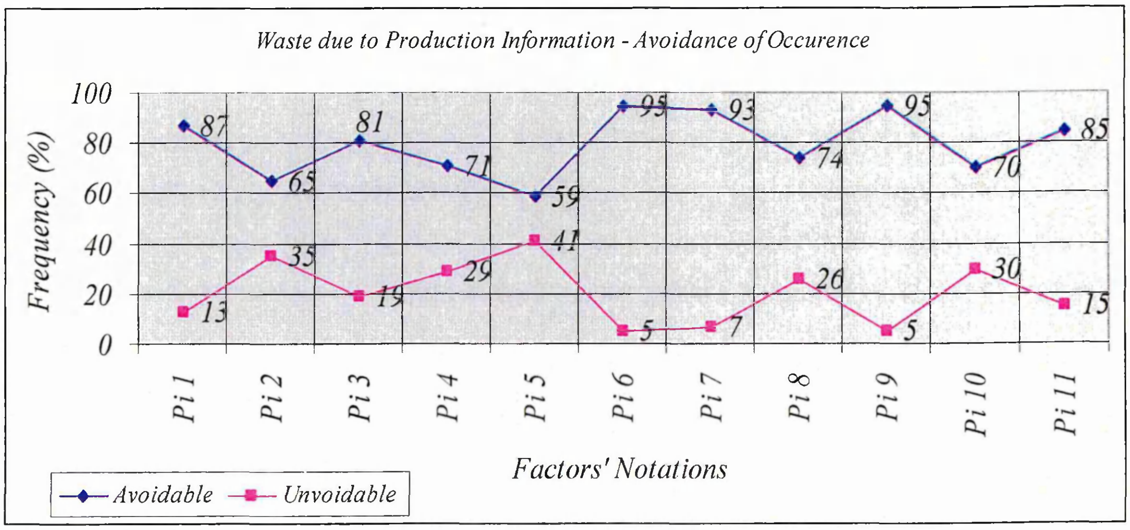


Figure 5.22 Avoidance of Occurrence - Wastes due to Production Information

The reliability and validity tests' statistics of the variables considered on the occurrence of wastes due to Production Information are presented in Table 5.30. The following facts are obtained:

a) Corrected Item-Total Correlation: All items value > 0.3
b) Cronbach's Alpha if Item Deleted: All items value < Total Cronbach's Alpha coefficient value (0.898)
c) Chi- Square is significant < 0.05; and
d) ANOVA (F-test) is significant < 0.05

Thus, deduction could be made from this Table 5.30 that the data collected are significantly reliable and valid. However, further investigations are made, (interview research survey report in Chapter Six), that ascertained these findings and established modalities of averting or minimising the occurrences of these scenarios.

Table 5.30 Reliability and validity Tests' Statistics of all the Variables - Wastes due to Production Information

Factors Considered	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi- Square (Sig.)	ANOVA F-test (Sig.)
1)Architectural drawing complexity and interpretation time lag	.729	.885	.898	.000	.001
2) Ambiguity of structural drawing and interpretation time lag	.823	.880		.000	
3) Inadequacy of Architectural specifications	.322	.958		.000	
4) Inadequacy of Mechanical Engineering specifications	.878	.877		.007	
5) Inadequacy of Electrical Engineering specifications	.837	.879		.009	
6) Inadequacy of Structural Engineering specifications	.845	.879		.001	
7) Inadequacy of Estimator/Quantity Surveyor specifications	.843	.879		.000	
8) Variation order and implementation approval delay	.657	.889		.000	
9) Alteration(s) subjected to due process for implementation	.778	.884		.000	
10) Modification(s) subjected to due process for implementation	.705	.887		.000	
11) Design errors	.744	.884		.001	

5.6.5 Discussion of Findings from "Avoidance of Construction Resources Wastefulness", (ACRW) - Wastes Due To Site Management Circumstances

The causes of wastes occurrence due to site managers' inefficiencies are presented in Table 5.31. The result shows that significant percentages of resources are wasted due to inadequate planning and organisation of the resources before the commencement of construction project (60% and 57% respondents support respectively). All eleven factors considered have rates of 50% and above, apart from one, (48%).

These results indicate that, inefficient utilisation of construction resources due to site managers is significant, which illustrates the significant role of site managers in resources efficient utilisation, and further highlights the need to critically evaluate and ascertain the issue of, "How site managers' efficiency and performances could be enhanced (Section 5.3)," in order to establish the modalities of achieving optimal resources utilisation during construction production process.

Table 5.31 Frequency of Occurrence - Wastes due to Site Managers' inefficiencies

Wastes due to Site Management	Factors' Notations	Frequencies of Occurrence
1) Inadequate planning of resources before project commences.	SM 1	60
2) Inadequate site organisation that often lead to wastages.	SM 2	57
3) Inadequate operation control.	SM 3	54
4) Inadequate project schedule that do lead to wastage.	SM 4	54
5) Delay in decision taking of construction - task operation time lag.	SM 5	54
6) Inadequate monitory systems.	SM 6	54
7) Ineffective "up-down" communication between construction participants.	SM 7	54
8) Poor schedule of resources that leads to wastage.	SM 8	53
9) Inexperience of the technicality require for a task.	SM 9	50
10) Lack of sufficient motivation that could enhance operative morale.	SM 10	50
11) Poor selection of materials and procurement of labour.	SM 11	48

Further investigations are carried out on the causes of site management inefficiency that resulted in resources wastefulness, to ascertain the factors consciousness in occurrence, and also, to classify these factors in relation to avoidance of the inefficient resources utilisation.

Table 5.32 shows the mean of occurrence of wastes due to the site management; the average of unconsciousness rates is 67%, while the avoidance rates average is 79%. Figures 5.23 and 5.24 illustrate the detail characteristics of all factors considered, and these figures show that the causes and occurrences of these factors are significantly unconscious and avoidable. None of the factors avoidance rate is less than 71%, apart from "Inexperience of the technicality require for a task", (63%).

These results are subjected to further investigation to investigate:

> *"Why site managers are not conscious of resources' wastes occurrences, and how could the site management consciousness be improved, towards achievement of an enhanced resources utilisation and wastes minimisation?"*

Also, based on these findings, interview research survey was carried out to establish an effective means of avoiding or minimising these predicaments The findings obtained from the interview research survey are presented in Chapter Six..

Table 5.32 Modes of Occurrence - Wastes due to the Site Management

Wastes due to Site Management	Con	Uncon	Av	Unav
Average of the Occurrences (%)	33	67	79	21

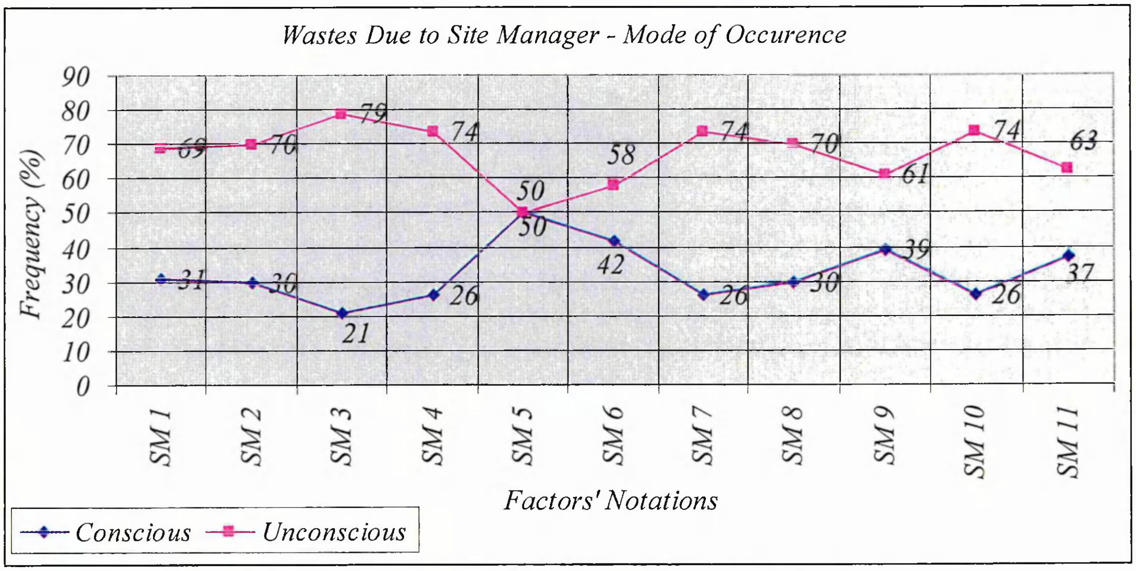


Figure 5.23 Modes of the Occurrence – Wastes due to Site Management

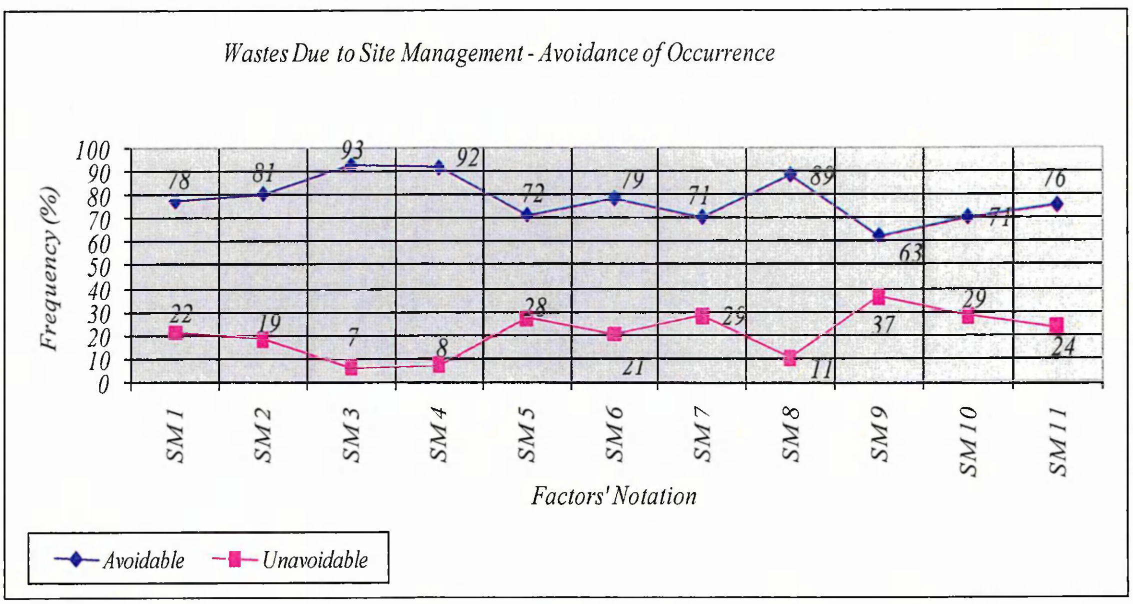


Figure 5.24 Avoidance of the Occurrence - wastes due to Site Management

The reliability and validity tests' statistics of all the variables considered on occurrence of wastes due to Site Management are presented in Table 5.32. The following facts were obtained:

a) Corrected Item-Total Correlation: All items value > 0.3.

b) Cronbach's Alpha if Item Deleted: All items value < Total Cronbach's Alpha coefficient value, (0.952).

c) Chi- Square is significant < 0.05.

d) ANOVA (F-test) is significant < 0.05.

Deduction could be made from findings, Table 5.32 that the respondents' responses are significantly consistent and the strengths of relationships of the items considered are also significant.

Table 5.33 Reliability and validity Tests' Statistics of all the Variables – Wastes due to Site Management

Factors Considered	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi-Square (Sig.)	ANOVA F-test (Sig.)
1) Inadequate planning system towards project execution	.701	.951	.952	.000	.000
2) Inadequate monitory systems	.794	.947		.000	
3) Lack of sufficient motivation to boast operative morale	.740	.949		.000	
4) Poor selection of materials and labour procurement system	.791	.948		.001	
5) Poor site organisation that leads to wastage	.804	.947		.004	
6) Delay in decision making and operation order time lag	.880	.944		.001	
7) Poor line communication systems that leads to time lag	.825	.946		.000	
8) Inexperience of the type of technicality require for the project	.783	.948		.007	
9) Poor project planning and Schedule that leads to wastage	.769	.948		.000	
10) Poor schedule of resources that leads to wastage	.757	.949		.003	
11) Poor operation control	.771	.948			

5.6.6 Discussion of Findings from "Avoidance of Construction Resources Wastefulness", (ACRW) - Wastes due to Design Team Circumstances

The causes of resources' wastes due to the Design team were evaluated. Five major factors were considered on frequency of occurrence; the consciousness of occurrence, and avoidance of the occurrence during construction production process. The findings obtained are presented in Tables 5.34 and 5.35; and, Figures 5.25 and 5.26.

All the factors investigated were found to significantly causing resources wastefulness with percentage rates above average. In comparison, the effect of "variation approval delay" is the most significant factor, (67%), followed by "waiting time for approval of alterations" by client or design team, (63%).

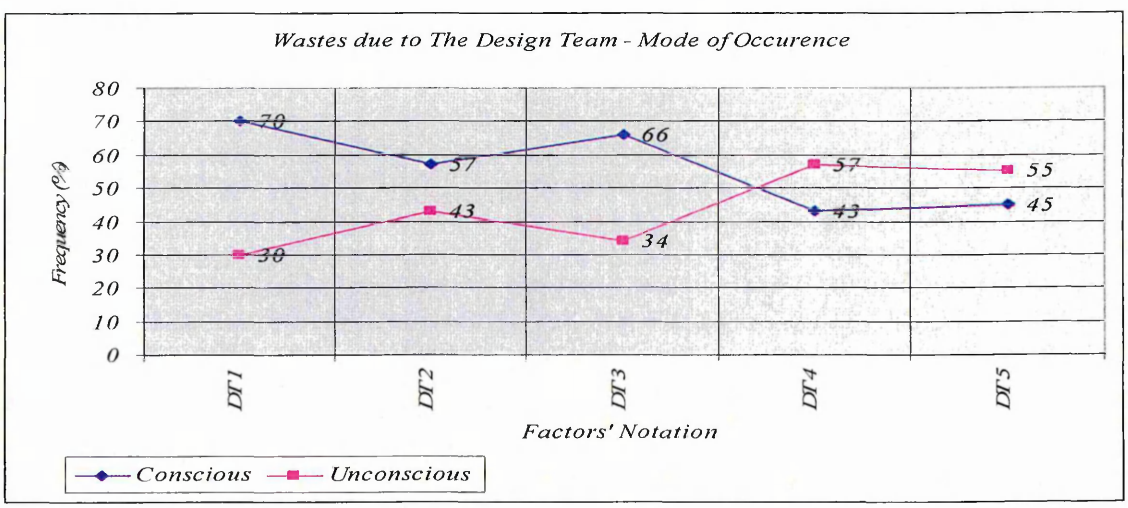
Table 5.34 Frequency of Occurrence - Wastes due to the Design Team

Wastes due to Design Team	Factors Notations	% Freq. of Occurrence
1) Variation. order delay that affect other work in progression	DT 1	67
2) Waiting time for alteration order.	DT 2	63
3) Delay in inspection to proceed to another stage of work.	DT 3	53
4) Communication gap between design and construction teams.	DT 4	60
5) Predominant meetings on variation, alterations and modifications, (time and manpower wastes).	DT 5	53

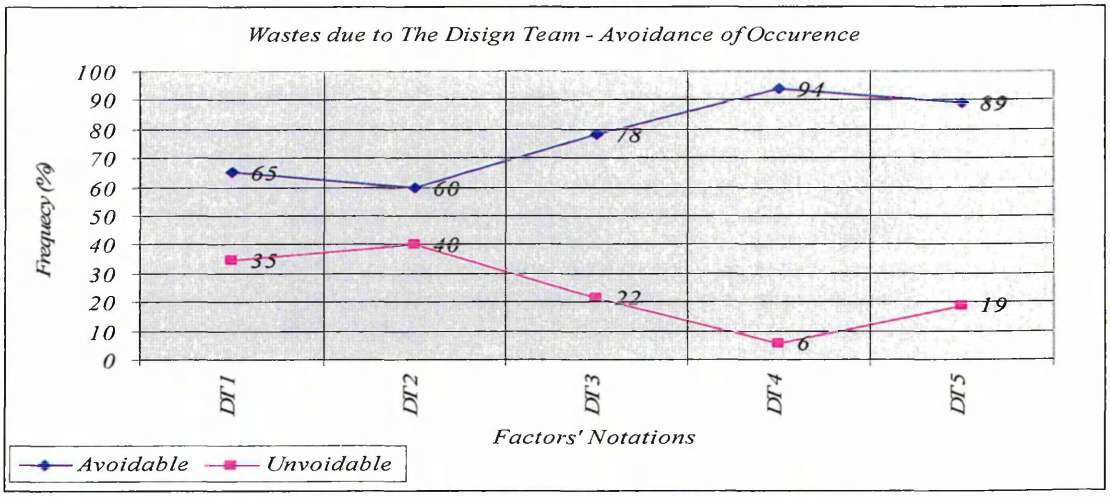
Deduction could be drawn from Table 5.35 and Figure 5.25 that 56% of the wastes due to Design Team occurs consciously, while 44% occurs unconsciously. However, the majority of these occurrences are significantly avoidable. Figure 5.26 indicates that none of the factors considered is unavoidable; the maximum unavoidable rate is 40% and the minimum avoidable rate is 60%.

Table 5.35 Modes of Occurrence - Wastes due to the Design Team, (%)

Wastes due to Design Team	Con	Uncon	Av	Unav
Average of the Occurrences (%)	56	44	77	24



Figures: 5.25: Modes of Occurrence– Wastes due to the Design Team



Figures: 5.26: Avoidance of the Occurrence - Wastes due to the Design Team

From these results, there is the significant indication that resources' wastes due to design team are practically avoidable. This buttressed the previous quantitative research survey Study Two (Section 5.5.3) results obtained, which indicates that "Architectural drawings and specifications" have maximum allowance for resources wastefulness. These facts are further investigated to ascertain the modalities of reducing or averting these predicaments towards enhancing efficient resources utilisation during production process. The findings are presented in Chapter Six.

The reliability and validity tests' statistics of all variables considered on wastes occurrence due to the design team are checked and presented in Table 5.36. The following facts are deduced:

a) Corrected Item-Total Correlation: All items value > 0.3
b) Cronbach's Alpha if Item Deleted: All items value < Total Cronbach's Alpha coefficient value, (0.937)
c) Chi- Square significant < 0.05
d) ANOVA (F-test) significant < 0.05

Deduction could be made from this Table 5.36 that the respondents' responses are significantly consistent and the strengths of relationships of the items considered are also significant.

Table 5.36 Reliability and validity Tests' Statistics of all the Variables - Wastes due to the Design Team

Factors Considered	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Total Cronbach's Alpha coefficient	Chi- Square (Sig.)	ANOVA F-test (Sig.)
1) Variation order delay that affect other work in progression	.814	.926	.937	.000	.000
2) Waiting time for alteration order	.813	.926		.000	
3) Delay in inspection to proceed to another stage of work	.887	.913		.000	
4) Communication gap between design and construction teams	.788	.931		.000	
5) Predominant meetings on variation/ alterations/modifications	.862	.917		,007	

5.6.7 Summary of Research Study Three: Evaluation and Establishment of the Measures for Resources Optimal Utilisation during the Production Process

The research Studies One and Two, (Sections 5.4 and 5.5), evaluated the factors that initiate or cause resources wastefulness. This Study Three, (Section 5.6), establishes and ascertains how these problems can be avoided or minimised, and also improvises how construction resources will be efficiently utilised during production process. As illustrated in Figure 5.27, this study identified and presented six wastes generation scenarios and areas of which there are significant needs for construction resources' wastes management towards efficient resources utilisation. That is, this study three identified and established several factors that contribute to wastefulness of resources. The group factors considered in this Study Three are illustrated in Figure 5.27 and these are:

a) resources' wastes due to materials inefficient utilisation;
b) resources' wastes that occurs due to manpower being not optimally utilised;
c) resources' wastes due to machine and equipment miss-management or under-utilisation;
d) resources' wastes that occur through production information;
e) resources' wastes incurred through the design team;
f) resources' wastes that resulted through site management ineffectiveness.

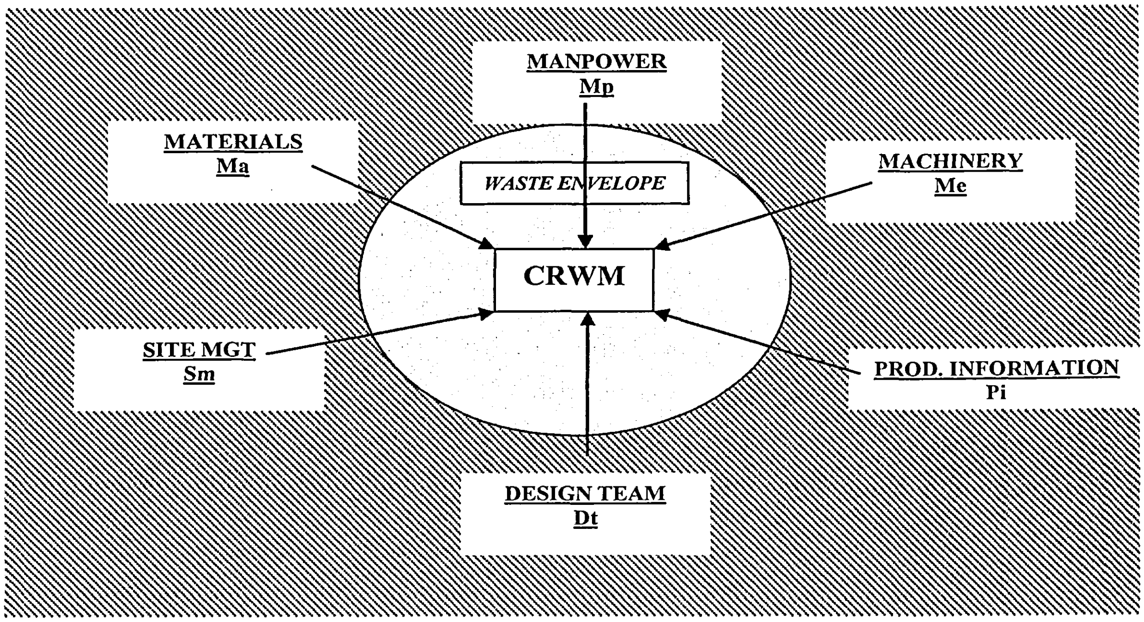


Figure 5.27 Factors towards Construction Resources' Wastes Management (CRWM)

The details of these results are presented in appendix (A). However, from the Table 5.37, it was found that the majority of the resources wastefulness in the construction industry occurs unconsciously, and could be avoided during the design stage before the production process commences. The results further indicate that majority of resources wastefulness are avoidable; based on the rationales that none of group avoidable rate is less than 73% and none of the group unavoidable rate is more than 27%.

Table 5.37 Summary of the Occurrence of Resources Wastefulness (Research Study Three)

Key: Frequency, (Freq); Conscious, (Con); Unconscious, (Uncon); Avoidable, (Av); Unavoidable, (Unav)

	Freq.	Con.	Uncon.	Av.	Unav
A) Wastes due to Materials	50	41	59	73	27
B) Wastes due to Labour	51	42	58	79	21
C) Wastes due to Plant and Equipment	52	45	56	83	18
D) Wastes due to Production Information	54	38	62	80	20
E) Wastes due to Site Management	53	33	67	79	21
F) Wastes due to Design Team	59	56	44	77	24
(Mean %)	53	43	58	79	22

5.7 QUANTITATIVE RESEARCH SURVEY SUMMARY

This chapter presented quantitative survey results obtained and discussed the findings deduced.

Data was collected by employing both structured and unstructured questionnaires. However, structured questions dominated the questionnaires research survey. Options were provided, (the majority were in Likert Scale rating), which enabled the respondents to chose the appropriate answers. This scale rating also enhanced the transference of the results obtained into computer to be analysed by using SPSS version 13.

Questionnaires were distributed widely and covered all the geographical zones in the UK, while the total number collected were 102, and all the respondents are experienced construction site managers. The questionnaires research survey format was divided to four main parts; the first part being demographic and others were based on the research objectives. The objectives of the questionnaires survey are to evaluate: The demography of the respondents, Site managers' efficient performance, Effect of budgeting for wastes' syndromes, and the avoidance of construction resources wastefulness during the production process. These parts were further sub-divided to sub-sections which allowed thorough evaluations. These sections were analysed and discussion of findings are presented in tables and figures.

Table 5.1 presents data obtained on respondents' site management status in respective organisations, and the years of experience as managers in the construction industry. While Table 5.2 presents numbers of employees in the respondents' organisations that are currently working in the UK and numbers of regions in which each respondent organisation operates in the UK. From Tables 5.1 and 5.2, there are indications that the research findings are significantly valid and reliable, based on the status of the site managers that responded, coverage of the questionnaires, and the multinational nature of the respondents' respective organisations.

The questionnaires research survey ascertained different causes of inefficient utilisation of construction resources before the commencement and during project execution; taking cognisance of enhancements of Site Management efficiencies and performance, the rationale for budgeting for wastes, that is, budgeting for wastes' syndromes, and the modalities of the occurrence of the construction resources wastefulness. Also, all these issues were related to different types of construction resources, (materials, manpower and machinery).

In this chapter, the findings of few issues were affirmed without further investigation, while some findings were further investigated. The significance of this mixed methods research approach is to triangulate the questionnaires' findings for validity and reliability purposes. Modalities of ascertaining validity and reliability have being explained in Section 4.8. Also the detailed rationales and advantages of the mixed methods for triangulation of findings have been discussed in Section 3.3.2.

In summary, this quantitative research study helped in the achievement of the following:

a) identifications of the factors that often lead to resources wastefulness;
b) establishment of the rationales for making allowance for resources wastefulness; budgeting for wastes' syndromes in construction industry;
c) assertion of the causes of conscious and unconscious resources wastefulness;
d) assertion of the types of wastes generated through materials, manpower, and machinery utilisation;
e) assertion of the resultant effect of the inefficient construction resources utilisation during production process.

Additionally, the findings from the quantitative research survey assisted in composition of the in-depth interview research survey semi-structured, (guide) questions.

Chapter Six presents the interview research data collected, analysed, and discusses the findings obtained.

CHAPTER SIX

QUALITATIVE INTERVIEW RESEARCH SURVEY DATA ANALYSES AND

DISCUSSION OF FINDINGS

6.0 QUALITATIVE DATA ANALYSES AND DISCUSSION OF FINDINGS

6.1 CHAPTER INTRODUCTION

This chapter presents the interview research survey, the analyses and findings. Also, discussions and deductions from findings are made, in consideration of the research objectives and questions. The interview research survey is divided into three main studies, and each study covers several themes. Each theme resolves a different problem on, "how construction resources will be optimally utilised in the industry". The survey identifies significant numbers of possible solutions to inefficient resources utilisation, which include radical approaches towards achievement of construction resources utilisation sustainability.

This research interview survey was conducted twice. The second interview survey conducted modifies themes obtained based on the first interview survey responses, and also, evaluates the emergence themes that were not substantially evaluated during the first interview survey. This thus links the differences in views and information obtained from the interviewees. The chapter concludes by presenting the summary of the interview survey outcomes, findings, and solutions established.

6.2 INTERVIEW RECORDING

The interviews were recorded using a digital audio recorder and audio tape recorder as backup. In addition to this, notes were taken at every interview, to take cognisance of follow-up questions on issues that might require additional explanations and emphases.

6.3 INTERVIEW DATA ANALYSES

The interview survey questions were divided into three main studies based on the conceptualised framework proposed in Section 4.3, and as illustrated in Figures 4.2, 4.3 and 4.4. All themes generated in the entire interview survey transcripts are listed and further grouped into the 3 main studies.

The interviews were firstly transcribed verbatim including all comments or questions raised by the interviewer. The data analyses involved coding the data into themes in order to draw inferences and conclusions. Hewitt-Taylor (2001) explains that, interview sentences, paragraphs, or sections of text need to be coded to represent a theme or idea, and the themes can either be predetermined based on the research questions or generated by the data as the analyses progress. Therefore, a thematic analysis method was explored for this research interview survey as explained in Braun and Clarke (2006) and Trochim (2006), using the framework approach described in Chapter Four. This thematic analysis method was found to be a comprehensive approach to generate and interpret the themes more accurately, (as explained in Section 4.7). After the themes had been identified and transcribed, the interview transcriptions were uploaded into the NVivo software package.

The NVivo Statistical Software Package was used for data analyses due to the large size of the narrative data collected. This software allowed easy identification of recurring themes; identification of specific themes concerning groups of participants or individual interviewees; and allowed for easy combining of data to identify particular patterns and meanings. That is, the facts generated from data collected were transcribed, coded and transformed to themes. These themes were conceptualised for deductions to be drawn.

The key stages for the data analyses as explained by Hewitt-Taylor (2001), and Braun and Clarke (2006), among other scholars, are:

(A) Familiarisation: the interview transcriptions were read several times to obtain comprehensive overviews of the content. That is:

1) Identifying a thematic framework: Key issues, concepts, and themes were identified according to the four main research questions. The data were then examined and referenced accordingly with emergent issues being derived from the respondents according to the pattern of particular views or experiences.

2) Identification of Exemplars: An exemplar is a "strong instance of a particularly meaningful transaction, intention, or capacity". This allows for identification of individual respondents concerns, actions, and practices that captures meanings that are applicable across varying situations during the interview.

3) Identification of Paradigm Cases: This involves identifications of strong instances of particular patterns of meanings. Paradigm cases embody rich descriptive information necessary for understanding participants' actions and understanding in a situational context.

4) Saturation: The transcripts are analysed up to a point of saturation. This is where it is evident that the same themes are recurring within the interview.

(B) Reflections: The findings are constantly reflected upon the perspective of the researcher in order to negotiate a clearer understanding of the topic under investigation. Creating a table of central themes and adjacent phenomenological comment of causes, how and why for each theme.

(C) Re-organisation of emergence themes: The themes and corresponding findings were re-organised logically and sequentially to enhance the flow of ideas.

(D) Writing succinctly: Writing a succinct sub-narrative (both textural and structural) of all interviewees' experiences in resources utilisation and construction resources management.

The subsequent sections, in this chapter, present the interview survey analyses, results, and discussion of findings in logical order of three main studies. Figure 6.1 illustrates the summary of the coded themes obtained through NVivo version 2, statistics software. The detail of the themes deduced during the interview survey are presented in Appendix (E)

All the respondents agreed to be contacted for further enquiries. Therefore, during the process of interview data analyses, the researcher actually found it necessary to unfold and affirm discrepancies on some emerging issues and information provided by some respondents that were exclusive from initial research propositions and have not be discussed with initial interviewees. Thus, further telephone contacts were made to obtain explanations; to ascertain and probe the new and emergence views. The issues that could not be resolved through telephone discussions warranted the researcher conducting follow-ups physical contact interviews. The first and second interviews questions are attached as Appendixes C1 and C2.

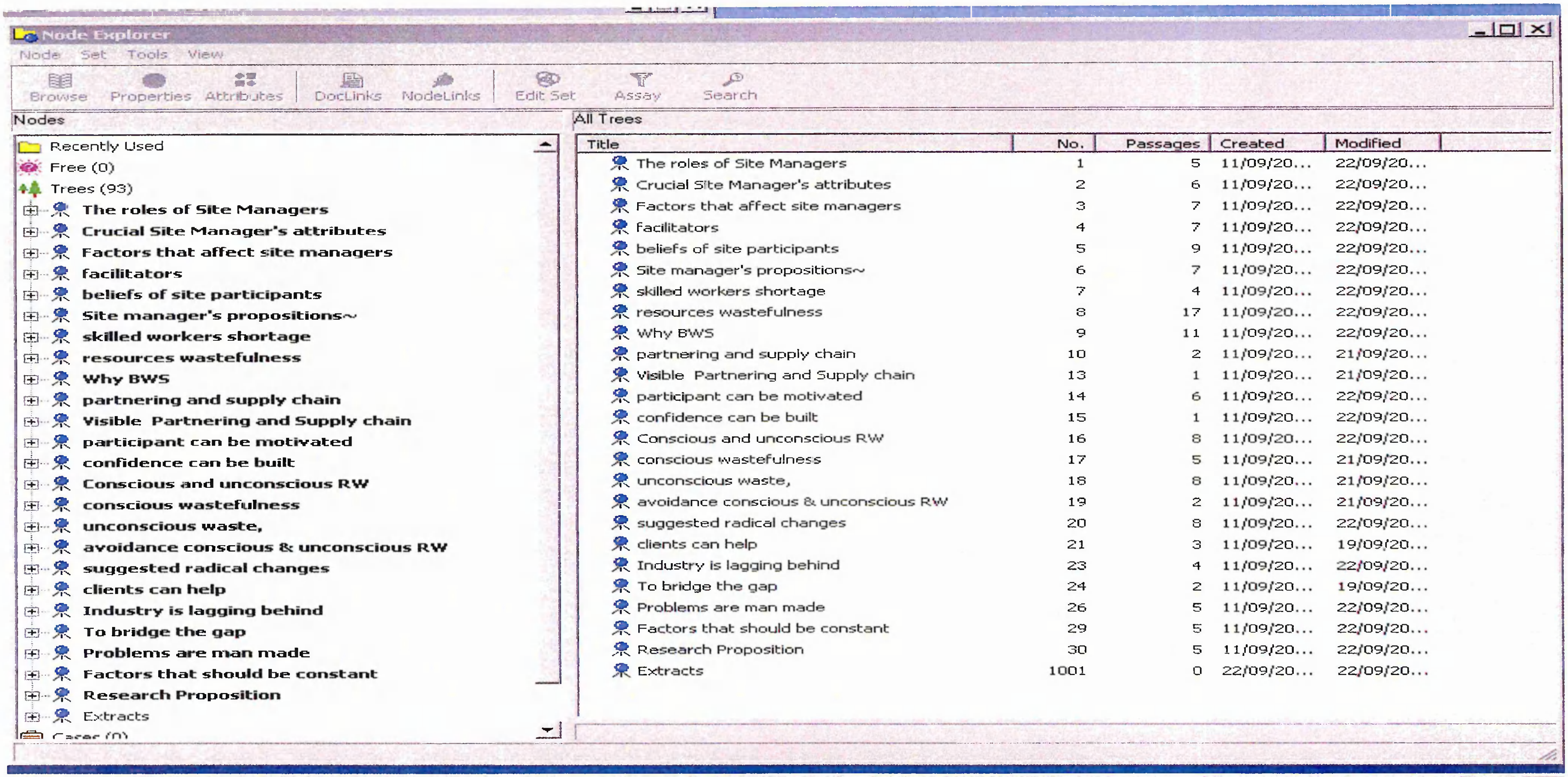


Figure 6.1 Summary of Themes and coded Nodes

6.4 QUALITATIVE INTERVIEW RESEARCH DISCUSSION OF FINDINGS

As explained in section 6.3, the information and findings obtained from the interview conducted were coded to themes based on the research objectives. The three broad studies of this interview research are: (i). Enhancement of Site Managers' Efficiency and Performances, (ii) Effects of Budgeting for Resources' Wastes Syndromes on resources utilisation, and (iii) Avoidance of Construction Resources Wastefulness before and during project execution. Themes in each study were arranged in logical order of understanding. The subsequent section presents the demography of the interview survey participants, and the findings deduced from the three main studies are presented in Sections 6.6, 6.7, and 6.8.

