FACTORS INFLUENCING THE PRACTICE OF RESOURCE PLANNING AND LEVELING IN THE KENYAN CONSTRUCTION INDUSTRY: A SURVEY OF CONTRACTORS IN NAIROBI COUNTY

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(Construction Project Management)

JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

2018

Factors Influencing the Practice of Resource Planning and Leveling in the Kenyan Construction Industry: A Survey of Contractors in Nairobi County.

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A thesis submitted in partial fulfillment for the Degree of Master of Construction Project Management in the Jomo Kenyatta University of Agriculture and Technology

2018

DECLARATION

This thesis is my original work and has not been presented for a degree in any other university

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DEDICATION

I dedicate this work to my late mum Mary Mutungi, my late grandmother Tabitha Mutungi and my two late sponsors Ms. Sherinah Ndambuki and Mr John Kyungu. Your care and support will always be cherished forever in my heart. May the Lord grant you eternal peace.

Special dedication goes to my dear wife, Salome, for her prayers, moral support and encouragement during the period of writing this work. “A man can only be as strong as those standing behind him”.

I would also like to dedicate this research to Baby Leon Fanaka. May you live to undertake such research at greater levels.

INSPIRATION

I always have only one desire in my heart, to be the best I can be, in every aspect of my life.

ACKNOWLEDGEMENTS

First I would like to thank the Almighty God for his mercies during the preparation of this work. I could not surely be where I am today without his protection and unending grace. I would also like to extend my gratitude to the Jomo Kenyatta University of Agriculture and Technology for giving me a chance to fulfill my dream of pursuing this noble course and also for funding this study.

Special gratitude goes to my supervisors Dr. Abednego Gwaya and Prof. Stephen Diang'a for their support and academic guidance during the accomplishment of this work.

I would also like to thank the following: Mr. Muriithi, for his insight and advice during the early stages of preparation of this work; Dr. Kivaa, for his cooperation and assistance; Mr. Cyrus Ong'ondo and Ms. Monica Wairimu for their advice and support.

Special thanks to Narinder Roopra and Motorways Construction Company for their resources and time. I would also like to sincerely thank all those who participated in my data collection.

I also acknowledge any errors of omission or commission which may be present in this work. Lastly, I would like to thank my wife Salome for her amazing and unwavering support throughout the entire period of this research. She always provided a shoulder to lean on during desperate times.

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LIST OF ABBREVIATIONS

CPM	Critical Path Method
ERL	Equipment Resource Leveling
ERP	Equipment Resource Planning
GDP	Gross Domestic Product
LOB	Line of Balance
LRL	Labour Resource Leveling
LRP	Labour Resource Planning
MRL	Material Resource Leveling
MRP	Material Resource Planning
NCA	National Construction Authority
PERT	Programme Evaluation and Review Technique
PMI	Project Management Institute
PMBOK	Project Management Body of Knowledge
RBVT	Resource Based View Theory
RII	Relative Importance Index
RL	Resource Leveling
RP	Resource Planning
RP&L	Resource Planning and Leveling
RP&LS	Resource Planning and Leveling Strategy
TOC	Theory of Constraints
WBS	Work Breakdown Structure

ABSTRACT

The performance of construction projects depends to a great extent on how best the resources are managed. Failure to manage the resources available through planning and leveling is likely to result in increased project costs, time overruns and poor quality. The purpose of this research was to study the Resource Planning and Leveling approaches adopted by contractors within Nairobi and the factors influencing the adoption of such techniques. This research mainly adopted a survey research design where questionnaires were used to collect data from contractors. Both qualitative and quantitative paradigms were adopted in this research. The research site was Nairobi and the target population was NCA 1-3 contractors. Random sampling was used to identify the 106 respondents. Data obtained was analyzed using descriptive statistics, relative importance index analysis, spearman's correlation analysis, multiple regression and thematic analysis. The study concluded that: though there is a high level (76%) of usage of Resource Planning and Leveling in the Kenyan construction industry much of which is non-structured, construction projects' progress continue to be affected by delayed materials, lack of labour and lack of equipment at the points of need. Resource Planning and Leveling was found to be practiced more in older contracting firms and where there is support from top management. A high degree of Resource Planning was found to be associated with reduced negative impact of construction project progress. The three most effective Resource Leveling techniques as experienced by contractors are fast tracking, Microsoft Project and substituting resources. The researcher also concluded that contractors are not only aware of the various Resource Leveling techniques existing in theory but also understand their effects on the project performance.

Key Words: *Resource Planning, Resource Leveling, Construction Project Performance, Contractors*

CHAPTER ONE
1.0 INTRODUCTION

1.1 Background to the problem

Construction industry has been defined as the total industry involving the utilization of human, natural and economic resources in the conception, design and construction, maintenance and demolition of building and civil engineering works (Chitkara, 1998). Therefore, construction as a sector of economy is defined by the economic activity of building and civil engineering works (Bon & Crosthwaite, 2000b). According to K'Akumu (2007), construction is a strategic industry in developing economies like Kenya. This is due to its contribution to the macro economy of any country, Gross Domestic Product (GDP), gross fixed capital formation, inter-sector linkages and Employment opportunities for the members of the public (United Nations Centre for Human Settlements, 1984). Ndaiga (2014) asserts that the construction industry is not only a significant contributor to our country's Gross Domestic Product (GDP) but also plays a leading role in determining our economic growth. According to Giang and Pheng (2010) and as cited by Muiruri and Mulinge (2014), the construction industry typically contributes to 11% of Gross Domestic Product (GDP) in most developing countries. The Kenyan construction industry is a key sector within the country's economy and its' level of activity gives an indication of the country's general economic performance (Ndaiga, 2014). It can also be argued that construction industry influences and is also influenced by economic growth in any country.

The construction industry is also known to make a notable contribution to other sectors of any country's economy. While it produces inputs required to support production process in other sectors, it also creates demand for outputs produced by those sectors of the economy. Sectors known to interact with the construction industry include agriculture, forestry, manufacturing, transport, mining and services. According to Bon and Crosthwaite (2000b) and as cited by Wibowo (2009), the construction industry has

a significant interaction with other economic sectors as a backward and forward linkage; the forward linkages depict correlations of inter-industry total sales to total output, while the backward linkages depict the relationship of inter-industry purchases to total input.

It is however important to note that the construction industry can only grow and thrive when construction projects are executed in an efficient manner. Efficiency is often a result of proper planning. Planning is arguably the most important role that a project manager plays within a construction project. This involves strategizing on the best means and methods of executing the project. A project has widely been defined as an activity which has a start and an end, consisting of activities which occur sequentially and most important of all, which requires resources (Project Management Institute, 2013). The theory of human needs suggests that humans have unlimited wants but the resources to satisfy the wants are limited. The same could be said about projects, the client has unlimited needs but the resources are limited. This constraint has the likely effect of resulting into increased project costs, schedule overrun and also compromising on the quality of the output. This creates the need for maximizing the use of the available resources to overcome such challenges. According to Reddy and Nagaraju (2015), resources play a vital role in construction projects. Resource requirement within a project include but not limited to unskilled labour, skilled labour, management, tools, equipment, construction materials and finances. The performance of construction industry depends chiefly on how best these resources are managed (Abeyasinghe, Greenwood, & Johansen, 2001).

Proper utilization of internal and external resources is mandatory, for which the construction companies have to execute best business decisions and maximized business goals for better survival in the existing competitive environment (Shi & Halpin, 2003). Construction project planners prepare a project schedule assuming that all the resources required for each activity will be available to the contractor at all times during the construction process (Aslani, *et al.* 2009). The process of distributing

available resources to various project activities' objectives is called 'Resource Planning'. This is done in a way so that the project completion schedule is least affected (Dubey, 2015).

The resource leveling problem arises when there are sufficient or even excess resources available and it is necessary to reduce the fluctuations in the pattern of resource usage. These fluctuations are very undesirable since they usually present financial, utilization, and labour difficulties contractors (Schultz, Slevin, & Pinto, 1987). The scheduling objective is to make the resource requirements fairly uniform, and in other cases to make them meet desirable non-uniform resource levels in resource leveling. Resource Leveling is a method for developing a schedule that attempts to reduce fluctuations in resource requirements. This technique levels the resources in such a way that we can apply them as uniformly as possible. According to Badawiyeh (2010) resource leveling is a trial and error method where noncritical activities are delayed beyond their early start with the aim of maintaining a uniform resource requirement levels. Dubey (2015) sums this up succinctly when he describes resource leveling as the act of taking a project with people assigned to a bunch of tasks and making it so that they do not have to work overtime. Some of the benefits which can be achieved from Resource Leveling include: reduction of peak demands for resources and creating requirements of the same resources in other off-peak times; there is continuity in the workforce since there is reduced need for the contractor to employ and fire employees at different stages of the project (Mendoza, 1995)

Construction planning effectiveness and construction project performance can be improved by optimizing the resources available (through planning and leveling) for the execution of the project. The performance of any construction project is therefore dependent on the level of resource management among other factors. Since Resource Planning and Leveling (RP&L) are the two most critical aspects of resource management, it can then be said that they influence to a great extent the performance of construction projects. This argument is supported by Reddy and Nagaraju (2015) when

they assert that failure to manage the resources available through leveling and optimization is likely to result in increased project costs.

1.2 Statement of the Problem

The construction industry in Kenya lacks a framework which can serve as guidance in the process of resource planning and leveling. Currently in the country, the process of resource planning and leveling is not based on a scientific approach which takes cognizance of all the prevailing conditions surrounding projects. This assertion is attributed to lack of literature locally explaining and correlating these prevailing conditions in the industry in a way that can guide contractors in the process of resource planning and leveling.

The successful completion and performance of a construction process is pegged on three basic performance parameters which have evolved to be regarded as the three pillars of any successful construction project: these include finishing the project within budget and schedule without compromising on the desired quality. Poor resource planning and leveling contributes to poor project performance. Mendoza (1995) agrees with this assertion by pointing out that majority of projects suffer from avoidable delays resulting from inadequate resource planning and control. Hegazy (2010) observes that proper resource planning and leveling helps resolve resource conflicts, which cause numerous challenges to the organization, such as: delay in completion of certain tasks, challenges in assigning a different resource to a certain task, inability to alter task dependencies, addition or removal of certain tasks and overall time and cost overruns of projects. He further argues that the aim of resource leveling is to increase efficiency when undertaking projects by maximizing on the resources available at hand.

Why is a study needed in the local industry? A number of studies have been undertaken in the field of resource planning and leveling. Researchers such as Bandelloni *et al*. (1994); Easa (1989); Fathi and Afshar (2008); and Garmsiri and Abassi (2012) among others have developed resource planning and leveling models from these studies for use

in the construction industries. However, it is important to note that all these models have been formulated based on studies done in developed countries. None of these studies have been carried out in developing countries and Kenya for that matter. The prevailing conditions in the Kenyan construction industry are unique and definitely different from those in the countries where these studies have been done. This assertion is supported by Yimam (2011) who points out a number of differences between the construction industry in developed and developing economies; in developing countries, there is extreme scarcity of resources and underdeveloped private sector while the opposite is true in developed countries. It would therefore be wrong to apply such models in the Kenyan construction industry. There is therefore the need to undertake a study which would take into consideration the nature and characteristics of the Kenyan construction industry and formulate a strategy applicable to it.

1.3 Purpose of the Study

The purpose of this research is to study the resource planning and leveling (RP&L) approaches adopted by contractors within Nairobi and the factors influencing the adoption of such techniques.

1.4 Objectives of the Study

1.4.1 Main Objective

The main objective of this study is to formulate an Optimal Resource Planning and Leveling strategy for the construction industry in Kenya.

1.4.2 Specific Objectives

1) To explore the practice of Resource Planning and Leveling among contractors in Nairobi.
2) To evaluate significant factors influencing Resource Planning in projects by contractors.
3) To evaluate the various Resource Leveling techniques employed by contractors.

4) To evaluate challenges and benefits associated with Resource Planning and Leveling.
5) To explore the views of the construction industry players regarding the impact of Resource Planning and Leveling on construction project performance.

1.5 Research Hypothesis

$$H_0: RP \neq \beta_o + (\beta_1\chi_1 + \beta_2\chi_2 \ldots\ldots\ldots + \beta_i\chi_i) + \varepsilon$$

$$H_1: RP = \beta_o + (\beta_1\chi_1 + \beta_2\chi_2 \ldots\ldots\ldots + \beta_i\chi_i) + \varepsilon$$

Where:

- RP is the Extent of Resource Planning (This variable, Y, will be proxied by three surrogates, Material Resource Planning, Labour Resource Planning and Equipment Resource Planning. These three variables will be integrated into one dependent variable)
- β_o is a constant (intercept of Y, the predicted value for Y when X = 0)
- β_i is the i^{th} regression coefficient of the i^{th} independent variable (χ_1);
- $\beta_i > 0$ and is large enough to make χ_1 influence ERP significantly;
- χ_1 refers to the i^{th} independent variable;
- ε is the error of fit (the assumption is that it will be small enough to be ignored)

The explanatory variables (X) in the equation are;

- Adequacy of labour
- Adequacy of plants and equipment
- Compliance with safety procedures
- Contractor's ICT Compliance
- Presence of qualified personnel

- Level of project documentation
- Financial status of the contractor
- Weather
- Prompt honoring of payments certificates
- Type of procurement system

1.6 Significance of the Study

Who stands to benefit from proper resource planning and leveling? Resources benefit the most because they get to avoid problems such as over allocation and becoming overwhelmed. The contractor can also avoid delays which are as a result of poor allocations. They can also identify and utilize unused times. Clients also get value for their money in the sense that they get good quality of work at a desired cost and at reasonable time period.