6.5 DEMOGRAPHY OF THE INTERVIEW SURVEY PARTICIPANTS

From the questionnaires survey result obtained, fifteen (15) respondents indicated interest in participating in this research further investigation, (Section 5.3.2, Figure 5.3). Every respondent had an equal opportunity of being interviewed, and unbiased interviews were conducted with eight construction site personnel. The rationales of selecting these participants have been discussed in Section 4.6.5. The additional reasons are:

a) All the respondents are practising professionals, directly involved in management of construction resources on construction sites.
b) The result of questionnaires survey demography indicates that none the personnel had less than ten years of experience as managers with requisite responsibilities on resources utilisation in different multinational construction organisations. The status and years of experience of the respondents are presented in Table 6.1.

Table 6.1 Demography of Personnel that indicated Interest to be interviewed and those interviewed

Respondents. (Name Withheld)	Status	Years of Experience	Comments
1)	Contract Manager	Above 15	Interviewed
2)	Senior Bldg Manager	Above 15	Interviewed
3)	Project. Quantity Surveyor	Above 15	Interviewed
4)	Site manager	Between 11 -15	Interviewed
5)	Planning Manager	Above 15	Interviewed
6)	Project. Manager	Above 15	Interviewed
7)	Senior Project. Manager	Above 15	Interviewed
8)	Senior Contract Manager	Above 15	Interviewed
9)	Project. Manager	Above 15	Not interviewed
10)	Project. Manager	Between 11 - 15	Not interviewed
11)	Quantity Surveyor	Between 6 - 10	Not interviewed
12)	Project. Manager	Between 6 -10	Not interviewed
13)	Planning Manager	Above 15	Not interviewed
14)	Site Manager	Above 15	Not interviewed
15)	Project Manager	Above 15	Not interviewed

6.6 INTERVIEW RESEARCH SURVEY STUDY ONE - ENHANCEMENT OF SITE MANAGERS' EFFICIENCY AND PERFORMANCES, (SMEP) ON RESOURCES UTILISATION

Interview Research Study One is to establish a Site Management Efficient Performance framework, (SMEP). This part of interview study validates the findings deduced from Questionnaires survey research "Study One". Some of the rationales for this study one have been stated in Section 5.4, which include: to evaluate causes of site managers' inefficiency and to establish the modalities of achieving efficient performance during the production process. This study identifies and evaluates the strengths of the site manager and the opportunities available that could be exploited or utilised on probable threats to and weaknesses of site managers towards optimal resources utilisation

6.6.1 Justification for Research Interview Study One

The researcher found it necessary to study how site managers could be efficient and possess intense potentials on their requisite duties towards optimal construction resources utilisation. Thus, the study identifies the "strengths" and the opportunities available to avoid or minimise probable weaknesses and threats that could jeopardise the efficient utilisation of construction resources during the production process.

6.6.2 Study One Objectives and Sub-Questions

From the research objectives, the objective of Study One is: To identify, evaluate and ascertain the factors that could enhance site managers towards minimisation of construction resources wastefulness. Also, to establish factors that will significantly enhance the site managers' efficiencies and performance. To achieve these objectives, the following research questions were explored:

Question 1a: What are the constraints on site managers that enhance the wastefulness of construction resources?

Question 1b: What are the factors that need to be constant towards efficient utilisation of resources?

However, during the interview survey, several sub-questions emerged which addressed specific issues as brought forth by the responses from the respondents. These are fully detailed in the subsequent sub-sections. In this study, six themes were identified as significant from the responses to the questions posed and the findings deduced were presented as follow, (Research Themes 1 to 6):

6.6.3 Research Theme 1: Essential Roles of Site Managers in Project Execution

The questions asked during the research interview from which this theme was deduced are:

a) What are the effects of involving a project or site manager that will execute the project during the design stage, in relation to efficient resources utilisation?
b) What are roles of site managers towards reduction of resources' wastes?

Based on these questions, the identified roles of site managers towards efficient project execution are:

1. Team integration: To integrate the finance, construction, and design teams together. Also, the Manager should advise on how economy can be achieved through wastes and costs reduction, delivering the project on time and at expected quality.
2. Team building: To identify and ensure that the right team(s) of workers are engaged to execute the project task(s), knowing their strengths and weaknesses. The manager should be able to envisage the quality and skill(s) require in achieving the anticipated quality, efficiency, and accuracy of a specific task.

3. Best procurement system: To advise the design team on the best procurement system that will enhance efficient resources utilisation. Also, to ensure that construction resources are available when required or as planned.
4. Technical advice: Construction workers habitually expect technical skill and explanation from the manager(s) even though the workers know what is to be done. Also, Sub contractors sometimes seek second opinion from the managers on site for clarification; thus construction site managers need to possess a broad experience of trades.
5. Error identifications: A competent builder is expected to possess several resources procurement and specification skills. Thus, s/he needs to be able to provide adequate advice on alternative methods available, and be able to identify flops on production information from the design team before construction project execution.
6. Suggestion of effective alternative methods for construction production process: An efficient site manager should be able to advice on alternative methods that will minimise resources wastefulness to the client and client's consultants. Though designers' attitudinal behaviours often jeopardise these efforts; the designers are habitually adamant on specification and appreciate the project aesthetics with less consideration of resources' efficiencies.
7. Planning towards resources' wastes minimisation and/or avoidance: Need to work towards wastes minimisation and to eliminate the avoidable ones, which are consciously or unconsciously incorporated into the design package.
8. Effective and efficient communication and information dissemination: The site manager or project manager needs to possess the ability of communicating effectively. Effective and efficient communication is paramount especially when new concepts or construction methods are introduced or required for executing atypical task, apart from the regular or traditional process which the project operatives commonly be acquainted with.
9. Project Planning, Monitoring, and Controlling: To ensure adequate planning is made for project execution before resources are ordered or procured. Also re-planning and monitor each task during project execution and seek to achieve the set target.

6.6.4 Research Theme 2: The Essential Site Managers' Attributes

The questions asked the interviewees that generate this theme during the interview were in these forms:

a) Kindly comment on the attributes of site managers in relation to efficient utilisation of construction resources. In your own opinion, which attributes do you consider to be very important towards efficient resources utilisation?

b) Which of the site manager's attributes could be considered essential towards efficient resources utilisation and why?

From the interview survey, the essential site manager's attributes that will significantly enhance construction resources utilisation during production process are:

1. Knowledgeable in several trades: The site manager should be able to exhibit considerable knowledge of many trades; should be able to explain work to be done to employees and be able to disseminate information that demonstrates the skills required for performing tasks. It is important for a site manager to have knowledge of many trades. Though, it may not be expected of a manager to be an expert in all aspects of trades, thus, there may be a need for peculiar training(s) that will enhance site managers being efficient in the project resources utilisation.
2. Ability to identify the limit of workers' efficiencies: The manager should be able to identify the skill of the worker who could execute a specific task efficiently, and possibly achievable when site participants clearly know the quality and accuracy that are expected from them.
3. Awareness: No matter the proficiency of a site manager, responsive awareness of key issues, factors and conditions of the project enhance project efficiencies. The ability to be aware of hindrances and to work towards avoidance is essential. When a manager foresees a problem on time, without knowing the actual solution to the problem, the opinion of an expert can be sought before leading to chain problems.
4. Quality management. Another important factor is quality management skills. Work performed to high standards at the first attempt avoids repetition, saves time loss and construction cost.
5. Motivation Strategies: Another important attribute of a site manager is the ability to motivate site participants. This will leads to enthusiasm, and enhance/energise efficient performance.

6. Updated Health and Safety Policy. These should probably be the prime concerns of site management. Workers tend to perform better in a favourable environment with adequate protective measures from hazards.

The following are significant towards improvement of the site managers' attributes:

1. Self-development and training: site managers need regular training, most especially on innovations that could enhance efficient and effective resources utilisation.
2. Efficient knowledge transfer: Embracing staff development and knowledge transfer schemes within workers who have had experience in similar jobs previously.
3. Availability of adequate resources: The availability of relevant and adequate resources for projects at the appropriate time is essential for efficient resources utilisation.
4. Efficient and effective team: Availability of efficient and effective teams and experienced personnel for projects.

6.6.5 Research Theme 3: The Apparent Factors that often affect Site Managers' Efficiency

The questions asked from which this theme was obtained are:

a) Kindly comment on factors that affect site managers in optimum utilisation of construction resources.

b) Some factors hinder site managers in efficient performance of their duties and resources utilisation. How can these be avoided or minimised?

From the interview conducted, the identified problems that often hinder site managers' efficiency are:

1. Contract duration and urgency of the job to commence: These factors often resulted in insufficient time to plan a project properly at inception and these have a considerable affect on the construction operation. Often site managers are constrained to deliver a project on time and thus are overly concerned with the timely delivery of the project.
2. Weather conditions: Another major constraint is weather. This affects the efficient use of some equipment and machines. A typical example is that, a tower crane cannot work efficiently or effectively during high winds, in many occasions, the weather considerably affects efficient construction operation.

3. Lack of skilled and experience workers: The major problem facing the industry nowadays is the lack of skilled and experience workers. These resulted in wastefulness of construction resources; labour, materials, plant and equipment and sometimes reworking are required.
4. Lack of experience and knowledge of the site manager from similar project(s) in achieving efficient resources procurement or integration of construction resources.
5. Lack of absolute control over nominated sub-contractors and suppliers. In several projects, site managers do not often possess absolute control over nominated contractors and suppliers, while this often hinders the site managers in efficiently controlling the contractors and the suppliers.
6. Design team rigidity: The production information produced by the design team was expected to be adhered to during project execution. In respect of this, the managers are often confronted with several challenges in attempts to minimise or avoid resources' inefficiencies, (conscious or unconscious wastes), in-built in the design package.
7. Labour short training period: In the past, trades were learned between four and five years, but currently, workers undergo training for about twelve months. Within the short period of training, the apprentices learn the trades frame, not really efficiency intricacies.

The identified solutions that will minimise the hindrances of the Site Managers' Efficiency are:

1. An enhanced planning and adequate programming of construction resources before and during project execution. Theoretically, all resources utilisation needs to be carefully forecast, programmed, and planned, and needs to be practically followed as far as possible.
2. The need for an adequate labour market forecast before the commencement of the project to avoid using semi-skilled labour during construction. Significantly, this will enhance labour selection and utilisation that could lead to efficient resources utilisation.
3. There is need to identify, employ and engage workers that are competent. Experience of site participants often counts in efficient resources utilisation.
4. Rational team building and an efficient construction team for the project.

5. Adequate information dissemination and transfer of knowledge. To clearly disseminate and explain the duties to be carried out, especially the semi skilled and unskilled labour.

6.6.6 Research Theme 4: The Achievement of Site Managers' Propositions

The following were the questions posed to interviewees that thus generate this theme:

a) What are the factors that enhanced the ease of accomplishments of site managers' propositions during the construction project production?
b) It could be said that, the accomplishments of site managers' propositions are often high, then why are resources wastes in the industry are still so high?

The causes of site managers' deficiency towards achieving their targeted efficiently as deduced from the interviewees' responses are:

1. Short initial planning period. There are often short lead-in periods to execute projects. This results in inadequate time to plan resources accurately and in logical sequence at the inception of the project. Typically, in construction plant and equipment operations, the site managers would need to properly and adequately plan modalities in the use of resources.
2. Short project delivery time expected: In most cases, resources optimal utilisation and adequate wastes reduction are not normally taken into consideration when projects are expected to be delivered speedily and on time; urgency in the need of project product(s). When the project design team and client are anxious over the project's end product, they are often less concerned with construction problems. In consequence, less attention is normally paid to resources utilisation and wastefulness.
3. Modification(s) during project execution: Changes and alterations either by the design team or the client often cause construction resources wastefulness deliberately or in coincidence.
4. Skeletal production information provided by the design team to commence the project: Inadequate or skeletal information provided by the design team at inception to commence the work often makes the project scope unclear to the site personnel. This often leads to time waste to interpret and integrate the production information, and identify the best construction methods that will reduce resources inefficiencies during the project in progress.

5. Aesthetics keenness and over assumption of design team: The design team are often concerned with aesthetics rather than the cost of construction or efficient resources utilisation; and provide design packages, (inconsiderate of its complexity), on the assumption that the production team should be able to interpret them for successful project execution.
6. Shortage of skilled workers: Among the major problems in the construction industry currently is the inability to engage experienced and skilled labour for work. Lack of skilled workers results in utilisation of semi-skilled workers. This often causes re-work in order to achieve the pre-determined quality. This problem is becoming a major issue in the construction industry globally.

The identified solutions that will enable Site Managers to achieve predetermined and targeted construction propositions are:

1. Availability of adequate time for detailed production information preparation: To facilitate construction work and the minimisation of alterations and modifications during construction production process, the design team need to adequately check for flimsy mistakes and ensure the adequacy of production information. Thus, considerable time is required to provide detailed production information. In consequence, probable factors that could cause resources inefficient utilisation during the construction phase could have being identified and corrected during the design stage. Rationally, provision of explicit design concept/design with adequate specifications will not only enhance achievement of propositions, but will considerably minimise alterations and modifications during the construction phase, and will lead to less resource, (materials, labour or machinery) wastefulness.
2. Prefabricated Materials and Panellised Components: The industry should enhance or adopt utilisation of off-site prefabrications of construction project components. Usually, precision towards wastes minimisation is easily achievable off-site, for example materials utilisation. Notably, pre-cast materials or other construction components brought to site for "fixing only" often minimise labour utilisation, leading to resources' wastes minimisation and efficient utilisation, while these enhance site managers' performance and achievement of proposition.
3. Experience and efficiency of Suppliers and Sub contractors: Sub-contractors need to be appointed based on both experience and efficiency. It might be possible to engage those that had worked with the companies, having a good track record of

competencies, or the sub contractors and suppliers that have worked on similar jobs previously

4. Availability of Contractor Design Team: The availability of an internal design team enhances resources' efficiency and site managers' efficient performance. The team will tend towards working on construction project target, scope, delivery time, cost effectiveness, quality and resources' wastes minimisation.
5. Effective Integration of Time and Cost saving Contrast. Significantly, time and cost are often in contrast. In several situations, the project construction cost compensates for targeted project delivery time. Thus, for efficient resources utilisation, site managers need to balance the effect of delivery time on cost which could cause resources wastefulness.
6. Clear and implicit Production information: Practically, a project properly designed with sufficient briefs enhances minimum alteration during construction phase; thus, there will be less resource (materials, manpower, and machinery) wastefulness. However, when specifications are not properly detailed at the inception of the project, this leads to frequent requests for interpretation, resulting in site managers' time wasting and considerably hinders the efficiency and proposition achievement of the site managers.
7. Availability of Efficient Skilled Workers: The availability of skilled workers to minimise utilisation of semi-skilled or inexperienced workers is paramount towards achievement of site manager and construction organisations' propositions. This shortage of skilled workers and utilisation of semi-skilled or inexperience workers often results in re-work and resources wastefulness to achieve the predetermined site managers' proposition. Therefore, site managers will need to possess refined labour marketing skills to achieve project propositions.
8. Appropriate procurement system: Adoption of an appropriate procurement system often enhances achievement of project propositions. For example, "design and build" and "package deal" procurement systems often yield less resource wastefulness, (in some specific projects), in comparison with other procurement systems. Since the design team produces production information and performs the construction operation, the site manager in the organisation could achieve project propositions better. Also, efficient resources utilisation should be recognised and in-built into the design concept.
9. Exact work to appropriate person or team(s): To achieve predetermined or expected site managers' or project proposition, there is a need to engage efficient and

effective sub-contractors and suppliers. The engagement or project award needs to be based on efficiencies, probably, those who had already worked for the organisation, or those who have work in similar project previously. These will enhance the efficient utilisation of construction resources. Machinery and equipment supplier work should be given to those who have significant knowledge, equipment, and workers. An enhanced efficiency of resources utilisation is achievable by selecting the right sub-contractors and contractors.

10. Adoption and Implementation of Prefabrication and Modular Construction Systems: Prefabrication and delivery of construction resources on site for fixing and assembly enhance site manager performance and efficient resources utilisation, In this regard, resources wastes will be at minimal, because the majority of resources' wastes have been done off-site, and the little wastes that could result from this system may be due to a few components that need trimming.
11. Adequate planning period at project inception: The urgent need of a project and lack of sufficient planning before the project commences habitually leads to time waste and hinders efficient resources utilisation. Thus an adequate planning period before any project commences will significantly enhance site managers' efficiencies during production processes.

6.6.7 Research Theme 5: The Factors that needed to be constant towards Site Managers' being efficient in resources utilisation

The question that was asked to address this theme was:

> "What are the factors that need to be constant towards efficient utilisation of construction resources?"

From the interview conducted the identified factors that need to be constant towards site manager being efficient in utilisation of construction resources are:

1. Regular Training: Construction organisations and government need to invest more in training. More so, efficient implementation of CICS is required – the "No Card No Work" system needs to be enforced and implemented. Construction workers need to know the organisation goals, objectives and policies; what is expected from the employees need to be clearly identified, ascertained, and the level of the efficiency to attained need to be clarified during the training and induction.

2. Healthy and secure environment: Safe environments motivate workers and workers have the tendency to work more efficiently in a secured and accident free environment
3. Effective and regular resources "market testing" and management: For efficient project execution, effective management is paramount, achievable through forecasting, market testing, and adequate planning.
4. Effective information and communication dissemination systems: Adequacy of information transfer enhances project execution. Construction information and communication systems need to be effective, to enable every worker to be aware of what is to be done, when, why and how to perform the task efficiently. More so, there is a need for an appropriate person to explain or disseminate the construction concept as the project progresses. However, the site manager needs to be familiar and acquainted with different types of information dissemination systems that will be effective for different project procurement methods and the intricacies required for efficiencies Also, the communication "gap" between the design team and the construction team has to be minimised, (bridged). Effective communication throughout the project and creation of appropriate methods and avenues of obtaining feedback is essential. That is, proper communication and information flows are significantly paramount for efficient resources utilisation during the construction production process.
5. Adequate and effective planning and forecasting: Adequate planning before the project commences and during project execution is essential for a project success. Also, effective monitoring is paramount towards achieving organisation and project set target. There is a need to plan ahead through effective forecasting of resources requirements and conditions that could hinder efficient resources utilisation. Effective planning of every construction activity, resources procurement, and utilisation significantly avoids or minimises construction resources wastes.

6.6.8 Research Theme 6: The Facilitators to Efficient Resources Utilisation

To verify and ascertain the facilitators that will enhance site managers towards efficient management of construction process and resources utilisation, the following questions were posed to the interviewees:

a) What are the facilitators that could enhance efficient utilisation of construction resources?

b) Kindly comment on the relative importance of the facilitators towards optimum utilisation of construction resources

The following are the important facilitators towards site managers' efficient resources utilisation:

1. Communication effectiveness and effective information dissemination: Effective information dissemination, retrieval and efficient communication to construction participants, the sub contractors, and suppliers are all very important for efficient utilisation of construction resources, and modalities of making these constants are paramount.
2. Pleasant environment: workers tend to perform better under pleasant environmental conditions that are secured, unconditionally free from hazards and accidents.
3. Production Information simplicity and explicitness.
4. Skilled workers participation in knowledge transfer and sharing.
5. Site managers' previous experience and knowledge from similar project(s).
6. Harmonisation of the manufacturers and designer's innovation: There is a need for the design team to be cognisant of manufacturers' standards, and endeavour to standardise design dimensions to manufacturers' standard dimensions. This will eventually reduce resources wastefulness and enhance efficient resources utilisation.
7. Good Managerial experience in various weather conditions and ability to cope with and manage adverse weather.
8. Enhanced variation control and client management: Effective variation control through effective management of client's change of mind,
9. Regular cost analyses and cost checks against market testing are required regularly: to guide against cost overrun of resources, which will jeopardise the profit and ineffectiveness.
10. Regular site meetings. Most probable problems and issues should be identified and discussed during site meetings within the design and construction teams. All suggestions for improvement need to be considered and applied.

To improve these Facilitators towards Efficient Resources Utilisation the following facts are essential:

1. Adequate planning and forecasting adequate planning before the project commences, through forecasting and up-front knowledge. Re-plan and cross check performance with pre-determined performance indicators.

2. Avoidance of concurrent mistakes: learning from past mistakes and avoidance of concurrent mistakes: This could be achieved through proper record keeping of job sequence denoting obstacle and problems, to indicate clearly how they were resolved.
3. Regular and effective meetings: Having regular meetings between the design and construction teams; to discuss how best a task on the project could be performed efficiently. Also, regular meetings with sub-contractors, to deliberate over project progress, identified problems, and available alternative methods to achieve project targets and objectives efficiently and effectively.
4. Appropriate and efficient team: The selection of an efficient working team and engagement of effective and efficient sub-contractors are paramount.
5. Regular training: To improve performance and efficiencies on these facilitators, the site managers and construction participants needs regular training.
6. Harmonisation of Design dimensions with Manufacturers Standards: As far as possible designer specifications should be to manufacturer component standards dimensions. In another way, in prototype projects, the manufacturers could produce modular components according to design specifications.
7. Adequate monitoring and resources control: Several wet trade, (In situ construction), requires close monitoring to avoid excessive, (wastes), and inefficient application of resources. A significant quantity of resources' wastes often occurs during wet trades, this thus requires effective supervision.

6.6.9 Summary of Interview Research Study One

Study one evaluates and ascertains factors that will enhance site managers towards efficient utilisation of construction resources. This study identifies and establishes the skills and attributes that site managers are required to possess which will significantly enhance the performance of essential management functions, (knowledge, and principles). This study also identified the factors that will facilitate site managers' efficiencies and ascertained how these facilitators will be improved.

The subsequent Section 6.7 discusses factors and themes that are not wholly in the control of the site manager, (whatever her/his acquired or in-built skills or attributes), but often hinders the efficient performance of site managers and perpetuates inefficient utilisation of construction resources. These factors are critically evaluated in research

Study Two with the broad heading "Budgeting for Wastes' Syndromes in the Construction Industry".

6.7 INTERVIEW RESEARCH SURVEY STUDY TWO - BUDGETING FOR WASTES' SYNDROMES, (BWS) IN THE CONSTRUCTION INDUSTRY

Among the issues evaluated in this study are the scenarios of "Budgeting for Resources Wastefulness" either consciously or unconsciously, and the Construction resources utilisations and wastefulness based on the construction participants' Knowledge, Attitudes and Perceptions, (KAP). Also in this research study, types and the significance of several motivators and incentives that will enhance the construction resources utilisation were ascertained.

The phrase "Budgeting for Wastes' Syndromes" implies the allowance, provision, or pre-notion for resources wastefulness occurrence during the construction production process. That is, setting aside or over-estimating of resources on envisaging that wastes will occur during the project production phase. This interview research study investigates the main research Objective Three. That is, to identify, evaluate, and ascertain the rationales for budgeting for resources' wastes in the construction industry and establish the modalities of reducing the causal-effects. The question addressed is,

> *"How and why do the design and construction teams budget for resources wastefulness?"*

Thus, based on the interview conducted, several themes and findings emerged, and these are presented in the subsequent Sub-sections 6.7.1 and 6.7.2.

6.7.1 Interview Research Study Theme 7: Beliefs of Site Participants' towards Resources' Wastes.

The questions that were asked that generates this theme are:

a) What are the probable beliefs of site participants on resources' wastes in the industry?
b) How can these beliefs be minimised?

c) What are the effects of these beliefs, "waste is normal" on project execution?

From the interview conducted, the rationales that make the site participants belief that the resources' wastes are inevitable are:

a) The construction environment and due to environmental factors which cannot be predicted precisely.
b) Wastes occurrence due to unavoidable human errors.
c) Most project sites are in congested or remote areas.
d) Due to insufficient time to plan adequately at project inception, also, the urgency of the need of the project, and delivery time constraints.
e) Lack of adequate experienced and skilled labour in the construction industry.

The solutions deduced that will significantly reduce construction participants' beliefs that resources' wastes are unavoidable are:

1. Motivation and Incentives towards wastes reduction: The beliefs of site participants on construction resources' wastes cannot be easily changed and an incentive in the form of a financial bonus to construction participants could significantly enhance efficiencies, thus reducing the beliefs on resources wastefulness. The workers need to be aware that, there are rewards for saving construction resources wastefulness; this will significantly enable them to be careful in resources utilisation.
2. Setting and striving to achieve wastes reduction targets: There is a need for organisations to set wastes' targets. A resources' wastes reduction target needs to be set and participants need to strive to achieve it. The construction participants should be aware that there are tolerable wastes; this will considerably enable the workers to be more careful in resources utilisation.
3. Reliable record and information on similar previous project executed: There is need for adequate information retrieval database on construction projects; where reference can be made, checked, and related to current project; efficiency, mistakes, correction and measure is practically applicable to avoid problems or obstacles during the construction process. Construction participants being aware that there is such a reference document, their beliefs about waste(s) will be challenged and they will become mindful of resources utilisation.
4. Training towards executing project efficiently and be resourceful: Construction participants need to be trained towards how to execute project tasks confidently and resourcefully.

5. Awareness of resources' wastes implication and wastes reduction benefits: Participants need to know the implications of efficient and inefficient resources utilisation. All construction participants need to be implicitly inducted towards wastes awareness, avoidance, and minimisation. In addition, workers need to know the cost implication of resources wastefulness; the effect, and the benefits of wastes reduction.

6.7.2 Interview Research Study Theme 8: Budgeting for Wastes' Syndromes

The questions that were asked from which this theme was deduced during interview are:

a) Why should the design and construction teams budget for wastes?
b) How can BWS beliefs be corrected or minimised?
c) What are the factors that contribute to allowance for or budgeting for wastes in the construction industry?

The identifiable causes of Budgeting for Wastes' Syndromes in Construction industry are:

1. Labour only sub-contractors' carefree attitude: Labour only contractors have the tendency of wasting materials since these contractors have somewhat fewer concerns with cost implication of the construction materials as a resource. Thus, additional resources somewhat allow resources sufficiency. However, if the contractors were allowed to supply and fix the materials, there is an increased tendency for them to be more careful in order to maximise profit.
2. Client unaware or nonchalant attitude: The majority of construction clients are unaware of the cost implication of resources' wastes that often occur during construction production process, otherwise, the clients will be more conscientious about finding possible measures of avoiding or minimising the "non-value-adding wastes", BWS, or re-occurrence in consequent project.
3. Inability to ensure labour efficiency: Often, labour is over-procured due to the inability to ensure efficiency, while in many cases to achieve timely delivery without delay that could occur due to inefficiency of labour or utilisation of semi-skilled ones. However, this often causes labour redundancy.
4. Ambiguous and inadequacy of production information: BWS occurs when there is a lack of adequate production information from the design team and the consultants, and inadequate time to prepare annotated production information.

5. Rigidity of the design team over production information. On many occasions, the design team is inflexible over specifications and often value project aesthetics over resources salvage, the designers habitually design and specify with less consideration of construction and materials utilisation implication, thus drive causes for BWS.
6. Construction project location: Significant numbers of construction projects sites environment are not conducive, wastes are often allowed for due to the failure of machine and equipment resources which may occur during the construction process.
7. Lack of skilled manpower resulting in the utilisation of semi-skilled workforce: Lack of adequate and experienced skilled labour in construction industry often causes the need to allow for waste to offset semi-skilled workforce mistakes. More so, site managers do over procure labour due to an inability of ensuring or ascertaining the efficiency of the available semi-skilled worker that will be employed.
8. Alterations and modifications: Habitual alterations in design concept(s) affect resources that have been procured contributes to resources' wastes that emanate BWS. In effect, many resources' wastes and allowance for wastefulness are due to the pre-assumption that alteration(s) and modification(s) will occur to the design concept, (drawings and specifications), during production process. Therefore, to prevent the delay this might cause during the production process, a quantity of resources are budgeted for and procured.
9. Avoidance of liquidation damage: Often avoidance of liquidation damages result in BWS, and procurement of resources in excess of actual quantity that will be required to complete a task. Significant quantities, (percentages) are theoretically added to resources that are visibly required; this is to prevent the probable effect of unforeseen circumstances that could cause delays.
10. Short project delivery time: Consciously quantities of resources are budgeted for by site managers to allow for possible wastes, when there is a time constraint to deliver projects. In respect, site managers are thus after time rather than cost or wastage to meet the delivery time. In many instances, site managers over procure resources to prevent any shortage that might arise during the construction process that could cause delay. That is, the site managers order in excess to prevent an inability to obtain materials promptly, when there is shortage and to avoid delay in delivery.
11. External Factors Control Limitation: Site managers have limitations to implement perfection during project executions because of a few external factors; such as

environmental and weather conditions. These factors cannot be adequately controlled, which often warrants budgeting for wastefulness.

12. Lack of new innovative skilled workers: Construction site managers often budget for resources wastefulness to limit the effects of tradition workers' inefficiency or semi skilled workers in applying new innovation or new construction methods required for a task.

The Solutions obtained from interviewees towards minimisation and/or avoidance of Budgeting for Waste Syndromes are:

1. Adequate time for production information preparation: There is a need for adequate time to prepare production information. When a project commences based on an interim estimate and specifications, consciously wastes are been allowed for and these many times causes resources misuses. To avert these, apart from adequate production information, valuing engineering technique will significantly reduce unnecessary resources and can equally be employed to identify the best construction procurement system that could reduce alteration and modification during the construction phase.
2. To value resources wasted: To make available the value of resources wasted during project construction. That is, to value wasted resources during production process and enables the design team and client to know the value of the wastes.
3. Adequate planning before and during the project execution: BWS can be minimised through effective management and adequate planning, re-planning and understanding the materials and other resources to be used for the project before commencement.
4. Site manager(s) advice at the design stage: An option to reduce BWS is the involvement of site managers to criticise the design before they are finally presented for construction. Competent builders should vet and point out flaws in specifications, and advise on alternative methods that could save resources wastages to the client and/or the client's consultants. Acceptance of redesigning when drawings are criticised will facilitate reduction in BWS. More so, the involvement of a project manager or site manager who will execute the project during design stage will significantly enhance efficient control, monitoring and supervision of the resources during the project's execution

5. Integration of design dimensions with manufacturers' standards: DT specifications to be in compliance to manufacturers' standards will significantly lead to minimisation of resources wastefulness.
6. Availability of complete production information at project inception: Adequate production information before construction production process commences will reduce the need for BWS.
7. Availability of skilled and experienced workers: Engaging construction participants who are experienced or skilled in the project to be executed. That is, involving contractors who have pre-knowledge of the work or who have capability and adequate work force to execute or manage the project will significantly reduce BWS, since fewer resources will likely be wasted during the construction process.
8. Ready availability of construction resources when needed: Readily available resources will made it unnecessary to order for excess that could lead to left-over. Thus, the design team need to be cognisant of resources that can be readily available in production information specifications, as far as possible.
9. Self-confidence on efficient Operation: To provide specific quantity required for a task/job and build in confidence to the users that the resources given will be enough for the work or task without quality being jeopardised. That is, to vet the quantity specified and issued out the vetted quantity and to make clear that any additional request will need explanation.
10. Adopting of an enhanced partnering and supply chain system: Engaging partnering and supply chain contractors for project executions where all partners will know their stake in the project, and be aware that profit achieved will be of benefit to all participants, the issue of BWS will be minimised, and this relatively will enhance the efficiencies of all stakeholders.
11. Standing order and query on obvious resources wastefulness: Site managers should be made to utilise resources by budgeting for fewer or no excess. When excess occurs, the site manager needs to be questioned. In consequence of this, they will be more conscious not to over-order.
12. Efficiency of the sub-contractors minimises BWS.
13. Adequate waste reduction training and awareness.
14. Encouragement of prototype projects and uniqueness of resources.
15. Reliable record and information on similar previous project executed: There is a need for adequate information retrieval database on construction projects, where reference can be made, checked, and related to current projects efficiencies,

mistakes, correction and to be measured practically, (as applicable), to avoid problems or obstacles during the construction process.

6.7.3 Summary of the Interview Research Survey Study Two

BWS is more or less a tradition in the construction industry. Many resources' wastes occur due to the pre-assumption that alterations and modifications will happen to the design concept, construction drawings, and specifications. To prevent the adverse effect on construction resources utilisation, several wastes are been budgeted for and procured.

The major contributor to BWS is the design team. It is the design team that produces production information that often causes chain contribution, BWS. In addition, the Site managers can only control so much, but, there is a limitation to enforce perfection, especially, environmental factors that cannot be adequately controlled. However, among the major solutions towards reduction of wastes is the involvement of the construction site manager to vet production information before being adopted for construction. In this regard, waste in all forms might have been identified and there will be less to budget for. If the designer designs to manufacturers' standards, there is a high possibility that BWS will be minimal.

One of the main problems in the construction industry is that, the workers like older systems of working. If the workers' working patterns, system and conception can be changed; these will not only reduce waste budgeting and/or wasted resources, but will also allow the site manager to plan ahead and procure resources accurately. It is often costly to make changes or alterations when the production process has started.

It is noteworthy that site management can only control and there is a limitation in enforcing perfection on construction resources utilisation, since construction site environmental factors and its impediments cannot be efficiently controlled.

6.8 INTERVIEW RESEARCH SURVEY STUDY THREE - AVOIDANCE OF CONSTRUCTION RESOURCES WASTEFULNESS, (ACRW)

6.8.1 Introduction

This research work classifies construction resources wastefulness as conscious or unconscious in occurrence and avoidable or unavoidable in usage. Thus, this Study Three is to identify factors that contribute to wastefulness of resources: the types, conditions, and modes of occurrence. The respondents classify these factors into conscious or unconscious in occurrence, and affirmed whether each factor is avoidable or unavoidable during the production process. Also, the respondents clarify the possible modalities to avoid or minimise the occurrence of the resources wastefulness during construction production process.

6.8.2 Interview Survey Study Three Objectives, (The Research Objective 3)

The third part of main research objectives is, "To improvise and ascertain how construction resources will be efficiently managed to minimise wastefulness during the production process".

The research question of which this main objective addressed is:

"How could construction resources be salvaged towards efficient utilisation?"

Also, the sub-questions which this study addressed are:

a) How can optimum construction resources utilisation be achieved currently?
b) Why is construction resources wastefulness so high in the construction industry?
c) Is there any incentive or motivation to reduce this construction wastefulness?

However, during the interview survey several sub-questions emerged which assisted in the in-depth interview and these are presented in the subsequence Sub-sections 6.8.3 to 6.8.8.

6.8.3 Interview Research Study Theme 9: Conscious and Unconscious Resources Wastefulness

This theme is two fold; the conscious and unconscious resources wastefulness. These enable the critical evaluations and assertions of several causes of conscious and unconscious resources wastefulness and made possible to establish how these problems could be significantly minimised or avoided.

6.8.3.1 Scenarios of conscious resources wastefulness

The questions asked to ascertain causes of conscious resources wastefulness are:

a) What are the factors that often lead to conscious wastefulness of resources?
b) Why are resources being wasted consciously during the construction production process?

The identified factors that often lead to conscious wastefulness of resources are:

1. Inadequate planning, occasionally caused by lack of sufficient time to plan before the project commences.
2. Scarcity of experience and skilled workers which results in utilisation of semi-skilled and unskilled workforce.
3. Over-procurement of labour due to the inability to ensure efficiency to meet the targeted delivery time, this overstaffing resulting in labour cost waste.
4. Unplanned redundancies and waiting time of plant and equipment.
5. Non standardisation of design dimensions with manufacturers' standards.
6. Safety factors in relation to time of delivery of the project by employing more resources than required.
7. Repetitive work due to poor workmanship.
8. Double handling due to resources positioning, trafficking and movement. Construction resources placed or stocked in inappropriate but available places that will require transportation to the place of usage often causes resources wastefulness.
9. Manpower redundancy and over procurement of labour due to an inability to ensure efficiency. That is, engaging excess manpower to execute the task in order to achieve the anticipated delivery time.
10. The environmental nature of the project site(s): several of the construction project sites are not environmentally pleasant; thus, many are times wastage is often being provided for probable unforeseen circumstances.

The solutions to avoid or minimise conscious resources wastefulness are:

1. Availability of sufficient time to plan the project before the project commences
2. Re-planning during project execution, and to forecast and guide against probable occurrence of inefficient utilisation of resources.

3. Adequate monitoring and control of work materials, workers, and machinery.
4. Availability of resources when required or needed, delivered promptly.
5. Implicit design and precise specification are enhanced by considering manufacturers' standards dimensions.

6.8.3.2 Issues of unconscious resources wastefulness

In relation to unconscious resources wastefulness, the following questions were posed to the interviewees:

a) Based on the questionnaire survey findings, the majority of resources' wastes occur unconsciously, while these can largely be avoided. Kindly comment on these scenarios.
b) What are the factors that lead to these scenarios?

The following findings were obtained during the interview survey as significant causes of unconscious resources' wastes during production process:

1. Insufficient time to plan before the project commences.
2. Human error and carelessness.
3. Lack of adequate planning to foresee redundancy of resources. Several unconscious wastes are due to adequate planning of resources. Many a time, plant and equipment hired often remain redundant for periods of time.
4. Complexity of design and inadequate specifications
5. Lack of site experience from previous job: a lack of experienced management or site participants on previous similar project(s).
6. Double handling due to Resources positioning, trafficking and movement, for example, materials placed or stocked in an available place that will require subsequent moving to place of usage.

The following facts were obtained, from the interview conducted, that will enhance the minimisation, or avoidance of unconscious resources wastefulness:

1. Proper planning and re-planning as the project progresses.
2. Training of workers in awareness and benefits in resources effective utilisation. Workers need to be aware that the benefits are for the organisation and all site participants, and these benefits have to be clearly stated.
3. Enhanced information dissemination and effective communication.

4. Challenge workers to be responsible for flimsy mistakes. Possibly, the workers need to be informed that they may be held responsible for obvious or careless resources wastefulness.
5. Monitoring of workers and plant efficiencies to avoid redundancy.
6. Adequate supervisions by experience/skilled superiors.
7. Availability of resources when required or needed, that is, prompt delivery.
8. Minimisation or avoidance of alteration and modification during work in progression through proper planning and implicit production information.
9. Minimisation or avoidance of human errors, through effective supervisions and monitoring, to avoid apparent or careless mistakes.
10. Adopting an effective supply-and-fix construction method, to reduce resources wastes, thus enhancing optimal utilisation of construction resources.

6.8.4 Interview Research Study Theme 10: Clients and Resources Wastefulness

The question that was asked to address this theme during the interview survey was:

> *"How can clients help to reduce or avoid construction resources wastefulness?"*

The three major facts obtained during the research interview; that could enable clients to assist in efficient resources utilisation are:

1. Seek to know the magnitude and value of resources wastes during project execution: After project completion, there is a need to create the possibilities which will enable client(s) to know the magnitude and value of resources' wastes that occurred during the project production process. While, most of the resources' wastes have been allowed for in the bill of quantities and paid for by the client; if clients know the actual wastes cost implication, the clients will strive to avert the occurrence(s) in subsequence project(s).
2. Seek for alternative resources available: Clients need to endeavour to know several alternative resources available for the project in relation to construction cost and delivery time. Clients required to seek for the alternative resources available that will be economical to deliver the project on time without jeopardising the project objectives. In respect of this, there is significant need for adequate briefing during the design stage for the designers to explain the intricacies of the design concept(s) to the client; this will enhance the reduction of wastes during the project production process.

3. To seek the advice of a site manager before the project commences: The advice of the site manager executing the project needs to be sought. The site manager needs to advice from experience the different approaches of executing the project that will minimise resources wastefulness, on time delivery and at minimum cost. The rational idea provided by the site manager can then be integrated into the design concepts. Also, designers need not only to be faithful to the client's briefs and aesthetics' perceptions, but to care more about the cost implications of their design concepts and consider several possible economies in the construction production process.

The following issues emerged during the interview conducted on "The Clients and efficient construction resources utilisation"

1. Several wastes that are accrued during the project construction have been paid for by the client knowingly and in many projects unknowingly, while the majority of the clients are ignorant or never bother to know the quantity or value of the wastes built-in in the design concept. More so, many changes, alterations, and modifications that occur from the client during the construction phase are due to a lack of adequate understanding of how the project will look after completion. Thus, when the project is in progress, the client is clearer about the project concept, and, in many circumstances, seeks for alteration(s) and modification(s).

2. Several property developers or clients rarely have interest in the actual construction processes or the cost when the construction product is in high demand or urgently required. While a significant number have a nonchalant attitude to wastes, since cost implication will be passed to who will rent or purchase the property. The prospectus buyer(s) or tenant(s) pays the cost of the project construction resources waste unknowingly.

3. Significantly, several clients are not remotely aware of the cost implication of wastes, while many have no means to compare efficacies of different resources that will serve the same purpose. Though many are inexperienced or ignorant of any efficient construction process or techniques that will save resources wastefulness during project execution; the interest of several clients is usually the final product that will fulfil their vision.

Thus, the construction management team, (the designers and contractors), need to work towards achievement of minimum construction cost and timely project delivery In addition, to create means that will enable clients to be aware of many intricacies of the construction concept: cost implications of several construction methods and efficiencies of several resources utilisation techniques in relation to wastes' reductions. By these, clients will be able to contribute effectively to wastes reduction.

6.8.5 Interview Research Study Theme 11: Effective Partnering and Supply Chain Systems towards Efficient Resources Utilisation.

The question addressed by the respondents from which deductions of Theme Eleven were made is:

> *"Kindly explain how partnering and the supply chain systems can reduce or minimise construction resources wastefulness?"*

The following were deduced during the interview discussions:

1. Adhering to a few partners and supply chain contractors: There is a need for continuity in partnership and supply chain contractors who have been working in togetherness with tested track record of effectiveness and efficiency. This will enable the partners and/or the supply chain contractors to be conversant with the construction organisation resources utilisation policies, and will invariably enhance ease of operation of both present and concurrent works with less or without instruction.
2. Manufacturers' components production in relation to design specifications: The involvement of manufacturers in partnership as components and materials suppliers, in a large project, might mean that they could standardise materials to designers' dimensional specifications. This will invariably enhance efficient resources utilisation and reduce resources, (materials, labour and machinery), wastes, during fixing and installation of the components or panels. The uniqueness and standardisation of the structural components will significantly reduce resources wastefulness and invariably lead to efficiencies.

3. Involvement of the partners and supply chain contractors during bidding: The partners and supply chain contractors involvement in construction project bidding is

important; enabling every partner to contribute expertise and advice on resources utilisation and achievement of construction efficiency to be considered at the outset. Such collaborative efforts will significantly enhance construction resources efficiencies during the production process. More so, every partner will exercise their roles towards achieving economic construction resources utilisation.

4. Panellised and modular construction systems: The partnering concept is significantly advantageous, but effective applicability in the construction industry is still difficult; especially its management. Adopting and effective implementation of panellised structures, modular construction systems and prototype projects, will enhance partners in efficient resources utilisation, and perpetuate efficient resources management

5. Partners' comparative advantage and mutual collaboration: The roles, strengths, and weaknesses of every partner need to be clearly identified and stated at the outset of the project and in the partnership agreement. While each partner performs the role(s) in which they have comparative advantage over the other. That is, individual exhibition and contribution of their professional expertise, working towards achieving the same goal of improved profit sharing and efficiencies.

6. Acquaint with new trends of construction and innovations: Maximum advantage of partnering and the supply chain system can be achieved while every partner is conversant with construction innovation, new trends, and efficiency of fixing components to minimise wastes. That is, all partners need to work towards achieving the best practice and maximise resources utilisation at minimum cost without jeopardising the product quality.

In summary, if manufacturers are in partnership and also supply materials, the manufacturers could be able to standardise the materials' dimensions to the designers' specifications; this will thus enhance reduction of wastes during fixing the construction components or panels. The uniqueness of the structure will invariably lead to resources efficient utilisation.

The partnering and the supply chain in practice have limitations in application when it comes to who will be actually responsible for the project outcome, management and leadership. However, mutual and joint responsibility enhances construction resources efficient utilisation. If sub-contractors and suppliers were given the opportunity to be part of the project as partners and have a stake on the overall project profit, and every partner knows that efficient resources utilisation is to his/her benefit, waste resources will be at a minimum. In addition, effective implementation of panellised structures, modular construction systems and prototype projects will enhance the construction organisations and the manufacturers to work in partnership.

6.8.6 Interview Study Theme 12: Skilled workers shortage in the construction industry.

The issues raised under this theme are:

a) *Among the major problems which the construction industry is encountering currently, is the lack of skilled and experience workers. How can this skilled workers shortage be reduced in the industry?*
b) *How can effective training implementation be achieved towards efficient resources utilisation?*

The major causes of skilled workers shortage in construction industry are identified as:

1. Trainees avoid apprenticeships for long periods. Several trainees are often eager to be employed and anxious to earn money and so end up as semi-skilled workers.
2. The current demands of workers, tied with few skilled labours being available, in respect to the emergence of many construction projects and regeneration.
3. The ease of labour mobility from one industry to the other. Workers move from the construction industry due to the tediousness of the industry in comparison with other organisation sectors such as service and manufacturing.

The possible solutions to minimise the skilled workers shortage in the construction industry are:

1. Implementation of previous skilled workers training structure: To reduce shortage of skilled labour problems, it is important to revisit the old system of skilled workers training. Apprentices need to spend more time to learn trades efficiencies; to undertake sufficient industrial training and obtain certificates of fitness by assessors. Construction organisations need to significantly increase the engagement of young graduates and apprentice, and provide more training towards resources efficiency.

2. Both NVQ and production performance efficient trainings are needed: The trainees need to be mandated to have both NVQ and production performance efficiency training. More industrial training schools need to be set up by many organisations for training and recruitment, in collaboration with government agencies.
3. Detailed construction problems and possible solution records for trainees: Availability of detailed construction problems that lead to inefficiency and possible solutions need to be made available from which young graduates can learn easily.
4. Intensive skilled training course and examination: All apprentices need to undergo skilled training courses and be examined. This training should be effectively incorporated within the short duration of time in which trainees are ready to learn
5. Knowledge management: This principle should fully be in practice and adequately implemented within construction organisations, not only within a company.
6. Collaborative training is required between the CITB, Colleges and Universities: There should be a proficient training scheme towards efficient resources utilisation for all construction participants. This should be in collaboration between the CITB, colleges, and universities. Graduates from colleges and universities need to have an industrial training certificate and be certified for efficiency.
7. The construction participants need to know the implication of being efficient: During training, the trainers should clarify the effects and implications of inefficient utilisation of resources and the advantages of efficient utilisation of resources.
8. Adoption and application of modular and standardised materials that will enhance labour utilisation towards efficiency and wastes reduction.

In addition, for construction workers to be efficient in resources utilisation:

1. The trainees need to build confidence of working efficiently.
2. Trainees need to know the implications of efficient and inefficient resources utilisation
3. Trainees need to be acquainted with the cost implications of resources wastefulness and the effects.
4. Trainees need to know the benefits of wastes reduction and to be aware that they may be asked to pay/account for careless mistakes that lead to inefficiency or resources' wastes.

Further pertinent facts obtained on this skilled workers shortage are:

1. Involving semi-skilled workers often causes delays in proceeding work. Also, involvement of semi-workers to execute a task to meet up time often requires close monitoring. These result resources (labour, materials, plant and equipment) wastes and sometimes rework.
2. Previously, a trade had to be learned for four to five years, but it is common presently that the trainees received training for less than 24months. Within the short period, the apprentices basically learn how to perform fundamental work not in detail or efficiently.
3. The demand for workers and emergence of many construction works and regeneration means that the contractors have no choice other than to employ those who can do the job either efficiently or otherwise.
4. The skilled labour demand supersedes the supply, (availability). In respect, this seldom makes the need, (requirement), to engage a labour agency to supply workers, while their quality or efficiencies are clearly unknown to the site manager.
5. Several construction projects are subject to be completed on time, and to work under stringent time constraints and the site managers are required to meet the project delivery period. This project short delivery time constrains site managers to employ both skilled and semi skilled labour to be controlled and monitored for the job that has to be done.

6.8.7 Interview Study Theme 13: "Man Made Problems"

During the interview, this theme prompted and was evaluated. The issue is:

"Man made Problems can only be resolved by man."

The interviewees were solicited to relate this issue to efficient utilisation of resources and resources waste management. During the interview, the suggested solutions that will significantly reduce or avert causes of "man made problems" are:

1. Regular and effective training: Site operatives need adequate training for efficient performance. To enhance labour efficiency, there is a need for industrial training in addition to education and apprenticeship. Efficient and effective implementation of Construction Skills Certification Scheme, (CSCS); and Construction Industry Training Board, (CITB) are important schemes that could enhance workers' efficiencies

2. Adequate information disposition. There is need for adequate induction when a new concept or construction methods are introduced or when a specific construction method is required to perform an operation apart from the regular or orthodox sequence which the project operatives are familiar with.
3. Proper planning and management: To avert or minimise the occurrence of careless mistakes and inefficiency.

Several inefficiency problems are not caused by materials or equipment, but often caused by "men" using them. Many workers know what to do but how to do it efficiently is the problem. To Abraham Maslow, human performance and efficiencies depend on satisfaction of their physiological needs and self-actualisation. Frederick Hertzberg identifies that hygiene and motivation facilitates human performance, (Swinton, 2008).

However, Douglas McGregor views people as being lazy, disliking work and needing the threat of job loss before they can perform maximally, (Swinton, 2008). Thus, irrespective of appreciation, motivation and satisfaction of needs enhance efficiencies of workers and resources utilisation. Several workers are seldom ready to take responsibility, often, they have to be monitored, directed and controlled adequately, to minimise or avoid "man made problems".

6.8.8 Interview Study Theme 14: Motivating Construction Participants towards Efficient Resources Utilisation

The following questions were used to investigate this theme:

a) *How can site participants be motivated towards reduction of resources wastefulness?*
b) *What are the likely incentives or measures that can enable site participants to work efficiently?*

From the interview survey, the identified approaches that will motivate or sensitise construction participants towards efficiency are:

1. Good working environment: Good environment with adequate infrastructures and facilities will enhance workers morale. Workers tend to work efficiently in an environment that is conducive and significantly free from hazards.

2. Training and career development: Workers tend to be efficient in work where they know that the organisation is inclined towards future career development.
3. Waste target profit sharing and appreciation: Setting waste targets percentage and enable the workers to know that when the target is met, there is a monetary bonus for all site participants that makes it possible. Financial bonus as rewards significantly enhances workers efficiency, and motivates workers to be efficient in resources utilisation.

Though financial incentives motivate workers, however, several interviewees agued that a monetary incentive is an act of indulgence and "double expenditure" Invariably, the workers are engaged to perform task(s) efficiently at first attempt; thus, workers should not expect to be paid for resources minimisation, rather, be charged for perpetual damages and carelessness or penalised if the wastefulness is due to an obvious mistake.

6.8.9 Interview Study Theme 15: The Construction Industry is lagging behind other Sectors in Efficient Resources Utilisation

The interviewees were solicited to:

a) Comment on the statement that: The construction industry is lagging behind other sectors such as manufacturing and service sectors in efficient resources utilisation.
b) Explain how the construction industry can bridge the gap of lagging behind in efficient resources utilisation in comparison with the service and manufacturing sectors.

The identified major reasons why the construction industry is lagging behind in efficient utilisation of resources in comparison to manufacturing and service sectors are:

1. The construction industry is more labour intensive in comparison to the manufacturing sector. Thus, human errors are often higher than that with the more automated machines used in the manufacturing industry.
2. On many occasions, constraints in the use of plant and equipment for site operation due to adverse environmental conditions affect resources efficiencies. In comparison, the manufacturing and service sectors often operate in an environment that is conducive. Several construction works are carried out mostly in an environment that cannot be predicted, monitored, or controlled adequately.

From the survey, to bridge the gap of construction industry lagging behind other sectors in efficient resources utilisation, these following suggestions are significant:

1. Adoption and implementation of effective and efficient partnering and the supply chain systems: Effective implementation of partnering and the supply chain will help with bridging the gap within the sectors. Invariably, in the event that manufacturers have agreed to work in partnership, towards the common objective of wastes reduction and efficient utilisation of resources, this gap will significantly reduce. This may require the production of components in modular forms which could be adoptable for several projects.
2. Adoptions and implementations of modular and prototype construction concepts: Construction organisations need to effectively implement modular and prototype construction concepts. Several construction components need to be modularly produced, prefabricated and in standard dimensions. However, construction specifications need to be in accordance with manufacturers' standards, dimensions and specifications.
3. Construction projects' components standardisation and uniqueness: More construction components should be standardised, unique and be modularly produced. These will enable them to be used and/or re-used for several projects.
4. Adequate and effective skilled labour training: Educating and training the operatives enhances resources efficient utilisation.
5. Adequate monitoring and control of the construction resources utilisation. This gap can also be bridged through an enhanced control of the construction sequence
6. Adequate and effective recording of construction problems, mistakes and their solutions into a database: Recording and learning from past mistakes to avoid repetition.

Though, construction labour can be trained effectively towards efficiencies and wastes reduction, however, if the significant numbers of materials' components are in modular forms, in panels and/or pre-cast the applications will be easier. Thus, the construction industry needs to encourage prefabricated, panellised and modular constructions. Panels and pre-cast materials are often easier to assemble than in-situ construction. These concepts will invariably not only reduce wastes, but also facilitate efficiencies.

Also, the construction industry cannot absolutely compete with manufacturing companies, which are automated, exploit robots on resources utilisation and often operate in environments that are conducive. Moreover, manufacturers produce the majority of construction organisation materials components. Thus, the construction industry will be able to minimise the gap in resources efficiencies and reduction of resources wastefulness if the components' manufacturers and the construction organisation could engage in a partnership towards a common objective.

6.9 APPROACHES TO MINIMISE OR AVOID CONSTRUCTION RESOURCES WASTEFULNESS DURING THE PRODUCTION PROCESS

Based on the interview survey conducted, this section outlined solutions to the construction resources wastefulness and present thirty four approaches to minimise or avoid construction resources wastefulness during the production process. Also, nine radical approaches that will significantly enhance the CRWM are drawn.

6.9.1 CRWM Approaches

1. Engaging regular sub-contractors and suppliers: The practice of regular sub-contractors and suppliers are significant in reducing resources wastage. The contractors or suppliers will be conversant with the company policies and operational systems. In addition, frequent meetings with these sub-contractors and suppliers are essential to discuss and affirm the efficient way forward on the next task(s) to be performed.
2. Performance appraisal of the construction organisations, the sub-contractors and suppliers: Frequent performance appraisal checks of the sub-contractors and suppliers by the organisation management and employees. Possible corrective measures are very important, while causes of underperformance will be corrected and recorded for future project reference.
3. Presentation of fully developed production information for construction processes: There is a need for adequate and fully developed production information before any project commences. In addition, the design team need to be more mindful and concerned with efficient resources utilisation in their drawings and specifications, that is, to design towards zero waste tolerance. These will enable the site manager to plan for the project efficiently before commencement, and consequently, will reduce wastes' occurrences.

4. Designing towards cost and time savings: During design stage, the designers need to educate the client on the cost implications of the design concepts. To make the client clearly aware and know the advantages and disadvantages of different alternative resources that could be used, possible approaches and procurement systems available for the project and the project execution. To design towards saving cost and time based on best approach, while the quality remains unaltered.
5. Effective knowledge sharing: Construction participants need to learn new ways of performing tasks or executing projects. Learning from others past mistakes, skilful and effective approaches that will minimise inefficient resources utilisation through knowledge sharing or transfer are paramount.
6. Good working environment: A pleasant working environment with adequate facilities enhances the performance of the construction workers. Workers tend to perform optimally in a favourable environment and where there are adequate protective measures against hazards.
7. Recognition and penalisation: Human beings are motivated to perform better when they receive recognition from others and/or superior officers. This satisfies the desire of being recognised, that they are important. As this factor is highly significant towards project success, however, a few workers need to be "threatened" with being penalised before performing efficiently. Therefore, when workers have performed excellently, the workers need to be appraised or alternatively, penalised for obvious mistakes.
8. Design to manufacturers' standards: The Design team should often consider the manufacturer(s) standard components. Thus, to design and specify in to the manufacturers' standard dimensions as far as possible. This will not only reduce wastage, but also enhance efficient resources utilisation.
9. Engaging a Waste Manager: Another important solution to minimise inefficient resources utilisation is the engagement or appointment of a construction Resources Waste Manager, whose duty will be to perpetually identify, recommend and monitor how optimal resources utilisation will be achieved at every stage and task. Among this manager's functional roles will be to monitor and forecast possible ways of making best use of resources, including tracking probable causes of resources' inefficiencies.
10. Adequate planning of resources procurement: That is, to ensure resources are constant through proper planning and an adequate procurement system. During construction, forward planning and re-planning are essential. Site management need

to think and plan ahead for unforeseen instances that could cause resources' wastes and inefficiencies. In addition, proper planning before ordering or procuring resources is essential. Sometimes there is a need to cut down the order and build confidence in the users by stressing that the resources provided will be adequate for the work or task to be done.

11. Enthusiasm towards efficiencies: Site participants need to be more enthusiastic in doing their job more efficiently, to develop the ability to avoid wastes. To boost workers morale, there is need to commend them on excellent performance and logically make correction on any shortfall.
12. Integration of resources waste implications to design concept(s): There is a need for architects; and other members of the design team to be aware or understand the effective construction method(s) to be employed for the proposed project before the final drawings are produced. That is, to understand the implication of the construction method(s) of their concepts on resources' utilisation, and how efficient resources utilisation will be achieved.
13. Setting wastes target and bonus sharing: Setting a minimum allowable percentage of resources' wastes, and tending towards achieving the target set. Any resource waste saved on the project, a monetary bonus in commensurate to percentage saved should be given to the site or project manager as incentive, while this bonus is shared between all site participants that made the resource-waste-target achievement possible.
14. Enhanced supply and fix contracting: There is a significant need to negotiate with the sub-contractor bearing in mind wastes reduction. To award resources procurement and installations to the supply and fix contractors. These concepts, (Supply and fix or supply chain), significantly reduces resources' wastes and enhances resources utilisation efficiencies.
15. Adequate wastes disposal techniques: The construction site manager or the construction organisation has to be more proactive in resources waste disposal. Materials waste produced by a sub-contractor has to be disposed from the site by the contractor. This implies that, the removal cost implications will be the sub-contractor function, and enable the sub contractors to be more conscious of materials' wastes knowing fully that the wastes evacuation cost is part of the contract awarded.
16. Awareness of wastes reduction benefits: Site participants need to be adequately informed and aware of the rationales and benefits of being efficient in resources

utilisation. That is, to be aware that the benefits are not for the contractors only, but, there are benefits and recognition for workers that are resourceful. Imperatively, this will ultimately motivate construction participants towards efficient resources utilisation and wastes avoidance.

17. Specification and adoption of re-usable materials: Designers should endeavour to specify materials that are re-usable. Possibly, panels that can be used several times without much damage. In consequence, materials that are removed from a site can be easily stored or transferred to another site or project to be re-used. Hence adopting a "smart" building system will significantly reduce materials' wastes that occur during the construction process.
18. Designing and Specifying Convertible Structures and Materials: Designers should tend towards designing convertible structures and specifying adaptable materials. This will enhance partnering between the designers and the manufacturers, when structures can be used in diverse ways and production can be made in large quantities. Similarly, wastes will be significantly reduced if the manufacturers' components are standardised and in conformity with design concepts specification.
19. Utilisation of panellised and prefabricated construction components. A significant number of building project components need to be in standard panels and adoptable for several projects, to enable construction teams to be conversant with the utilisation of the materials. Adoption of standardised products will significantly reduce resource, (labour, materials or equipment), wastes occurrence.
20. Setting targets and adequate monitoring of the target with adopted site KPIs: There is a need to set a minimum allowable resources waste target, where adequate project monitoring is essential. Both workers' productivity and efficiencies have to be adequately monitored. In consequence, the adequate practical implementations of site construction key performance indicators are paramount. The KPIs will significantly enhance the resources efficient utilisation target set and the monitoring process.
21. The availability of skilled and experienced workers: Among the major problems confronting the construction industry currently is a lack of skilled and experienced workers. To reduce this predicament, previous skilled workers training systems have to be revisited, while workers need to spend more time learning trades efficiently and effectively; to acquire sufficient industrial training and obtain certification of competency from proficient assessors.

22. Adequate induction on efficient resources utilisation: Both the design and construction teams need adequate training towards efficient resources utilisation. It should be requirement for construction graduates to acquire adequate industrial training and to be certified for efficiencies. During training, the trainees require to know the effects and implications of resources efficient utilisation and wastefulness on project delivery. Thus, construction and government organisations need to provide more training schools and encourage potential individuals to study construction and its related courses by providing an enhanced scholarship or bursary which will motivate the prospective trainees.
23. Effective partnering and the supply chain implementation: There is a need for effective implementation of partnering and the supply chain systems, to enhance efficient resources utilisation during the production process. All partners need to know the relative importance and benefits of the possible profit that will accrue by being efficient in resources utilisation.
24. The availability of construction resources on request: To avert inefficient resources utilisation, there is need for the design team to consider the availability of the resources to be used for the construction project; specification of readily available resources, rather than specifying scarce resources is essential. This will make it unnecessary to request for excess that will eventually not be fully utilised and lead to wastes.
25. Adequate resources procurement and utilisation programme: Site management need to programme resources procurement adequately to minimise operatives, plant and equipment redundancies. Thus, there are needs for timely resources delivery, careful storage and to be cognisant of the project, (tasks) lead-in time. Also, there is a need to deliver materials nearest to the point of usage, to minimise resources utilisation time expended during transportation; this will minimise double handling.
26. Regular and effective meetings on resources utilisation: There is a need for regular meetings between the design and construction team management to deliberate on the most appropriate method(s) for executing the design concepts and task(s). Also it is necessary for regular meetings during the project production process to evaluate or re-evaluate the programme of work.
27. Making stakeholders aware of the value of resources wasted: There is a significant need for the stakeholders and the clients to know the cumulative effects of resources wasted during the construction production process. That is, creating possibilities of enabling stakeholders to be aware of the magnitude and value of resources' wastes

generated during the construction production process. Also, the stakeholders need to know the causes or rationales of each waste scenario. By this, the occurrence of such waste will be avoided in subsequent project(s).

28. To design and specify to manufacturers' standards: Many manufacturers' components/products are modularly prefabricated, having standard measurements. Hence, the construction components' specifications need to follow the manufacturers' specifications. These will enhance the partnership between the manufacturers, contractors, sub-contractors, or the suppliers.
29. Adoption of modular components and modular construction systems: There is a need for a significant number of construction components to be standardised, and modularly produced. The modular components will enhance resources to be used for several projects. In addition, panels and pre-cast materials are much easier to assemble than in-situ ones; thus, this will not only reduce wastes, but also facilitates efficiencies. Also, it will be easier to train labour when the components are in modules.
30. Minimisation or avoidance of perpetual alterations and modifications: To minimise alterations and modifications during work in progress through provision of explicit and detailed production information before the construction production commences.
31. Avoidance of short lead-in time to commence project or task(s): Several construction project products are needed within a short duration of time. This often arises to a short lead-in time. That is inadequate time to plan and/or to perform the project or task(s) efficiently.
32. Effective and efficient information dissemination: Site managers receive production information package from the design team, and convey the information to construction participants. Thus, on several occasions, the manager acts as a "middle man" between the design team and the site workers. Therefore it is imperative for the site manager to be skilful in communication and seasoned in information dissemination.
33. Avoidance or minimisation of perpetual plant and equipment inefficiencies: One of the major problems in the construction industry is that, the majority of the plant and equipment resource is not efficiently utilised. Plant is often hired for hours for work of few minutes. Also, the plant and equipment operatives' redundancies are equally high. The site manager need to plan and foresee possible machinery inefficiencies and minimise the occurrences. Therefore, adequate procurement planning is highly essential for this resource with other resources, (materials and labour).

34. Adequate buildability assessment of the design concept(s): There is a need to look at buildability of design concepts in perspective, while working towards zero waste tolerance. However, the urgent need of a project and lack of sufficient planning period before the project commences often lead to resources wastage, these factors need to be rationally guarded against.

6.9.2 Radical Approaches that will Enhance CRWM

The followings are the significant radical approaches towards enhancement of CRWM during production process:

1. Consistency in utilisation of suppliers and sub-contractors: Consistency in utilisation of suppliers and sub-contractors that have already been introduced to the construction organisation policies is significant. That is, the regular engagement of suppliers and sub-contractors who have already adapted to the organisation system(s), and policies. However, the efficient performance of such sub-contractors or suppliers must have been certified.
2. Adoption of a proactive operational structure for construction participants: There is a significant need to institutionalise a best practice operational structure for the design and construction teams. The combined efforts, (views) of seasoned construction site managers on efficient construction resources utilisation should be acquired to form a proactive mission statement. At one time, seasoned construction site managers had encountered "brain storming" problem(s) and have successfully overcome the predicament(s), and in consequence have identified the best method of overcoming the obstacle(s).
3. Avoidance of aged and traditional construction operating systems and concepts: The construction organisations should tend towards modern methods of construction and effectively implement new innovative concepts such as partnering, bench marking, and the supply chain systems. These concepts significantly enhance optimum resources utilisation and need to be adopted and implemented effectively.
4. Adoption of the modalities for valuing wasted resources: To value resources wasted during construction work at project completion and made known the cost (implication) to all construction participants. Clients and clients' consultants need to be aware of cost implications and causes of resources wastefulness after project completion. The majority of clients are not really aware of the magnitude or the

value of wastes that occurred during project construction. Unconsciously, this waste cost is part of the cost of construction paid by the clients. Knowing the resources' wastes cost incurred in a completed project, clients will be unwilling to lose such in future project(s).

5. Construction components' standardisation: Components' specifications and dimensions should be in accord with manufacturers' standard dimensions. The standardisation of structure will significantly reduce resources' wastes and lead to efficiencies. Also, through modular structures, and designs components that are adoptable for several construction projects, the materials that are removed from a site can be stored or transferred to another site for use and re-use. Thus, these will drive the construction industry towards "zero" waste tolerance and resources utilisation sustainability.
6. Avoidance the use of bricks and blocks for construction where possible: Practically, during construction, bricks and blocks utilisation produce lots of resources' wastes and inefficiencies. The industry should tend towards panellised materials and assembly sheet structures as an alternative to bricks and blocks. Using panellised materials and sheet structures, the designer(s) and manufacturer(s) will find it easier to work as supply chain partners.
7. Adoption and implementation of smart and re-usable components: Another significant best practice is for the designers to specify materials that are re-usable by designing and specifying panels that can be used several times without being damaged. The designer could also design convertible structures and specify convertible materials. Smart building will significantly reduce wastefulness of materials that occurs during alterations and modifications.
8. Mandated efficient production and performance training certificate: That is, the adoption and implementation of a mandated efficient performance training certificate for site workers. Construction trainee should be mandated to have at least an NVQ and in addition to this, efficient production and performance training certificate. In this regard, more industrial training schools need to be established by construction organisations and government institutions for training and recruitment of graduates and apprentice. This skilled training scheme needs to be integrated within the short duration of time which many trainees are ready to learn in recent years.
9. Availability of construction database for efficient resources utilisation problems and their relative solutions: Problems that lead to inefficiency and their possible

solutions should be made available from which young graduates and trainees can easy learn. This can be made available in manuscripts, and audio visual for training and as reference. In addition, knowledge management principles and concepts should be effectively implemented through this means. This should be efficiently practised not only within a construction organisation, but also within the construction industry at large.