The findings of this study would therefore not only be of great benefit for the contractor but also to the client. Proper resource management will result to reduced cost of delivering the project which translates to increased gain for the contractor in a traditional Design-Bid-Build (DBB) building contract. The same gain will accrue to the client for the modern project delivery methods such as turnkey and cost plus contracts.

1.7 Justification of the Study

A project can be defined as a one-time activity which has defined objectives and which has to be executed within the stipulated time period, to the required quality with a given amount of resources. Proper resource management is thus of great importance if a project is to meet the above three aspects. Resource management involves three main activities, resource planning, resource allocation and resource leveling. The scheduling of any project depends to a large extent on these aspects of resource management.

From the above argument, it can easily be agreed that the importance of proper resource planning and leveling cannot be overstated. This study would therefore be key to ensuring contractors engage in resource planning activities which would later translate to project success. The findings of this study would also give the impact of resource leveling on project performance. A positive impact would encourage the need for raising awareness among project participants in incorporating resource leveling techniques in their resource management. A negative impact would discourage smoothing of resource accumulation on projects.

Adoption of a scientific approach to resource planning and leveling would result in: reduction in resource conflicts, availability of resources at right times and maximization of resource utilization. These result to delivery of quality product within budget and time translating to better performance by contractors in handling projects.

1.8 Scope of the Study

In the course of pursuing this research, the focus of attention was on the contractors who are the planners and executors of the construction project. The unit of observation and analysis was therefore the contractor.

There are unlimited amount of resources that are utilized within a construction project, however, this study was limited to materials, labour and equipment. This is because materials, labour and equipment constitute the largest contribution to project resources.

Geographically, the study was done within Nairobi County, Kenya. This is due to the fact that the county has the highest level of construction activity within the country. As per the NCA register, the county also has the highest concentration of contractors compared to the rest of the country. The unit of analysis was the contractor. A survey design was adopted and questionnaires distributed to contractors who were chosen at random.

The independent variables included the awareness and usage of resource planning and leveling, factors influencing resource planning and leveling, various resource leveling techniques employed by contractors, challenges and benefits associated with resource planning and leveling while the dependent variable will be the practice of resource planning and leveling which will be measured by parameters such as; presence of resource plans, adherence to such resource plans, knowledge of resource leveling and application of the resource leveling.

1.9 Limitations

The research was faced with inadequate financial resources. The grant provided by the university was inadequate to cover the entire study and therefore the researcher had to look for other means to obtain extra finances to run the remaining section of the study.

There was fear that some of the intended respondents may have lacked willingness to provide information regarding their projects with the fear that they might be exposing their secrets of how they execute their projects. However, all measures were taken to assure the target respondents that the motive of the study was purely for academic purposes and their responses would be treated with confidentiality.

There were also concerns that the response rate may not have been adequate and this would result to unreliable data collected if it was insufficient to be representative of the target population. This was countered by increasing the target respondents to ensure that data collected was adequate to be analysed.

1.10 Study Outline

This study consists of five chapters. Chapter one covers background information, problem statement, objectives of the research, research questions, research justification, scope of the study, limitations and assumptions made in the study. The chapter also includes the study outline. Chapter two includes literature review from secondary sources of data and conceptual framework. Chapter three covers research methodology

by discussing the research instruments and methods of data collection. Chapter four includes research findings, data presentation and data analysis. The last chapter covers conclusions and recommendations based on the results obtained and analyzed in the previous chapter. Areas of further study are also included in this chapter.

1.11 Definition of Terms

(a) Project; it is a group of tasks, performed in a definable time period, with the aim of meeting set objectives. It is usually a one-time program with a life cycle, and a specific start and end. It has a work scope that can be categorized into definite tasks, a budget, and requires use of different resources. Many of these resources may be scarce and may have to be shared with others. It may require the establishment of special organization, or the crossing of traditional organizational boundaries (Bakouros, Yannis, & Kelessidis, 2000).

(b) Scheduling; The process of converting a general plan for a project into a schedule based on time and resource constraints (Singh, 2013).

(c) Float; The total amount of time that an activity may be deferred from its early start time without affecting the project completion date (Tarek & Wail, 2010)

(d) Critical path; A path comprising of activities with zero float.

(e) Resource; Skilled human personnel, equipment, services, supplies, commodities, material, budgets, or funds (Duncan, 1996).

(f) Resource Planning; this involves determining what resources(people, equipment, materials, etc.) are needed in what quantities to perform project activities (Kumari & Vikranth, 2012).

(g) Resource Breakdown Structure (RBS); A hierarchical structure of resources by resource category and resource type used in resource leveling schedules (Project Management Institute, 2005).

(h) Project calendar – defines the workable time periods for the project.

(i) Resource Calendar; A calendar of working days and nonworking days that determines those dates on which each specific resource is idle or can be in use. It helps determine resource availability dates and resource holidays (Project Management Institute, 2005). A resource calendar defines the workable time periods for the specific resource.

(j) Resource leveling/smoothing; any form of schedule network analysis in which scheduling decisions (start and finish dates) are driven by resource availability, requirements and constraints (Project Management Institute, 2005).

(k) Resource-Limited/Constrained Schedule; A project schedule whereby schedule activities, start dates and finish dates depend on expected resource availability. A resource-limited schedule does not have early start, late start, early finish or late finish dates. (Project Management Institute, 2005)

(l) Resource Histogram; A bar chart showing the amount of time that a resource is scheduled to work over a series of time periods. (Project Management Institute, 2005).

(m) Heuristics; or "rule of thumb," is used to allocate resources to activities in such a way as to minimize project delay (Badawiyeh, 2010).

CHAPTER TWO
2.0 LITERATURE REVIEW

2.1 Introduction

This chapter comprises a review of literature on the implementation of resource planning and levelling techniques within construction projects. Critique of the existing literature and identification of the research gap shall also be covered. Issues related to resource levelling and those which are likely to affect the successful implementation of construction projects will be discussed under the conceptual framework.

2.2 Project planning

Project planning has been argued by many to be the cornerstone of any project implementation. Project management requires a proper strategy which is usually formulated at the planning stage. It gives a road map of how the project will be implemented and the resources which shall be employed in the process of executing the project. Planning involves defining project goals, specifying tasks and formulating how the objectives shall be met (Badawiyeh, 2010). Planning also involves preparing budgets and deadlines within which various tasks should be completed. According to Winter (2006), a typical project implementation lifecycle has five phases. The first phase is project conception and initiation. During this phase, an idea for a project will be carefully examined to determine whether or not it benefits the organization. During this phase, a decision making team will identify if the project can realistically be completed.

The second phase is project definition and planning. A project plan outlining the work to be performed is prepared at this stage. It is during this phase that the team evaluates the time, budget and resource requirements. The next phase is usually project launch. Resources' tasks are distributed and teams are informed of responsibilities (Gido & Clements, 2003a). This is a good time to bring up important project related information. Project performance and control is the next phase. Project Managers will compare

project status and progress to the actual plan, as resources perform the scheduled work. During this phase, Project Managers may need to adjust schedules or do what is necessary to keep the project on track. The last phase during project implementation is project closure. After project tasks are completed and the client has accepted the works, an evaluation is carried out to assess project performance.

2.2.1 Project Constraints in Project Planning

A constraint could be defined as state, quality or sense of being restricted in the process of carrying out an action (Lau & Kong, 2006). This could be partial or total. In construction projects, constraints are either internal or external and are likely to affect the project performance in one way or another. Mostly, the impact is usually negative. Constraints affect the three main pillars of construction project performance; time, cost and quality. A schedule constraint would be a limitation affecting when activities can be scheduled to be carried out and would result to project delays. A cost constraint is a restraint on the project budget and would include factors such as lack of finance and delay of project funds.

a) Technical or Logic Constraints

These are constraints related to the logical sequence and diagram in which project activities occur. These constraints deal with the actual construction processes that are tasked to complete the activities (Gidyelew, 2010).

b) Physical Constraints

These are constraints related to physical properties of the site and the work. According to Sriprasert & Dawood (2003), they include constraints such as space, technological dependency, safety, and environment

c) Resource Constraints

A project resource constraint is any limitation or restraint placed on resource usage, such as what resource skills or disciplines are available, and the amount of a given resource available during a specified time frame (Tarek & Wail, 2010).

When labour, equipment, material or capital are limited, there may be need to reschedule the project activities in order to satisfy this constraint. This will commonly imply scheduling such activities which require those resources in a sequential manner. This might result to instances where activities overrun their allowable slack. This means they become critical and end up causing a delay in the project completion.

Where resource limitations are known from the start of the project, it is always best to acquire additional resources to satisfy the project needs if possible. However this may not be applicable in all situations due to other limitations such as physical, technical and cost constraints.

i) Labour Constraints

Human resources are typically classified by the skills they bring to the project: carpenter, steel fixer, welder, painter, operator, inspector and engineer among others. Sometimes, the available labour lacks the skill and expertise to effectively execute their mandates in the project. It is for this reason that once the project team or contractor get effective workforce, they find it very difficult to release them. They feel that they may get jobs elsewhere and lose them. They will then tend to hold on to them even when there is no work for them at the moment.

ii) Materials Constraints

Most of the material resources required for construction activities are in non-renewable and not easily replenished. Some are not available locally and have to be imported from overseas. Periodic shortages are also bound to occur. Poor performance of projects has been blamed on material unavailability and shortages within the construction industry.

iii) Equipment Constraints

Equipment is usually presented by type, size, and quantity and is often overlooked as a constraint. The most common mistake is the assumption that the resource pool is satisfactory for the entire project. High crashing or delay costs can be avoided by recognizing all equipment constraints before the start of the project.

d) Economic Constraints

Economic constraints are as a result of budget limitations and allocation of money (Lau & Kong, 2006). Budget limitations may affect the construction system adopted for project delivery resulting to suboptimal choice which leads to failure to achieve project goals. Lack of effective funds allocation on the other hand may result to negative effects on the project progress.

e) Legal Constraints

There are many rules and regulations surrounding the implementation of construction projects in regard to work laws, works supervision and safety guidelines (Lau & Kong, 2006). Work laws may prohibit execution of construction work in some areas on certain times such as at night or even during the weekends. These constraints are likely going to negatively impact on the project schedule.

f) Environmental Constraints

All construction activities take place in an environment (Sriprasert & Dawood, 2003). Approvals for construction projects must be sought from the National Environmental Management Authority (NEMA) before the implementation of any construction project. Delayed approvals are likely to cause project delays. Other arising environmental issues such as traffic limit, excavation permits, tree preservation and noise control are also going to affect the project negatively.

g) Social Constraints

Most public projects cannot take place without involvement of the communities in which they are to be implemented. Failure to involve such people is likely going to

cause riots and sabotage of the project. In instances where such people are not competent to undertake such works, the project execution might not be effective. Use of labour based systems instead of using technology based techniques due to pressure from the public may also result to poor quality work and increased costs.

2.3 Project scheduling

Project scheduling involves identification of the activities sequence based on the execution order. Activity interdependence ought to be considered in project activities sequencing.

2.3.1 Classification of Scheduling Problems

a) Time constrained schedule

In this schedule, the project must be completed within a predetermined duration. The time is fixed and resources are assumed to be flexible in the sense that more resources can be employed into the project to ensure that the project is completed within the imposed date (Schweiz, 2014).

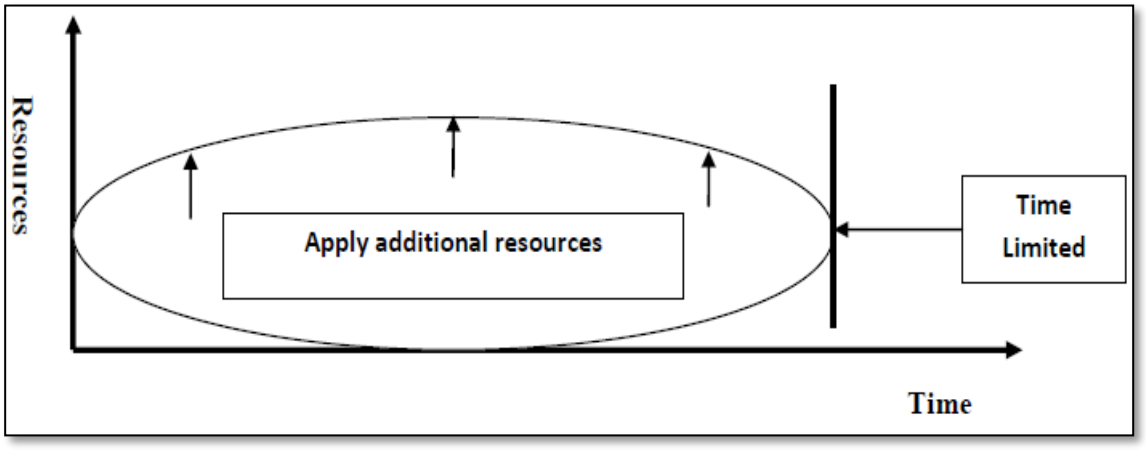

Figure 2.1: Time-Limited Resource Scheduling

Source: (Burke, 2003)

Despite the assumption that resources are unlimited in time-constrained scheduling, the aim is to obtain most economical usage of resources and this would result to an attempt to achieve lowest peak usage of resources (Badawiyeh, 2010).

b) Resource constrained schedule

This is a resource schedule in which the amount of available resources is fixed and cannot be exceeded. Burke (2003) defines resource constrained scheduling as a method for developing the shortest schedule when the number or amount of available resources is fixed. The time is however flexible and can be extended to comply with the level of resources available.

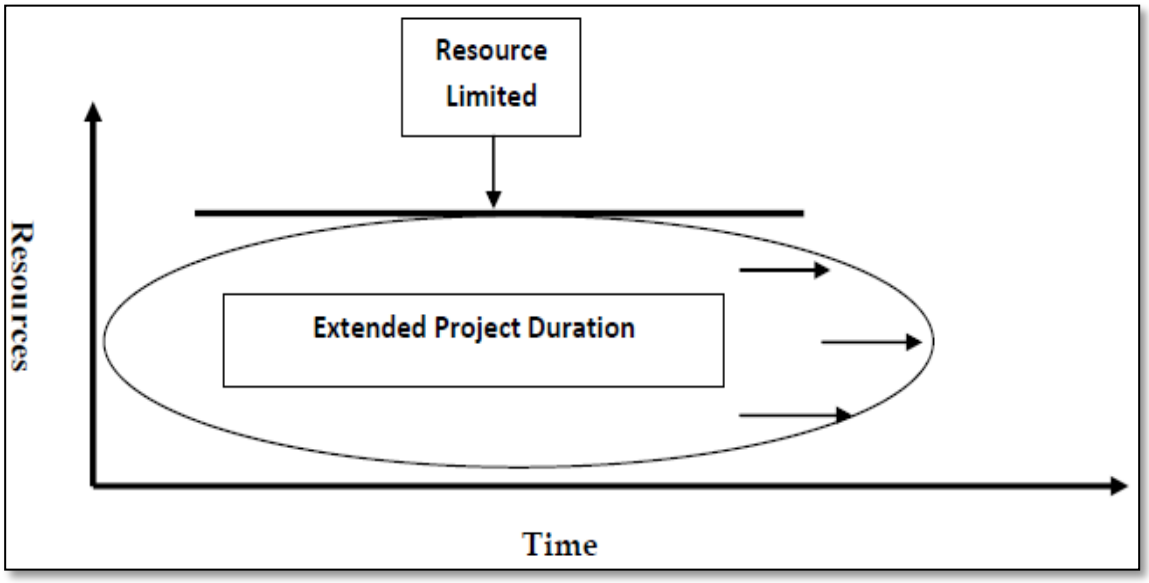

Figure 2.2: Resource-Limited Resource Scheduling

Source: (Burke, 2003)

Gido & Clements (2003a) assert that resource constrained leveling is an iterative procedure of assigning resources to activities found on the least slack. Incase multiple activities require the same limited resources simultaneously, and then the activities with least float will take precedence. The remaining resources will be assigned to activities with the second least float. This process continues until all the resources are exhausted meaning that lower precedence activities may have to be postponed if the resources are

inadequate. This would result to a shift in the original project deadline if any activity within the critical path is delayed.

2.4 Resource Management

The significance of resource loading is that it underscores the fundamental interdependencies between construction activities and resources under which they will be performed (Nosbisch, *et al*. 2005). Resource leveling goes a step further and actually adjusts a CPM's estimated early start dates depending on resource availability. It evaluates the resource demand of the entire project and tries to reduce challenges associated with inadequate quantities and/or fluctuations in resource requirements on a day-to-day or weekly basis.

Resources can be grouped into two categories; renewable and non-renewable. According to Badawiyeh (2010), renewable resources exist on a period by period foundation which means that the quantity can be renewed from time to time. Such resources are obtained, replenished or reproduced easily. Non-renewable resources on the other hand are not easily replenishable. While project resources include both types, majority of them are non-renewable and thus raising concerns over continued availability.

2.4.1 Resource Planning in Construction Projects

The four main essential resources required in any construction project include; materials, equipment, people and time. For the project to accomplish the project plan and schedule, it is important to make sure that the necessary materials, personnel, equipment and time are availed in desired quantities at the time they are scheduled for in the project plan and schedule.

Despite resource planning phase being very important in construction projects, many projects suffer avoidable delays from inadequate resource planning and control

(Mendoza, 1995). Resource planning aims to identify resource quantities for different activities and schedule these resources over the project duration.

The aim of undertaking resource planning is to identify the: types of labor required for the project; roles and key responsibilities for each labor type; number of people required to undertake each role; quantities and types of equipment required; items of equipment needed and their purposes and total amount of materials required (Kass, 2012; Kumari & Vikranth, 2012; Stukhart, 1995; Badawiyeh, 2010)

A Resource Plan summarizes the amounts of resources needed to execute the project. A properly prepared Resource Plan should be able to specify the exact quantities of materials, labor, and equipment required to complete the project.

A Resource Plan is supposed to be created during the resource planning phase of the project. Those responsible for the project resource management will need to create a comprehensive Resource Plan. This helps to ensure that all the resources required to execute the project are identified. By implementing proper resource planning practices, it also helps the project stakeholders with budgeting and forecasting project expenditure.

2.4.1.1 Different aspects of resource planning

a) Labour Resource Planning

The most important resource to a project is its people; the project team. According to Mendoza (1995), human resources for construction projects can be grouped in to three categories; office personnel, construction personnel (field supervision and labor) and construction sub-contractors.

The task of personnel recruitment for construction projects lies with the project manager who may delegate the responsibility to the construction manager or other project team members. It is thus the responsibility of the recruiting officer to acquire the personnel

according to the needs of the project. It is also their responsibility to release the personnel from the project if they are no longer needed by the project.

b) Material Resource Planning

The materials plan is used to guide the project manager in planning for material resources. Depending on site constraints, different approaches could be used to plan for the materials schedule. Concepts like Just-In-Time (JIT) have been used for confined sites. Though this concept is widely considered as the best for procuring materials, it can only be used for materials whose future availability is certain. While different sites adopt different strategies for materials planning and scheduling, they should all ensure that materials are present on site at the time the project schedule dictates and they should not be seen to delay the project.

c) Equipment Resource Planning

This involves identification of all the equipment that will be required to accomplish the project, e.g.: office equipment (PCs, photocopiers, mobile phones etc.), telecommunications equipment (cabling, switches etc.) and machinery (heavy and light machinery).

Sequencing of construction activities should be in such a way that equipment from one activity can be shifted to the other on its completion. This aims to reduce the total requirement of equipment at any given time. It also seeks to achieve effective utilization of equipment on the project.

2.4.1.2 Resource Estimating Techniques

a) Expert Judgment

This involves consultation of persons who are experienced in resource estimation and allocation matters. Such people include those who have done similar work in the past. This technique is easy to use provided the expert is easily reliable and accessible. The

expert builds up the estimate based on their understanding of the project requirements (Sheen, 2012). The main advantage of this technique is that it is quick and most accurate for uncertain tasks if the expert is knowledgeable. The problem with the method is that the expert may not be available or may even provide misleading information (Berkeley, 2006).

b) Bottom-Up Estimating

This involves decomposition of activities into smaller work components. It simply means breaking down large complex activities into smaller bits or pieces and working out the resource assignments for each piece (Buglione & Ebert, n.d.). According to Muldoon (2014), bottom-up estimating relies on lower-level components of the WBS.

It is a process of estimating individual activity resource needs or cost and then adding these values together to come up with a total estimate. Bottom-up estimating is a very accurate means of estimating; as long as the estimates provided at the schedule activity level are accurate. However, it has the a weakness in that it takes a considerable amount of time to perform bottom-up estimating since each activity has to be estimated accurately to be included in the calculations. The smaller and more detailed the activity, the greater the accuracy and cost of this technique (Berkeley, 2006). The problem with this technique is that it is time consuming, and it may be impossible to decompose activities that cannot be easily defined (Sheen, 2012).

c) Analogous Estimating

This method is generally used at the beginning of the project when less is known. This involves consideration of previous similar activities (Duncan, 1996). It basically compares the current project with similar projects in the past. Values from past projects are extrapolated to produce estimates for the current project. It is quick and relatively easy but not very accurate (Buglione & Ebert, n.d.). This technique is highly appropriate for those scenarios where the type and nature of work is similar and the

resources used in execution of the work are also similar. This however only works if the activities and activity durations are similar.

d) Parametric Model Estimating

This technique is used for estimates which are quantitatively based, such as cost per square metre or number of installations per day (PMI, 2000). A formula is usually developed for estimating the resources or time needed to perform a project task (Berkeley, 2006). This means inserting data about the project into the formula, database, spread sheet, or computer program that comes up with an estimate.

The software or formula that is used for parametric estimating is based on a database of actual durations from past projects. The formula is based on the historical experience of previous projects (Buglione & Ebert, n.d.). The parametric model is often developed by the PMO based upon lessons learned on many past projects. A classic example from construction projects would be the parametric model for estimating time and resources based upon the plinth area of new construction.

Parametric Model Estimating is a very accurate and easy estimating technique. However, not every activity or cost can be estimated quantitatively. Another disadvantage is that parametric models do not exist for tasks until there is a large experience base for such tasks.

e) Three Point Estimating

As the name suggests, three values are considered: a realistic estimate, that's most likely to manifest, an optimistic one which represents the best case scenario, and a pessimistic one that represents the worst case scenario (Project Management Institute, 2013). The final estimate is the weighted average of the three. Optimistic, pessimistic and most likely values are determined to calculate resource estimate. The most likely estimate is weighted most heavily. The equation is (O + 4M + P) / 6 (Project Management Institute Inc, 2000). The three estimates may be generated using other

estimating techniques such as Analogous or Parametric Models. In some cases, the project plan is based most likely estimate while the pessimistic and optimistic values are used for reserve analysis as is the case in Programme Evaluation Review Technique (PERT) analysis (Berkeley, 2006).

A variation on this technique is the PERT analysis which uses a weighted average of the realistic, pessimistic and optimistic estimates to create a PERT estimate (Jucan & Sprague, 2013). When using this approach, the most likely estimate is usually what is used in the project plan but the pessimistic and optimistic estimates are utilized during the reserve analysis. Also, an activity that has a big difference between the pessimistic and optimistic estimates is an uncertain activity and should thus be tracked in a risk register. The advantage of this technique is that it provides boundaries on expectations. The disadvantage is that it is time consuming since three estimates must be created and the most likely is still a big guess while the actual could be significantly better or even worse.

f) Published Data Estimating

Published data estimating refers to information obtained from published sources regarding production rates, unit costs in labor trades among other data in different locations (Muldoon, 2014). This is a good technique for those tasks for which there is accessible published data. Based on published data estimating, the task is compared to the tasks for which data exists and the actual durations or cost of the closest comparable task is chosen from the data and used to extrapolate the estimate. This method is used by most Project Managers to help them determine the extent of resource requirement. Such Project Managers rely on articles, books, journals, and periodicals that collect, analyze, and publish data from other people's projects.

The advantage of this method is that it can be very accurate when the project conditions match the conditions under which the published data was generated (Sheen, 2012). However, the main disadvantage is that most of the activities may not have published

data upon which to be calculated. The other problem is the biasness of the institutions compiling the data

g) Vendor Bid Analysis

This is a technique used when working with vendors on uncertain activities. The analysis considers the assumptions made by the supplier while producing the estimates. The method goes an extra mile in doing a sensitivity assessment on such assumptions. A consulting firm is usually hired to verify the vendor's estimates (Buglione & Ebert, n.d.).

h) Reserve Analysis

This is a fundamental technique for estimating as it considers the level of risk and uncertainty in the project and establishes a reserve pool of resources or time (PMI, 2000). This involves adding extra resources to the project schedule or cost (called a *contingency reserve* or a *buffer*) to account for any extra risk.

With respect to schedule reserve, allocation is done on the path float of the non-critical activities so as to provide a buffer around such activities with the most uncertain estimates (Sheen, 2012). A conservative estimate is used for critical path tasks. With respect to resource reserves, a level of reserve is set based upon the uncertainty in the project and also the risks. It is common to have resource reserves of approximately 10% to 20% over and above the estimated cost of a project for projects with high uncertainty and an approximately 0% to 5% reserve for projects with lower uncertainty (Muldoon, 2014).

i) Alternative analysis

This involves considering several different options for assigning resources. This includes varying the number of resources as well as the kind of resources you use. Most of the times, there is usually more than one way of accomplishing an activity and this method helps choose among the possibilities.

j) Project management software

Software such as Microsoft Project have features incorporated within their set-ups to enable resource estimation. Such software also estimate the project constraints and therefore assist in determining the best combinations for resource assignments.

2.4.2 Resource allocation/loading

Soanes and Stevenson (2003) define allocation as the action or process of sharing something. In projects, allocation could therefore be taken to mean the process of sharing needed and/or available resources commonly based on a work breakdown structure which shows the logical sequence and duration for each activity (Heerkens, 2002). Variations in the utilization of these resources usually cause fluctuations in the resource profile. This is not desired in any project because the process of managing those fluctuations becomes a difficult exercise (Hamilton, 2001).

The resource allocation exercise is required in both resource and time constrained projects. However, according to Badawiyeh (2010), in both cases the process suffers from two major drawbacks. The first challenge is to achieve a level demand for labour, materials and equipment. The second is optimizing the project duration without experiencing restrictions on the quantity of resources required during the project (Badawiyeh, 2010).