6. 10 CHAPTER SIX: QUALITATIVE INTERVIEW RESEARCH SURVEY SUMMARY

The questions used for this qualitative interview research study were modified from the results obtained in the quantitative survey. Eight experienced Construction Site Managers, (respondents), participated in this interview survey. The selections were based on the experience, and status of the respondents, who could provide adequate and require information that address the research questions, aims, and objectives. The interviewees are top managers in the multinational construction industry who had worked in many construction sites with significant years of experience and knowledge in construction resources management.

The interview information was recorded with an audio tape digital recorder, uploaded to computer, transcribed, and coded. NVivo statistic software was use to analysed the information collected. The themes deduced were summarised and reported in logical order to the research questions and objectives.

The significant themes investigated during the interview survey, and the findings deduced are presented in sequential order that could be logically understood and applicable towards efficient resources utilisation and waste management.

This chapter concluded with thirty four approaches to CRWM and nine radical approaches that will significantly enhance the CRWM.

The next chapter, (Chapter Seven) presents the CRWM operational framework based on the combined quantitative and qualitative research surveys conducted.

CHAPTER SEVEN

CONSTRUCTION RESOURCES' WASTES MANAGEMENT

OPERATIONAL FRAMEWORK

7.0 CONSTRUCTION RESOURCES' WASTES MANAGEMENT OPERATIONAL FRAMEWORK

7.1 CHAPTER INTRODUCTION

Based on the critical evaluation of the three main research studies and the factors identified in the theoretical framework presented in Chapter Four, Figures 4.3 to 4.5, several novel findings and frameworks emerged. These frameworks (presented in Chapters Five and Six) cumulatively led to the establishment of the concise CRWM operational framework presented in this chapter.

In this chapter, the need and novelty of the CRWM operational framework is related to the current practice and principles, and scholarly literature and viewpoints.

This chapter outlined the novel best practice framework established, and concludes by logical presentation of the framework in figures and tables for practical use.

7.2 NECESSITY OF THE CRWM FRAMEWORK BASED ON ESTABLISHED FACTS FROM SCHORLARLY LITERATURE AND VIEWPOINTS

Egan (1998) report affirmed that the industry is under achieving, while the function and the mission of the construction industry is to give its customers the best value for money and the satisfaction with a job well done at minimum cost, within a reasonable time frame and the expected quality. Egan (1998:15) advice that:

> *"the areas in which there are needs for change in the UK construction industry include: change in working conditions, skills and training, design approaches, use of technology and relationships between companies. More so, construction participants' efficiencies, and values are under-researched"*

Also, Nigel Griffiths, Member of Parliament and Minister for Construction in 2003 ascertained that:

"In the global economy, all UK industry is under pressure to continually improve to maintain competitiveness and attract investment. The construction industry has started to recognise that greater efficiencies are possible". - *Constructing Excellence, (2003b:2)*

Though, the UK construction industry is still competing favourably with other developed nations, as indicated in the reports of Priestly (1994), Latham (1994), Egan (1998) and DTI (2004). However, Egan (1998:38) stress that:

"What we are proposing is a radical change in the way we build. We wish to see, within five years, the construction industry deliver its products to its customers in the same way as the customer - lead manufacturing and service industry. To achieve the dramatic increases in efficiency and quality that are both possible and necessary we must all rethink construction".

Also, Ballard, the Co-founder and research director of the Lean Construction Institute underlined the need for more research studies towards efficient resources utilisation, and states that:

"Even though testing of theory and development of the production system is done primarily through field experiments, the implementation of the Lean Project Delivery System is a research topic in its own right. Various fields of study can help us better understand implementation; particularly organisational development. We are specifically interested in the dynamics of organisational change provoked by initiating change in a single element such as production control".

- Ballard (200:7).

In addition, the Construction Excellence (2006a:7) affirms that:

"Lean does work, it reduces cost and time, while simultaneously improving client's satisfaction........But, it's tough, and more importantly, it's tough to keep it going! Perhaps, that is why so many organisations have tried, but so far, few have yet succeeded in making the technique work consistently"

Towards improving construction industry products, the industry requires to rethink the process through which it delivers its projects, with the paramount aim of working towards achieving continuous improvement in performance, (Egan, 1998). Also, Egan (1998) pointed that the construction industry needs to ignore the belief that construction is so unique that there are no lessons to be learned from previous projects undertaken, and to improve through re-engineering all traditional ways of the construction processes, that are restrictive and confrontational.

Therefore, there are clear indications of significant inefficiency in the construction production process and resources utilisation; hence there are needs for adequate integration of project product processes in which resources' wastes in all forms will be reduced significantly to enhance both quality and efficiency.

Based on these established facts from the literature, the current practices, and innovations in the industry towards efficient utilisation of resources during production process were thoroughly evaluated.

7.3 NECESSITY OF THE CRWM FRAMEWORK BASED ON CRITICAL EVALUATION OF THE CONSTRUCTION INDUSTRY CURRENT PRACTICE

The CRWM operational framework was found to be necessary after several current innovations and measures that are in practice in the industry had been thoroughly evaluated.

During the evaluation of current practices, it was found that the following issues have not been addressed and these "gaps" were comprehensively evaluated in this research work.

a) The constraints that unable the site manager being efficient in utilisation of construction resources.
b) The issues of BWS on utilisation of construction resources based on the knowledge, attitude, and perception, (KAP) of construction participants and ascertaining the modalities of minimising or avoiding the effect during production process.
c) Establishment of conscious and unconscious wastefulness of construction resources, and ascertaining the modalities to minimise or avoid the occurrences.
d) The issues of Lean Construction project delivery system on efficient and effective resources utilisation in which many construction organisations found the consistent application of the principles difficult.

Figure 7.1 illustrates the concurrent sequence of the re-assessment process that will improve the construction industry and its products delivery. As illustrated in the Figure 7.1 and indicated in Figure 7.3, the logical sequence of construction resources utilisation re-engineering process towards achievement of the CRWM best practice framework, are:

a) Resources' wastes identification: This is achievable through evaluation of current innovations, principles and practice, and identification of the deficits, (the gaps).
b) Re-assessment of resources' wastes management techniques: Proposition of efficient resources' wastes management techniques and concurrent re-assessment of the current practice approaches towards achieving best practice CRWM.
c) Resources' wastes evaluation: This is achievable through re-engineering of current practice and identification of causes of the inefficient resources utilisation and the establishment of the practical solutions towards efficient CRWM.

The establishment of the CRWM framework will enhance efficient resources utilisation and Lean Construction principles and techniques during the construction production process.

7.4 ESTABLISHMENT OF THE CAUSES OF RESOURCE WASTEFULNESS DURING THE PRODUCTION PROCESS

This research study critically evaluated and ascertained the different causes of inefficient utilisation of construction resources before the commencement and during projects' executions. The factors towards enhancement of Site managers' inefficient performance were ascertained, including the issues that often lead to budgeting for resources wastage, and budgeting for wastes' syndromes. It further evaluated and established the modalities of occurrence of construction resources wastefulness, and the avoidance of the occurrence. These factors are explicitly illustrated in Figure 7.2.

As illustrated in the Figure 7.2 and reflected in Figure 7.3, the research study identified causes of construction resources' wastes in the sequence of wastes generation and wastes proposition. These were related to different types of construction resources', (materials, manpower, and machinery), wastes.

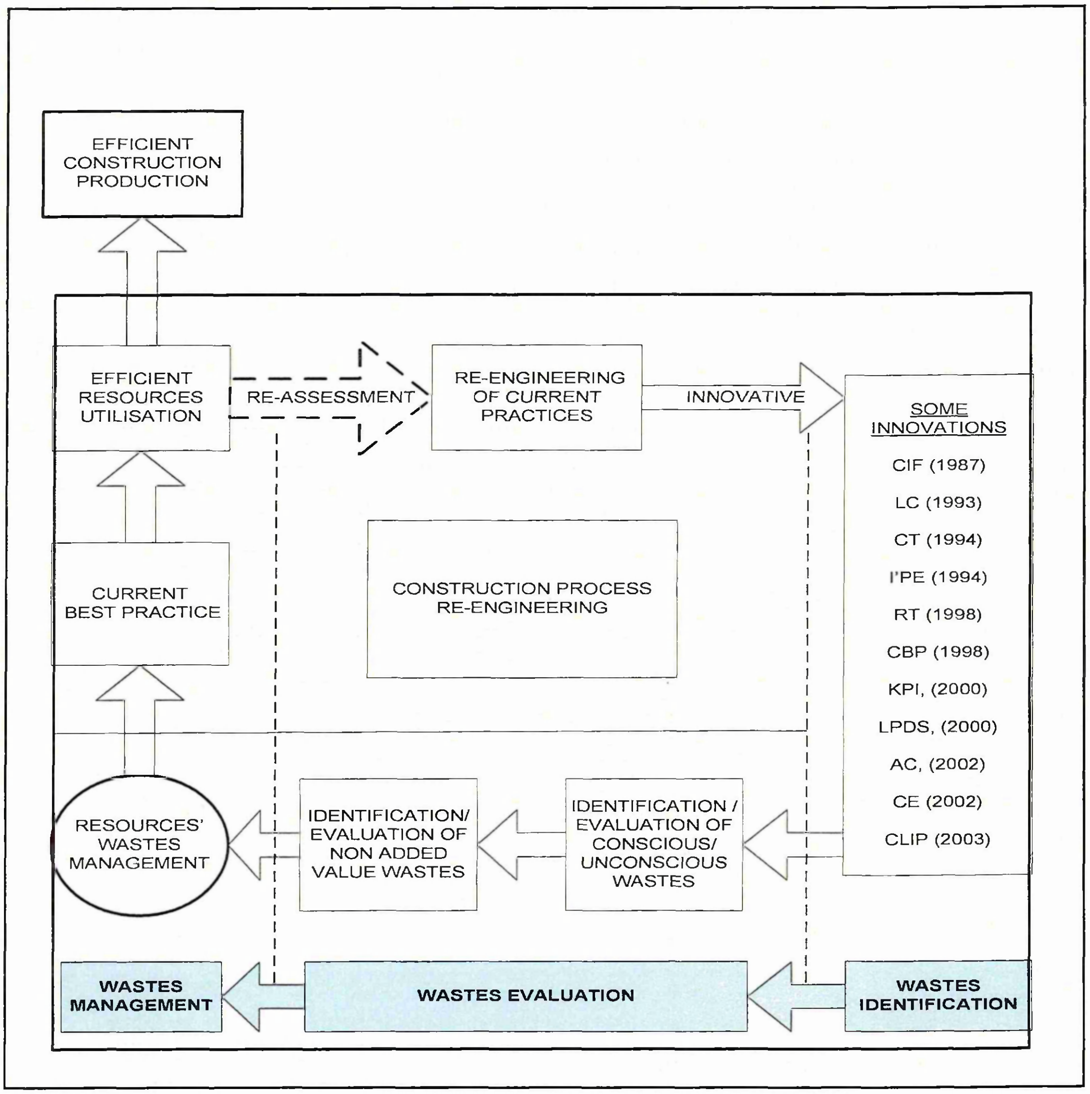


Figure 7.1 Construction Resources Utilisation Re-Assessment Structure

By exploitations of both quantitative and qualitative research surveys, the novel findings that predominantly cause construction resources inefficiency during the production process were achieved. These are illustrated in Figure 7.2 in sequence of:

1. identification of the factors that often lead to resources wastefulness through site managers' circumstances;
2. identification of the rational for making allowance for resources wastefulness, budgeting for wastes' syndromes in the construction industry;
3. identification of the causes of conscious and unconscious wastefulness;
4. identification of types of wastes generated through materials, manpower and machinery utilisation;

5. ascertaining the resultant effects of inefficient construction resources utilisation during production process.

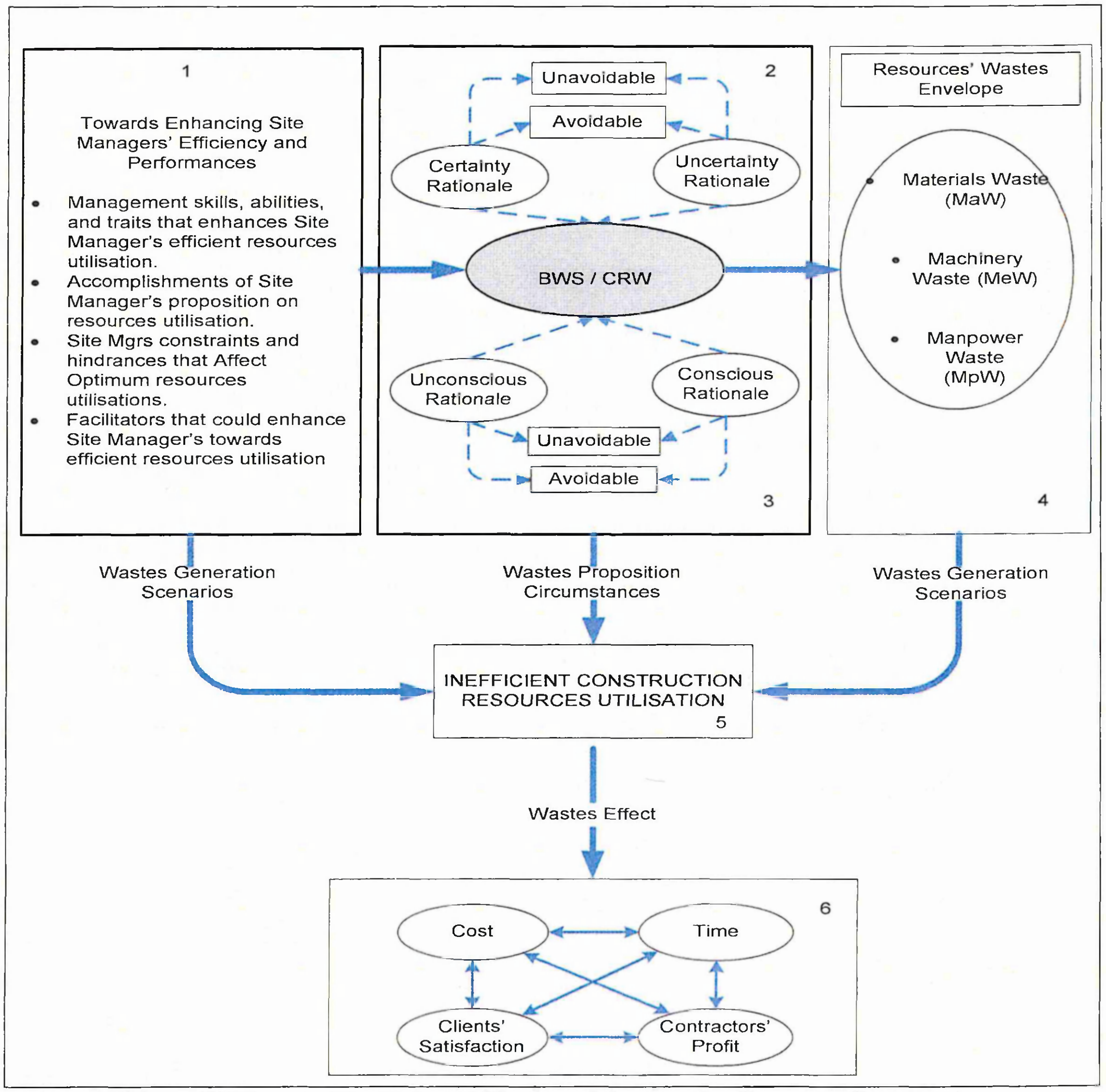


Figure 7.2 Causes of Inefficient Utilisation of Construction Resources Framework

Key: BWS: Budgeting for Wastes' Syndromes; CRW: Construction Resources Wastefulness

The extraneous effects of construction resources inefficiency are the construction cost, delivery time, constructors' profits, and client's satisfaction. However, these factors are assumed to be constant in this research work based on the research proposition. This research is based on the fact that:

> *"A project could be completed within estimated cost, proposed delivery time; to the expected quality, and even to client's satisfaction with lots of resources' wastes"*
>
> - *The research proposition*

Thus, the first part of this research study identified and established the factors that are associated with Site Managers on the inefficient utilisation of resources. By investigating factors that will enhance Site Managers' efficiency and performances, several findings were established and these are presented in Chapters Five and Six

The second part of the research considered the issue of "Budgeting for Wastes' Syndromes", (BWS). These BWS are related to the knowledge, attitude, and perception, of construction site participants towards resources utilisation. The study of BWS is found to be essential since:

> *"At least fifty percent of the problems that exist in projects are either totally or partially behavioural in nature, while, the percentage could be as high as seventy five percent in some project set ups".*
>
> *- Dinsmore (1990:2)*

Also, human co-ordinates, manages, delegates, performs, processes, decides, approves, solve problems and carryout all the activities. The human management process requires making effective use of people that are involved in the project.

In the second part of CRWM research, (Study Two), the workers' beliefs, behaviour, and attitudes on resources utilisation and wastefulness, the contributing factors and the underlying rationales for budgeting for resources' wastes in the construction industry were established. The factors investigated are group based on the sources of occurrence: wastes due to materials, labour, plant and equipment utilisation. Also, wastes occurrence due to production information, site management and design team inefficiency were evaluated.

The final part of the research study, (Study Three), investigated and ascertained the occurrence of conscious and unconscious resources wastefulness, and several findings were established and presented as frameworks towards minimising resources inefficiency.

Based on these three studies, several approaches and possibilities of avoiding the occurrence of resources wastefulness during construction production process were established. Thus, the collective deductions from these three main studies were used to establish the CRWM operational framework.

7.5 CONSTRUCTION RESOURCES' WASTES MANAGEMENT OPERATIONAL FRAMEWORK

This research work significantly evaluates construction resources utilisation, identifies causes of resources wastefulness, and ascertains significant solutions to avoid resources wastefulness in the industry.

Several factors that contribute to resources wastefulness, including solutions to minimise each problem were evaluated, established and presented in Chapters Five and Six, through the explorations of both quantitative and qualitative research methods.

The research aim as stated in Chapter One is:

> "To establish a best practice operational framework for efficient utilisation of construction resources during the production process"

Also, the objectives of this research are:

1) to evaluate and ascertain the Site Managers' constraints that enhances the construction resources wastefulness;
2) to identify and ascertain the rationales of budgeting for resources' wastes in the construction industry;
3) to investigate and establish various sources of resources wastefulness during the construction production process;
4) to ascertain how construction resources could be efficiently utilised, to minimise wastefulness during the production process, based on best practice;
5) to develop and validate a Construction Resources' Wastes Management, (CRWM) operational framework, that will facilitate optimal resources utilisation during the production process.

In line to this research aim and objectives, Figure 7.3, presents the CRWM Operational Framework.

In addition to the Figure 7.3, Table 7.1 presents several factors that require considerations towards efficient resources utilisation. To enhance the practical applications, the findings outlined in Table 7.1 are grouped as follow:

A. Roles and essential attributes of Site managers towards efficient resources utilisation.
B. Causes of resources inefficiency and approaches towards efficient construction resources' wastes management.
C. Drivers towards efficient resources utilisation.
D. Factors that will significantly uphold efficient resources utilisation.

Table 7.1 outlines the significant factors towards efficient resources utilisation before and during the construction production process in sequence of the research objectives. Also, Table 7.2 presents thirty four approaches towards CRWM, and Nine radical approaches that will enhance the effective achievement of the CRWM during production process. The detailed explanations of the factors in these Tables 7.1 and 7.2 have been presented in Chapter Six.

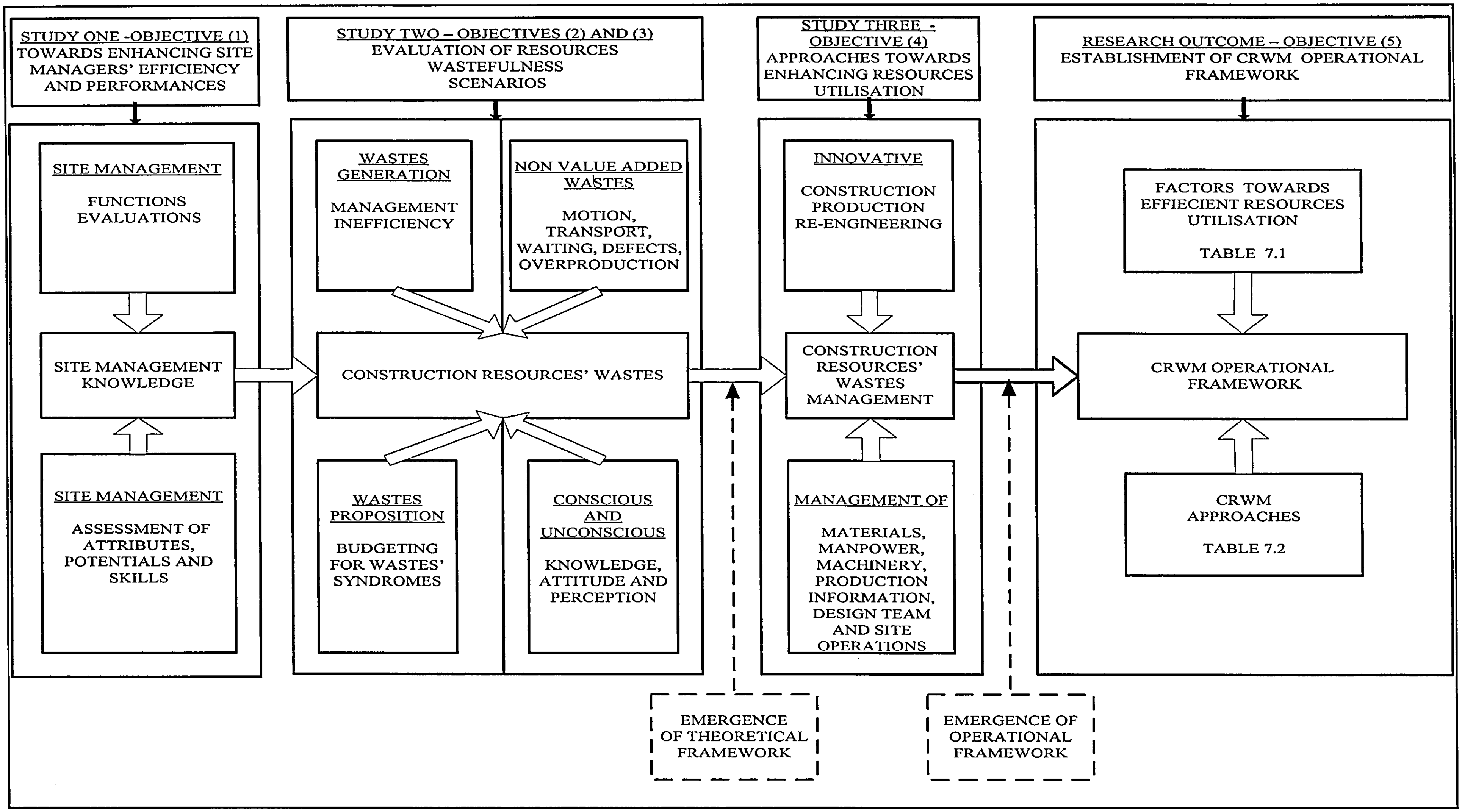


Figure 7.3: CRWM Operational Framework

Table 7.1 Approaches towards Efficient Resources Utilisation

Concepts	Issues Addressed	Findings
A) Roles and essential attributes of Site managers towards efficient resources utilisation	Issue 1: Principal roles of the site managers towards efficient project execution.	Site manager's principal roles are: 1. Effective resources integration and management. 2. Effective team building. 3. Best procurement system. 4. Technical advice. 5. Flops identification. 6. Suggestion of effective alternative methods for construction production processes. 7. Planning towards resources' wastes minimisation and/or avoidance. 8. Effective and efficient communication and information dissemination. 9. Adequate project planning, monitoring and controlling.
	Issue 2: Key Site managers' attributes	Site managers' attributes that are found to be essential are: 1. Knowledgeable on several trades. 2. Ability to identify the limit of workers' efficiency. 3. Awareness and prompt identification of possible problems and hindrances. 4. Quality management. 5. Motivation strategies. 6. Updated health and safety policy.
		The following are found to be useful towards improvement of site managers attributes: 1. Self-development and training. 2. Efficient knowledge transfer. 3. Availability of adequate resources. 4. Efficient and effective team building.

B) Identified causes of resources inefficiency and the approaches towards efficient construction resources' wastes minimisation.	Issue 1: Factors that affects site managers	The identified problems that often affect site managers' efficiency and performances: 1. Contract duration and urgency of the job to commence. 2. Weather conditions. 3. Lack of adequate skilled and experience workers. 4. Lack of adequate experience and confidence of site manager on resources procurement and integration of construction resources. 5. Inefficiency of nominated sub-contractors and suppliers. 6. Design team rigidity. 7. Labour short training period.
		Solutions towards reduction of the effects of the factors that often affect the Site managers' efficiency and performances: 1. Adequate planning and programming of construction resources before and during project execution. 2. Adequate forecast of construction resources market before the commencement of the project. 3. Employing the right teams who are competent for the job. 4. Good team building and efficient construction team for project. 5. Effective communication and information transfer.
	Issue 2: Beliefs of site participants towards resources utilisation	Rationales that made site participants envisage that resources' wastes are inevitable: 1. Construction environment and environmental factors which cannot be predicted precisely. 2. Pre-conception of human errors. 3. Location of some projects; congested or remote areas. 4. Insufficient time to plan properly at project inception, and urgency in the need of the project; delivery time constraints. 5. Inadequate of skilled labour in construction industry; use of semi-skilled workers.
		The solutions to reduce the beliefs that wastes are unavoidable: 1. Motivation and incentives towards wastes' reduction. 2. Setting and striving to achieve wastes reduction target. 3. Good record keeping and information retrieval systems on similar previous projects executed. 4. Enhanced training schemes towards being resourceful. 5. Awareness of resources' wastes implications and wastes reduction benefits.

	Issue 3: Budgeting for Wastes' Syndromes	Major causes of budgeting for wastes' syndromes in the construction industry are: 1. Labour only sub-contractors' carefree attitudes. 2. Clients' unaware or nonchalant attitudes to wastes. 3. Inability to ensure resources efficiency. 4. Lack of adequate and explicit production information. 5. Rigidity of designer on production information without much consideration for construction and resources utilisation implications. 6. Construction projects' locations. 7. Inadequacy of skilled manpower resulting to utilisation of semi-skilled workforce. 8. Alterations and modifications. 9. Avoidance of liquidation damage. 10. Short project delivery time. 11. External factors control limitation, such as weather. 12. Inadequacy of new innovation skilled workers.
		Important solutions to minimise or avoid BWS: 1. Adequate production information preparation time. 2. To value resources wasted for stakeholders' awareness. 3. Adequate planning before and during the project execution. 4. Site manager's advice during design stage. 5. Integration of design dimensions with manufacturers' standards. 6. Availability of complete production information at project inception. 7. Availability of skilled and experienced workers. 8. Readily availability of construction resources when needed. 9. Self-confidence on efficient operation. 10. Adopting of an enhanced partnering and the supply chain systems. 11. Previous knowledge of construction participants on similar work. 12. Standing order and penalty on obvious resources wastefulness. 13. Efficient sub-contractors and suppliers. 14. Adequate wastes reduction training and awareness. 15. Prototype and modular construction projects.

	Issue 4: Site managers' propositions, (intentions) achievement	Major causes of inability to meet the targeted site managers' efficiency: 1. Short initial planning period. 2. Short project delivery time. 3. Modifications during course of project execution. 4. Skeletal production information provided by the design team to commence the project. 5. Aesthetics keenness and over assumption of design team. 6. Shortage of skilled workers.
		Solutions to enhance site managers to achieve the targeted propositions: 1. Detailed design and specifications. 2. Prefabricated materials and panellised components. 3. Experience and efficient suppliers and sub contractors. 4. Effective integration of time saving and cost saving contrast. 5. Unambiguous design and specifications to minimise variations, modifications and alterations. 6. Availability of efficient and skilled workers. 7. Appropriate procurement system. 8. Right work to right person/team(s). 9. Adoption and implementation of prefabrication and modular construction systems. 10. Adequate planning period at project inception.
C) Drivers towards efficient resources utilisation	Issue 1: Factors that should be constant towards efficient resources utilisation	Essential factors that need to be constant towards site managers' efficient performance are: 1. Regular training. 2. Healthy and secured environment. 3. Effective and regular resource(s) market testing and management. 4. Effective information and communication disseminating systems. 5. Adequate and effective planning and forecasting.

	Issue 2: Facilitators towards efficient resources utilisation	Important facilitators towards efficient resources utilisation are: 1. Good communication and effective information dissemination. 2. Favourable environment. 3. Production information simplicity and explicitness. 4. Skilled workers participation on knowledge transferring and sharing. 5. Site manager's previous experience and knowledge from previous similar job. 6. Harmonisation of manufacturers' and designers' innovation. 7. Good managerial experience on various weather conditions and ability to copy and manage adverse weather. 8. Enhanced variations control and client's management. 9. Regular cost analyses and cost checks. 10. Regular and effective site meetings.
		Enhancement of facilitators towards efficient resources utilisation 1. Adequate planning and forecasting. 2. Avoidance of concurrent mistakes. 3. Regular and effective meetings. 4. Right combination and efficient team(s) selections. 5. Regular trainings. 6. Matching the design components' dimensions with manufacturers' standards, or vice visa. 7. Adequate monitory and resources control.
D) Factors that will significantly uphold efficient Resources Utilisation	Issue 1: Conscious resources wastefulness	Causes of conscious resources wastefulness: 1. Improper planning and lack of sufficient time to plan before the project commences. 2. Scarce skilled workers which results in utilisation of semi-skilled and unskilled workforce. 3. Over procurement of labour due to inability to ensure efficiency to meet targeted delivery time. 4. Unplanned redundancy and waiting time of plant and equipment. 5. Non-standardisation of design dimensions with manufacturer(s) standard components. 6. Safety factors in relation to project delivery time warranting engagement of more resources than required. 7. Repetitive work(s) due to poor workmanship. 8. Double handling due to resources positioning, trafficking and movement. 9. Manpower redundancy and over-procurement of labour due to inability to ensure their efficiency. 10. Non environmentally-friendly of the project site.

		Solutions to avoid or minimise conscious resources wastefulness: 1. Availability of sufficient time to plan a project before it commences. 2. Re-planning during project execution to forecast probable inefficient utilisation of resources. 3. Adequate monitoring and control of resources: materials, workers and machinery. 4. Availability of resources when required or needed; on-time delivery. 5. Explicit design and precise specifications taking into consideration manufacturers' standards.
	Issue 2: Unconscious resources wastefulness	Causes of unconscious wastes: 1. Insufficient time to plan before the project commences. 2. Human error and carelessness. 3. Lack of adequate planning against Redundancy of Resources. Plant and equipment purchased or hire and remain redundant or unused for a long period of time. 4. Poor and inadequate design and resource specifications. 5. Inadequate or lack of experience from similar previous job(s). 6. Double handling due to resource positioning, trafficking and movement.
		Solutions to reduce unconscious resources wastage: 1. Proper planning and re-planning as the project progresses. 2. Training of workers to be aware of the benefits of efficient resources utilisation. 3. Enhanced information dissemination and effective communication. 4. Making workers to be responsible for flimsy mistakes. 5. Adequate monitoring of workers and plant efficiency to avoid redundancy. 6. Adequate supervision by experience/skilled superiors. 7. Availability of resources when required or needed; on-time delivery. 8. Minimisation or avoidance of alterations and modifications during work in progress. 9. Adopting of effective supply and fix contractors or suppliers.
	Issue 3: Clients and resources wastefulness	How client(s) can help to reduce or avoid construction resources wastefulness: 1. Seek to know the magnitude and value of resources wasted during project execution. 2. Seek for alternative resources available that could save cost and time. 3. Seek the advice of an experienced construction site manager before the project commences.

	Issue 4: Partnering and the Supply chain towards efficient resources utilisation	How partnering and supply chain systems can effective reduce inefficient resources utilisation: 1. Adhering to regular partners and the supply chain contractors. 2. Manufacturers' components production in concordance to design specifications. 3. Involvement of partners and the supply chain contractors during bidding. 4. Effective implementation of panellised and modular construction systems. 5. Partners' comparative advantage and mutual collaborations. 6. Awareness of new trends of construction methods and innovations which are efficient in resource use.
	Issue 5: Skilled workers shortage	Causes of skilled workers shortage currently: 1. Trainees often avoid apprenticeships for long period. 2. The demand of workers tied with a scarcity of skilled labour. 3. Emergence of many construction works and regeneration. 4. Easy mobility of construction labour.
		Solutions to minimise skilled workers shortage: 1. Need to revisit old system of skilled workers training systems. 2. NVQ and production performance efficient trainings are essential. 3. Detailed construction problems and possible solutions' records/database are required for training. 4. Intensive skilled training courses and examinations. 5. Adequate knowledge shearing from experienced workers. 6. Collaboration training between vocational schools, colleges and universities. 7. The construction participants need to know the implications of being efficient. 8. Modular and prefabrication materials' components utilisation which will reduce labour usage. 9. Modular forms of construction methods that will ease the training of learners.
	Issue 6: "Man-made" Problems	Solutions to reduce or avert causes of "man-made" problems: 1. Regular and effective training. 2. Adequate information disposition. 3. Proper planning and management 4. Adequate and effective induction(s).