One possible heuristic for allocating resources as described by Mendoza (1995) is as follows;

i) For those activities whose earliest start times (ES) coincide with the project start time, allocate the resources first to those activities with least total float and then in order of increasing total slack. This process can be terminated if all available resources are exhausted or all activities have been ‘satisfied’ by the resources allocated to them.

ii) If all the resources are exhausted in the first step, the earliest times remaining activities, which have not been assigned resources, are increased.

iii) The third step involves modifying the subsequent parts of the network calculations appropriately. For those activities whose earliest start correspond to when resources are next available, repeat the first step (Mendoza, 1995).

2.4.2.1 Resource Allocation Methods

a) Limiting Assumptions

Splitting of activities is not allowed in this method; once an activity starts, it must be carried out to completion. The amount of resources used for such activity cannot be changed (Akpan, 2000).

b) Risk Assumptions

Activities with the highest float are assumed to pose least risk (Atkinson, 1999). This is because such activities are taken to be flexible and can be delayed for long periods while other activities are being executed. The nature the activity in terms of complexity has no effect on the risk.

c) Time-constrained projects: Smoothing Resource Demand.

This method puts emphasis on resource utilization (Cherf, 2012). It is difficult to manage a schedule when resource availability is erratic. Project Managers commonly resolve this by employing resource leveling techniques that balance and smooth resource demand (Badawiyeh, 2010). The main principle behind leveling is to delay non-critical activities using slack to reduce peak demand. This has the effect of reducing the level of resource usage over the life of the project (Zanen & Hartmann, 2010). It also reduces the fluctuations in resource demand.

2.4.3 Resource scheduling

Meredith *et al*. (2001) state that with a look at a hypothetical project, the fundamental method for resource leveling is easy and simple. For instance, for the simple Activity on Arrow (AOA) network, the activity duration is shown above the arc while the resource usage (workers) is shown in brackets below the arc.

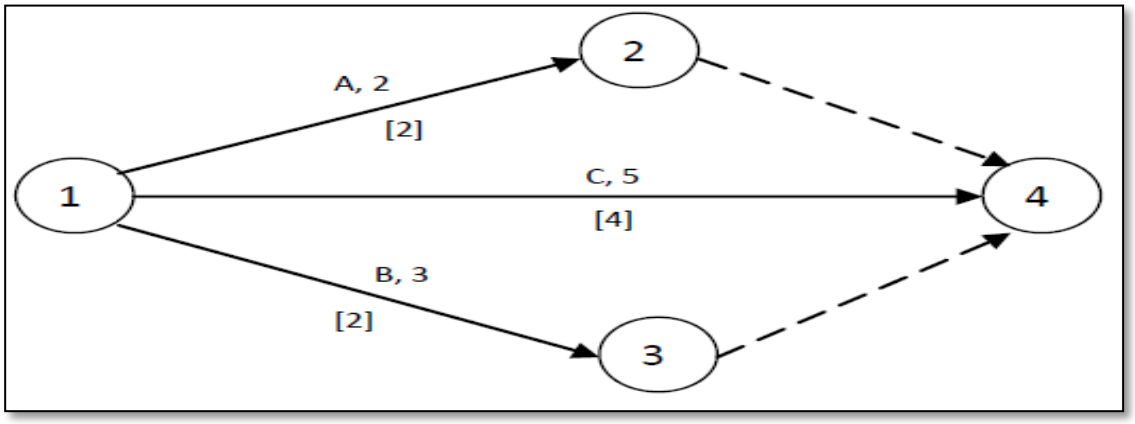

Figure 2.3: Activity on Arrow diagram (AOA)

Source: (Author, 2016)

Event one is precedent to activities (A), (B) and (C), and all are precedents to event four. Activity (A) requires two days and two workers while activity (B) requires three days with and workers. Activity (C) needs five days and four workers. In case all these tasks are started on their early start dates, the resource loading diagram will appear as shown in the figure below.

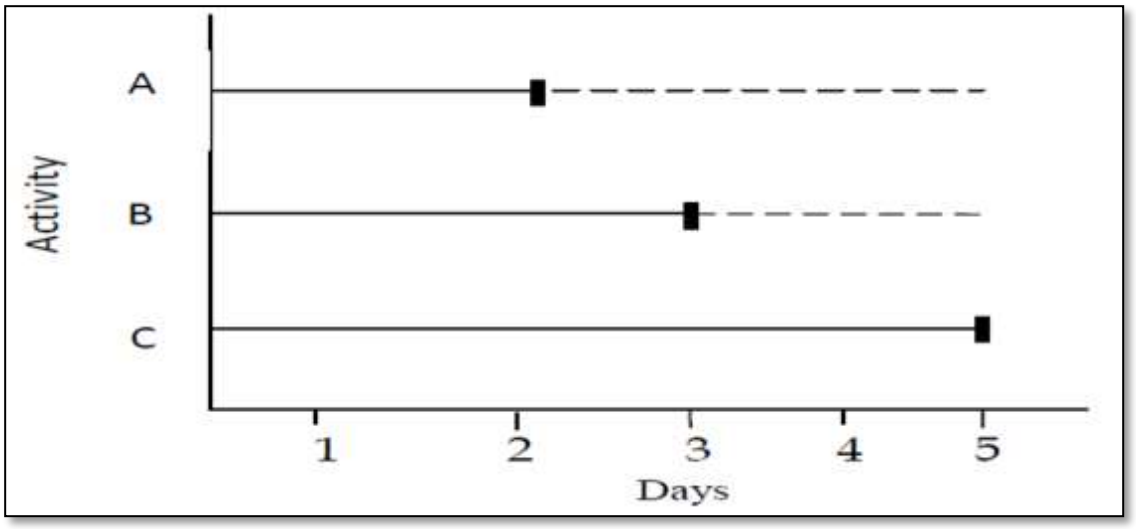

Figure 2.4: Resource schedule for hypothetical project

Source: (Author, 2016)

Assuming a botanical garden project which utilizes only backhoes as the only resource and that all backhoes are interchangeable, the diagram below illustrates an example of a schedule for the project. The bar chart shows activities on a time scale with dependencies on the vertical axis and schedule on the horizontal axis.

Figure 2.5: Resource scheduling of a botanical garden project

Source; (Gidyelew, 2011)

The resource profile below shows when the backhoe is needed. It also shows the fluctuations in the demand for the backhoe. For example, the profile shows that four backhoes are required during periods 4 through to 10.

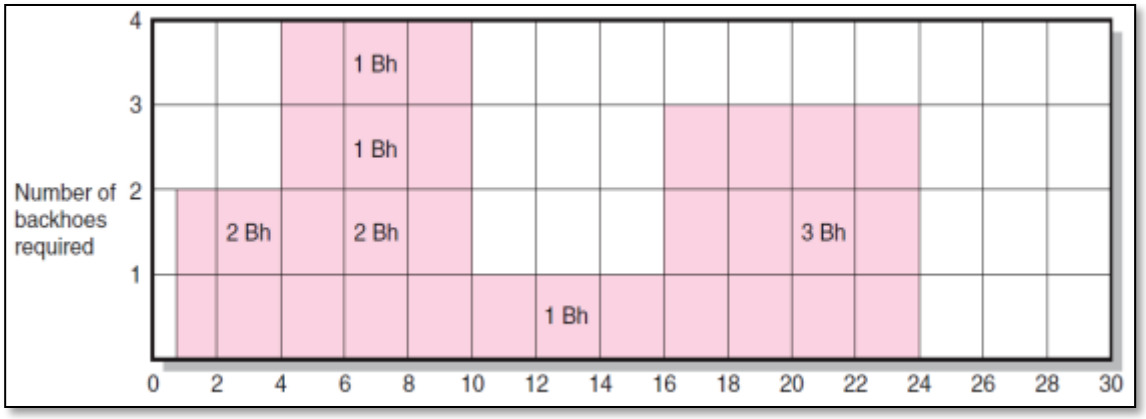

Figure 2.6: Resource profile for a botanical garden project

Source; (Gidyelew, 2011)

2.4.4 Resource loading

Resource loading is the precedence to resource leveling. This means that before a schedule can be leveled, the resource requirements for different tasks have to be defined, identified and loaded. Resources comprise general categories of labor and equipment which are needed to accopmlish the project activities. The total daily requirement for any particular resource is computed by adding up the resource loading from all activities scheduled that day (Nosbisch *et al*., 2005). The resource profile generated from the resource loading can then be utilized to determine the required daily resource staffing levels. Nosbisch *et al.* (2005) further argue that the importance of resource loading is that it relates fundamental interdependencies between scheduled activities and resources required for performing such activities.

The reource loading diagram for the earlier given Activity On Arrow network (Figure 2.3) and Resource schedule (Figure 2.4) is shown below.

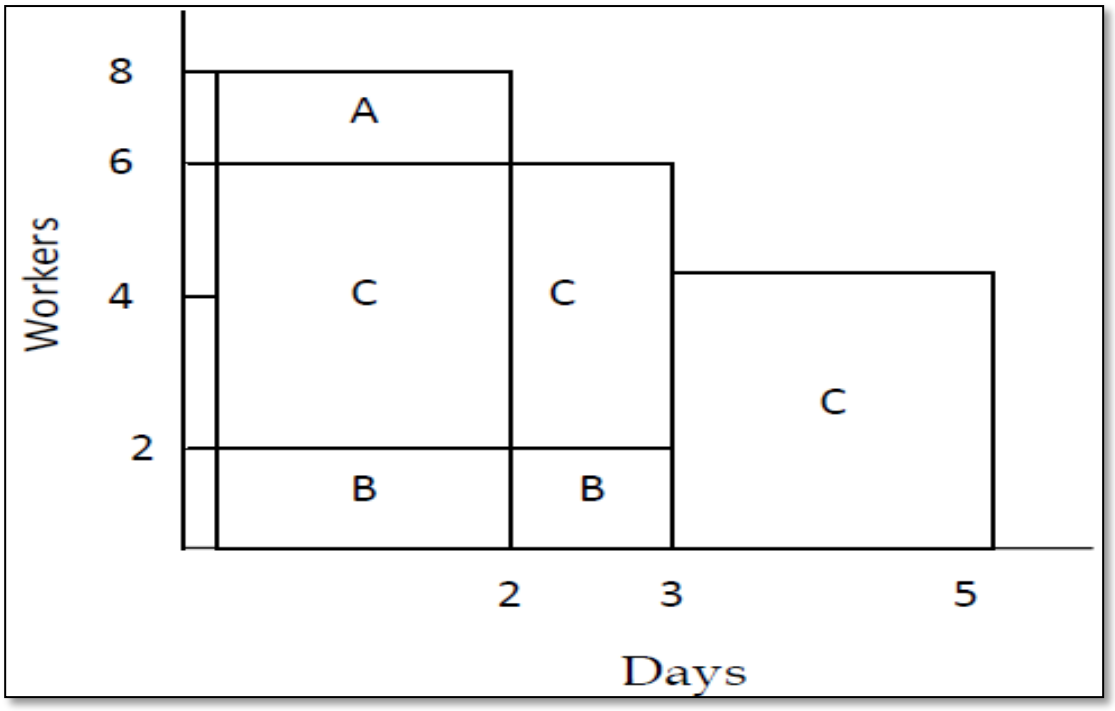

Figure 2.7: Resource Loading Diagram

Source: (Author, 2016)

When the resource requirements are plotted against time and the cumulative resource requirements plotted the following graph is obtained. One of the plots indicates activities started as earliest as possible, the other corresponds to when activities are started as late as possible. A straight line drawn between the two plots would indicate a uniform resource usage.

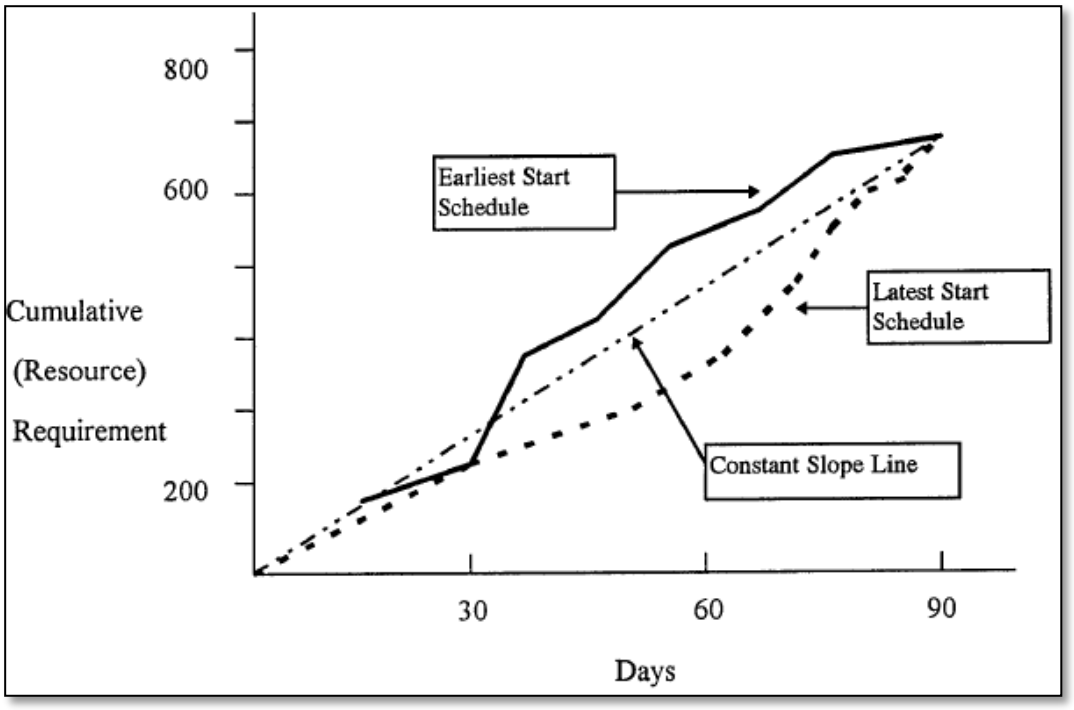

Figure 2.8: Cumulative resource graph

Source: (Mendoza, 1995)

For the example above, assuming that the resource represents workers, within the 90-day period, the total worker-days required is 700. This means the daily demand for workers on that site is 700/90 = 8 workers.