	Issue 7: Motivation of construction participants towards efficient resource utilisation.	Possible ways to motivates construction participants: 1. Good working environment with adequate infrastructure and facilities. 2. Carrier building, training and knowledge transfer. 3. Setting and adhere to wastes target set and to make the workers belief that the target can be achieved. 4. Profit sharing based on the value of resources' wastes saved. . 5. Appreciation for job performed efficiently.
	Issue 8: Construction industry is lagging behind other sectors in efficient resources utilisation.	Major causes of construction industry lagging behind in efficient utilisation of resources in comparison to manufacturing and service sectors: 1. Construction sector is more labour intensive in comparison with other sectors. 2. Human errors are higher in construction industry than manufacturer(s) automated machines. 3. Various unpleasant environmental factors, manufacturing, and service sectors are normally in a controllable and conducive environment. 4. Several manufacturers' components are mechanical or automated fix.
		To bridge the gap of construction industry being lagging behind other sectors: 1. Adoption and implementation of effective and efficient partnering and the supply chain systems. 2. Adoption and implementation of modular and prototype construction concepts. 3. Construction project(s) components standardisation and uniqueness. 4. Adequate and effective skilled labour training. 5. Adequate monitory and control of the construction resources utilisation. 6. Adequate and effective recording of construction problems, mistakes and their solutions into database for referencing and training.

TABLE 7.2 CRWM BEST PRACTICE	
(A) Approaches towards CRWM	1) Engaging regular sub-contractors and suppliers. 2) Regular appraisal of sub-contractors and suppliers. 3) Fully developed production information. 4) Design towards cost and time savings. 5) Effective knowledge management. 6) Good working environment. 7) Achievement recognition and penalty for obvious mistake. 8) Design to manufacturers' standards. 9) Engaging a Resources' wastes manager. 10) Adequate planning of resources procurement. 11) Development of enthusiasm towards efficient resources utilisation. 12) Awareness of resources' wastes implications. 13) Setting wastes target. 14) Enhanced supply and fix contracting. 15) Adopting adequate resources' wastes disposal techniques. 16) Adequate awareness of wastes reduction benefits. 17) Designers need to specify re-usable materials. 18) Designing convertible structures and specifying convertible materials. 19) Adoption and implementation of effective panellised and prefabrication, modern methods of construction techniques. 20) Monitoring set target with the site KPIs. 21) Effective training for skilled workers. 22) Training toward efficient resources utilisation. 23) An enhanced and effective partnering and the supply chain systems. 24) Readily available resources on request. 25) Adequate resources programming. 26) Regular effective meetings on resources utilisation. 27) Making clients aware of the value of wasted resources. 28) Design and specify to manufacturers' standards. 29) Adoption of modular components and construction. 30) Minimisation or avoidance of alterations and modifications. 31) Avoidance of short leading time for project commencement. 32) Effective and efficient information dissemination. 33) Avoidance of perpetual plant and equipment inefficiency. 34) Adequate assessment of design concept buildability.
(B) Radical approaches that will enhance the effective achievement of the CRWM	1) Consistency in utilisation of suppliers, and sub-contractors; those that are already familiar with the organisation policies. 2) Adoption and implementation of proactive operation and mission statements for construction participants. 3) Avoidance of aged and traditional construction operating systems and concepts. 4) Adoption of modalities to value resources wasted at project completion and its cost implication need to be presented to all the construction participants. 5) Designers' specifications and dimensions should be in concordance with the manufacturers' standards. 6) Avoidance of bricks and blocks for construction works. 7) Adoption and implementation of smart and re-usable components for construction. 8) Adoption and implementation of a mandated efficient production performance training certificate. 9) Availability of construction database problems, including their respective possible solutions.

7.6 SIGNIFICANCE OF THE CRWM OPERATIONAL FRAMEWORK

The CRWM study achieves the following novel outcomes:

a) The establishment of a framework that will enhance site managers towards efficient construction resources utilisation. This research addressed the issues of inefficient resources utilisation, and inefficient implementation of site managers' functions from the perspective of inherent constraints that leads to resources inefficient utilisation during the production process. Site managers' strengths, weaknesses, opportunities, and threats, (SWOT) were identified. The factors that hinders, and those that will enhance site managers towards efficient performance during the production process were ascertained. This Site Management Efficient Performance, (SMEP framework) was established and presented in this research Study One.

b) The establishment of a framework for budgeting for resources' wastes syndromes in the industry. The behavioural features of site participants based on knowledge, attitudes and perceptions were evaluated, and solutions to minimise or to avoid these problems were identified and ascertained. Thus, effects and solutions to Budgeting for Wastes' Syndromes were established, (EBWS framework) and presented in this research Study Two.

c) The establishment of a framework for minimisation and avoidance of the occurrences of conscious and unconscious wastefulness of resources during production process. This research study identified and ascertained the rationales for construction resources wastefulness, (CRW), based on conscious and unconscious occurrences. Several occurrences were unfolded. A framework on Avoidance of Construction Resources Wastefulness, (ACRW) was established and presented in this research Study Three.

d) The establishment of an operational framework for Construction Resources' Wastes Management, (CRWM). This is the combination of the research studies One, Two, and Three. The established Construction Resources' Wastes Management operational framework, (CRWM operational framework) is presented as Figure 7.3 and Tables 7.1 and 7.2.

The efficient implementation of the CRWM best practice framework will:

a) Significantly enhance the construction stakeholders' prediction of possible causes of inefficiency in resources utilisation, before or during construction project. Also, to ascertain factors that need consideration which will significantly guide against resources wastage occurrences, either consciously or unconsciously;
b) Reduce construction costs, delivery time and consequently, enhance client's satisfaction;
c) Enhance Lean Production Delivery System, (LPDS) and Construction Lean Improvement Programme, (CLIP) initiations of which the consistent applications are still difficult in the industry; and
d) Enhance efficient resources utilisation and sustainability in the industry.

7.7 CHAPTER SEVEN SUMMARY

This chapter outlined the need and the significance of the research framework in relation to established facts from literature and current innovations in the UK construction industry. The objectives and the novelty of each part of the research study were clearly highlighted. The factors that were considered during the evaluations and establishment of the causes of inefficient resources utilisation were illustrated; this includes the construction innovation re-assessment process. These illustrations, (Figures 7.1 and 7.2) augment the research theoretical framework, (Figure 4.3) and were incorporated into the best practice CRWM framework.

The novel CRWM best practice framework was presented in both figures and tables for practical application. Several causes of inefficient resources utilisation and the solutions to each predicament are presented in Table 7.1. In addition, Table 7.2 presents thirty four factors that will significantly enhance CRWM and nine radical approaches that will strengthen the successful achievement of the CRWM.

In this Chapter Seven, the originality of the CRWM research study and the importance of the efficient implementation of the CRWM framework established were outlined.

The next chapter, (Chapter Eight) presents the validation report of the CRWM best practice operational framework.

CHAPTER EIGHT

CRWM OPERATIONAL FRAMEWORK VALIDATION REPORT

8.0 CRWM OPERATIONAL FRAMEWORK VALIDATION REPORT

8.1 CHAPTER INTRODUCTION

This chapter presents the CRWM operational framework validation report. The CRWM framework established in Chapter Seven was presented to practical and experienced construction site managers for verification. This is to affirm the strength, weakness, reliability and practicability of the research framework. The validation process is divided into two stages. The significance of each stage is clearly defined in each stage section. Each stage feedback is presented, analysed and the outcomes are clearly outlined. The combined outcome and significance of the two validation phases are summarised and presented, and the chapter concludes with a chapter summary.

8.2 VALIDATION STAGE ONE - VERIFICATION OF THE FFECTIVENESS AND RELATIVE IMPORTANCE OF THE SOLUTIONS AND RADICAL APPROACHES TOWARDS CRWM

The solutions towards CRWM outlined in Chapter Seven, (Table 7.2), were presented in the form of questionnaires for evaluation. This is to rank the factors in order of importance and to ascertain the practicality of the factors. Twelve construction site managers participated in the assessment. The respondents were instructed to rate the factors in the questionnaire in order of agreement, from (1) to (5); where (1) denoted "absolutely disagreed", and (5) indicated "strongly agreed". Also, columns, (spaces) were provided in the questionnaires for the respondents to comment on each factor; to affirm the practicability and effectiveness of these factors towards efficient resources utilisation and resources' wastes management during construction production process.

The questionnaires were sent to the respondents to be completed, and the respondents were interviewed on the collection day of the completed questionnaires. The interview enhanced the questionnaires' responses and enabled the respondents to provide detailed explanations and the rationales of agreeing or disagreeing with the factors presented for the assessment.

The questionnaires data collected were collated and analysed using the Statistical Package for Social Sciences, (SPSS), and the analysed data and findings are presented in Sub sections 8.2.1, 8.2.2, and 8.2.3.

The questionnaires administered for this assessment is shown as in Appendix (C3).

8.2.1 Validation Stage One - The Respondents' Demography

Considerations were given to the twelve construction site managers who participated in this first stage of the research framework validation, in respect to the respondents' status, years of managerial experience in the construction industry, and the size of organisation they work. The participants work within multinational organisations with wider geographical operational areas, hence they have acquired various, broad and seasoned experience and knowledge in resources utilisation and construction resources' wastes management.

Table 8.1 shows cross-tabulation of the respondents' current managerial positions, and the respective years of managerial experience in the construction industry. This Table 8.1 shows that the majority of the respondents are project managers, (58.3%); 16.7% are site managers; while the senior site manager, senior project manager and senior contract manager represent 8.3% each. Also, 75% of the respondents have above fifteen years of working experience as a manager in the construction sector, with 25% having between 11 and 15 years of working experience.

Table 8.2 shows that the organisations, in which the respondents' works, operate in wider geographical regions in the UK; 25% of the organisations cover eight regions, while others cover not less than nine regions. In respect of numbers of employees, only one organisation engaged between 351 and 400 full time workers currently, while the remaining 11 respondents' organisations have more than 400 employees.

Therefore, it could be affirmed from Tables 8.1 and 8.2 that the respondents possess adequate managerial skills, potentials and experience in construction resources utilisation and management.

Table 8.1 Managerial Positions of the Respondents; and the Number of Years as a Manager in the Construction Sector

		Number of years as a manager in the construction sector		Total	%
		(11 - 15)yrs	Above 15		
Managerial positions	Project managers	2	5	7	58.3
	Site managers	1	1	2	16.7
	Senior site manager		1	1	8.3
	Senior project manager		1	1	8.3
	Senior contract manager		1	1	8.3
Total		3	9	12	
%		25%	75%		

Table 8.2 Number of full time Employees working presently in the Respondents' Organisations in the UK, and the Number of Regions, (Counties), in which the Respondents' Organisations operate in the UK

		Number of regions in which the respondents' organisations operate in the UK					Total	%	Cumulative %
		Eight	Nine	Ten	Eleven	Fourteen			
Number of full time employees working in the respondents' organisations, in the UK	Over 400	2	1	1	6	1	11	91.7	91.7
	351 – 400	1	0	0	0	0	1	8.3	100
Total		3	1	1	6	1	12		
%		25	8.3	8.3	50	8.3			
Cumulative %		25	33.3	41.6	91.6	100			
		25	75%						

8.2.2 Respondents' Feedback on Solutions towards CRWM

The respondents assigned the appropriate values to the proposed factors from "strongly agreed" (5), to "absolutely disagreed", (1). Table 8.3 shows the rank and order of the factors, on the relative importance of the factors towards efficient resources utilisation. Also, in Table 8.3, each factor "Strongly agreed" and "agreed" percentages are summed together and presented in the adjacent column. It was found that the addition of each factor strongly agreed and agreed rate of all the 34 factors are above average. This table illustrates that eleven factors have a very high influence on efficient resources utilisation during the production process, with 100% agreement rate. Also, there is a clear indication that the last three factors have lesser influence on optimal resources utilisation, in comparison with other factors.

Table 8.3 Validation Stage One: Respondents order of agreement of the solutions towards CRWM

The Solutions towards CRWM in order of preference		Frequency in %				
		(A) Strongly agreed	(b) Agreed	(Strongly agreed) + (Agreed)	(c) Less agreed	(d) Disagreed
1	Availability of fully developed production information before the project commences	100	0	100	0	0
2	Adequate planning of resources procurement	83	17	100	0	0
3	Buildability assessment before project commences	83	17	100	0	0
4	Adequate resources programming and forward planning	83	17	100	0	0
5	Regular assessment of sub-contractors and suppliers efficient performance and skills updating	75	25	100	0	0
6	Effective implementation of modular components and modular construction methods.	67	33	100	0	0
7	Availability of adequate time for planning project before it commences	67	33	100	0	0
8	Adoption of adequate resources' wastes disposal techniques	50	50	100	0	0
9	Effective and efficient information dissemination and retrieval during construction production process	50	50	100	0	0
10	Readily available resources on request through adequate procurement system	42	58	100	0	0
11	Adequate implementation of resources supply and construct and/or fix contracting methods	25	75	100	0	0
12	Design to manufacturers' standard dimensions	75	17	92	8	0
13	Provision of adequate infrastructures, facilities and safe working environment	67	25	92	8	0
14	Avoidance or minimisation of alterations/ modifications during construction process	50	42	92	08	0
15	Provision of effective motivators for the trainees and apprentice	42	50	92	08	0
16	Adequate monitory of wastes target set against site KPIs,	42	50	92	08	0
17	Motivation towards enthusiasm and efficient utilisation of construction resources	25	67	92	08	0
18	Effective training toward efficient resources utilisation	17	67	84	8	8
19	Effective partnering and the supply chain systems	58	25	83	17	0
20	Regular engaging or employing sub-contractors and suppliers	58	25	83	17	0

21	Setting wastes target and strive towards achieving the set target	50	33	83	17	0
22	Consciousness of design team towards efficient resources utilisation and resources efficiency	33	50	83	17	0
23	Adoption and implementation of effective panellised, prefabrication, and modern methods of construction systems	25	58	83	17	0
24	Adoption and efficient implementation of site KPIs	25	58	83	17	0
25	Construction participants and clients need to know value of wasted resources accrued during project execution.	25	58	83	9	8
26	Construction and design teams viable/ effective meetings on resources utilisation.	25	58	83	9	8
27	Adequate awareness of resources' wastes implications on construction product(s).	25	58	83	9	8
28	Design and specify re-usable materials, as far as possible	58	17	75	17	8
29	Construction participants adequate awareness of benefits that accrued for resources' wastes reduction	50	25	75	25	0
30	Avoidance of perpetual plant and equipment inefficiency	42	33	75	25	0
31	Construction participant achievement recognition of excellence and "threat" of penalty for obvious mistake(s)	33	42	75	25	0
32	Engaging resources' wastes manager	33	34	67	33	0
33	Designing convertible structures and specifying convertible/re-useable materials.	25	42	67	25	8
34	Effective implementation of knowledge management and transfer	8	59	67	33	0

The majority of the respondents' affirmed that these facts are ideal and important towards efficient resources utilisation. However, from the respondents' comments, it was established that the construction client(s) often provide insufficient time for project commencement, and there is often a requirement for a project to be delivered within a short duration of time; these considerably affect adequate project planning before the project commences.

The issue of inadequate production information for construction was related to the design fees provided by the clients for the preparation of the construction production information package. Most often the cost of design is habitually low in order to reduce total construction cost. Hence, the designers often keep detailed drawings to a minimum to reduce the drawings' costs.

Also, the majority of the respondents ascertained that, to reduce construction resources' wastes, adequate collaboration between the design and construction teams is important. In addition, to enhance the use of construction resources efficiently, sufficient planning time before the project commences, and the engagement of regular suppliers or the supply chain sub-contractors are absolutely essential.

8.2.3 Feedback on Radical Approaches towards CRWM

The radical approaches established towards CRWM were presented to the respondents to ascertain their practicality and reliability. These are the factors that will significantly enhance the established solutions towards construction resources utilisation inefficiency. The analysed feedback is presented in Table 8.4 and was augmented with the comments provided by the respondents.

The majority of these approaches are agreed with by the respondents. Among these factors, the respondents rated four approaches as being highly significant towards achieving optimal CRWM. Each of these four factors has a 100% agreement rate, (the summation of “Strongly agreed” and “Agreed”). The acceptance of “eradication or avoidance of in-situ construction works” towards enhancing CRWM was rated to be less significant in comparison with other factors, though the rate is above average, (67%).

From the supportive information provided by the respondents, it is affirmed that the majority of these approaches presented towards enhancement of CRWM are excellent. However, some of the propositions could be somewhat difficult to achieve based on divergent organisations’ potentials, clients’ needs and requirements. Also, the majority of well organised construction firms innovate and built-up skills are the company strengths to achieve an advantage over others. Thus, a few organisations may be reluctant to provide viable facts towards the “availability of a database for various rationales and causes of inefficient resources utilisation, and practicable solutions to achieve efficiency” for general use.

Also, the majority of the respondents emphasised that the "eradication or avoidance of the older and traditional construction operating systems and concepts" could be a long term aim to achieve less wasteful resources; presently some construction traditional systems are still more economical, while some are more efficient in use than the contemporary, (modernised) ones.

Table 8.4 Validation Stage One: Respondents' order of Agreement to the Radical Approaches towards CRWM

The radical approaches towards CRWM in order of preference		Frequency in %				
		(A) Highly agreed	(B) Agreed	((Strongly agreed) + (Agreed)	(C) Less agreed	(D) Disagreed
1	Designers' components, specifications, and dimensions should be in accordance with manufacturers' standards.	83	17	100	0	0
2	Adoption and implementation of a certified production performance training certificate	50	50	100	0	0
3	Adoption and implementation of practical procedures and mission statement to construction participants on efficient resources utilisation.	25	75	100	0	0
4	Availability of database for various rationales and causes of inefficient resources utilisation, and possible solutions to achieve efficiency	67	25	92	8	0
5	Organisations need to be consistent on engaging suppliers and sub-contractors	58	34	92	08	0
6	Adoptions of modalities for valuing cost implications of all resources wasted during construction process at project completion	42	50	92	08	0
7	Adoption and implementation of smart, and re-usable components for construction	58	17	75	25	0
8	Avoidance of the aged and traditional construction operating systems and concepts	42	33	75	17	8
9	Avoidance of in-situ construction works, (bricks and blocks).	50	17	67	25	8

8.3 VALIDATION STAGE TWO - VERIFICATION OF THE APPLICABILITY AND VIABILITY OF THE CRWM OPERATIONAL FRAMEWORK

This is the second stage of the CRWM framework validation. The first stage of the research framework validation established the relative importance of all the solutions and approaches towards CRWM, while this Stage Two is conducted to verify the viability and practicality of the research framework. Each respondent's feedback, comments and suggestions are analysed and the follow up actions taken are outlined.

8.3.1 Validation Stage Two– The Respondents' Demography

Four experienced construction managers, working in different construction organisations, were provided with the CRWM operational framework, (Figure 7.3, Tables 7.1 and 7.2), for appraisal. The purpose of the framework validation, including the aim and objectives of the research study were clearly stated in the letter sent to the respondents. The managers that participated in this Second Stage of the framework validation are outside those that participated in Stage One. This is to enable a new set of construction personnel to view and comment on the viability and practicality of the framework. Table 8.5 shows the demography of the team that were involved in the validation Stage Two. All the respondents have above fifteen years work experience and all the organisations where these respondents' works have over 500 full time employees.

Table 8.5 Stage Two Validation: The Respondents' Demography

Organisation (Name withheld)	Managerial status of the respondents	Years of experience as a manager	Number of employees in each respondent's organisation	Organisation type
A.	Project manager	Above 15	Over 500	Design and Build Management Partnership
B.	Senior project manager	Above 15	Over 500	Estate Developers' Corporation
C.	Project manager	Above 15	Over 500	Design and Build Contractors
D.	Senior site manager	Above 15	Over 500	Design and Build Contractors

8.3.2 Respondents' Feedback

The feedback received on the CRWM framework was remarkable and encouraging. The respondents clearly expressed their opinion and pointed out several issues that require clarification or modification. The responses from each verifier and follow up actions are as follow:

(A) Verifier One - Comments and Suggestions

You have identified very good and coherent points that adequately address various issues towards CRWM and which will ultimately enhance resources utilisation during the production process. I strongly agree with most of the points, (factors) you identified. Generally, this is good research with value adding information and findings for managing construction projects and developing the industry; to be more responsive to resources usage and ultimately clients care.

However, you can note these comments as additional information:

- In the framework figure presented, among the "approaches towards enhancing resources utilisation"- In my opinion, it is significant to include the management of:

- Stakeholders expectations;

- Clients Objectives and Strategic Briefing;

- Programme and appropriate sequencing of activities

These factors are essential as they directly or indirectly affect resources usage.

- You stated major roles of the Site Managers, which some are somewhat Project Managers' duties. The Site Managers role is more of an implementer than a planner.

- In the radical approaches towards CRWM, you pointed "the avoidance of bricks and blocks for construction works". I agreed that these materials utilisation causes lots of resources wastefulness and are labour intensive in comparison with precast or prefabricated materials. Nevertheless, bricks and blocks are more useful in some parts of the building envelope than other materials. They can also be crushed, and re-cycled. I will rather suggest the words "the minimisation" rather than "the avoidance".

- In the factors identified on causes of "the construction industry lagging behind in the efficient resources utilisation in comparison to manufacturing and service sectors", I strongly agree with all these points you mentioned - the causes and solutions to bridge the gap. Besides, construction processes unlike manufacturing have many unforeseen circumstances which are unpredictable.

Feedback Analysis (A)

- This framework is developed to reduce construction resources wastefulness during production process. The research is of the opinion that the Client's expectation, objectives and strategic briefings must have been taken into consideration during the project design stage, and production information preparation.

- In this research work, Site Manager is being referred as any project construction leader that engages in day to day management of construction work during production process. This is clearly defined in the "Glossary of Terms". Besides, different organisations have different designations for a project leader, (Site Manager, Project Manager and Construction Manager).

(B) Verifier Two - Comments and Suggestions

This research work is very logical and rational. The established solutions and approaches towards CRWM Tables 7.2 are very extensive. A site management resources waste plan for a particular contract will improve waste management practices and help to reduce the amount of wastes produced (and the associated cost). To obtain the best possible results, a full waste minimisation initiative is the key to success, either in small or large project.

In affirmation, before any project commences, a Project Leader should be in place, and this project leader:

- *Must be able to communicate with staff and management;*
- *Should be able to put in place the required resources, information, staff motivation and training strategies;*
- *Have a good knowledge of the Contract and especially its operations side, including Health and Safety; and*
- *Management must also recognise that the Project Leader will require time set aside for waste minimisation activities.*

Thus, when the Project Leader has been established, the programme can get underway, following the steps below:

- *Planning;*
- *Site Acquisition;*
- *Production Process;*
- *Staff Education and Training; and*
- *Monitoring.*

Probably the framework can also incorporate these five essential factors?

Feedback Analysis (B)

All these factors have been evaluated in the research objectives two and three, presented in detail in Chapters Five and Six and integrated in the framework. Planning is one of the major roles of a Site Manager. However, apart from adequate planning before the project commences, planning is required at any interface of project stages and is essential to re-plan when there is any alteration or modification to the initial Business Case. Staff acquisition, Staff Selection and Effective Team Building have been clearly stated among the major roles of a project/site manager's attributes; the attributes that will enhance efficient utilisation of resources and minimisation of resources' wastes during production process. The research established that Staff education and training are essential and have been stated among the issues that require urgent attention in the construction industry. The problem of having an inadequate supply of skilled workers is one of the major factors causing both conscious and unconscious resources wastefulness, and several solutions to minimise the effects have be defined in the framework.

(C) Verifier Three - Comments and Suggestions

- Based on the research objectives you presented, the Research Framework flowchart is logical, illustrative and rational from where it started to the final objective, (the outcome). However, in my opinion the Design Process need to be considered before the evaluation of the Site Manager' Efficiencies and Performance. For effective waste management, the Design Process has to be carefully considered in addition to other factors of resources waste management process outlined in your framework flowchart.

- The factors identified under "the Roles and Essential attributes of Site Managers towards efficient Resources Utilisation" are too generic. Probably you could separate the roles of a Site Manger from a Project Manager. Note that a Site Manager is a small "cog" in a big "engine".

- In my opinion, the 34 itemised factors on "Approach to minimise or avoid Construction Resources Wastefulness" are okay, though some need more expansion to enhance clarity.

- Many factors have been identified as the solutions or approaches to CRWM in the Table 7.2. These factors are very practicable. However, is it possible to integrate these factors? Probably there may be a need to rank these factors; to identify the most paramount ones and less significant ones.

Feedback Analysis (C)

- The CRWM framework is developed towards efficient resources utilisation during the production process. The framework is based on a proposition that, "a project could be completed within budgeted cost, time frame, quality expected and even satisfy clients' needs with lots of resources wastefulness. However, the effect and significance of the Design Phase on resources waste management were considered, evaluated and presented among other issues in Chapters Five and Six, (under Research Objectives Two and Three). The research identified the need for adequate and explicit production information for construction works and several requirements that will enhance the Design Team in its preparation were drawn.

- The issue of dividing roles of site manager and project manager have been explained under analysis of the first verifier's feedback. In addition, in an organisation with several site managers reporting to a superior line manager, all the managers' task is to efficiently utilise construction resources.

- The detailed explanations of all the outlined factors in this framework are presented in Chapter Six. However, as suggested by the verifier, the outlined factors, (phrases), presented in the Tables were further checked, modified and stated explicitly.

- The verifiers of the validation Stage Two framework are not aware of the first phase of this research framework validation. The ranked order of relative importance of the solutions and approaches towards CRWM best practice approach have been established in the framework validation stage one. The feedback obtained and the analyses are presented in Section 8.2.

(D) Verifier Four - Comments and Suggestions

- A well thought out approach to CRWM, with a great deal of information that requires collation and adoption by the construction industry. There is a great deal of educating required in the industry towards effective implementation of this CRWM framework established.

- During the construction stage, Site Mangers have a great deal of input in resources waste management through efficient operation/implementation of the production processes. I agree with the factors you identified in this framework, they will ultimately enhance Site Managers' efficiency on resources utilisation.

- This is a very informative study and you seem to have analysed all resources waste problems from all directions. You have managed to put on paper what every Site Manager should be doing on any project s/he works on. I will be interested to read your final CRWM best practice.

8.4 CHAPTER EIGHT SUMMARY

This chapter presented the analyses and reports of the CRWM operational framework validated. The framework validation was conducted in two phases. The first stage collected information from twelve respondents on the relative importance and effectiveness of all the factors towards CRWM best practice. The Second stage sought the opinion of four verifiers on the practicality and strength of the CRWM framework developed.

The respondents were randomly selected; however, there was careful consideration of the managerial status, and the size of organisation in which the respondents' works. These criteria are very important factors to achieve reliable and viable findings. None of the respondents has less than eleven years working experience as a manager, and none of the companies in which the respondents' works employed less than 350 permanent construction site workers. All the organisations were multinational. Thus, there are clear indications that all the validation participants are practically and widely experienced in construction resources utilisation.

The questionnaires administered for the first stage of the framework validation were augmented with interviews, which enabled each respondent to comment and affirm the answers provided on the structured questionnaires. No interview was conducted in the second stage of the validation, only the framework figure and tables were presented to the respondents for verification.

In the validation Stage One, the solutions and radical approaches towards CRWM outlined in Table 7.2 were verified; to ascertain the effectiveness of their practical application towards efficient resources utilisation. This process also allowed the factors to be ranked in order of importance towards CRWM. From the information analysed, there were clear indications that the approaches are feasible towards the minimisation and/or avoidance of construction resources wastefulness during the production process.

Also, it was established that there is a need for a radical change in the way all construction organisations deliver their products. In consequence, the construction sector needs to be more proactive in resources' wastes reduction. In addition, all the respondents ascertained that to achieve the best out of the facts outlined, the design and construction teams need to work in conjunction with the clients towards adequate implementation of the resources' wastes management strategies, (the best practice), in order to reduce construction resources' wastes that have been accepted or disregarded in the past.

The CRWM operational framework validation Stage Two verifiers ascertained that the framework developed is very robust, vast, and practicable. The respondents virtually agreed with all the factors, solutions and the framework established. It was confirmed that the research study analysed resources' wastes problems from various practical directions. In addition, the respondents ascertained that the findings are valued and worthy of adoption and implementation by the construction industry. However, the verifiers pointed out a few issues that require clarification and modification which were duly addressed.

In summary, the validation stages one and two respondents and verifiers strongly affirmed that the CRWM framework is viable and the effective implementation will vastly reduce resources wastefulness during construction production process.

The conclusion and areas that required further research, based on this research findings and frameworks, are presented in the next chapter, (Chapter Nine).

CHAPTER NINE

RESEARCH SUMMARY, RECOMMENDATIONS AND CONCLUSION

9.0 RESEARCH SUMMARY, RECOMMENDATIONS AND CONCLUSION

9.1 CHAPTER INTRODUCTION

This chapter summarises all the phases of the research process; the methodology, the research design, including the summary of the research findings. In addition, based on the research findings, this chapter recommends some practical areas that require further studies.

Research towards enhancement of CRWM, based on resources utilisation, lean construction, and resources sustainability is inexhaustible. However, several significant factors towards construction resources waste management were established and highlighted in this research study. There is a need for concurrent re-assessment of construction resources utilisation in the industry, thus, areas for further studies based on the inferences established in this research work are recommended. Also, this chapter presents the conclusion drawn from the CRWM study and the chapter summary.

9.2 RESEARCH PROCESS SUMMARY

(a) Research Introduction

Chapter One introduced the research work and clearly established the need for the research, including the research aim, the objectives, research question and sub-questions, and summarised the research methodology and approach that was exploited to achieve the research objectives. The research information was collected within the UK construction industry; with the conviction that the UK construction industry is vast in innovation. Thus, it is of opinion that the results obtainable will be significantly viable for construction efficient resources utilisation globally.

(b) Literature Review

Chapter Two presented the statement of facts from literature on construction project management principles, site managers' functions, knowledge, skills, and attributes on construction resources utilisation. Also, current innovation, principles and practices in the UK construction industry toward achieving effective and efficient project objectives during construction operation process were appraised.

(c) Research Methodology

Chapter Three presented the research methodology. In this part of the research, different types of research methodology, the merits, and demerits, and also the rationales for adopting diverse research methodology were ascertained. A mixed methods research approach was adopted for this research study. It involves the exploitation of quantitative questionnaires and qualitative interview research methods. Thus, this part assists in the identification of the appropriate research design and methods that were employed.

(d) Research Methods

Chapter Four presented the research design and methods. The approaches that were adopted for information and data collection for the research study were clearly stated; including the approaches and modalities that will enhance valid and reliable findings. The needs to conduct an adequate pilot study on the research instruments were highlighted; which is to ascertain the adequacy of quantitative questionnaires' questions and qualitative interview explored.

(e) Quantitative Questionnaires Research Survey

The research Chapter Five presented the quantitative questionnaires data collected, analysed, and findings obtained. This is the first stage of the Research Design operationalisation; data and information collection, collation, and interpretation. Few findings obtained were concluded in this Chapter Five, while the majority of the findings from this quantitative questionnaires survey were further investigated through the exploitation of in-dept qualitative interview survey, to evaluate and ascertain the questionnaires survey findings reliability, and for triangulation purposes.

(f) Qualitative Interview Research Study

Chapter Six of the research study presented the data collected and analysed, and the findings deduced from the qualitative in-depth interview survey. The questions used were modified from the results obtained from the quantitative questionnaires survey.
The summary of the interview themes, the findings and deductions presented in this Chapter Six assisted in establishment of the research operational framework.

(g) CRWM Operational Framework

The Construction Resources' Wastes Management operational Framework for efficient resources utilisation during the construction production process was established and presented in Chapter Seven. This novel framework was based on both quantitative and qualitative research studies exploited for data collection. This chapter concluded with the novelty of the framework, and significance of its adequate implementation.

(h) Research Validation Report

The validation report of the CRWM operational framework established was presented in Chapter Eight. The established framework of the research was evaluated through exploitation of quantitative questionnaires and qualitative research methods. From the comments provided by the respondents, there were clear indications that the adequate implementation of the established operational framework will enhance construction resources' wastes management and efficient resources utilisation in the industry.

9.3 ACHIEVEMENT OF THE RESEARCH OBJECTIVES

This research study established a CRWM operational framework which is a piece of concept development research; theory is consistently developed, structured, and validated to establish a reliable framework. The unique framework established was based on three main and extensive studies, and the novelty of each study is based on four research objectives. The research objectives investigated and the achieved findings are drawn in this section.

9.3.1 Research objective One - The CRWM Research Study One

The first objective of this research study is:

> *"to evaluate and ascertain site managers' constraints that enhances construction resources wastefulness."*

The first part of this research study critically evaluates the issues "Towards Enhancement of the Site Managers' Efficiency and Performances", (SMEP), on construction resources utilisation and wastes' management. Based on the identified problems and the causes, validated solutions were deduced and established which will enhance site managers' performance significantly and perpetuate efficient resources utilisation during construction production process.

This is a scenarios building study on Site managers circumstances during product(s) production process in the construction industry.

The following deductions were achieved in this SMEP research study:

1. The site manager's skills, attributes and potentials that are significantly important towards being efficient in resources utilisation; and the factors that are essential to achieve the site managers' propositions during production process were established.
2. The site manager's key functions towards efficient resources utilisation were established. Several management principles were evaluated and the major ones that will contribute to efficient resources utilisation were ascertained.
3. Several site manager's essential and desirable knowledge, skills, and attributes that will lead to efficient construction resources utilisation during production processes were identified and established; these are recognised as the factors that will 'Strengthen' the construction site manager's efficiency and performances.
4. The causes of construction resources wastefulness due to the site manager's deficiencies were identified. These factors are referred as 'the weaknesses' of site managers that often causes construction resources inefficient utilisation.
5. The factors that hinder site managers from performing efficiently, which are referred as 'the threats' to site manager's efficiency, and the modalities of the occurrence avoidance were established.
6. The facilitators that will enhance the site manager's performance, and minimise resources wastefulness were ascertained. These are factors that the Site manager needs to embrace as 'the opportunities' towards efficient performance.

The Study One established factors that will enhance the Site manager's efficiency and performances. In addition, it is equally essential to evaluate other factors that remotely concern the Site manager, but often cause resources inefficient utilisation during production process. These issues were investigated and established through the research Objective Two.

9.3.2 Research Objective Two - The CRWM Research Study Two

Research Objective Two is:

> *"to identify and ascertain the rationales of budgeting for resources' wastes in the Construction Industry; and to establish how these scenarios will be minimised towards achieving efficient resources utilisation."*

Research Study Two evaluated and investigated the BWS concept from the perspective of the construction participants' knowledge, attitudes, and perceptions. That is, the beliefs, attitudes, and behaviours of the construction participants, (the design and construction teams), towards construction resources utilisation and wastes' management.

These BWS scenarios were evaluated on five main headings. Different contributing factors towards budgeting for resources' wastes through materials, manpower and machinery utilisations were evaluated. Factors based on construction production information, the design team, and the site management were extensively investigated and ascertained. In addition, the wastefulness allowance of different types of construction resources, and resources' wastes in-built of different production information were identified.

In this BWS study, several significant facts emerged and were presented. Among the main facts deduced were the perceptions of site operatives that construction resources wastage is normal and has to be budgeted for during the production information preparation. Also, there is a clear indication that, the workers show a carefree attitude towards resources utilisation. Findings confirmed that the majority of these wastes originate from the design team and could be avoided through the provision of adequate and explicit production information for construction works. Also, the provision of adequate motivation and incentives, either in monetary value or in gesture towards reduction of BWS was found to be essential. In addition, provision of bonus based on the reduction of "wastes target set" will be effective in reducing resources inefficiency and the effects of BWS during production process.

These research studies SMEP and BWS, (Studies One and Two), evaluated the factors that cause resources wastefulness. Subsequently, Study Three established and ascertained how the construction resources inefficiencies could be avoided or minimised during construction production process.

9.3.3 Research Objective Three - The CRWM Research Study Three Part (A)

The third objective of this research study is:

"to investigate and establish various sources of resources wastefulness during the construction production process and to establish how these wastes could be avoided".

Thorough evaluation of the research objective three improvises how the resources will be efficiently utilised during production process. This study identified six wastes generation scenarios and established factors that will enhance construction resources' wastes management during the production process. The group factors considered and evaluated are:

a) the resources' wastes due to materials inefficient utilisation;
b) the resources' wastes that occur due to manpower not optimally utilised;
c) the resources' wastes occurrence due to the ineffective management or under-utilisation of machine and equipment;
d) the resources' wastes that occur through inadequate production information;
e) the resources' wastes that incur through the design team;
f) the resources' wastes that result from site management ineffectiveness.

This study established that the majority of resources wastefulness in the construction industry occurs unconsciously and, the occurrences are largely avoidable. Thus, measures of avoiding construction resources wastefulness during construction production process were established. Among these factors are the effective involvement of the project client(s) and all stakeholders in construction resources utilisation and wastes' management, and construction participants' awareness of the cumulative effect of resources wastage. In addition, effective implementation of partnering and the supply chain construction techniques are equally essential.

9.3.4 Research Objective Four - The CRWM Research Study Three Part (B)

In this research, the objectives one, two and three identified several causes of resources wastefulness and several approaches that are appropriate to enhance CRWM during construction production process. In addition, towards the achievement of a novel "CRWM operational framework" there was thorough investigation of other paramount issues based on the research Objective Four.

The CRWM research objective four is:

> *"to evaluate the conscious and unconscious occurrences of construction resources' wastes and to establish how these occurrences could be avoided during the production process.*

The evaluation of the objective four established the unconscious and conscious wastes' occurrences and the avoidance during construction production process. These facts were ascertained through critical evaluations of the different modes of occurrence: materials, machinery, manpower, site management, production information, and the design team.

9.3.5 Research Objective Five

This is the final objective which this research achieved. The CRWM research objective five is:

> *"to develop and validate a Construction Resources Waste Management, (CRWM) operational framework, that will facilitate Optimal Resources Utilisation, (ORU), during the production process".*

Firstly, this objective presented the CRWM best practice in the form of a framework. This was achieved by combining the facts and findings obtained from the three principal studies conducted, and these were presented in logical order to enhance its applicability. Secondly, the best practice operational framework established was presented to experienced construction site managers for verification. The validation approaches, feedback obtained and analysed are presented in Chapter Eight. In summary, the feedback received from the validation exercises affirmed that the CRWM research framework developed is largely viable and that efficient implementation will immensely reduce construction resources wastefulness during the production process.

9.4 SUMMARY OF THE MAIN FINDINGS

The details causes of the resources' wastes and the effective approaches to avoid the occurrences have been comprehensively presented in Chapters Five, Six and Seven. This section presents the summary of the research main findings: the major causes of resources wastefulness during construction production process and the approaches established which will significantly minimise the resources wastage during the production process.

(A) The major causes of resources wastefulness during construction production process are:

- Inadequate Production Information: Several resources' wastes are due to lack of adequate information from the design team to the construction team, and inadequate perception of wastes' implications by the designers. The design team proposed and often made the client(s) believe that the design concept will meet the project objectives and needs. However, the designers' concepts and aesthetics pre-occupation with less consideration of costs' implications, applicability and construct-ability often resulted in mass resources wastage during production process. In addition, over assumption on production information is another critical issue towards resources inefficiency. The design team usually presents incomplete or inadequate production information to work with on site, on the assumption that the production team will understand, and would be able to interpret the drawings or specifications without full detail of the specifications.
- Lack of adequate skilled workers and the use of semi-skilled workers: The lack of adequate skilled workers resulted in the use of semi-skilled workers. These consequently cause poor workmanship or repetitive work(s) in order to achieve the desired quality. This is one of the principal problems in the industry currently. That is, the inability to find proficient and skilled labour to engage.
- Redundant period of the procured plant and equipment: Machinery is often hired and delivered to site for days, while this resource is utilised for only a few minutes daily. Wastefulness in plant and equipment is significantly high; several pieces of equipment on site remain redundant or inefficiently utilised during construction process.
- Construction participants and clients unaware or mindful of the wasted resources value: The majority of clients are unaware or ignorant of the monetary value of the resources wasted during construction works, while a few act nonchalantly. Some clients are only interested in the project end products. Several clients cannot evaluate nor presume the wastes' cost implications. Some are aware, but careless of wastes' cost, particularly when there is an urgent need for the project.

- Short contract duration: Among the major problems that often lead to BWS and CRW is the contract duration; the time planned and agreed to deliver the complete project or task(s). Many times, site managers over-source resources at the expense of time in an attempt to avoid liquidation damages, thus considering time saving to be paramount. That is, considering the possibility of delivering the project on time, hence engaging extra resources for a specific task, so that the job can be completed on time.
- Habitual alterations and modifications: Modifications of the design concept during the project in progression often affects efficiency, and thus, contribute much to resources wastefulness. Also, changes in design, alterations and modifications affect the resources already procured and, in consequence, lead to resources' wastes.
- Unavailability of resources on request: The inability to obtain resources quickly when there is a shortage during usage often causes delays that perpetuate resources' wastes. Therefore, to avoid delay, site managers often over-order to guard against any shortage that may arise during the construction process.

(B) Based on the facts and findings obtained, (the causes of construction resources inefficient utilisation), the following approaches were established which will significantly minimise the resources wastage during construction production process:

- Engaging regular sub-contractors and suppliers: The practices of regular sub contractors and suppliers are significant in reducing resources wastage. The regular contractors or suppliers will be conversant with the company policies and operational systems. In addition, regular meetings with these sub-contractors and suppliers are essential to discuss and affirm the efficient way-forward on the next task(s) to be performed, which, in consequence, will enhance efficiency.
- Regular performance appraisal of the construction organisations, the sub-contractors and suppliers: Regular performance appraisal of the sub-contractors and suppliers by the organisation management and employees, and vice visa, is very important. While causes of underperformance will be corrected and recorded for future reference.
- Presentation of fully developed production information for construction process: There is a need for adequate and fully developed production information before the commencement of any project. This will enable the site manager to plan for the project efficiently. In addition, the design team need to be more mindful and

concerned with efficient resources utilisation in their drawings and specifications; that is, to design towards zero waste tolerance. These factors will not only enhance resources utilisation, but also will reduce the unconscious waste occurrences.

- Design to manufacturers' standards: The Design team should often consider the manufacturers' standard components. Thus, to design and specify in respect to standard components' dimensions of the manufacturers, as far as possible. This will reduce off cuts, wastage, and resources utilisation inefficiencies.
- Adequate planning of resources procurement: That is, to ensure resources are constant through proper planning and an adequate procurement system. During construction, forward planning and re-planning are essential. Site management need to think and plan ahead for unforeseen instances that could cause resources' wastes and inefficiencies. In addition, proper planning before ordering or procuring of resources is significant. Sometimes there is a need to cut down the order and build confidence in the users by stressing that the resources provided will be adequate for the work or task(s) to be done.
- Setting waste target: Setting a minimum allowable percentage of resources' wastes and tending towards achieving the target set. From the costs saved on the project, a monetary bonus commensurate to the percentage saved should be given to the site or project manager as motivation, while this will be shared by all site participants that made the savings possible.
- An enhanced supply and fix contracting: There is a significant need to negotiate with the sub-contractor bearing in mind wastes reduction. To award resources procurement and installations to the supply and fix contractors. Having Supply and Fix or Supply Chain contractors as part of project profit beneficiary significantly reduces resources' wastes and often enhance efficient resources utilisation.
- Awareness of wastes' reduction benefits: Site participants need to be adequately informed about and aware of the rationales and benefits of being efficient in resources utilisation. That is, to be aware that the benefits are not for the contractors only, but, also there are benefits and recognition for workers that are resourceful. Imperatively, this will significantly motivate construction participants towards efficient resources utilisation and waste avoidance.
- Setting waste target and adequate monitoring of the target with adopted site KPIs: There is need to set a minimum allowable resources waste as target, where

adequate project monitoring is essential. Both workers' productivities and efficiencies have to be adequately monitored. In respect, the adequate practical implementations of site construction key performance indicators are paramount. The KPIs will significantly enhance efficient resources utilisation, target set and the monitoring process.

- Adequate provision of skilled workers' training: Among the major problems confronting the construction industry currently is the lack of skilled and experienced workers. To reduce this predicament, previous skilled workers training systems have to be revisited; while workers spend more time learning trades efficiently and effectively, to acquire sufficient industrial training and obtain certification of competency from proficient assessors.
- Training toward efficient resources utilisation: Both the design and construction teams need adequate training towards efficient resources utilisation. It is required for construction graduates to acquire adequate industrial training and to be certified for efficiencies. During training, the trainees require to know the effects and implications of resources efficient utilisation and wastefulness on project(s) delivery. Thus, construction and government organisations need to provide more training schools. Also, there is a need to encourage the potential individuals to study construction and its related courses by providing an enhanced scholarship or bursary which will motivate the apprentice.
- Effective partnering and the supply chain implementation: There is a need for effective implementation of partnering and supply chain systems. To enhance efficient resources utilisation during the production process, all partners need to know the benefits and the relative importance of being efficient in resources utilisation.
- Making stakeholders aware of the value of resources wasted: There is a significant need for all the stakeholders, including the clients, to know the cumulative effects of resources wasted during construction process. That is, creating possibilities of enabling stakeholders to be aware of the magnitude and value of wastes generated during the construction production process. Also, the stakeholders need to know the causes or rationales of each waste scenario. By this, the occurrence of such waste will be avoided significantly in subsequent project(s).
- Designing and specifying to manufacturers' standards: Many manufacturers' components and products are having standard measurements. Hence, the

construction components' specifications need to follow the manufacturers' specifications, as far as possible. Moreover, these will enhance the partnership between the manufacturers, contractors, sub-contractors, and/or the suppliers.

- Adoption of modular components and modular construction systems: There is a need for a significant number of construction components to be standardised, unique, and modularly produced. Panellised and modular construction need to be encouraged. Panels and pre-cast materials are much easier to assemble than in-situ construction, thus, this will not only reduce waste but also facilitate efficiencies. Also, it will be easier to train labour when the components are in modules. This will enhance efficiencies and perpetuates wastes reduction. In addition, it will invariably ease skilled labour knowledge transfer within organisations if the majority of construction resources are in modular forms and unique.
- Avoidance of a short lead-in time to commence project or task(s): Several construction project products are needed within a short duration of time. This often leads to a short lead-in time, that is, an inadequate time for the project or task(s) execution.
- Avoidance or minimisation of perpetual plant and equipment inefficiencies: One of the major problems in the construction industry is that, the majority of the plant and equipment resource is not efficiently utilised. Plant is hired for hours to do a job of few minutes. Also, plant and equipment operatives' redundancies are equally high. Therefore, adequate procurement planning is essential for this resource with other resources, (materials and labour), to minimise redundancies.

(C) Towards efficient and effective resources utilisation, the following are among the fundamental approaches that will enhance the CRWM solutions established:

- Consistency in utilisation of Suppliers and Sub-contractors: Consistency in utilisation of suppliers and sub-contractors that have already attuned to the construction organisation policies is significant. There is a need for consistent engagement of suppliers and sub-contractors who have already adapted to the organisation system, set up and policies. However, the efficient performance of such sub-contractors or suppliers must have been certified.
- Adoption of a proactive and operational mission statement for construction participants: There is a significant need to institutionalise a best practice mission

statement for the design and construction teams' adoration. The combined efforts, (views) of seasoned construction site managers on efficient construction resources utilisation should be acquired to form a proactive mission statement. At some time, seasoned construction site managers have encountered a "brain storming" problem and have successfully overcome the predicament, and in consequence have identified the best method to resolve the particular obstacle or crisis.

- Avoidance of older and traditional construction operating systems and concepts: The construction organisations should embrace modern methods of construction and effectively implement new innovative concepts such as partnering, bench matching, and the supply chain systems. These concepts significantly enhance optimum resources utilisation and need to be adopted and implemented effectively.
- Adoption of the modalities for valuing wasted resources: To value resources wasted during construction work at project completion and reveal the cost implication to all construction participants. Clients and clients' consultants need to be aware of cost implications and causes of resources wastefulness after project completion. The majority of clients are not really aware of the magnitude or value of wastes that occurred during project construction. Unconsciously, these wastes cost are part of cost of construction paid by the clients. Knowing all resources' wastes cost, clients will be unwilling to lose such in future project(s).
- Construction components' standardisation: Construction specifications and dimensions should be in accord with manufacturers' standards dimensions. The standard dimension of the structure will definitely reduce resources' wastefulness and invariably lead to efficiencies. Also, when the designs components are adoptable for several construction projects, materials that are removed from a site can be stored or transferred to another site for use. Conversely, the manufacturers should produce to designers' specifications and dimensions; for several prototype projects. Thus, these will drive the construction industry towards "zero" waste tolerant and resources utilisation sustainability.
- Adoption and implementation of smart and re-usable components: Another significant approach is for the designers to specify materials that are re-usable by designing and specifying panels that can be use several times without being damaged. The designer could also design convertible structures and specify

convertible materials. Smart building will significantly reduce wastefulness of materials that occurs during alterations and modifications.

- Mandated efficient production and performance training certificate: That is, the adoption and implementation of a mandated efficient performance training certificate for site workers. Construction trainees should be mandated to have at least an NVQ and in addition to this, trainee should obtain a certification on efficient production and performance. In this regard, more industrial training schools need to be established by construction organisations and government institutions for training and recruitment of graduates and apprentice. This skilled training scheme needs to be integrated within a short duration of time which many contemporary trainees are ready to learn.
- Availability of a database for construction pools of problems and their relative solutions: Pools of construction problems that lead to inefficiency and possible solutions should be made available from which young graduates and trainees can learn easily. This can be made available in manuscripts, and audio visual for training and as reference. In addition, knowledge management principles and concepts should be effectively implemented through this means, and be efficiently practised not only within a construction organisation, but also within the construction industry at large.

9.5 SUMMARY OF THE RESEARCH

Construction project successes are conventionally attached to the achievement or completion of the specific operation or task within cost, time frame, and quality expected, (the three-dimensional project scope). However, many projects are completed within the budgeted cost; time frame; quality expected, and even satisfy the client's implied need with lots of resources wastefulness. Current practices in the construction industry were thoroughly evaluated, and it was found that several significant issues, (gaps), that have the consequence of vast resources wastefulness were unforeseen, not envisaged and as a result, remain un-addressed.

To reduce resources wastefulness and to enhance profits and stakeholders satisfaction, this research work evaluated construction resources utilisation in different dimensions, identified several significant factors, (gaps) that contribute to resources wastefulness, and established solutions to minimise each problem. For practical application, the "gaps" identified of which solutions were established for implementation are:

- The constraints that enhances the site manager being inefficient in the utilisation of construction resources.
- The issues of BWS on utilisation of construction resources based on the knowledge, attitudes, and perceptions, (KAP) of construction participants.
- Establishment of conscious and unconscious wastefulness of construction resources.
- The issues of Lean Construction Project Delivery on efficient and effective resources utilisation in which many construction organisations found the consistent application of the principles difficult.

In consequence, this research study developed an operational framework towards minimisation/avoidance of the inefficient construction resources utilisation during the production process. This framework is presented in forms of figure and table, and in logical sequence. To enhance implementation, the summary of the several factors that require consideration towards efficient resources utilisation are outlined, grouped and in sequence of:

- Roles and essential attributes of project managers towards efficient resources utilisation.
- Identified causes of resources inefficiency and approaches towards efficient construction resources' wastes management.
- Drivers towards efficient resources utilisation.
- Factors that will significantly uphold efficient resources utilisation.

The research further presented thirty four approaches, (solutions) towards CRWM and nine radical approaches that will enhance the achievement of the CRWM during construction production process.

The study affirmed the viability, practicality and effectiveness of the CRWM operational framework developed. The best practice framework developed was presented to experience construction site managers for validation. This process was conducted in two stages. The first stage ascertained the relative importance and confirmed the effectiveness of all the factors established towards CRWM. The second stage affirmed the practicality and the strength of the best practice framework. The respondents virtually agreed with all the factors and solutions established. Few issues that require clarifications and modifications were indicated by the verifiers and these were thoroughly addressed.

The verifiers established that the CRWM operational framework developed is very robust, vast, and practicable. In addition, it was confirmed that the research study evaluated, analysed and presented all resources' wastes problems from diverse practical directions. It was affirmed that the findings are valued and worthy of adoption and implementation by the construction industry. This implies that, the effective implementation of the CRWM framework will vastly reduce resources wastefulness during the construction production process which will perpetuate cost savings, enhance profit and stakeholders' satisfaction.

9.6 RESEARCH SCOPE AND LIMITATION

This research study was carried out within the UK construction industry. However, the inferences and conclusions drawn are significant towards enhancing construction resources' wastes management globally. This research work evaluates and established a CRWM operational framework. The resources considered are materials, machinery and manpower. The research is based on the proposition that, several construction projects are completed within estimated cost, time frame, quality expected and even satisfying the clients and stakeholders implied needs with lots of resources wastefulness during production process. Thus, the impact of cost, delivery time, project quality, inflation, and government policies were assumed to be constant, and hypothetically have negligible effect on resources utilisation in this research work.

9.7 GENERALISATION OF THE RESEARCH FINDINGS AND CRWM OPERATIONAL FRAMEWORK

The issue of validity and reliability assurance of the research outcome have been presented in Section 4.8. This research data was collected from a significant number of experienced Site Managers in different multinational construction organisations, and covered the wider geographical regions in the UK. The research was triangulated: both quantitative questionnaires and qualitative interview research approaches were explored to obtain information. The obtained data was analysed using appropriate statistical tools; and the reliability and validity tests' statistics shown that the data collected are significance. However, the framework developed was also two-stage validated. The outcome of the validation processes affirmed the practicality and viability of the research outcome, and the evaluators confirmed that the CRWM framework developed is robust.

The UK construction industry is vast in innovation and research, and several British Standards, (BS), and Code of Practices, (CP), are adopted by many nations; thus, this research outcome and novel framework developed will be significant for global construction industry implementation.

9.8 RECOMMENDATIONS FOR FURTHER STUDIES

Despite the establishment of several modalities of optimising the utilisation of construction resources in the construction industry during production process in this research work, there is a need for more research in many areas towards enhancing efficient resources utilisation during production process. Further research needs to be investigated on the following issues:

a) There are several inferences on potentials and attributes of site managers towards enhancing construction resources utilisation; however, more extensive research is needed to investigate and establish the interrelationship of these factors. That is, the correlation of each factor identified on resources utilisation and resources inefficiency.
b) Many facilitators towards efficient resources utilisation were established. More studies are necessary to relate these to assumed constant factors: construction cost, project delivery time, government policies, and inflation towards achieving optimal resources utilisation during production process.
c) This research data were obtained within, and limited to the UK construction industry which is assumed to be significant for global implementation; however, other countries resources utilisation efficiency could be evaluated in comparison, to ascertain the global reliability of the framework established.

9.9 CONCLUSION

Research on lean construction and resources sustainability is vast. It is ascertained that the importance of the industry is immense; the industry contributes a large amount to a national gross domestic profit, (GDP) and income, and the construction industry products are very important to other organisation sectors. Therefore, concurrent re-assessment of the approach to resources utilisation, to adequately meet the clients, governments, contractors and all stakeholders' objectives is paramount. The practicability of the CRWM operational framework was established, and it was affirmed by valuators that the framework will significantly enhance construction resources' wastes management and efficient resources utilisation during production process if adequately implemented. The established CRWM framework is based on the UK construction industry, however, the findings and inferences will be significant for global implementation.

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APPENDIX A:

DETAILED QUANTITATIVE RESEARCH SURVEY RESULTS OF *AVOIDANCE OF CONSTRUCTION RESOURCES WASTEFULNESS, (ACRW)* IN PERCENTAGE RANKED ORDER

Key: Frequency, (Freq); Conscious, (Con); Unconscious, (Uncon); Avoidable, (Av); Unavoidable, (Unav)

	Freq.	*Con.*	*Uncon.*	*Av.*	*Unav*
A) Waste Due To Materials	50	41	59	73	27
B) Waste Due To Labour	51	42	58	79	21
C) Waste Due Plant and Equipments	52	45	56	83	18
D) Waste Due To Production Information	54	38	62	80	20
E) Waste Due To Site Management	53	33	67	79	21
F) Waste Due To Design Team	59	56	44	77	24
(Mean)	***53***	***43***	***58***	***79***	***22***

Detailed Descriptive Statistics for Avoidance of Construction Resources Wastefulness

Descriptive Statistics

		Freq	Con	Unco	Av	Unav
A) Waste Due To Materials	(Mean)	50	41	59	73	27
1) Material Damage on Stock Piling		59	33	67	81	19
2) Off-Cut Due To Irregular Shape		55	59	41	40	60
3) Design Not To Manufacturer Standard - Mat Off Cut		55	33	67	85	15
4) Specification Error		51	21	79	81	19
5) Over Ordering Due To Quantity Surveyor Mistake		50	31	69	89	11
6) Pilferage		50	67	33	65	35
7) Weather Condition - Materials Spoilage		49	36	64	64	36
8) Over Ordering Due To Engineers Faults		49	31	69	92	08
9) Residual and Spillage during Work in Progress		48	49	51	69	31
10) Drying Shrinkage Due Adverse Weather		48	45	55	40	60
11) Excess Ordering Of Mat. For Usage Unreturned		47	74	26	88	18
12) Transit Waste - Braking and Spillage		47	29	71	73	27
13) Planning Error		46	22	78	88	12

Descriptive Statistics	Freq	Con	Unco	Av	Unav
B) Waste Due To Labour	**51**	**42**	**58**	**79**	**21**
1) Double Handling	60	65	35	77	23
2) Rework Due to Mistake	58	27	73	85	15
3) Unskilled Operation - Increasing Completion Time.	54	42	58	84	16
4) Waiting T. for Mat. To Use - Redundancy Period	54	33	67	82	18
5) Lack of Coordination among Gang	51	35	65	88	12
6) Weather Condition - Work Delay	51	65	35	29	71
7) Insufficient Tools and Equip. to Use - Waiting T.	50	34	66	87	13
8) Wrong Constr. Method Leading To T. Delay	49	30	70	89	11
9) Less Work Apportionment	48	39	61	88	12
10) Right Operation for Wrong Work - Delay or Rework	48	49	51	92	8
11) Traffic between Plant Position to Operation Place	48	29	71	71	29
12) Over Staffing For A Particular Project Execution	46	55	45	81	19

Descriptive Statistics	Freq	Con	Unco	Av	Unav
C) Waste Due Plant and Equipments (Mean)	**52**	**45**	**56**	**83**	**18**
1) Low Output Capacity than Required For the Gang in Operation	56	23	77	93	8
2) Operation And Plant Position, Traffic - Mat. And Labour Waste	54	53	47	81	19
3) Long Break/Position/Stationary Un-Used, Rental Cost	53	57	43	84	16
4) Breakdown during Work In Progress - Material/Labour Waste	53	22	78	52	48
5) Early Delivery Time and Redundancy Period	52	62	38	71	29
6) Uncoordinated Skill of Plant Operator and Controller	50	37	63	94	8
7) Lack of Coordination within Gang - Redundancy/Inefficiency	50	29	71	96	4
8) Wrong Construction Method and Repeated Work For Plant	50	54	46	88	12
9) Un-Experience Operator - Minimal Efficiency/Productivity	49	33	67	82	18
10) Poor Communication System within the Gang - Time Lag	49	75	25	85	15

Descriptive Statistics	**Freq**	**Con**	**Unco**	**Av**	**Unav**
D) Waste Due To Production Information (Mean)	**54**	**38**	**62**	**80**	**20**
1) Inadequacy of Architectural Specification	60	38	62	87	13
2) Design Error	57	21	79	65	35
3) Architectural Drawing Complexity and Interpretation Time Lag	56	24	76	81	19
4) Variation Order and Implementation Approval Delay	55	57	33	71	29
5) Modification Subjected To Due Process for Implementation	55	63	37	59	41
6) Inadequacy of Electrical Engineering Specification	53	31	69	95	5
7) Inadequacy of Structural Engineering Specification	53	30	70	93	7
8) Ambiguity of Structural Drawing and Interpretation Time Lag	53	25	75	74	26
9) Inadequacy of Mechanical Engineering Specification	52	31	69	95	5
10) Alteration Subjected To Due Process for Implementation	51	58	42	70	30
11) Inadequacy of Estimator/Quantity Surveyor Specification	51	35	65	85	15

Descriptive Statistics	Freq	Con	Unco	Av	Unav
E) Waste Due To Site Management (Mean)	**53**	**33**	**67**	**79**	**21**
1) Inadequate Planning System towards Project Execution	60	31	69	78	22
2) Poor Site Organisation That Leads To Wastage	57	30	70	81	19
3) Poor Operation Control	54	21	79	93	07
4) Poor Project Planning and Schedule That Leads To Wastage	54	26	74	92	8
5) Delay in Decision Making and Operation Order Time Lag	54	50	50	72	28
6) Inadequate Monitory System	54	42	58	79	21
7) Poor Line Communication System That Leads To Time Lag	54	26	74	71	29
8) Poor Schedule of Resources That Leads To Wastage	53	30	70	89	11
9) Inexperience of the Type Technicality Require For the Project.	50	39	61	63	37
10) Lack of Sufficient Motivation to Boast Operative Morale	50	26	74	71	29
11) Poor Selection of Materials & Labour Procurement System	48	37	63	76	24

Descriptive Statistics	Freq	Con	Unco	Av	Unav
F) Waste Due To Design Team (Mean)	**59**	**56**	**44**	**77**	**24**
1) Var. Order Delay That Affect Other Work in Progression	67	70	30	65	35
2) Waiting Time for Alteration Order	63	57	43	60	40
4) Comm. Gap between Design and Construction Teams	60	43	57	94	06
5) Predominant Meeting on Variation/Alteration/Modification	53	45	55	89	19
3) Delay in Inspection to Proceed To another Stage of Work	53	66	34	78	22

APPENDIX B:

QUANTITATIVE RESEARCH SURVEY QUESTIONNAIRE

OPTIMUM UTILISATION OF CONSTRUCTION RESOURCES DURING THE BUILDING PRODUCTION PROCESS

RESEARCH QUESTIONNAIRES

"A project could be completed within the estimated cost; time frame and quality expected with amass resources wastefulness"

----- *THE RESEARCHER'S PERCEPTION*

THANK YOU IN ADVANCE FOR YOUR VALUABLE SUPPORT.

JULIUS A. FAPOHUNDA

Sheffield Hallam University

A) SITE MANAGERS' EFFICIENT PERFORMANCE, SMEP FRAMEWORK

In these questionnaires, the term "Site Manager" means the personnel in charge of managing the Building Production Process (BPP) at the project site.

Kindly rate these factors on ease of accomplishment during Building Production Process, BPP
Please, indicate if this factor is Essential [E], or Desirable [D], for efficient building production.

A1).The building production is complex in nature and Integrations of Site managers' tasks are complex too.

Tick as appropriate:

(i) ***Rating Score***: - Very High Accomplish (4), High (3), Low (2) and Very Low (1), Never (0)

(ii) ***Requirement:*** - Desirable ***[D]***, and Essential ***[E]***

EASE OF ACCOMPLISHMENT	*RATING [0] To [4]*					*REQUIREMENT [D] OR [E]*	
A) MANPOWER							
1. Manpower as Planned	*4*	*3*	*2*	*1*	*0*	***D***	***E***
2. Staff Acquisition -----Skilled	*4*	*3*	*2*	*1*	*0*	***D***	***E***
3. Staff Acquisition -----Unskilled	*4*	*3*	*2*	*1*	*0*	***D***	***E***
4. Team Selection And Combination	*4*	*3*	*2*	*1*	*0*	***D***	***E***
5. Manpower Control	*4*	*3*	*2*	*1*	*0*	***D***	***E***
6. Labour productivity Prediction	*4*	*3*	*2*	*1*	*0*	***D***	***E***
7. Labour Motivation Strategies	*4*	*3*	*2*	*1*	*0*	***D***	***E***

B) MATERIALS							
1. Adequate Material Control Strategies	*4*	*3*	*2*	*1*	*0*	***D***	***E***
2. Adequate Stock/Store Control	*4*	*3*	*2*	*1*	*0*	***D***	***E***
3. Procurement of Materials as Planned	*4*	*3*	*2*	*1*	*0*	***D***	***E***
4. Efficient Materials Organisation	*4*	*3*	*2*	*1*	*0*	***D***	***E***
5. Efficient Co-ordination of Material	*4*	*3*	*2*	*1*	*0*	***D***	***E***

C) MACHINERY							
6. Plants Output Prediction	*4*	*3*	*2*	*1*	*0*	***D***	***E***
7. Plants Output Prediction	*4*	*3*	*2*	*1*	*0*	***D***	***E***
8. Control of Machinery	*4*	*3*	*2*	*1*	*0*	***D***	***E***
9. Efficient Machinery Procurement	*4*	*3*	*2*	*1*	*0*	***D***	***E***
10. Efficient Organisation of Machinery	*4*	*3*	*2*	*1*	*0*	***D***	***E***
11. Efficient Organisation of Machinery	*4*	*3*	*2*	*1*	*0*	***D***	***E***

D) CONSTRUCTION RESOURCES COST							
12. Construction Cost as Planned	*4*	*3*	*2*	*1*	*0*	*D*	*E*
13. Resources Cost Control	*4*	*3*	*2*	*1*	*0*	*D*	*E*
14. Resources Cost Budgeted	*4*	*3*	*2*	*1*	*0*	*D*	*E*
15. Purchase Cost Control	*4*	*3*	*2*	*1*	*0*	*D*	*E*
16. Order Cost Control	*4*	*3*	*2*	*1*	*0*	*D*	*E*
17. Holding Cost Control - (To Avoid Waste)	*4*	*3*	*2*	*1*	*0*	*D*	*E*
E) CONSTRUCTION RESOURCES COST							
18. Construction Cost as Planned	*4*	*3*	*2*	*1*	*0*	*D*	*E*
19. Resources Cost Control	*4*	*3*	*2*	*1*	*0*	*D*	*E*
20. Resources Cost Budgeted	*4*	*3*	*2*	*1*	*0*	*D*	*E*
21. Purchase Cost Control	*4*	*3*	*2*	*1*	*0*	*D*	*E*
22. Order Cost Control	*4*	*3*	*2*	*1*	*0*	*D*	*E*
23. Holding Cost Control - (To Avoid Waste)	*4*	*3*	*2*	*1*	*0*	*D*	*E*
F) QUALITY IN CONSTRUCTION							
24. Adequate Quality Control	*4*	*3*	*2*	*1*	*0*	*D*	*E*
25. Achieving Quality Predicted	*4*	*3*	*2*	*1*	*0*	*D*	*E*
F) TIME MANAGEMENT							
26. Efficient Time as Planned and Defined	*4*	*3*	*2*	*1*	*0*	*D*	*E*
27. Time Control And Sequence	*4*	*3*	*2*	*1*	*0*	*D*	*E*
28. Activities Duration Estimated	*4*	*3*	*2*	*1*	*0*	*D*	*E*
29. Activities Duration Scheduled	*4*	*3*	*2*	*1*	*0*	*D*	*E*
30. Adequate Activities Control	*4*	*3*	*2*	*1*	*0*	*D*	*E*
G) RISK IN CONSTRUCTION							
31. Efficient Risk Features Identification							
32. Risk Assessment And Quantification							
33. Adequate Risk Response Against Threat							
34. Risk Alternative Strategy							
35. Emergency Cover-Up Planned							
H) RESOURCES PROCUREMENT							

36. Integration of Procurement ---- Materials, Manpower And Machinery	*4*	*3*	*2*	*1*	*0*	*D*	*E*
37. Resources Source Selection	*4*	*3*	*2*	*1*	*0*	*D*	*E*
38. Resources Evaluation And Assessment	*4*	*3*	*2*	*1*	*0*	*D*	*E*
39. Market Condition Prediction	*4*	*3*	*2*	*1*	*0*	*D*	*E*
40. Prediction of Procurements' constraints	*4*	*3*	*2*	*1*	*0*	*D*	*E*
41.							
42.							