2.4.5 Resource Fluctuations in Construction Projects

a) Types of Resource Fluctuations

Fluctuations in resources can be classified depending on their influence on the efficiency of resource utilization: (a) acceptable fluctuations; and (b) undesirable fluctuations, as shown in the figure 2.9 below (Jun, 2010). Acceptable fluctuations represent a gradual build-up and run-down of resources, and can be represented graphically by a mountain or bell shape in the resource histogram as shown in the figure below (Mattila & Abraham, 1998b). In this type of fluctuation, a contractor needs to gradually increase the level of resource utilization to satisfy resource demands during

different phases of the project and then steadily release them toward the end of the project (Jun, 2010). Gradual build-up and run-down of construction resources will minimize the number of times a contractor has to employ, release, and then rehire similar resources (Mattila & Abraham, 1998b).

On the other hand, undesirable fluctuations represent temporary decreases in demand for resources which creates a valley shape resource histogram as depicted in figure 2.9 below. In this type of fluctuation, a contractor is forced to either (a) release the additional construction resources and rehire them at a later stage when needed; or (b) retain the idle construction resources on site until they are required later. A productive and cost effective schedule can only be achieved if these undesirable fluctuations are determined and minimized (Jun, 2010).

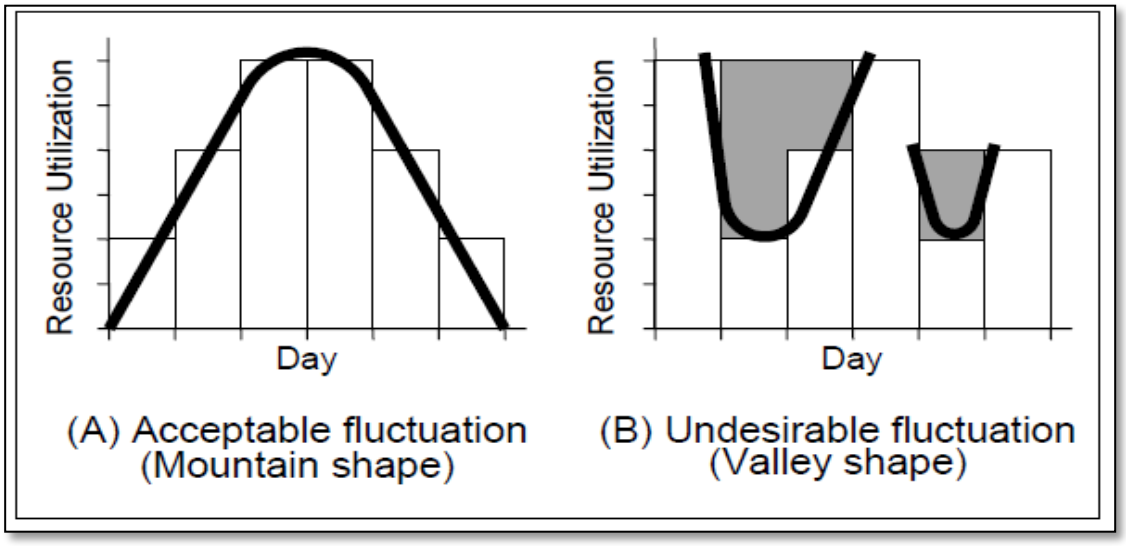

Figure 2.9: Types of resource fluctuations

Source: (Jun, 2010)

b) Impacts of Resource Fluctuations

Resource fluctuations present various negative impacts as discussed by Harris (1978); (1) it results into high turnover of construction workers which is not only costly but also troublesome; (2) increased costs due to unemployment compensation for released

employees; (3) there is the need for time to readjust to the working conditions for the rehired workers; (4) released workers may get job opportunities in other sites and thus will be unavailable once there job arises; and (5) interruptions in the learning curve effects thereby decreasing productivity.

As such, undesirable resource fluctuations affect the overall project performance and particularly productivity and cost (Jun, 2010). Again, high demand for resources during peak periods is likely going to cause congestion issues on the site. Accordingly, it causes poor productivity, increased cost, and in the end, project delays (Hendrickson, 1989). These negative impacts result to poor resource utilization efficiency and project performance.

2.4.6 Factors Influencing Contractor's Resource Planning

According to Trigunarsyah (2005), planning is a process of developing options and determining actions to enhance opportunities and minimize threats posed to project objectives. Planning also defines and assigns responsibilities for particular activities to different individuals. Resource planning must be appropriate to the particular project, cost effective in addressing the challenges, timely to enhance success, realistic within the project context, and owned by all parties (Trigunarsyah, 2005).

Several authors have pointed out a number of factors which influence resource planning by contractors. These include: adequacy of plants and equipment (Mendoza, 1995); adequacy of labour (Nosbisch *et al*. 2005); compliance with safety procedures (Mattila & Abraham, 1998a); contractor's ICT Compliance (Mendoza, 1995); contractor's organizational structure (Joshi & Patil, 2015); contractor's project management capability (Dubey, 2015); financial status of the contractor (Garmsiri & Abassi, 2012); weather (Schweiz, 2014); prompt honoring of payments certificates (Singh, 2013); technical competence (Tawalare & Lalwani, 2012); and type of procurement system (Winter, 2006).

2.4.7 Contractor's Resource Planning Success Indicators

According to Takim and Akintoye (2002) and as cited by Mbugua, *et al*. (1999), performance or success indicators specify the measurable evidence required to prove that a planned effort has achieved the desired result. These indicators should be established before the activity is undertaken. This enables the planners to easily establish the level of success achieved by the action taken.

Some of the indicators for resource planning include: ability of plan in facilitating project resource optimization (Takim & Akintoye, 2002); adequacy of plan in determining suppliers' delivery dates (Mendoza, 1995); ability of plan to adhere to cost estimate (Saqib, Farooqui, & Lodi, 2008); ability of plan to adhere to project technical requirements(Zanen & Hartmann, 2010); ability of plan to adhere to quality (Takim & Akintoye, 2002); ability of plan to adhere to time (Gates, 2010); ability to adequately accommodate contractors work (Sheldon Shaeffer, 2006); clarity in communication (Salleh *et al*., 2009); ability to integrate sub-contractors work (Mendoza, 1995); plan's flexibility (Singh, 2013); plan's provision of basis for preparing labour and material schedules (Takim & Akintoye, 2002) and plan's provision for facilitating project monitoring and control (Mendoza, 1995).

2.4.8 Resource leveling

Resource leveling is a technique used in project and resource scheduling with the aim of minimizing fluctuations in resource requirement at different stages of the project. It levels the resource usage in a way that we require approximately constant amount of resources on site. It can be seen as a trial and error method, one which should ensure that the overall project duration is not interfered with. Gido and Clements (2003) assert that optimization of the use of labour and equipment is significant in the process of resource leveling. The underlying assumption is that continuous and consistent use of the fewest resources is most desirable in construction projects (Badawiyeh, 2010). Verzuh (2003) states that Project Managers ought to avoid troughs and peaks in the resource profile. They should use a set of people and equipment on a consistent rate as

it is more effective and prevents costs associated with every upswing in the uptake of new members of the workforce or procuring more equipment.

Resource leveling is a process which gives an idea about availability of sufficient resources to perform the activities in the chosen project according to the plan (Reddy & Nagaraju, 2015). The main objective of resource leveling is to regularize and flatten the resource profile. However, it is important to note that this should have minimal or zero effect on the project schedule and budget. In order to accomplish resource leveling, it is a common practice to delay some of the project activities with the aim of overcoming conflicts arising from resource availability and requirement. However, such delays should only be applied to activities which are not in the critical path so as to avoid time overruns. Another common approach to resource would be altering the logical relationships among different activities.

2.4.8.1 Resource Leveling Procedures

A short procedure as discussed by Dubey (2015) involves three steps;

> ***Step 1:*** Allocation of resources serially in time. This involves starting with the first time-period (Day 1 or Month 1) and scheduling all activities as required by the method statement with available resources. The same procedure is then repeated for all subsequent time-periods
>
> ***Step 2:*** When several activities share same resources, preference should be given to activities with minimum float.
>
> ***Step 3:*** Activities which are not in the critical path are rescheduled where necessary so as to free resources for utilization by critical activities.

This process may result to stretching of the initial project duration since non-critical activities may become critical when they are delayed beyond their slack limits. Once resource leveling is complete, resource smoothing may be carried out for further

optimization of the problem (Dubey, 2015). Resource smoothing has no effect on the project duration and only works on activities which are not in the critical path.

According to Reddy and Nagaraju (2015), the step by step procedure to be followed in the resource leveling process is shown in the figure below.

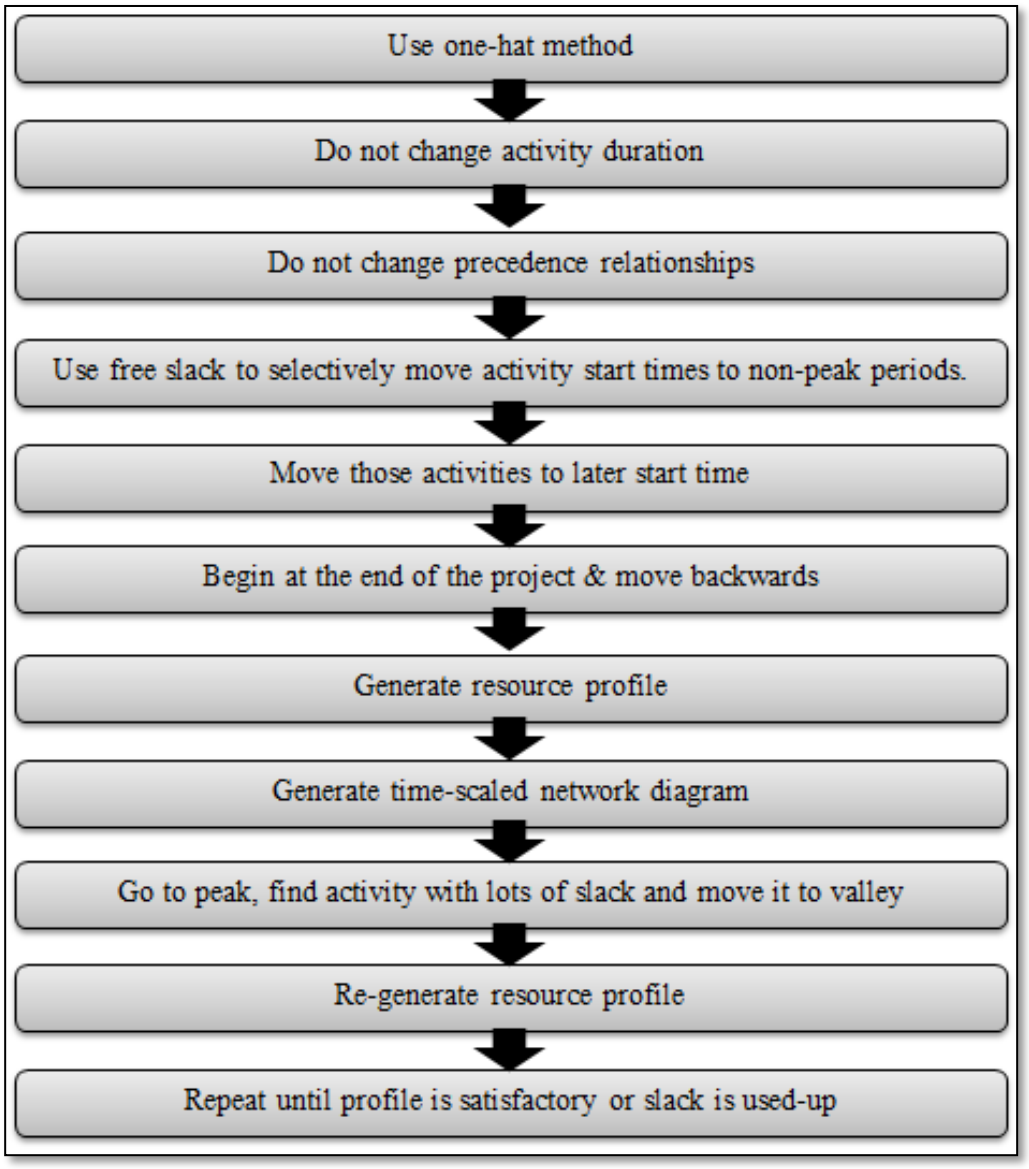

Figure 2.10: Step by step procedure in the resource leveling process

Source: (Reddy & Nagaraju, 2015).

2.4.8.2 Significance of Resource Leveling

According to Badawiyeh (2010), the advantages of resource leveling affect the entire organization leading to enhanced overall operations. From a management level, it can be agreed that organizations which practice resource leveling need less management attention on project activities thus giving them time to concentrate on other aspects of the organization. This is because they are not overloaded with the work of tackling daily resource management.