I) Project Scope Determinant	*4*	*3*	*2*	*1*	*0*	*D*	*E*
J) Delegation Of Authority	*4*	*3*	*2*	*1*	*0*	*D*	*E*
K) Nominated Supplier control	*4*	*3*	*2*	*1*	*0*	*D*	*E*
L) Sub-contractors Control	*4*	*3*	*2*	*1*	*0*	*D*	*E*
M) Others (Kindly Specify)							
i	*4*	*3*	*2*	*1*	*0*	*D*	*E*
ii	*4*	*3*	*2*	*1*	*0*	*D*	*E*
iii	*4*	*3*	*2*	*1*	*0*	*D*	*E*

A2). Kindly rate how these factors hinder Site managers towards Optimal Utilisation of Resources.

Please, write as appropriate:

Rating Score: - Very High Hindrance (5), High (4), Mild (3), Low (2) and Very Low (1), No (0)

EFFECT ON OPTIMUM UTILISATION OF RESOURCES	RATINGS: Write as Appropriate [0 to 5]
1. Communication With Design Team	//////////////////////////////
• Architects	
• Structural Engr	
• Mechanical Engr	
• Electrical Engr	
• Estimator	
• Quantity Surveyor	
• Project Manager	
• Client	

2. Alteration Response To Effects Change	
3. Modification Response To Effect Change	
4. Time Lapse in Approval of Change Due to Spec. error	
5. Material availability	
6. Skilled Labour availability	
7. Unskilled Labour availability..............................	
8. Project Complexity Subject To Clarification	
9. Working/Operation Space And Congestion	
10. Skill Plant availability	
11. Design Team Drawing and/or Specification clarity.	/////////////////////////////
• Architects	
• Structural Engr	
• Mechanical Engr	
• Electrical Engr	
• Estimator	
12. Sub- Contractor Performance and conformity	
13. Nominated Suppliers Performance	
Others (Kindly Specify) i).. ii).. iii)..	

FURTHER COMMENTS ON A2.

A3)

1. ***Kindly rate how these factors affect Site managers towards optimal resources utilisation during building production processes.***
2. ***Indicate if it is Desirable, D or Essential, E for optimal resources utilisation and***
3. ***During what stage can it be best improved: Design Stage (DS) or Production Phase (PP).***

(i) **Please, Write the Rating**: - Very High Effect (5), High (4), Mild (3), Low (2) and Very Low (1)

(ii) **Tick Requirement: -** Desirable ***[D]*** or Essential ***[E]***

(iii) **Please, when could it be Best Improved: -** Design Stage, ***[DS]*** or Production Phase, ***[PP]***

Factors That Affect Site managers On Optimal Resources Utilisation	**RATING** *Choose [1] - [5]*	**REQUIREMENT** *[D] or [E]*		***BEST IMPROVED*** *[DS] or [PP]*	
A) SKILLS/EXPERTISE					
1. Knowledge Management		*D*	*E*	*DS*	*PP*
2. Human Resources Management		*D*	*E*	*DS*	*PP*
3. Materials Management		*D*	*E*	*DS*	*PP*
4. Cost Management		*D*	*E*	*DS*	*PP*
5. Quality Management		*D*	*E*	*DS*	*PP*
6. Risk Management		*D*	*E*	*DS*	*PP*
7. Time Management		*D*	*E*	*DS*	*PP*
8. Procurement Management		*D*	*E*	*DS*	*PP*
9. Staffing And Recruitment		*D*	*E*	*DS*	*PP*
10. Negotiation Power		*D*	*E*	*DS*	*PP*
11. Problem Solving		*D*	*E*	*DS*	*PP*
12. Contract Mgt & Administration		*D*	*E*	*DS*	*PP*
13. Client Interest management		*D*	*E*	*DS*	*PP*
14. Supplier & Sub Contractor Mgt		*D*	*E*	*DS*	*PP*
15. Motivation Strategies		*D*	*E*	*DS*	*PP*
16. Change Management		*D*	*E*	*DS*	*PP*
		D	*E*	*DS*	*PP*
		D	*E*	*DS*	*PP*

Factors That Affect Site managers' On Optimal Resources Utilisation	RATING *Choose [1] - [5]*	REQUIREMENT *[D] or [E]*		*BEST IMPROVED* *[DS] or [PP]*
B) TRAITS/QUALITIES				
17. Leadership		*D*	*E*	*DS PP*
18. Integrity		*D*	*E*	*DS PP*
19. Enthusiasm in achievement		*D*	*E*	*DS PP*
20. Empathy and Compassion		*D*	*E*	*DS PP*
21. Competency		*D*	*E*	*DS PP*
22. Cool Under Pressure		*D*	*E*	*DS PP*
23. Challenging		*D*	*E*	*DS PP*
24. Creative Thinking		*D*	*E*	*DS PP*
		D	*E*	*DS PP*
		D	*E*	*DS PP*

Factors That Affect Site managers On Optimal Resources Utilisation	RATING *Choose [1] - [5]*	REQUIREMENT *[D] or [E]*		*BEST IMPROVED* *[DS] or [PP]*
C) ABILITIES/POTENTIAL				
25. Delegation of task and responsibilities		*D*	*E*	*DS PP*
26. Assertiveness		*D*	*E*	*DS PP*
27. Objective Setting		*D*	*E*	*DS PP*
28. Decisiveness		*D*	*E*	*DS PP*
29. Team Building		*D*	*E*	*DS PP*
30. Facilitation		*D*	*E*	*DS PP*
31. Concurrent Project Evaluation		*D*	*E*	*DS PP*
32. Energy Management		*D*	*E*	*DS PP*
33. Dispute Resolutions		*D*	*E*	*DS PP*
		D	*E*	*DS PP*
		D	*E*	*DS PP*

Factors That Affect Site managers On Optimal Resources Utilisation	RATING Choose [1] - [5]	REQUIREMENT [D] or [E]		*BEST IMPROVED* [DS] or [PP]	
D) AWARENESS					
34. Performance Measurement		D	E	DS	PP
35. Contract forms & strategies		D	E	DS	PP
36. Tendering strategies		D	E	DS	PP
37. Laws And Arbitration		D	E	DS	PP
38. Whole Life Costing		D	E	DS	PP
39. Brief Writing		D	E	DS	PP
40. Health & Safety Regulations		D	E	DS	PP
FURTHER COMMENTS ON A3:					

A4) 1) kindly rate these factors in relation to importance towards optimal resources utilisation during building production processes.
2) Please Indicate if it is desirable. [D] or essential [S] for optimum resources utilisation

Kindly tick as appropriate:

(i) **Rating Score**: - Very High Facilitator *(4),* High *(3)*, Mild (2), Less *(1)* Not a Facilitator *(0)*

(ii) **Requirement: -** Desirable ***[D]*** and Essential ***[E]***

Factors That Facilitates Site managers' Performance	RATING Tick [0] - [4]					REQUIREMENT Tick either [D] or [E]	
1. Production Information Simplicity and	0	1	2	3	4	D	E
Explicitly	0	1	2	3	4	D	E
2. Communication effectiveness	0	1	2	3	4	D	E
3. Efficient Cost Analysis	0	1	2	3	4	D	E
4. Efficient Cost Control	0	1	2	3	4	D	E
5. Expressive Process Integration	0	1	2	3	4	D	E
6. Alterations & Modification minimisation	0	1	2	3	4	D	E
7. Variation control and minimisation	0	1	2	3	4	D	E
8. Resources Availability	0	1	2	3	4	D	E
9. Resources Procurement System	0	1	2	3	4	D	E
10. Site managers' Experiences on similar work	0	1	2	3	4	D	E
11. Project Participants Skill And Knowledge	0	1	2	3	4	D	E
12. Project In-Built Morale & Motivation	0	1	2	3	4	D	E
13. Job Appraisal & Satisfaction	0	1	2	3	4	D	E
14. Technological Change During Work In	0	1	2	3	4	D	E

Progress	*0*	*1*	*2*	*3*	*4*	*D*	*E*
15. Friendly Project Locality And Environment	*0*	*1*	*2*	*3*	*4*	*D*	*E*
16. Legal And Local Authority regulations	*0*	*1*	*2*	*3*	*4*	*D*	*E*
17. Weather Condition ... a) Winter b) Summer							
Others (Kindly Specify)							
i	*0*	*1*	*2*	*3*	*4*	*D*	*E*
ii	*0*	*1*	*2*	*3*	*4*	*D*	*E*
iii	*0*	*1*	*2*	*3*	*4*	*D*	*E*
COMMENTS ON A4:							

B) EFFECT OF "BUDGETING FOR WASTE SYNDROMES", EBWS.

This implies allowance or provision for resources wastefulness occurrence either consciously or unconsciously. That is, setting aside or over - estimation of resources in envisaging that waste will occur during construction process.

Rating Score for level of contribution: -

Very High ***[5]***, High ***[4]***, Mild ***[3]***, Low ***[2]*** and Very Low ***[1]*** No Contribution ***[0]***

Factors That Contributes To Budgeting For Waste Syndromes

A) DUE TO MATERIALS (Possibility of :)

(Kindly Circle the Appropriate level of contribution)

1) Specification uncertainty	[0]	[1]	[2]	[3]	[4]	[5]
2) Design not to manufacturer standard - materials off cut	[0]	[1]	[2]	[3]	[4]	[5]
3) Quantity surveyor mistake	[0]	[1]	[2]	[3]	[4]	[5]
4) Engineers faults	[0]	[1]	[2]	[3]	[4]	[5]
5) Material damage on stock piling	[0]	[1]	[2]	[3]	[4]	[5]
6) Planning error	[0]	[1]	[2]	[3]	[4]	[5]
7) Adverse weather - Drying shrinkage	[0]	[1]	[2]	[3]	[4]	[5]
8) Irregular shape - Off-cut	[0]	[1]	[2]	[3]	[4]	[5]
9) Pilferage - Security lapse	[0]	[1]	[2]	[3]	[4]	[5]
10) Ordering of materials for usage unreturned to store	[0]	[1]	[2]	[3]	[4]	[5]
11) Residual and spillage during work in progress	[0]	[1]	[2]	[3]	[4]	[5]
12) Transit waste - Brake & Spillage	[0]	[1]	[2]	[3]	[4]	[5]
13) Weather condition - materials spoilage	[0]	[1]	[2]	[3]	[4]	[5]
Others (Kindly Specify)						
14)	[0]	[1]	[2]	[3]	[4]	[5]
15)	[0]	[1]	[2]	[3]	[4]	[5]

B) DUE TO MANPOWER (*Possibility of :*)

(Kindly Circle the Appropriate level of contribution)

1)	Waiting time for material to use - Redundancy period	[0]	[1]	[2]	[3]	[4]	[5]
2)	Double handling	[0]	[1]	[2]	[3]	[4]	[5]
3)	Insufficient tools and equipments to use - waiting time	[0]	[1]	[2]	[3]	[4]	[5]
4)	Unskilled operation - increasing the time of completion	[0]	[1]	[2]	[3]	[4]	[5]
5)	Rework due to mistake	[0]	[1]	[2]	[3]	[4]	[5]
6)	Lack of coordination among gang	[0]	[1]	[2]	[3]	[4]	[5]
7)	Wrong construction method leading to delay /time lapse	[0]	[1]	[2]	[3]	[4]	[5]
8)	Weather condition - work delay	[0]	[1]	[2]	[3]	[4]	[5]
9)	Right operation for wrong work - delay or rework	[0]	[1]	[2]	[3]	[4]	[5]
10)	Traffic between plant position to operation place	[0]	[1]	[2]	[3]	[4]	[5]
Others (Kindly Specify)							
11)	....	[0]	[1]	[2]	[3]	[4]	[5]
12)	....	[0]	[1]	[2]	[3]	[4]	[5]
13)	....	[0]	[1]	[2]	[3]	[4]	[5]

C) DUE TO PLANT AND EQUIPMENT (Possibility of :)

(Kindly Circle the Appropriate level of contribution)

1)	Delivery time & redundancy period	[0]	[1]	[2]	[3]	[4]	[5]
2)	Un-experience operator - minimal efficiency/productivity	[0]	[1]	[2]	[3]	[4]	[5]
3)	Breakdown during work in progress - material/labour waste	[0]	[1]	[2]	[3]	[4]	[5]
4)	Lack of coordination within gang - redundancy/inefficiency	[0]	[1]	[2]	[3]	[4]	[5]
5)	Operation and plant position, traffic - mat. and labour waste	[0]	[1]	[2]	[3]	[4]	[5]
6)	Uncoordinated skill within plant operator and controller	[0]	[1]	[2]	[3]	[4]	[5]
7)	Possible repeated work for plant	[0]	[1]	[2]	[3]	[4]	[5]
8)	Poor communication system within the gang - time lag	[0]	[1]	[2]	[3]	[4]	[5]
9)	Long break/position/stationary un-used, rental cost	[0]	[1]	[2]	[3]	[4]	[5]
Others (Kindly Specify)							
10)	....	[0]	[1]	[2]	[3]	[4]	[5]
11)	....	[0]	[1]	[2]	[3]	[4]	[5]
12)	....	[0]	[1]	[2]	[3]	[4]	[5]

D) DUE TO PRODUCTION INFORMATION (Possibility of :)

(Kindly Circle the Appropriate level of contribution)

1)	Architectural drawing complexity and interpretation time lag	[0]	[1]	[2]	[3]	[4]	[5]
2)	Ambiguity of structural drawing and interpretation time lag	[0]	[1]	[2]	[3]	[4]	[5]
3)	Inadequacy of Architectural specification	[0]	[1]	[2]	[3]	[4]	[5]
4)	Inadequacy of Mechanical Engineering specification	[0]	[1]	[2]	[3]	[4]	[5]
5)	Inadequacy of Electrical Engineering specification	[0]	[1]	[2]	[3]	[4]	[5]
6)	Inadequacy of Structural Engineering specification	[0]	[1]	[2]	[3]	[4]	[5]
7)	Inadequacy of Estimator/Quantity Surveyor specification	[0]	[1]	[2]	[3]	[4]	[5]

Others (Kindly Specify)

8)	....	[0]	[1]	[2]	[3]	[4]	[5]
9)	....	[0]	[1]	[2]	[3]	[4]	[5]
10)	....	[0]	[1]	[2]	[3]	[4]	[5]

E) DUE TO SITE MANAGEMENT ((Possibility of :)

(Kindly Circle the Appropriate level of contribution)

11)	Inadequate planning system towards project execution	[0]	[1]	[2]	[3]	[4]	[5]
12)	Inadequate monitory system	[0]	[1]	[2]	[3]	[4]	[5]
13)	Lack of sufficient motivation to boast operative morale	[0]	[1]	[2]	[3]	[4]	[5]
14)	Poor selection of materials and labour procurement system	[0]	[1]	[2]	[3]	[4]	[5]
15)	Poor site organisation that may leads to wastage	[0]	[1]	[2]	[3]	[4]	[5]
16)	Delay in decision making and operation order - time lag	[0]	[1]	[2]	[3]	[4]	[5]
17)	Poor communication system that may leads to time lag	[0]	[1]	[2]	[3]	[4]	[5]
18)	Inexperience technicality types required for the project	[0]	[1]	[2]	[3]	[4]	[5]
19)	Poor project planning And Schedule that leads to wastage	[0]	[1]	[2]	[3]	[4]	[5]
20)	Poor schedule of resources that may leads to wastage	[0]	[1]	[2]	[3]	[4]	[5]
21)	Poor operation control	[0]	[1]	[2]	[3]	[4]	[5]

Others (Kindly Specify)

22)	....	[0]	[1]	[2]	[3]	[4]	[5]
23)	....	[0]	[1]	[2]	[3]	[4]	[5]
24)	....	[0]	[1]	[2]	[3]	[4]	[5]

F) DUE TO DESIGN TEAM (Possibility of)

(Kindly Circle the Appropriate level of contribution)

1)	Variation order delay that may affect other work in progression	[0]	[1]	[2]	[3]	[4]	[5]
2)	Waiting time for alteration order	[0]	[1]	[2]	[3]	[4]	[5]
3)	Delay in inspection to proceed to another stage of work	[0]	[1]	[2]	[3]	[4]	[5]
4)	Communication gap between design and construction teams	[0]	[1]	[2]	[3]	[4]	[5]
5)	Predominant meeting on variation/alteration/modification	[0]	[1]	[2]	[3]	[4]	[5]

Others (Kindly Specify)

6)	…………………………………………………………..	[0]	[1]	[2]	[3]	[4]	[5]
7)	…………………………………………………………..	[0]	[1]	[2]	[3]	[4]	[5]
8)	…………………………………………………………..	[0]	[1]	[2]	[3]	[4]	[5]

COMMENTS ON B1:

B2) QUESTION: *What are the levels of agreement of these factors towards Budgeting for Waste Syndrome, BWS of construction resources?*

Ratings: - Strongly Agreed *(4)*, Agreed *(3)*, Undecided *(2)*, less Agreed *(1)* and Disagree *(0)*

Kindly Tick the Appropriate level of Agreement:

FACTORS TOWARDS BUDGETTING FOR WASTE SYNDROMES	*RATING [0] to [4]*				
1. The belief that site participant has for resources wastefulness are:					
a) Resources wastefulness is inevitable	*4*	*3*	*2*	*1*	*0*
b) Wastefulness is normal	*4*	*3*	*2*	*1*	*0*
c) Resources have to be sufficient to accommodate wastage	*4*	*3*	*2*	*1*	*0*
d) Others (Kindly Specify)	*4*	*3*	*2*	*1*	*0*
i	*4*	*3*	*2*	*1*	*0*
ii	*4*	*3*	*2*	*1*	*0*

2. Site participant reaction to resources utilisation as follows:					
a) Carefree	*4*	*3*	*2*	*1*	*0*
b) Ignorant	*4*	*3*	*2*	*1*	*0*
c) Normal	*4*	*3*	*2*	*1*	*0*
d) Displease	*4*	*3*	*2*	*1*	*0*
e) Nonchalant	*4*	*3*	*2*	*1*	*0*
f) Others (Kindly Specify)	*4*	*3*	*2*	*1*	*0*
i	*4*	*3*	*2*	*1*	*0*
ii	*4*	*3*	*2*	*1*	*0*

3. The behavioural pattern of site operatives to resources utilisation are:					
a) Carefree	*4*	*3*	*2*	*1*	*0*
b) Ignorant	*4*	*3*	*2*	*1*	*0*
c) Normal	*4*	*3*	*2*	*1*	*0*
d) Displease	*4*	*3*	*2*	*1*	*0*
e) Nonchalant	*4*	*3*	*2*	*1*	*0*
f) Others (Kindly Specify)	*4*	*3*	*2*	*1*	*0*
i	*4*	*3*	*2*	*1*	*0*
ii	*4*	*3*	*2*	*1*	*0*

4. The likely incentives or measures that will be effective for resources waste reduction in construction industry are:					
a) Monetary Bonus to waste minimisation	*4*	*3*	*2*	*1*	*0*
b) Target job and resources saving scheme	*4*	*3*	*2*	*1*	*0*
c) Payment in relative to sensitivity of the resources	*4*	*3*	*2*	*1*	*0*
d) Damage free incentive package	*4*	*3*	*2*	*1*	*0*
e) Carefulness awards	*4*	*3*	*2*	*1*	*0*
f) Waste awareness awards	*4*	*3*	*2*	*1*	*0*
g) Others (Kindly Specify)					
i.	*4*	*3*	*2*	*1*	*0*
ii.	*4*	*3*	*2*	*1*	*0*

5. The allowance of wastefulness in this production information is high					
a) Architectural Drawings and Spec.	*4*	*3*	*2*	*1*	*0*
b) Structural Drawings and Spec.	*4*	*3*	*2*	*1*	*0*
c) Mech. Drawings and Spec.	*4*	*3*	*2*	*1*	*0*
d) Elect. Drawings and Spec.	*4*	*3*	*2*	*1*	*0*
e) B. O. Q	*4*	*3*	*2*	*1*	*0*

6. The allowance for these resources wastefulness is high.					
a) Materials, Ma	*4*	*3*	*2*	*1*	*0*
b) Manpower, Mp	*4*	*3*	*2*	*1*	*0*
c) Machinery, Me	*4*	*3*	*2*	*1*	*0*

B3) KINDLY TICK ONE, THE MOST APPROPRIATE

7. What is the percentage accuracy of Quantities Surveyor or Estimators budget to actual construction resources utilised?

   a) Very low ( ) b) Low ( ) c) Mild ( )
   d) High ( ) e) Very High ( )

8. How does production information drawings and specifications usually conform to actual construction standard?

   a) Very low ( ) b) Low ( ) c) Mild ( ) d) High ( )
   e) Very High ( )

C) AVOIDANCE OF CONSTRUCTION RESOURCES WASTEFULNESS, ACRW

Building construction resources wastefulness could be classified as - conscious or unconscious in occurrence and avoidable or unavoidable in usage.

C1) i. kindly classifies these causes of resources wastage as conscious [CON] or Unconscious, [UNC] in occurrence and avoidable, [AV] or unavoidable, [UNAV] in usage. Kindly tick as appropriates.

ii. What is the rate of occurrence: Kindly write from Very High [5] to Very Low [1]

Causes Of Resources Wastage	Occurrence (Pls; Tick One)		Frequency Rate	Usage (Pls; Tick One)	
A) WASTE DUE TO MATERIALS	Conscious [Con]	Unconscious [Uncon]	Rate btw 1- 5 as Appropriate	Avoidable [Av]	Unavoidable [Unav]
1) specification error				Av	Unav
2) Design not to manufacturer standard - materials off cut				Av	Unav
3) over ordering due to quantity surveyor mistake				Av	Unav
4) Over Ordering Due To Engineers faults				Av	Unav
5) material damage on stock piling				Av	Unav
6) Planning error				Av	Unav
7) drying shrinkage due adverse weather				Av	Unav
8) Off-cut due to irregular shape				Av	Unav
9) pilferage				Av	Unav
10) Excess ordering of materials for usage unreturned to store				Av	Unav
11) Residual and spillage during work in progress				Av	Unav
12) Transit waste - braking and spillage				Av	Unav
13) Weather condition - materials spoilage				Av	Unav
Others (Kindly Specify)					
14				Av	Unav
15				Av	Unav
16				Av	Unav

Causes Of Resources Wastage	Occurrence (Pls; Tick One)		Frequency Rate	Usage (Pls; Tick One)	
B) WASTE DUE TO LABOUR	Conscious [Con]	Unconscious [Uncon]	Rate btw 1- 5 as Appropriate	Avoidable [Av]	Unavoidable [Unav]
1) Waiting time for material to use - Redundancy period				Av	Unav
2) Double handling				Av	Unav
3) Over staffing for a particular project execution				Av	Unav
4) Insufficient tools and equipments to use - waiting time				Av	Unav
5) Unskilled operation - increasing the time of completion				Av	Unav
6) Rework due to mistake				Av	Unav
7) Less work apportionment				Av	Unav
8) Lack of coordination among gang				Av	Unav
9) Wrong construction method leading to delay or time delay				Av	Unav
10) Weather condition - work delay				Av	Unav
11) Right operation for wrong work - delay or rework				Av	Unav
12)Traffic between plant position to operation place				Av	Unav
Others (Kindly Specify)					
13				Av	Unav
14				Av	Unav
15				Av	Unav

Causes Of Resources Wastage	Occurrence (Pls; Tick One)		Frequency Rate	Usage (Pls; Tick One)	
C) WASTE DUE PLANT AND EQUIPMENTS	Conscious [Con]	Unconscious [Uncon]	(Rate btw 1- 5 as Appropriate	Avoidable [Av]	Unavoidable [Unav]
1) Early delivery time and redundancy period				Av	Unav
2) Low output capacity than required for the gang in operation				Av	Unav
3) Un-experience operator - minimal efficiency/productivity				Av	Unav
4) Breakdown during work in				Av	Unav

progress - material/labour waste					
5) Lack of coordination within gang - redundancy/inefficiency				Av	Unav
6) Operation and plant position, traffic - mat. and labour waste				Av	Unav
7) Uncoordinated skill of plant operator and controller				Av	Unav
8) Wrong construction method and repeated work for plant				Av	Unav
9) Poor communication system within the gang - time lag				Av	Unav
10) Long break/position/stationary un-used , rental cost				Av	Unav
Others (Kindly Specify)					
11				Av	Unav
12				Av	Unav

Causes Of Resources Wastage	**Occurrence (Pls; Tick One)**		**Frequency Rate**	**Usage (Pls; Tick One)**	
D) WASTE DUE TO PRODUCTION INFORMATION	Conscious [Con]	Unconscious [Uncon]	Rate btw 1- 5 as Appropriate	Avoidable [Av]	Unavoidable [Unav]
1)Architectural drawing complexity and interpretation time lag				Av	Unav
2) Ambiguity of structural drawing and interpretation time lag				Av	Unav
3) Inadequacy of Architectural specification				Av	Unav
4) Inadequacy of Mechanical Engineering specification				Av	Unav
5) Inadequacy of Electrical Engineering specification				Av	Unav
6) Inadequacy of Structural Engineering specification				Av	Unav
7) Inadequacy of Estimator/Quantity Surveyor specification				Av	Unav
8) Variation order and implementation approval delay				Av	Unav
9) Alteration subjected to due process for implementation				Av	Unav
10) Modification subjected to due				Av	Unav

process for implementation					
11) Design error				Av	Unav
Others (Kindly Specify)					
12				Av	Unav
13				Av	Unav
14				Av	Unav

E) WASTE DUE TO SITE MANAGEMENT	Conscious [Con]	Unconscious [Uncon]	(Rate btw 1- 5 as Appropriate	Avoidable [Av]	Unavoidable [Unav]
1) Inadequate planning system towards project execution				Unav	Av
2) Inadequate monitory system				Unav	Av
3) Lack of sufficient motivation to boast operative morale				Unav	Av
4) Poor selection of materials and labour procurement system				Unav	Av
5) Poor site organisation that leads to wastage				Unav	Av
6) Delay in decision making and operation order time lag				Unav	Av
7) Poor line communication system that leads to time lag				Unav	Av
8) Inexperience of the type technicality require for the project				Unav	Av
9) Poor project planning And Schedule that leads to wastage				Av	Unav
10) Poor schedule of resources that leads to wastage				Av	Unav
11) Poor operation control				Av	Unav
Others (Kindly Specify)					
12				Av	Unav
13				Av	Unav
14				Av	Unav

F) WASTE DUE TO DESIGN TEAM	Conscious [Con]	Unconscious [Uncon]	(Rate btw 1- 5 as Appropriate	Avoidable [Av]	Unavoidable [Unav]
1) Variation order delay that affects				Av	Unav

other work in progression					
2) Waiting time for alteration order				Av	Unav
3) Delay in inspection to proceed to another stage of work				Av	Unav
4) Communication gap between design and construction teams				Av	Unav
5) Predominant meeting on variation/alteration/modification				Av	Unav
Others (Kindly Specify)					
6				Av	Unav
7				Av	Unav

COMMENTS ON C1:

C3). *Kindly indicate in the box provided, the rate of occurrence of these type of waste in relation to Construction Resources Utilisation.*

OCCURENCE RATING:

Very High Occurrence, 5; High, 4; Mild, 3 Low, 2 and Very low, Occurrence 1

Kindly write the most appropriate rate from 1 to 5 into each box. All boxes need to be filled.

SOURCES OF WASTE		RESUOURCES *Kindly write into the box the most appropriate Rate Very High [5] and very Low[1] in occurrence*		
		Materials	**Manpower**	**Machinery**
A	**Machinery** Motion			
B	**Machinery** Waiting			
C	**Machinery** Transport			
D	**Machinery** Defects			
E	Over Procurement			
F	Others (Kindly Specify)..................			
i				
ii				

D) DEMOGRAPHY

All information to be provided will be treated in confidence and remain anonymous.

D1) How many employees does your establishment have in UK?
(Tick one box only)

Less than 50 [ ]1	51 - 100 [ ]2		101 - 150,		[ ]3	
151 - 200	[ ]4	201 - 250	[ ]5	251- 300[ ]6		
301 - 350	[ ]7	350 - 400	[ ]8	Over 500		[ ]9

D2.) In which regions does your organisation operate in The UK?
(Tick as many as applicable)

North East	[ ]1	North West	[ ]2	Yorkshire/Humberside	[ ]3
East Midland	[ ]4	West Midland	[ ]5	East Anglia	[ ]6
London	[ ]7	South East	[ ]8	South West	[ ]9
Wales	[ ]10	Scotland	[ ]11	North Ireland	[ ]12
Channel	[ ]13	Islands	[ ]14		

D3) Years of Experience as a Manager in Construction Organisation

Less than 5yrs [ ]1 6 - 10 [ ]2 11 - 15 [ ]3 above 15 [ ]4

D5) Please, we will be interested to contact you for further useful enquiries, if the need arises. Kindly indicate your interest.

Yes [ ]1 No [ ]2

D6) Please, we will be interested to send the summary of the findings to you. Kindly indicate your interest.

Yes [ ]1 No [ ]2

D7) Name of Organisation...
D8) Name of the Professional completing the Questionnaires..................................
D9) Present Status in the Organisation...
D10) Telephone Number...
D11) Email address...

PLEASE, WE WILL GREATLY APPRECIATE IF THE COMPLETED COPY OF THIS QUESTIONNAIRE COULD BE RETURNED BEFORE THE YEAR END, 2006

THANKS FOR THE VALUABLE SURPORT.

Julius Fapohunda Tel: 07961367002; email: bldrfapo@yahoo.com

APPENDIX C

INTERVIEW SURVEY LETTER AND GUIDING QUESTIONS

Sheffield Hallam University

Faculty of Development and Society

Sheffield Hallam University
Collegiate Crescent
Sheffield S1 1WB UK

Telephone +44 (0)114 225 5555
www.shu.ac.uk

Executive Dean of Faculty
Professor Sylvia Johnson

March 21ST, 2007

Dear Sir,

SOLICITING FOR RESEARCH INTERVIEW

Sheffield Hallam University, Built Environment Division, is currently engaging in a research project in one of the major predicaments facing construction resources utilisation, and Lean construction techniques of which the application and achievement is still inconsistence in the industry.

The research is to establish an operational framework on how construction resources could be efficiently utilised during the production process.

To achieve robust findings, the research is sub-divided into three folds:

i. Factors that affects Site Managers' Efficient Performance.
ii. Allocation/Budgeting for Waste Syndromes of construction resources and motivational factors towards efficient resources utilisation.
iii. Construction Resources Wastefulness Scenarios.

Quantitative Questionnaire Survey had been carried out and data obtained had been analysed to obtain some facts. This interview is set to find answer to some silent questions, *(how and why)*, and to affirm the facts obtained from the questionnaire survey, for validity and reliability of the research outcome.

This letter is to solicit your permission to be interviewed on this subject.

We believed that the information and facts obtainable from your wide experience with other notable professionals in the industry would be substantial enough to establish the research operational framework.

The framework is presumed to reduce the predicament of inefficient utilisation of construction resources during production process and enhance lean construction principle and practice, when adequately implemented.

Strict confidentially will be maintained and the research is covered with all research ethics principles and practice.

If you are agreeable to participate in an interview, kindly specify a date and time that will be convenience for you between April 2nd and 27th, 2007 through the email address below. We will also call you to confirm the date.

At completion of the research, a copy of the summary will be forwarded to you for record purpose.

We count on you for the achievement of this research success.

Thanks for the anticipated support.

Yours truly,

Julius A Fapohunda
Email: **bldrfapo@yahoo.com;** *Tel: 07961367002; 01142254008; 01142253208*

APPENDIX C:

OPTIMUM UTILISATION OF CONSTRUCTION RESOURCES DURING THE PRODUCTION PROCESS

RESEARCH QUALITATIVE INTERVIEW SURVEY GUIDE

"A project could be completed within the estimated cost; time frame and quality expected with amass resources wastefulness"

----- *RESEARCHER'S OPINION*

THANK YOU IN ADVANCE FOR YOUR VALUABLE SURPORT.

JULIUS A. FAPOHUNDA

Sheffield Hallam University

INTERVIEW SURVEY GUIDE QUESTIONS

This interview survey is divided into three sections; each section represents different propositions and objectives. Thus, the sections will collectively be used to develop the research operational framework. The results obtained from quantitative research survey were used to draw these interview guide questions.

(A) SITE MANAGERS EFFICIENT PERFORMANCE

1) The ease of accomplishment or achievement of site management propositions, tasks during Construction production process were grouped, rated and ranked (*As shown in Table 1*)

Table I: The Result on ***the ease of Accomplishment site management propositions or tasks*** during Construction production process.

		(%)
1.	Quality in Construction	77
2.	Project Scope Determinant	75
3.	Risk in Construction	74
4.	Delegation of Authority	73
5.	Materials Efficiency	73
6.	Sub-Contractors Control	70
7.	Machinery Efficiency	69
8.	Resources Procurement	69
9.	Time Management	69
10.	Manpower Efficiency	68
11.	Nominated Supplier Control	65

DEDUCTIONS:

i. It could be deduced that the accomplishments of these factors are possible,

ii. Some factors are very highly accomplished.

QUESTIONS:

1. Kindly comment ***in support or in contrasts*** on these deductions.
2. The results shown ***high percentages of accomplishment of these tasks***, in your opinion, ***why resources wastefulness is still at high*** in the industry?

2) Based on results obtained through questionnaires survey, the rate of factors that hinders Site managers efficient performances on Optimal Utilisation of Construction Resources are summarised in table 2:

Table 2: Result of the Factors That Hinders Site managers' Efficient Performances

		%
1.	Time Lapse in Approval of Change Due to Spec. error	80
2.	Sub- Contractor Performance and conformity	77
3.	Nominated Suppliers Performance	72
4.	Material availability	67
5.	Skilled Labour availability	67
6.	Project Complexity Subject to Clarification	66
7.	Modification Response to Effect Change	66
8.	Alteration Response to Effects Change	66
9.	Design Team Drawing and/or Specification clarity.	65
10.	Working/Operation Space and Congestion	65
11.	Communication with Design Team	63
12.	Skilled Plant operators availability	51
13.	Unskilled Labour availability	48

DEDUCTIONS

a) It could be deduced that majority of these factors hinders Site managers' efficiency.
b) In comparison, hindrance through skilled plant operators and unskilled labour availability are low.