Secondly, resource leveling promotes workers' morale. This is because they have a guaranteed job security without the fear of being fired once there is no work for them. Keeping approximately constant personnel on site reduces labor turnover and consequently reduces the cost of investing in labour training. Human retention in any site results to increased experience thereby reducing costly errors in work execution. This reduces the cost of production thus increasing project profitability.

2.4.8.3 Structure of resource leveling

According to Reddy and Nagaraju (2015), many organizations carry out resource leveling in a structured manner. A work based structure is prepared giving the scope and how the tasks have been organized and allocated to different members of the team. The structure helps the project team to execute the project tasks effectively, efficiently and on time. Most construction companies are looking for adequate resource optimization with the aim of improving productivity thence resulting to profitable projects (Reddy & Nagaraju, 2015). The key to such would be completing projects on time, within the targeted budget without compromising the quality required of the project. Resource leveling enables the contractor to utilize the available resources at optimum levels without any wastage by avoiding over-allocation and under-allocation of resources to project tasks.

2.4.8.4 Types of Resource Leveling

There are two types of resource leveling, “time-constrained” and “resource-constrained” (Nosbisch *et al*. 2005). If the project scheduling is being conducted by the contractor, the technique use in resource leveling should be based on the potentiality of project time adjustment. If the project period cannot be adjusted, then the contractor should adopt time-constrained leveling with the aim of maintaining the scheduled project completion date (Hussain *et al*. 2014).

However in a case where the contractor has the leeway to adjust the project duration, resource-constrained leveling would be best applicable. This will prevent occurrence of resource over-allocations but might result to a delay in the project duration. This is best applicable if the contractor has experienced excusable delays; reasons beyond his control (Suttle, 2016). The period of time between the contractual completion date and the delayed completion date will then be the amount of time extension that the contractor should ultimately seek from the owner (Nosbisch *et al*. 2005).

a) Time-constrained leveling

This type of resource leveling is commonly practiced together with time constrained project scheduling. The project duration is preset using a network analysis of the different logical relationships in project activities. The predetermined project completion date cannot be extended. Alterations affecting activity durations and required resources at any given time interval are adjusted within the available float except those within the critical path (Badawiyeh, 2010).

Time-constrained leveling works under the assumption that the project must be finished by a certain time, using as few resources as possible. Since time (not resource usage), is critical, the project will not be allowed to be delayed.

b) Resource-constrained leveling

Unlike time-constrained leveling, resource-constrained leveling begins at the status date and works forward to project completion, allocating time to activities based on logic and resource availability. This technique recognizes that the project must be completed as soon as possible without exceeding a certain level of resource availability. This technique assumes that the client is willing to let the project delay beyond the early finish date if all required resources are unavailable.

Project duration is considered to be of no importance since project criteria is limited to resources available (Gray & Larson, 2006). Consequently if demand exceeds availability, activities will be delayed till needed resources are made available (Badawiyeh, 2010).

2.4.8.5 Automatic and Manual Resource Leveling

a) Automatic resource leveling

Primavera revolutionized resource leveling paradigm in 1986 when it introduced built-in automatic resource leveling. The program user is required to define several heuristics or rules that will guide the software in determining which activities should or should not be delayed due to prevailing resource constraints. The program is capable of making these logic decisions within a split second (Nosbisch *et al*., 2005).

The software levels all the resources as the user has no control in decision making. It is just impossible for an application to take into account all the possible conditions and restrictions from the real world projects in order to produce good results through an automatic levelling (Dubey, 2015). When resource leveling is carried out automatically, it is the responsibility of the project manager to review the schedule critically to make sure the schedule is realistic.

The major drawback associated with automatic resource leveling, however, is realized when the practice is applied to a contractually-specified CPM schedule submittal (Nosbisch *et al*., 2005). Since there are no logic ties linking the activities which have been leveled, the "backward pass" is not able to calculate accurately late dates for the leveled activities. Consequently, leveled activities are shown to have float values that are not representative of their true criticality (Nosbisch *et al*., 2005). Since most construction contracts assess the impact of project delay by reviewing the total float values, this leveling approach is not accepted by many.

b) Manual resource leveling

Manual leveling has been utilized in one form or another since the start of Critical Path Method (Nosbisch *et al*., 2005). Manual Leveling is always preferred over automatic leveling as it gives much more control in decision making (Dubey, 2015). It involves use of preferential logic to stagger activities which are resource-constrained.

According to Nosbisch *et al*. (2005), the merit of this technique is that slack values reflect the status of leveled activities since an accurate forward and back pass can be achieved for the entire schedule. This is the reason why most contractors and clients opt to undertake resource leveling manually so as to prepare the resource plan to reflect the contractually specified requirements. The major drawback would be the long periods of time required to undertake the process.

2.4.8.7 Resource leveling models

According to Jun (2010), several resource leveling algorithms and models have been developed by different researchers with the aim of increasing the resource utilization efficiency by reducing resource fluctuations in resource utilization. This has the ultimate aim of reducing the negative impact that these fluctuations have on the construction project performance. Most of these models are formulated to reduce resource fluctuations by shifting activities which do not fall on the critical path within

their available floats in such a way that the original scheduled project duration is not affected.

In a dissertation by Jun (2010), some of these resource leveling models include: (a) Sum of Quarters Method (Ahuja, 1976; Bandelloni, Tucci, & Rinaldi, 1994; Burgess & Killebrew, 1962; Harris, 1978; Hegazy, 1999; Son & Skibniewski, 1999); (b) Absolute difference between Resource Consumptions in Consecutive Time Periods (Easa, 1989; Senouci & Adeli, 2001; Senouci & Eldin, 2004); (c) Deviation Between Actual Resource Usage and a Specified or a Uniform Usage (Akpan, 2000; Chan, Chua, & Kannan, 1996; Leu & Yang, 1999; Mattila & Abraham, 1998; Son & Mattila, 2004); (d) Sum of Squares of Resource Changes (Ahuja, 1976).

In the same report by Jun (2010), several optimization models have been developed to integrate resource allocation and resource leveling techniques in order to increase the levels of resource utilization efficiency without ignoring the constraints on resource availability (Chan et al. 1996; Hegazy, 1999; Leu & Yang, 1999). These models utilized metrics to produce optimal schedules that provide improved resource utilization profiles and minimum project durations while complying with resource availability constraints.

2.4.8.8 Resource leveling techniques & their Impacts

a) Doing nothing

This is possible if the over allocation is within acceptable limits. This technique has no effect on both the schedule/time and the resource/cost.

b) Delay non-critical tasks within available float

When resources are not available for a given activity, the task can be delayed. Tasks which are likely to be postponed are those which do not fall on the critical path. This is to ensure minimal interruption to the project predetermined completion period (Badawiyeh, 2010). While this technique has no effect on the schedule/time or

resource/cost under normal circumstances, it would have an effect on the resource/cost in the event of inflation.

c) Extend non-critical task durations within the available float

This has no effect on both schedule and cost except for situations where there is inflation (Kastor & Sirakoulis, 2009).

d) Add resource of equal or greater capability

Addition of more resources has the effect of reducing the project duration. There is likely going to be a cost impact since the additional resource will have a new cost value. The project duration is likely to reduce when resources are added (Winter, 2006). However, the learning curve of the new resource ought to be considered. Resource-wise, additional resources come at an additional cost.

e) Substitute resource of equal or greater capability

Substitution of existing resources has the effect of either reducing or increasing the project duration. This depends on the capacity and efficiency of the new resource. However there is need to consider the learning curve for the new resource (Mendoza, 1995). There is likely going to be a cost impact since the alternative resource will have a different cost value

f) Delay critical path tasks

Delay of critical activities should be the considered after all attempts have been made on the non-critical tasks. When there is a common pool of resources, priority for resource allocation should be given to projects with minimum float. The schedule/time impact is equivalent to the delay (Atkinson, 1999). There will be a cost impact due to project time extension (delay damages) and inflation costs.

g) Extend critical path task durations

The impact on the schedule is equal to the amount of delay. The cost impact will be influenced by the level of inflation. Delay damages will also affect the project completion cost (Suttle, 2016).

h) Splitting tasks into non sequential pieces

Certain types of work may be interrupted in between execution. Rather than carrying out an activity sequentially, it is split into smaller activities which are not sequential (Dubey, 2015). The weakness with this approach however is that resources tend to lose time as they re-adapt themselves to previous tasks (Mendoza, 1995).

The schedule/time impact is equivalent to the part of the task that extends beyond activity float. The cost impact is due to delay damages as a result of project time extension, inefficiencies in splitting tasks and inflation costs.

i) Authorize Overtime

Resources may be required to work overtime if they are to complete their assigned work. This would mean that they will have to be paid more wages as compensation over and above what they earn during normal standard working hours. However this strategy can only level resources up to a certain limit (Dubey, 2015).

This method has the likelihood of reducing the project schedule time while increasing the project cost due to premium cost rates associated with working beyond the normal working calendar.

j) Crashing

This involves assigning of extra resources to critical path tasks in addition to the existing resources with the aim of getting the work done faster. This however has a short term negative effect of additional labour and equipment costs (Tarek Hegazy, 2010).

k) Fast tracking

This involves performance of tasks within the critical path in parallel instead of sequentially as previously planned. This helps the planner buy time. The prominent feature of this technique is that although the work is completed for the moment, possibility of rework is higher (Dominguez, 2010). There is also an increased risk within the project schedule.

l) Microsoft Project

Microsoft Project has the ability to automatically level resources based on the resource calendar, task types, their dependencies and constraints set up by the programmer. This can also be achieved by leveling the resources manually via the resource usage view option (Kastor & Sirakoulis, 2009).

In case of resource conflicts such as under or over allocations, the following options are available; delay of certain tasks, assigning different resources to activities, review of task dependencies (logic relationships), remove certain tasks or add tasks to the programme (Dominguez, 2010).

m) Modify the scope

This involves restructuring the project brief to either increase or reduce the amount of work to be executed. If the project can function satisfactorily without some of the sections, the client may opt to exclude such tasks from the contract.

The schedule/time and resource/cost could increase or decrease depending on the nature and volume of the new work compared to the original scope (Wilkens, 2006). The schedule/time could shorten due to less work or work of less quality being accomplished. The vice versa is true. The same logic could be applied for resource/time impact

2.4.8.9 Heuristics in Resource Leveling

In simple terms heuristics means the use of rules of thumb which have worked in similar situations. Priority rules are methods followed by Project Managers to level over allocated resources, which can either be done manually or through using a computer program (Meredith *et al*., 2001).

Priority rules are commonly embedded in project scheduling software thus making resource leveling of fluctuating resource demands process easy to implement. Some of the common rules according to Badawiyeh (2010) include;

a) ***As soon as possible:*** this is considered to be the standard leveling rule. All activities are assumed to start at their earliest possible times. Resources are allocated on that basis.

b) ***As late as possible***: contrary to the first rule, the aim of this rule is to delay the cash outflows thereby preserving resources by starting all activities at their latest start times. However this should not extend the overall project completion period

c) ***Shortest task first***: this is considered to be implementable in technological precedence.

d) ***Most resources first***: the assumption underlying this rule is that activities of high significance demand scarce resources.

e) ***Minimum slack first***: in this case float available and resources required have a negative relationship. This means the longer the available float, the less the required resources. This rule aims at reducing late activities to avoid the 'student syndrome' (planned procrastination).

f) ***Most critical followers***: in this rule, the activity with more preceding activities is assigned needed scarce resource first. It is assumed that activities in such a scenario can cause damage to project performance if delayed.

g) ***Most successors***: This rule is just like the previous rule, although in this case the activity with less preceding activities is considered first with the same rational.

h) ***Arbitrary***: arbitrarily, neither early start dates nor late start dates is of importance. The importance lies in the value of the task to be performed and what effect does it have on the overall project. For example the delivery of a major item to a construction site such as steel is going to generate a certain amount of income which serves the company's objective (Badawiyeh, 2010). It will thus mean that resources required to achieve such objective need to be availed first.

2.5 Challenges experienced in Resource Planning & Leveling

Many challenges have been cited by authors in both the manufacturing and construction industries as the contributing factors to their lack of practicing structured and formal resource planning and leveling. Some of these factors have also been raised by those who have been carrying out resource planning and management. These include: lengthy payment terms (Pennypacker, 2009); ignorance of network methods to capacity constraints (Bakouros *et al*., 2000); tedious exercise (Aitken, 1993); lack of knowledge on how to carry out resource planning and leveling (Pennypacker, 2009); resource unavailability (Mendoza, 1995); lack of commitment by top level management (Badawiyeh, 2010); site storage constraints (Bandelloni et al., 1994); technical incompetence (Pennypacker, 2009); contractor's project management incapability (Suttle, 2016); late honoring of payments' certificates (Badawiyeh, 2010); adequacy of plants and equipment (Dubey, 2015); contractor's organizational structure or organizational problems (Easa, 1989); contractors ICT compliance challenges (Garmsiri & Abassi, 2012); too many variations (MacKenzie, 2013); project complexity and materials shortages or late delivery (Ibrahim, 2014); claims (Aitken, 1993); plants, equipment's & machine breakdown/inadequacy (Pennypacker, 2009); disputes and communications problem (Ubani et al. 2010); poor work definition (Ibrahim, 2014); environmental regulations and inadequate project documentation (Joshi & Patil, 2015); design deficiencies (Kastor & Sirakoulis, 2009); project risks, uncertainty and delays

(Mendoza, 1995); absenteeism of workers/shortage of craftsmen and increase in prices of materials or labour (Ubani *et al*., 2010).

2.6 Benefits of Resource Planning & Leveling

Resource Planning and Leveling has quite a number of benefits. These include: balanced resources, reducing over allocations or overtime (Nagaraju, Reddy, & Chaudhuri, 2012); validates schedule; makes the schedule realistic (Suttle, 2016); predicts dates based on information entered. This is based on durations, links and resources assigned (Tawalare & Lalwani, 2012); determines or predicts resources needed (Singh, 2013); helps maintain the lowest uniform number of employees to perform the work (Wilkens, 2006); establishing plans for material delivery (Tawalare & Lalwani, 2012); reducing the daily demand for cash (MacKenzie, 2013); less management attention is required (Singh, 2013); reduced project costs (Akpan, 2000); reduced cost of learning (Bandelloni et al., 1994); improved learning curve (Bandelloni et al., 1994); enhanced overall organizational strategic planning (Dubey, 2015); better view of future projects (Easa, 1989); reduction of errors (Fathi & Afshar, 2008) and increased workers' morale due to guaranteed job security (Singh, 2013).

2.7 Construction Project Performance Indicators

According to Masu (2006) and cited by Lamka, Githae and Diang'a (2015), construction project performance is determined by the scale of completion of a project within the original set contract sum, the set standards, the contract duration, client satisfaction and environmental sustainability.

Saqib, Farooqui, and Lodi (2008) classify project critical factors into seven broad categories: Project Management Factors; Client-related Factors; Procurement-related Factors; Contractor-related factors; Project Manager-related Factors; Design team-related Factors; and Business and Work Environment-related Factors. Out of these categories, 77 factors are enumerated by the authors. Some of the Client-Related factors identified in this research include: Influence of client/ client's representative; Client's

experience; Client's knowledge of construction project organization; Client's emphasis of quick construction; Client's emphasis on low construction cost; Client's project management and Client's confidence in construction team.

According to Shenhar, Levy and Dvir (1997) as cited by Chan (2001), there are four dimensions of project success: Project efficiency; Impact on customer; Business success and Preparing for the future. Atkinson (1999) instead talks about two dimensions: Delivery Stage (which includes Cost, Time, Quality and Efficiency) and Post Delivery Stage (which includes Impact on customer and Business success) Lim and Mohamed, (1999) group project success indicators into two broad categories: Micro Viewpoint (Time, Cost, Quality, Performance and Safety) and Macro Viewpoint (Time, Satisfaction, Utility and Operation). Such factors have been diagrammatically represented in figure 2.11.

According to Egan (1998) and as cited by Takim and Akintoye,(2002), the following have been identified as the key indicators of project success; Construction cost, Construction time, Defects, Client satisfaction (product), Client satisfaction (service), Profitability, Productivity, Safety, Cost predictability (construction), Time predictability (construction), Cost predictability (design) and Time predictability (design).

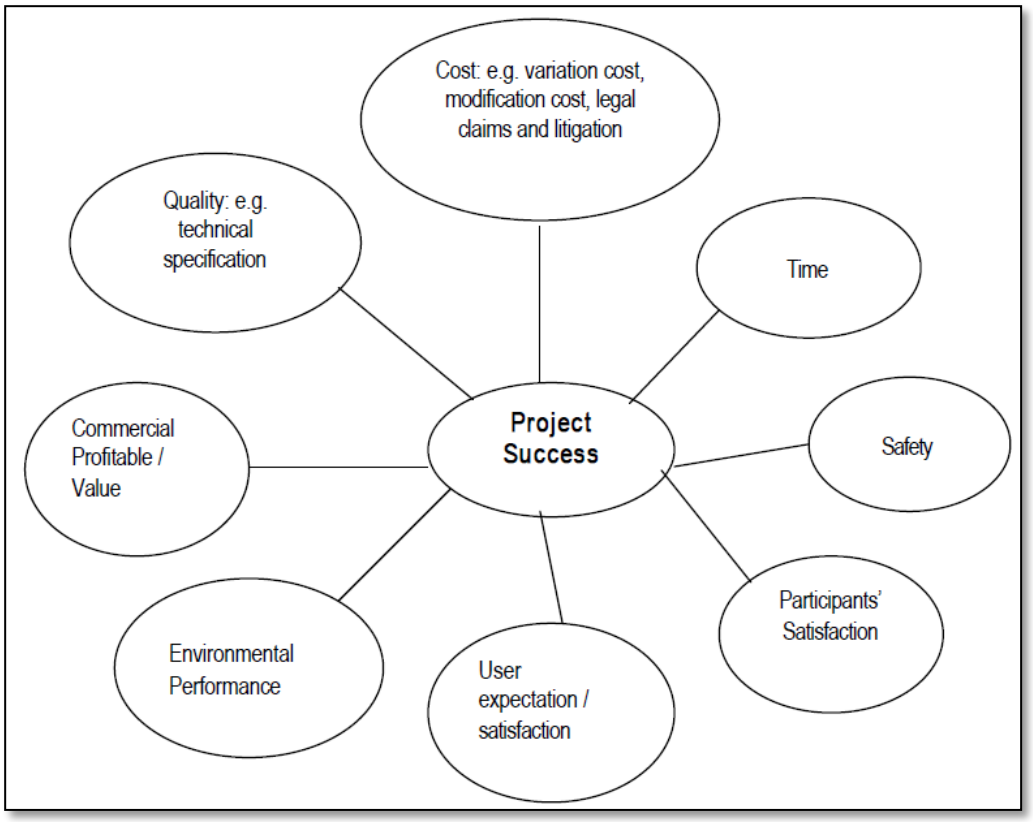

Figure 2.11: Consolidated Framework for Measuring Project Success

Source: (Chan, 2001)

2.8 Theoretical Framework

2.8.1 Project Implementation Theory

Nutt (1996) refers to implementation as a series of steps taken to plan change process so as to elicit compliance required to install changes. Implementation theory according to Palfrey (2002) is an area of research which investigates goal setting and the mechanisms put I place to achieve those goals. According to Kamau and Muturi (2015), the theory of project implementation is employed by Project Managers to make predetermined changes in organizations by creating environments in which the changes can thrive. In line with this theory, Slevin and Pinto (1989) argue that it is a difficult and complex exercise to implement a project successfully. The project manager is

required to dedicate more effort and time to financial, human and technical variables if he has any intention of realizing project success. Kamau and Muturi (2015) further argue that quite a number of factors are capable of influencing project implementation if they are not handled with care. These include inflation which has the effect of increasing the project cost, bureaucracy in government institutions, poor performance of contractors, increase or decrease in scope of the work, frequent change of leadership, change in pre-contract consultants, ineffective and inefficient project finance structure, variations in designs and political influence (Kamau & Muturi, 2015).

The theory of project implementation emphasizes several critical success factors in project implementation. Some of these include; management support, project schedule plan, personnel, trouble shooting and monitoring.

For any project to be successful there should be support from top management. According to Schultz, Slevin and Pinto (1987), management support during project implementation is a major determinant to the success or failure of the project. Project management could be regarded as one of the means in which the top management implements its goals and objectives for the firm.

Project schedule plan is the other factor highlighted in the project implementation theory. It involves providing a road plan or strategy of how to achieve the desired objectives in the project. Slevin and Pinto (1989) have drawn parallels between the different stages of project implementation. The client's consultant (usually the project manager) is involved in formulating the project schedule plan. However the consultant must engage the client in formulating the plan. Anyanwu (2003) asserts that the degree to which the client is involved in the planning process determines the level of success experienced by the project.

The other critical factor is human resources. This includes all the human resources employed in the project. Schultz *et al*. (1987) argue that efficient utilization of human resources creates efficiency of any organization, whether public or private. Slevin and

Pinto (1989) however assert that the human resources for the project team are commonly chosen without regard for the skills necessary to actively contribute to the project success.

Monitoring is another key success factor determining project success. There should be continuous monitoring throughout the different phases of the project if success is to be realized. Monitoring is done at different levels, at the project level and at corporate or organization level.

Trouble shooting is another factor within the project implementation theory which is critical in project implementation. According to Kamau and Muturi (2015), regardless of the perfection of the project plan, it is impossible to predict all the problems which might arise. Competent people should be hired if such problems are to be overcome easily.

In light of this theory, the success of project implementation depends on quite a number of factors. Most of these factors are also inherent to construction projects. For example, bureaucracy may result to late payments to contractors in government projects, change of leadership such as the Project Manager, change in scope of work, change in pre-contract consultants among other factors.

The critical success factors highlighted within the project implementation theory have also been seen (as discussed previously in this research) to be major determinants in the success of construction projects. The client and Project Manager should show support for the projects being undertaken, a project schedule plan should be prepared, competent personnel should be employed and the entire process of implementation should be monitored. This research is concerned with formulation of research plans and the implementation of such plans and therefore this theory forms a good basis for this research.

2.8.2 Agency Theory

Agency theory defines and describes the relationship between one person (the principal) and another (the agent) where the latter is required to perform services on behalf of the former. Agency theory was exposited by Alchian and Demsetz (1972) and further refined by Jensen and Meckling (1976). According to the theory, there is a contractual relationship between the two parties. Usually, the principal would be required to pay the agent for his services.

Agency theory addresses the relationship where in a contract one or more persons (referred to as the principal) engages another person (known as the agent) to undertake services on their behalf involving delegation of some decision making authority to the agent (Jensen & Meckling, 1976). This happens due to separation of ownership and control, when the owners of the company or the board of directors (the 'principals') have to engage managers and other employees ('agents') to carry out activities of the business and need to monitor and evaluate their performance to ensure they act in the interest of the owners.

Economists Alchian and Demsetz (1972) were the first to argue that monitoring the performance of individual work output is always a cost of any firm and that the organization is inefficient when the flow of information on individual performance is minimized. This can easily happen if there are large teams who act autonomously (Alchian, 2012). The main concern of agency theory as proposed by Jensen and Meckling (1976) is how to draft contracts in which the agent's performance can be determined so as to act with the principal's interests in mind.

Based on the idea that different employees will always have diverse goals, two main *agency problems* arise: how to align the conflicting goals of agents and principals, and how to ensure that agents perform in the way principals expect them to (Alchian, 2012). These problems can occur when executives or managers make decisions based on their personal goals and manipulate information on performance, perhaps by altering figures

and numbers with the aim of pleasing the principal. Problem arises when the principal cannot verify the authenticity and accuracy pf information presented by the agent (Eisenhardt & Martin, 2000).

The important assumptions underlying agency theory are that: potential goal conflicts exist between principals and agents; there is sometimes a conflict of interest between principals and agents; information asymmetry frequently exists between parties; agents are more risk averse than the principals while efficiency is the effectiveness criterion (Otundo, 2015).

The Project Manager is commonly regarded as client's agent. Since most of the clients do not have a background in construction related knowledge, they engage Project Managers who transact on behalf of them. The manner in which the Project Manager utilizes resources should be to the best interest of the client. As pointed out in the theory, conflicts are bound to occur between agents and principal, it would thus be in the interest of the project to engage a Project Manager whose principles and ideologies are close to those of the client. There should also be maximum flow of information from the client to the Project Manager and vice versa.

2.8.3 Resource Based View Theory (RBVT)

According to Awino and Marendi-getuno (2014), Resource Based Theory (RBT) originated from the ideas of Penrose (1959). He provided insights on the resource perspective of the organization. However, according to Awino and Marendi-getuno (2014), the resource based view of the organization was introduced by Wernerfelt (1984) and late supported by Barney (1991) in his works. Awino and Marendi-getuno, (2014) assert that many authors such as (Nelson & Winter, 1982; Dierickx & Cool, 1989; Mahoney & Pandian, 1992, Eisenhardt & Martin, 2000 and Zollo & Winter, 2002) have made considerable contribution to the conceptual development of the theory.

The Resource Based View Theory (RBVT) highlights the significance of organizational resources and their effect on firm's performance and its competitiveness in the market. The theory asserts that each firm has a set of unique resources which are critical in ensuring the firm not only survives but also grows within the industry in which it operates. These resources range from technical, financial, physical and human, and they all contribute to the success of the firm.

However, according to Awino and Marendi-getuno (2014), critiques of the theory have argued that while some resources promote competitive advantage of the firm, others do not. It can also be argued that mere presence of resources does not contribute to success until such resources are coordinated and integrated (Awino & Marendi-getuno, 2014).

Any construction project requires resources. The resources listed in the Resource Based View Theory such as technical, financial, physical and human are all utilized in every construction project.

2.8.4 Adopted theoretical framework

This study seeks to employ all the above theories. It combines aspects of the project implementation theory, agency theory and the resource based view theory. Critical aspects of this research such as top management support, formulation of resource plans, adequacy of qualified personnel and monitoring are all anchored on the theory of project implementation. The agency theory was critical in providing insights on the relationship between contractors and those employed on sites as their agents. The resource based view theory provided the researcher with important knowledge on the organization of resources.

2.9 Research gap

While it would be true to say that quite a number of authors have addressed the issue of resource management, the author feels that the subject of resource planning and leveling in the Kenyan construction industry is not well covered. This is due to a number of reasons which create a gap to be researched on.