QUESTIONS:

a) Kindly comment in support or contrasts on these results.
b) How best can these hindrances be avoided or controlled?

3) Some attributes that affect Site managers were identified and grouped, the frequency of the effects were summarised in ranked order as: (***Details shown in Table 3***)

1.	Traits/Qualities	80%
2.	Skills/Expertise	72%
3.	Abilities/Potentials	72%
4.	Awareness	67%

DEDUCTIONS

a) The rates of these factors' impacts on site managers' optimum resources utilisation during production process were found generally to be above average.

b) Some of these factors are very high.

QUESTIONS:

a) 1) Kindly comment on these deductions, in support or contrast.

b) 2) In your opinion, out of these groups of factors identified, which one can be considered crucial towards efficient resources utilisation, and why?

c) 3) Kindly explain how these factors could be best improved?

Table 3: Detail Result of the Attributes That Affect Site managers on Optimum Resources Utilisation

		%
(A)	***TRAITS/QUALITIES (Mean)***	***80***
1	Leadership	90
2	Competency	89
3	Enthusiasm in achievement	82
4	Cool Under Pressure	81
5	Integrity	79
6	Creative Thinking	77
7	Challenging	75
8	Empathy and Compassion	68

	Factors	%
B)	***SKILLS/EXPERTISE (Mean)***	*72*
1	Risk Management	80
2	Time Management	79
3	Procurement Management	78
4	Knowledge Management and Shearing	76
5	Problem Solving	76
6	Quality Management	76
7	Contract Mgt & Administration	73
8	Cost Management	72
9	Staffing And Recruitment	71

10	Materials Management	71
11	Supplier & Sub Contractor Mgt	71
12	Human Resources Management	70
13	Client Interest management	68
14	Change Management	65
15	Motivation Strategies	61
16	Negotiation Power	61

		%
(C)	***ABILITIES/POTENTIAL*** ***(Mean)***	*72*
1	Decisiveness	81
2	Team Building	79
3	Objective Setting	75
4	Assertiveness	75
5	Delegation of task and responsibilities	73
6	Dispute Resolutions	70
7	Concurrent Project Evaluation	67
8	Facilitation	66
9	Energy Management	59

		%
(D)	***AWARENESS*** ***(Mean)***	*67*
1	Health & Safety Regulations	82
2	Performance Measurement	75
3	Contract forms & strategies	64
4	Whole Life Costing	64
5	Tendering strategies	63
6	Brief Writing	62
7	Laws And Arbitration	61

4) The ***relative importance of some facilitators towards Optimum Resources Utilisation*** was rated. The ranked - order are presented in Table 4.

Table 4: The Ranked Order of Factors That Facilitates Optimum Resources Utilisation (in %)

1. Production Information Simplicity and Explicitly	89
2. Communication effectiveness	87
3. Resources Availability	80
4. Alterations & Modification minimisation	80
5. Variation control and minimisation	78
6. Project Participants Skill And Knowledge	77
7. Efficient Cost Control	77
8. Site managers' Experiences on similar work	76
9. Resources Procurement System	75
10. Efficient Cost Analysis	75
11. Expressive Process Integration	71
12. Summer Weather Condition	70
13. Project In-Built Morale & Motivation	69
14. Job Appraisal & Satisfaction	69
15. Winter Weather Condition	68
16. Friendly Project Locality and Environment	66
17. Legal And Local Authority regulations	64
18. Technological Change during Work In Progress	61

DEDUCTIONS

a) It was found that all these factors are somewhat important towards efficient resources utilisation.

b) Some of these factors are highly important.

QUESTIONS:

a) Kindly comments on these results, in support or contrast.

b) Please in your opinion, how could these factors can be significantly improved towards optimal resources utilisation?

B) EFFECT OF BUDGETING FOR WASTE SYNDROMES

1) The level of contribution to allowance/budgeting for waste syndromes of construction resources in the industry were summarised in Table 5:

TABLE 5: LEVEL OF CONTRIBUTION OF GROUPED FACTORS TOWARDS ALLOWANCE FOR WASTEFULNESS

1.	Contribution due to Design Team, DT	63%
2.	Contribution due to Materials	58%
3.	Contribution due to Manpower	57%
4.	Contribution due to Machinery & Equipment	55%
5.	Contribution due to Production Information	55%
6.	Contribution due to Site Management	50%

DEDUCTIONS

a) All these factors contribution were found to be ***somewhat above average.***

b) These results indicated that, resources wastefulness is through various allowance or provision.

QUESTIONS

a) Kindly comment on these results in support and in contrast

b) In your opinion, what are the likely effects of this allowance on resources utilisation during production process?

c) Please, in your opinion, how could these scenarios can be minimised?

2) Based on *beliefs of site participants*, the results obtained through questionnaire survey are summarised as follows:

1.	Resources Waste is inevitable	85%
2.	Resources waste is normal	71%
3.	Resources have to be sufficient to accommodate waste	67%

DEDUCTIONS

a) The result obtained through the survey indicated that there is high agreement on these statements.

b) In comparison, the belief that resources ***waste is inevitable*** is rated highest.

QUESTIONS:

a) Kindly comment on this belief, in support or contrast. (Why?)

b) How can these participant's beliefs be corrected towards optimal resources utilisation?

3) Some factors have been identified as incentive or measure towards effective Resources waste minimisation

1.	a) Monetary Bonus to waste minimisation	79%
2.	b) Target job and resources saving scheme	74%
3.	c) Payment in relative to sensitivity of the resources	71%
4.	d) Damage free incentive package	67%
5.	f) Waste awareness awards	56%
6.	e) Carefulness awards	45%

DEDUCTIONS

a) There is a consensus above average to these factors that were identified as incentives or measure towards waste minimisation.

b) In comparison the agreement to carefulness awards is very low.

QUESTIONS

a) Kindly comment, either in contrast or in support on these deductions.

b) Please, in your opinion, how can these be implemented or achieved

C) AVOIDANCE OF CONSTRUCTION RESOURCES WASTEFULNESS

Some causes of resources wastefulness were identified. Their frequencies and mode of occurrences were summarised and in ranked order as in table 6. (***Details shown in table 7***)

TABLE 6: THE SUMMARY OF RESOURCES WASTEFULNESS.

Key: **Frequency,** ***Freq.***
Occurrence: Conscious, ***Con***; Unconscious, ***Uncon***;
Usage: Avoidable, ***Av***; Unavoidable, ***Unav.***

	Freq.	*Con*	*Unco*	*Av*	*Unav*
A) Waste Due To Materials	50	41	59	73	27
B) Waste Due To Labour	51	42	58	79	21
C) Waste Due Plant and Equipments	52	45	56	83	18
D) Waste Due To Production Information	54	38	62	80	20
E) Waste Due To Site Management	53	33	67	79	21
F) Waste Due To Design Team	59	56	44	77	24
(Mean %)	53	43	58	79	22

DEDUCTIONS

a) The percentage of occurrence of all the factors were above average, with mean of 52%
b) The majorities of these Resources wastefulness unconsciously occurred with mean of 58%, only few occur consciously, mean of 42%.
c) Majorities of the sources of wastefulness were avoidable, with mean of 78%, only few are unavoidable., mean of 22%

QUESTIONS

a) Kindly comment on these results
b) Please in your opinion, what are scenarios that lead to ---?
   - Conscious resources wastefulness
   - Unconscious resources wastefulness
c) What are the possibilities of making unconscious wastefulness conscious?
d) How could these occurrences be avoided?
   - conscious waste
   - Unconscious waste

Table 7: DETAIL RESULT OF AVOIDANCE OF CONSTRUCTION RESOURCES WASTEFULNESS (%)

	Freq.	Con	Unco	Av	Unav
A) Waste Due To Materials (Mean)	50	41	59	73	27
1) Material Damage on Stock Piling	59	33	67	81	19
2) Off-Cut Due To Irregular Shape	55	59	41	40	60
3) Design Not To Manufacturer Standard - Mat Off Cut	55	33	67	85	15
4) Specification Error	51	21	79	81	19
5) Over Ordering Due To Quantity Surveyor Mistake	50	31	69	89	11
6) Pilferage	50	67	33	65	35
7) Weather Condition - Materials Spoilage	49	36	64	64	36
8) Over Ordering Due To Engineers Faults	49	31	69	92	8
9) Residual and Spillage during Work at Progress	48	49	51	69	31
10) Drying Shrinkage Due Adverse Weather	48	45	55	40	60
11) Excess Ordering Of Mat. For Usage Unreturned	47	74	26	88	18
12) Transit Waste - Braking and Spillage	47	29	71	73	27
13) Planning Error	46	22	78	88	12

	Freq.	Con	Unco	Av	Unav
B) Waste Due To Labour	51	42	58	79	21
1) Double Handling	60	65	35	77	23
2) Rework Due to Mistake	58	27	73	85	15
3) Unskilled Operation - Increasing the Time of Completion	54	42	58	84	16
4) Waiting Time for Material to Use - Redundancy Period	54	33	67	82	18
5) Lack of Coordination among Gang	51	35	65	88	12
6) Weather Condition - Work Delay	51	65	35	29	71
7) Insufficient Tools and Equipments to Use - Waiting Time	50	34	66	87	13
8) Wrong Construction Method Leading To Delay or Time Delay	49	30	70	89	11
9) Less Work Apportionment	48	39	61	88	12
10) Right Operation for Wrong Work - Delay or Rework	48	49	51	92	8
11) Traffic between Plant Position to Operation Place	48	29	71	71	29
12) Over Staffing For A Particular Project Execution	46	55	45	81	19

	Freq.	Con	Unco	Av	Unav
C) Waste Due Plant and Equipments (Mean)	52	45	56	83	18
1) Low Output Capacity than Required For the Gang in Operation	56	23	77	93	8
2) Operation And Plant Position, Traffic - Mat. And Labour Waste	54	53	47	81	19
3) Long Break/Position/Stationary Un-Used, Rental Cost	53	57	43	84	16
4) Breakdown during Work In Progress - Material/Labour Waste	53	22	78	52	48
5) Early Delivery Time and Redundancy Period	52	62	38	71	29
6) Uncoordinated Skill of Plant Operator and Controller	50	37	63	94	8
7) Lack of Coordination within Gang - Redundancy/Inefficiency	50	29	71	96	4

8) Wrong Construction Method and Repeated Work For Plant	50	54	46	88	12
9) Un-Experience Operator - Minimal Efficiency/Productivity	49	33	67	82	18
10) Poor Communication System within the Gang - Time Lag	49	75	25	85	15

D) Waste Due To Production Information (Mean)	Freq. *54*	Con *38*	Unco *62*	Av *80*	Unav *20*
1) Inadequacy of Architectural Specification	60	38	62	87	13
2) Design Error	57	21	79	65	35
3) Architectural Drawing Complexity and Interpretation Time Lag	56	24	76	81	19
4) Variation Order and Implementation Approval Delay	55	57	33	71	29
5) Modification Subjected To Due Process for Implementation	55	63	37	59	41
6) Inadequacy of Electrical Engineering Specification	53	31	69	95	05
7) Inadequacy of Structural Engineering Specification	53	30	70	93	07
8) Ambiguity of Structural Drawing and Interpretation Time Lag	53	25	75	74	26
9) Inadequacy of Mechanical Engineering Specification	52	31	69	95	05
10) Alteration Subjected To Due Process for Implementation	51	58	42	70	30
11) Inadequacy of Estimator/Quantity Surveyor Specification	51	35	65	85	15

E) Waste Due To Site Management (Mean)	Freq. 53	Con 33	Unco 67	Av 79	Unav 21
1) Inadequate Planning System towards Project Execution	60	31	69	78	22
2) Poor Site Organisation That Leads To Wastage	57	30	70	81	19
3) Poor Operation Control	54	21	79	93	7
4) Poor Project Planning and Schedule That Leads To Wastage	54	26	74	92	8
5) Delay in Decision Making and Operation Order Time Lag	54	50	50	72	28
6) Inadequate Monitory System	54	42	58	79	21
7) Poor Line Communication System That Leads To Time Lag	54	26	74	71	29
8) Poor Schedule of Resources That Leads To Wastage	53	30	70	89	11
9) Inexperience of the Type Technicality Require For the Project	50	39	61	63	37
10) Lack of Sufficient Motivation to Boast Operative Morale	50	26	74	71	29
11) Poor Selection of Materials and Labour Procurement System	48	37	63	76	24

F) Waste Due To Design Team (Mean)	Freq. 59	Con 56	Unco 44	Av 77	Unav 24
1) Variation Order Delay That Affect Other Work in Progression	67	70	30	65	35
2) Waiting Time for Alteration Order	63	57	43	60	40
4) Communication Gap between Design and Construction Teams	60	43	57	94	6
5) Predominant Meeting on Variation/Alteration/Modification	53	45	55	89	19
3) Delay in Inspection to Proceed To another Stage of Work	53	66	34	78	22

ADDITIONAL INTERVIEW QUESTIONS

1) Please, kindly suggest some possible radical changes/ways that can reduce construction resources wastefulness.
2) "The construction industry is lagging behind other sectors in resources optimum utilisation, such as in manufacturing industry and service sectors". As far as possible, how can the construction industry bridge this gap?
3) "Problems are "man-made" and can only be solved by man". How can this be achieved with regard to optimum resources utilisation?
4) In your opinion, what are the coherent factors that need to be constant for efficient utilization of construction resources during:
    a) Design Stage?
    b) Construction Phase?
5) How could resources wastefulness be reduced through:
    a) Planning
    b) Controlling
    c) Monitoring of resources

6) Apart from the above, what are the factors to be considered towards optimal utilisation of construction resources?
7) Why do construction participants envisage that construction resources wastefulness is unavoidable?
8) Please, in your opinion how can unavoidable wastes be minimised during project construction phase?
9) Summarily, kindly expand on how unconscious occurrences of wastefulness can be conscious of and be avoided?
10) The general belief in the industry is that waste will occur during construction and there is allowance for resources wasteful (Material, Manpower and Machinery), what effects do these actually have on:
    a) Resources utilisation
    b) the site participant
11) Please, in summary, kindly comment on this research work and its pre-assumption:
    "A project could be completed within the estimated cost, time frame and quality expected with amass resources wastefulness"

Thanks for the positive support.

APPENDIX D:

OPTIMAL UTILISATION OF CONSTRUCTION RESOURCES OPERATIONAL FRAMEWORK VALIDATION

STAGE ONE QUESTIONS

The attached table presents the probable causes of construction resources utilisation inefficiencies; also, it highlights suggestions towards achieving efficiencies.

In this study, "Waste" means misuse, inappropriate utilisation or inefficient implementation; thus "Resources Waste" is a term use to qualify inefficient utilisation of resources, (materials, manpower, and machinery) that result from inadequate planning, inadequate control, or ineffective monitoring of construction procedures.
Initial findings were obtained from literatures and augmented by collection of information and data from both quantitative and qualitative research survey methods.

Summary of the results obtained are presented in table, comprises three main headings, (Sections):

Section A: Causes of Construction Resources Wastefulness,

Section B: Possible Solutions to Reduce or Avoid Construction Resources Wastefulness and

Section C: Suggested Radical Approach towards Efficient Resources Utilisation

Kindly **rate** these factors, write the numeral in order of agreement.
Also, **comment or suggest** how these factors could be improved.
Please, additional note(s) could be attached for comment, suggestions, and explanations.
Thank you for the valuable time that you are providing.

Julius A Fapohunda
Email: **bldrfapo@yahoo.com**
Mobile: **07961367002 & 07988913680**

Sheffield Hallam University

Summary of Findings for Evaluation

Section (A): Causes of Construction Resources Wastefulness

Kindly rate the following factors in order of agreement:

Highly agreed (4), Agreed (3), Less Agreed (2), Not applicable (1)

Kindly write the preferred rank, your comment and suggestions in the columns provided

Serial Number	Factors	Kindly write the rank, by choosing between 1 - 4	Comment/Suggestions (Kindly endeavour to evaluate these factors, your comments and suggestions will strengthen these deductions)
1.	Inadequate production information that was available or provided for project execution.		
2.	Inadequate time to plan project properly at inception, due to urgency in the need of project product and urgency for the project to commence.		
3.	Insufficient experienced and skilled workers in the industry that necessitate the use of semi-skilled workers for some tasks.		
4.	Traditional skilled workers addict, working pattern and non readiness to adapt to new innovative construction methods.		
5.	Predominant Machinery and Equipment redundancy.		
6.	Predominant manufacturers and designers component dimension disparities.		
7.	Unfavourable working environment project sites. Examples are congestion, weather, and restrictions.		
8.	Clients and construction participants unaware of accrued value of resources waste, that is,		

	cost implication of all resources wasted during project construction.		
9.	Over assumption and not implicit of construction production information, hoping that construction team should be able to interpret the production information without any assistance or interpretation.		
10.	Short contract duration leading to insufficient resources planning or inadequate forecast that could reduce resources wastefulness		
11.	Habitual alteration and modification during work in progress, with perception that these scenarios are normal		
12.	Unavailability of resources on request, due to inadequate of procurement plan from onset or resources scarcity.		
Other factors (Kindly suggest and comment)			
13			
14			
15			

Section (B): Possible Solutions to Reduce or Avoid Construction Resources Wastefulness

Kindly Rank the following factors in order of agreement:
Highly agreed (4), Agreed (3), Less Agreed (2), Not applicable (1)
Kindly write the preferred rank, your comment and suggestions in the columns provided

Serial No.	Factors	Kindly write the rank, between 1 - 4	*Comment/Suggestions* (Kindly endeavour to evaluate these factors, your comments and suggestions will strengthen these deductions)
1.	Availability of fully developed production information: before the project commences		
2.	Consciousness of design team towards efficient resources utilisation and resources efficiency		
3.	Effective implementation of knowledge management, shearing and transfer between construction organisations, apart from within an organisation.		
4.	Regular engaging or employing sub-contractors and suppliers that are conversant to the organisation policies or resources utilisation		
5.	Regular assessment of sub-contractors and suppliers, efficient performance and skills updating, and the organisation obtaining feedback about its construction performances from the suppliers and sub-contractors.		
6.	Provision of adequate infrastructures, facilities and safe working environment		
7.	Construction participants recognition of achievement and penalty threaten for obvious mistakes		
8.	Engaging resources Waste Manager for monitoring and forecasting probable inefficiencies before and during construction process.		
9.	Adequate planning of resources procurement.		

10.	Motivation towards enthusiasm and efficiencies.		
11.	Adequate awareness of resources waste implication on construction product and esteem of the worker.		
12.	Adoption and efficient implementation of "Site Construction Key Performance Indicators" (S_KPIs)		
13.	Setting waste target and strive towards achieving the set target.		
14.	Adequate monitoring of waste target set, against the adopted "site construction key performance indicators" (S_KPIs)		
15.	Adequate implementation of "supply and fix" contracting method.		
16.	Adoption of adequate resources waste disposal techniques and to ensure that the sub-contractors and suppliers dispose solid resources wasted.		
17.	Construction participants' adequate awareness of benefits that are accrued for resources waste reduction and to be efficient.		
18.	Design and specify re-usable materials, as far as possible.		
19.	Endeavour to design and specify to manufacturers standard dimensions.		
20.	Designing and specifying convertible structures and materials.		
21.	Adoption and implementation of panellised, prefabrication, and modern methods of construction.		
22.	Provision of effective motivators for the trainees and apprentice		
23.	Effective training toward efficient resources utilisation. Trainees need to obtain a certified certificate on resources'		

	efficient utilisations.		
24.	An enhanced implementation of partnering and the supply chain system.		
25.	Readily available resources on request through adequate procurement system.		
26.	Adequate resources programming and forward planning.		
27.	Construction and design teams regular and effective meetings on resources utilisation efficiency and modalities of executing work and tasks resourcefully		
28.	Construction industry needs to create modalities that will enable construction participants and clients to know the "accrued value and cost implication" of all resources wasted during project execution.		
29.	Adoption and implementation of modular components and modular construction methods.		
30.	Avoidance or minimisation of alteration and modification during construction process.		
31.	Availability of adequate time for planning before project commences.		
32.	Effective and efficient information dissemination and retrieval during construction process.		
33.	Avoidance of perpetual plant and equipment inefficiencies and redundancy through adequate resources procurement planning.		
34.	Adequate evaluation of design concept buildability before project commences		
Other factors (Kindly suggest and comment)			
35.			
36.			

Section (C): Suggested Radical Approach towards Efficient Resources Utilisation

Kindly Rank the following factors in order of agreement:
Highly agreed (4), Agreed (3), Less Agreed (2), Not applicable (1)
Kindly write the preferred rank, your comment and suggestions in the columns provided

Serial Number	Probable Findings	Kindly write the rank, by choosing between 1 – 4	Comment/Suggestions - (Kindly endeavour to evaluate these factors, your comments and suggestions will strengthen these deductions)
1	Organisation need to be consistent on engaging suppliers and sub-contractors that possess tested efficiency, and already have acquitted to the organisation policies.		
2	Adoption and implementation of practical procedure and mission statement to construction participants on efficient resources utilisation.		
3	Eradication or avoidance of the aged and traditional construction operating system and concept.		
4	Adoptions of modalities for valuing all accrued resources wasted during construction process at project completion, and to disclose the cost implication to all construction participants including the clients.		
5	Designers' component, specifications, and dimensions should be in accordance with manufacturers' standards.		
6	Manufacturers' products to designers' specification and dimension; for a large and prototype projects.		
7	Eradication or reduction of in-situ construction works and adoption of prefabrication, panellised or modular construction system.		
8	Adoption and implementation of smart,		

	and re-usable components for construction:		
9	Adoption and implementation of a certified production performance training certificate:		
10	Availability of database for various rationales and causes of inefficient resources utilisation, and possible solutions to achieve efficiencies.		
Other factors (Kindly suggest and comment)			
11			
12			

Section (D): Demography

All these information will be treated confidentially and will remain anonymous.

D1). How many employees are working presently in your organisation, in The UK? (Tick one box only)

Less than 50	[ ] 1	51 - 100	[ ] 2	101 - 150	[ ] 3
151 - 200	[ ] 4	201 - 250	[ ] 5	251 - 300	[ ] 6
301 - 350	[ ] 7	350 - 400	[ ] 8	Over 400	[ ] 9

D2). In which Regions do your organisation operates in The UK (Tick as many as applicable)

North East	[ ] 1	North West	[ ] 2	Yorkshire/Humberside	[ ] 3
East Midland	[ ] 4	West Midland	[ ] 5	East Anglia	[ ] 6
London	[ ] 7	South East	[ ] 8	South West	[ ] 9
Wales	[ ] 10	Scotland	[ ] 11	North Ireland	[ ] 12
Channel	[ ] 13	Islands	[ ] 14		

D3). Years of Experience as a Manager in Construction Organisation

Less than 5yrs [ ] 1   6 – 10 yrs [ ] 2   11 – 15 yrs [ ] 3 above 15 yrs [ ] 4

D4). Please, we will be interested to contact you for further useful enquiries, if there is need. Kindly indicate your interest.

Yes [ ] 1   No [ ] 2

D5). Please, we will be interested to send the summary of the research findings to you. Kindly indicate your interest.

Yes [ ] 1   **No** [ ] 2

D6) Name of Organisation**...**

D7) Name of the Professional completing the Questionnaires**....................................**

D8) Telephone Number**...**

D9) Present Status in the Organisation**...**

D10) Telephone Number**...**

D11) Email address**..**

Thanks for the valuable support provided.

Julius A. Fapohunda, (The Research Student)

APPENDIX E:

Sub-Questions that generated and Themes deduced during Interview Research Survey

STUDY ONE:

SITE MANAGEMENT EFFICIENT PERFORMANCE:

(The Strength, Weakness, Opportunity and Threat: SWOT)

1) The roles of Site managers in Project execution
   - *What are the effects of involving Project or Site manager to execute the project during design stage?*
   - *What are roles of Site managers in any type of procurement system to reduce resources wastage?*

2) Crucial Site manager's attributes
   - *Kindly comment on attributes of site managers in relation to efficient utilisation of construction resources. And in your own opinion, which do you consider to be very important?*
   - *Which of the Site manager's attributes could be considered crucial towards efficient RU and why?*

3) Factors that affect site managers
   - *Kindly comment on factors that affect Site Mangers' on optimum utilisation of construction Resources.*
   - *Some factors hinder Site Mgr in efficient performance of his/her duties and resources utilisation. How can these be avoided or minimised?*

4) Site manager's propositions Achievement
   - *What are the factors that enhance the ease of accomplishments of Site manager's propositions during construction project production?*
   - *It could be said that, the ease accomplishments of Site manager's propositions are often high, then why RW in the industry is still high?*

5) Factors that should be constant towards efficient resources utilisation
   - *What are the factors that need to be constant towards efficient utilisation of construction resources?*

6) Facilitators to efficient Resources utilisation:
   - *What are the facilitators that could enhance efficient utilisation of construction resources?*
   - Kindly comment on the relative importance of the facilitators towards optimum utilisation of construction resources?

STUDY TWO:
EFFECT OF BUDGETING FOR WASTE SYNDROME, (EBWS)

7) The Beliefs of Site Participants' Towards Resources Utilisation

- *What are the beliefs of site participants on resources waste or utilisation in the industry?*
- *Is there a way that this belief be reduced, probably through incentives or motivation*
- *What are the effects of the belief that waste is normal in project execution?*

8) Budgeting for Waste Syndromes

- *Why budgeting for waste?*
- *How can BWS believes be corrected?*
- What are the factors that contribute to allowance for or budgeting for waste in construction industry?

STUDY THREE:
AVOIDANCE OF CONSTRUCTION RESOURCES WASTEFULNESS, ACRW

9) Resources Wastefulness

- *How can optimum construction resources utilisation be achieved nowadays?*
- *Why Construction Resources Wastefulness is high in the construction industry?*

10) Conscious and Unconscious Resources Wastefulness

- *What are the causes of conscious and unconscious waste*
- *How can these unconscious wastes be conscious of?*
- *Kindly comments on incidence that often lead to conscious and unconscious wastage of construction resources?*
- How can these conscious and unconscious wastes be avoided or minimised?

11) Clients and Resources Wastefulness

- *How can client involvement be useful in project resources efficiencies?*

12) Partnering and Supply Chain

- *Explains more how these partnering and supplier chain can reduce BWS*
- *What are the measures of reducing waste by contractors?*
- How visible operational system of Partnering and Supply chain system in relation to optimum utilisation of construction resources could be achieved.

13) Skilled Workers Shortage

- *The major problem facing the industry now-a-days is that, lack of skilled and experience workers. How can this industry implement sound and skilful training towards efficient resources utilisation?*

14) Problems are man made

- *"Problems are man made and can only be resolved by man" Kindly relate this to efficient utilisation of resources and resources waste management.*
- *How can these problems be minimised?*

15) Participants can be Motivated

- *How can site participants be motivated towards reduction of resources wastefulness?*
- *What are the likely incentives or measure that could enable site participants to work efficiently?*

16) Construction Industry is lagging behind other Sectors in Efficient Resources utilisation

- *Comment on this statement: "The construction Industry is lagging behind other sectors such manufacturing and service sectors in resources utilisation?*
- *How can construction industries reduce its gap of efficient resources utilisation in relation to other sectors?*

17) Suggested Radical Changes towards Efficient Resources Utilisation

- *Suggest some radical approach that can reduce resources wastefulness in the industry.*
- *What are the possible radical ways or approach that can reduce CRW?*

18) Research Proposition

- *Comment on this research and its proposition "A project could be completed within budgeted cost, time frame and quality with amass resources wastefulness*

APPENDIX F:

PUBLISHED PAPERS IN CONFERENCE PROCEEDINGS FROM THE OPTIMAL UTILISATION OF CONSTRUCTION RESOURCES RESEARCH STUDY

APPENDIX F1:

PAPER ONE - THE PAPER PUBLISHED IN BEAR, APRIL 2006, CONFERENCE PROCEEDINGS, HONGKONG

BUDGETING FOR WASTE SYNDROMES (BWS) WITHIN THE CONSTRUCTION INDUSTRY

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ABSTRACT

In the construction industry, project site operatives see the wastefulness of resources as inevitable. Moreover, there is often an absence of appropriate resources to support a structured approach to waste management. This situation makes participants to a project exhibit nonchalantly towards optimising the "nuclear use" of construction resources. It is also an important realisation that, these resources, materials, manpower and machinery are not only increasing in cost daily but also becoming increasingly scarce.

Previous research has shown that more than 30% of construction resources often end up wasted during the building production process. These present an important rationale to evaluate the resource waste syndrome within the construction industry, and to identify the appropriate measure for achieving optimal utilisation of these resources.

In order to achieve this, a KAP (Knowledge, Attitudes and Perceptions) quantitative approach was adopted in which a survey was carried out with inputs from site operatives and the project management team, where structured questionnaires were administered and analysed. This addressed operative attitude to work, belief in resources wastefulness and utilisation, the motivation toward averting wastage, and waste management control system adopted on sites. This paper identified the behavioural features of site participants in resources wastefulness and provided an incentive framework for achieving efficient utilisation of construction resources, including self-fulfilment, belongingness and appraisal. It is concluded that the implementation of the framework proposed will assist in this construction industry-regenerating era.

Key Words: Behavioural Features, Building Production, Construction Resources, Incentives, Waste Syndromes

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APPENDIX F2:

PAPER TWO - THE PAPER PUBLISHED IN CIOB AFRICA, JUNE 2006, CONFERENCE PROCEEDINGS, SOUTH AFRICA

The Impact of Construction Resource Wastage (CRW) on Building Production (BP)

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ABSTRACT

Different professionals in the field of construction have made constructive contributions towards achieving better results for building production through proper and adequate planning of design and construction processes. Nonetheless, there is still predominant wastage of resources in relation to materials, manpower and machinery.

These resources wastage can represent up to 30% of the total building cost. This indicates the need for integration of waste control with planning, and monitoring of the efficiency of construction processes right from design stage. It is this background, which has been the motivation for this research, in order to define, assess and evaluate some sources of resources waste, and to investigate the impact of these sources on construction production in relation to cost and time. To achieve these, empirical research survey was carried out with semi structured questionnaires and interview, which was administered and analysed.

This paper viewed to what degree this impact occurred in terms of conscious or unconscious in occurrence, avoidable or unavoidable in use, and visible or invisible in sight. The research also ranked these factors in order of intensity of the impacts. The research inferences unfold how construction resources wastefulness affects the achievement of the set objectives of clients, contractors, participants and other stakeholders. It is concluded that the effective implementation of the research results will enhance efficient construction resources utilisation during construction production process.

Key Words: Construction Resources, Resources Wastage, Waste Control, Building Production, Recourses Utilisation

APPENDIX F3:

PAPER THREE - THE PAPER PUBLISHED IN CITC – IV, JULY 2007, CONFERENCE PROCEEDINGS, GOLD COAST, AUSTRALIA

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"Accelerating Innovation in Engineering, Management and Technology"
July 11 -13, 2007, Gold Coast, Australia

Investigation of Site managers' Constraints on Construction Resources Utilisation

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Abstract

The capability of controlling and monitoring construction resources and the application of production information to achieve predetermined objectives of scope, cost, time, quality, and clients' satisfaction are the primary function of project managers. However, the applications of this production information are usually hindered by their complexity, ambiguity and inadequacy of information provided by the design team. These often results in various conscious, unconscious, or unavoidable resource wastage. Thus, this paper addresses the restraints on project managers in the optimal minimisation of resource wastefulness during the building production process. The investigation and discussions are based on an action survey, comprising structured verbal interviews and informal discussions with project managers. The research identifies and evaluates problems associated with site managers' constraints and resultant effects upon on cost of construction, time of project delivery and quality of the end product. Design team attitudes towards project change, implication of inefficient communication to effect change, production documents inadequate information and due process protocol constraints the implementation of change at occurrence, are identified as the facilitators of this predicament. The suggestion made in this paper will provide the opportunity for significant waste minimisation procedure. Thus, the implementations will lead to more proactive and efficient building production

Key Words: - Construction Resources, Project Change, Production Information, Project Manager, and Resources Wastage,

APPENDIX F4:

PAPER FOUR - PAPER PUBLISHED IN EuroMOT, SEPTEMBER 2008, CONFERENCE PROCEEDINGS, FRANCE

International Association for Management of Technology

EuroMOT 2008 - The Third European Conference on Management of Technology

TOWARDS ACHIEVING SUSTAINABLE CONSTRUCTION THROUGH EFFICIENT CONSTRUCTION RESOURCES MANAGEMENT

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Abstract

The active campaigning for Sustainable Construction follows directly from the necessity to satisfy the needs of construction industry stakeholders and the requirements of future generations. These needs are tailored towards meeting social, economic and environmental importance that can be evaluated by means of life cycle assessment. For the construction industry to become truly sustainable, the industry has to re-engineer towards lean principles where the requirement for effective resources waste management is considered paramount.

This paper identifies, evaluates and proposes an effective management framework that could support sustainable construction through efficient utilisation of construction resources. Initial facts and insights were obtained through a detailed review of literature, augmented by primary data acquired by means of questionnaires and interviews with construction practitioners. The data collected were analysed using SPSS and NVivo statistical packages.

Findings from the research highlight that several clients are unaware of the magnitude of resources being wasted during construction through inattention of designers and ambiguous information used during production. Moreover, construction participants

somewhat believe that resources wastefulness is normal occurrence and has to be "budgeted" for during resources estimation. However, majority of these resource wastes are avoidable, despite several constraints facing site managers. These constraints include ineffective management of partnering and the supply chains, and inadequate skilled workers in the industry. In respect of these, careful planning of resources before the project commences is absolutely essential.

The proposal outlined in this paper will significantly enhance the efficient utilisation of construction resources and perpetuate sustainable construction, if properly implemented.

Keywords: Construction Resources Waste Management, Lean Construction, Partnering, Sustainable Construction, the Supply Chain