Many models have been formulated for both resource planning and leveling and cited by different authors such as Abeyasinghe *et al*. (2001); Ballard, (2000); *Bandelloni et al*. (1994); Easa (1989); Fathi and Afshar (2008); Garmsiri and Abassi (2012); Hegazy, (1999); Hussain *et al*. (2014); Iranagh and Sonmez (2012); Jun (2010); Kastor and Sirakoulis (2009); Leu and Yang (1999); MacKenzie (2013); Mattila and Abraham (1998a); Mattila and Abraham (1998b); Yesugey (2014); Reddy and Nagaraju (2015); Schweiz (2014); Senouci and Adeli (2001); Senouci and Eldin (2004); Son and Mattila (2004); and Son and Skibniewski (1999). However, all these models have been postulated by authors from developed countries for their construction industries. This means that using these models for the Kenyan industry would therefore be misleading. The same argument holds for the challenges, barriers and benefits associated with resource leveling established in this literature review. Further, some of the challenges, barriers and benefits associated with resource management found in literature review have been based on the manufacturing sector in the developed countries.

2.10 Conceptual Framework

Conceptual framework can be defined as the graphical presentation of the linkage between the different identified variables within the study. These include both independent and dependent variables. In this study, the dependent variable will be the practice of resource planning and leveling among contractors. The parameters to be relied upon in measuring this variable are presence of a resource plan, adherence to the resource plan, knowledge of resource leveling techniques and practice of the same. The independent variables will consist of awareness and usage of resource planning and leveling, challenges associated with resource planning and leveling, barriers associated with resource planning and leveling, benefits associated with resource planning and leveling, and finally solutions available in overcoming the above challenges. All these independent variables affect the practice of resource planning and leveling in one way or another as it has been explained in the literature review. The conceptual framework is as shown in figure 2.12.

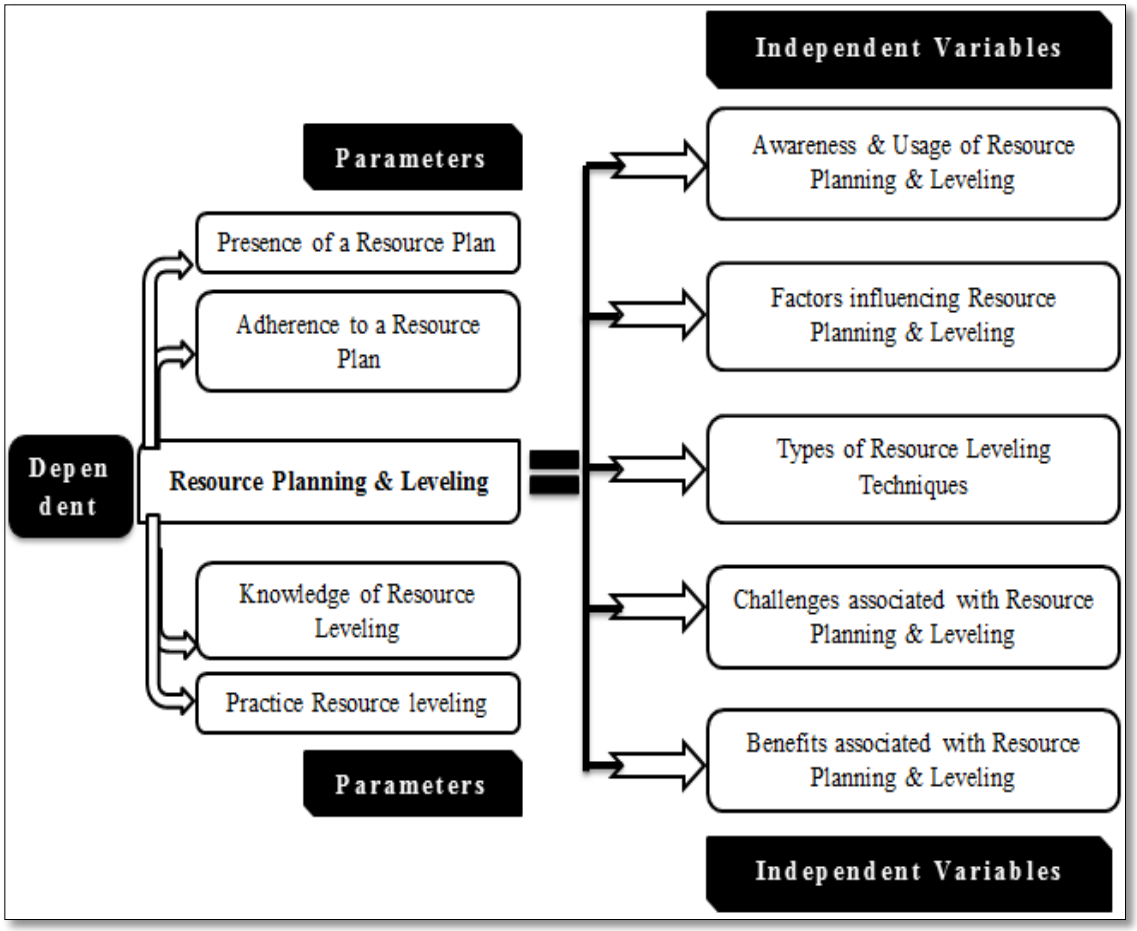

Figure 2.12: Conceptual framework

Source: (Author, 2016)

2.11 Discussion

The chapter begins by discussing the concepts of project planning and the techniques employed in different Project Managers in planning for their projects. Other aspects discussed under project planning include the various project constraints such as technical, physical, resources, economic, legal, environmental and social. The impact of these constraints on the project performance was discussed under each section. The two types of project scheduling problems were identified as the time-constraint and resource-constraint.

The chapter also broadly discusses the concept of resource management. The various issues discussed under this literature include; the nature of resources, resource planning in construction projects, resource scheduling, resource loading, resource fluctuations in construction projects, resource leveling. It was established that it is important to consider all the aspects of resource planning which are; human resource, materials and labour. Resource estimation techniques employed in the construction industry were also highlighted and discussed in detail. Two types of resource fluctuations were identified in this section, acceptable and undesirable fluctuations, with the latter found to impact negatively on the project performance. Resource leveling was discussed under the following sections; resource leveling procedures, significance of resource leveling, structure of resource leveling, types of resource leveling, resource leveling models, resource leveling techniques, heuristics in resource leveling. A number of resource leveling techniques and their effects on the project performance were also discussed in this section.

Other topical issues discussed in this chapter include challenges experienced in resource leveling and the benefits of resource leveling. The theoretical framework is modeled from the Project Implementation Theory, Agency theory and the Resource Based View Theory. The conceptual framework was based on the relationship between the independent and dependent variables. The independent variables have been extracted from the study objectives and explained by the theoretical framework.

CHAPTER THREE
3.0 RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the research design adopted, target population, sampling strategy and the sample which is the outcome of the sampling exercise. The chapter also indicates the adopted research instruments, procedures for data collection and data analysis.

Welman (2005) describes research methodology as the process of considering and explaining the logic behind research techniques and methods which allow the means to explore a given phenomenon. It is only through the use of sound methods and techniques that reliable conclusions can be made. According to Kothari (2012), research methodology may be understood as a science of studying how research is done scientifically. It could be described as the procedures by which researchers go about describing, explaining and predicting phenomena (Rajasekar, Philominathan, & Chinnathambi, 2006).

This study sought to establish the factors influencing the practice of resource planning and leveling among contractors in the construction industry. In doing so, the researcher sought to find possible relationships among outlined variables in the conceptual framework, discover the strength of the relationship where it existed and was based on objectivity, neutrality measurement and validity of results.

3.2 Research strategy

There are two broad categories of social research; quantitative and qualitative research. Silverman (1993) argues that an attempt to define the distinctiveness of the two is problematic.

3.2.1 Qualitative paradigm

Bryman (2008) asserts that qualitative research strategy emphasizes words rather than quantitative figures during data collection and analysis. The same argument is supported by Mugenda and Mugenda (1999) who point out that qualitative research includes designs, techniques and measures that do not produce discrete numerical data but rather produces words which are often grouped into categories. The same authors further argue that modes of inquiry in qualitative research strategy include; ethnography, educational critiques, case studies, participatory among others. Ankrah (2007) on the other hand indicates that qualitative research approach comprises methodologies such as case studies, action research, grounded theory and ethnographies. Silverman (2006) points out that there are four main methods of carrying out qualitative research. These include; observation, textual analysis, interviews, audio and video recording. Qualitative methodologies are commonly explanatory or descriptive in nature with a general objective of answering *'how?'* and *'why?'* questions (Walker, 1997). Qualitative research also seeks to develop themes from collected data (Creswell, 2003).

The main aim of qualitative objectives is to gain insights on people's ideas towards various issues (Badawiyeh, 2010). In such a method views, understandings and opinions are gathered and investigated. Qualitative research strategy aims at discovering the underlying motives and desires, using in depth interviews for the purpose (Kothari, 2012).

3.2.2 Quantitative paradigm

According to Walker (1997), quantitative research approach seeks to address questions such as '*how much'* or '*how many*?' and provides a strong basis for explaining phenomenon. Ankrah (2007) asserts that this kind of research strategy enables a researcher to identify variables which are significant and to what extent, in a scientific manner. It also allows explanatory assertions and inferences to be made regarding the sample and population at large. Three approaches are commonly employed in

undertaking quantitative research; experimentation, desk research and surveys (Ankrah, 2007). Bryman (1988) points out that there are five main methods of carrying out quantitative research (Silverman, 2006). These include; social survey, experiments, official statistics, structured observation and content analysis. This research adopts survey approach through questionnaire administration to target respondents. Random sampling is used in quantitative research to ensure the sample is representative (Mugenda & Mugenda, 1999).

3.2.3 Adopted Research Strategy

In this study, the researcher stated the problem and formulated research objectives and questions. The researcher then defined the target population, selected the research site, collected and analyzed data and presented the results, giving conclusions and recommendations. While the same procedure could be followed in both quantitative and qualitative researches, difference is seen in techniques of data collection, type of data collected, methods of data analysis and interpretation of the results (Mugenda & Mugenda, 1999).

This research is quantitative because of the following reasons: (i) the method of data collection used was survey, (ii) data collected was mainly analyzed statistically, (iii) it addresses questions such as '*how many*?, (iv) provides a strong basis for explaining phenomenon, (v) identifies variables which are significant, (vi) random sampling was used to identify the respondents, (vii) based on meanings derived from numbers.

This research is qualitative because of the following reasons: (i) part of data collected was in form of words (ii) data collected was partly analyzed qualitatively (textual analysis), (iii) it addresses questions such as '*why*? (iv) seeks to develop themes from collected data.

While this research has aspects of quantitative research strategy during data analysis, qualitative research strategy is prevalent as the main aim of the research was to establish motives and respondents attitude towards the subject matter of the research.

3.3 Research Design

Based on the above elaborate description given by Kombo and Tromp (2006); Sekaran (1992), Cooper and Schindler (2006), and Kothari (2004), this research adopts a descriptive study design.

However, based on the argument raised by Bryman (2004), Bryman and Bell (2007), Creswell (2009), and Spector (1981), this study can also be classified as a survey research design, because both qualitative and quantitative data were collected on several variables during the same time. Survey research comprises a cross-sectional design in relation to which data are collected predominantly by questionnaire or by structured interview and at a single point in time with the aim of collecting a body of quantitative or quantifiable data in connection with the variables, which are then examined to detect patterns of relationship or association (Bryman, 2008). Broadhurst, Holt and Doherty (2012) indicate that methods used to collect data in a survey research include questionnaire, interview (structured or loosely structured), observation, analysis of documents and unobtrusive methods. The researcher used questionnaires to seek the opinions and actual information from the target population. Data obtained was both quantitative and qualitative and was analyzed qualitatively and quantitatively where applicable.

3.3.1 Research site

The research site for the proposed study was Nairobi County. This formed the basis for establishing the target population. The research was confined to building contractors registered under categories NCA1 to NCA3 in this geographical scope. This is due to limitations in terms of time and financial resources. With so much construction activity

within Nairobi, the results obtained in this study can easily be deduced to give a true reflection of the situation as it is in the entire country.

3.3.2 Target Population

The National Construction Authority has created a register for all contractors engaging in construction works in the entire country. There are mainly five classes of works namely; Building works, Road works, Water works, Mechanical Engineering works and Electrical Engineering works. The contractors engaging in all these works have been grouped into categories NCA1 to NCA8 depending on sizes of projects they can handle based on their financial capability. The target population in this study comprised of all contractors in categories NCA1 to NCA3 operating within Nairobi County. Two reasons were used to arrive at this target population. First, inclusion of all classes of contractors would consume a lot of time and resources which are limited in this research. Secondly, most of the contractors in the lower classes handle small projects which may not require structured resource planning and leveling.

According to the NCA register accessed on 26th August 2016 via *http://www.nca.go.ke/index.php/k2/contractors-center/search*, there are 3,622 contractors enlisted for all categories, for all classes of works and operating within Nairobi region. Out of these, 689 have been registered under building works class. The total number of contractors in categories NCA1 to NCA3 is 145. The target population therefore was established to be 145 contractors.

3.4 Sampling

Probability (random) sampling was adopted for this study. According to Israel (1992) a probability sample is one where each element of the entire population has a known probability of selection and which is not zero. A random sample allows a known probability that each elementary unit will be chosen (Fridah, 2002). The main advantage

of probability sampling is the researcher's ability to determine specific bias and error in relation to the collected data (Latham, 2007).

The method of random sampling chosen for this study was simple random sampling. The following measures were taken to ensure there was no bias; all of the units were listed in a manner that made it easy to identify them orderly (numbers were assigned to them), all units to be studied were represented, each unit was represented once and no unit from outside was included in the list. After numbers were assigned to the units, they were written on pieces of papers of equal sizes, after which they were folded and put in a rotating drum. A different person was then used to pick a number of pieces equivalent to the sample size of the study.

3.4.1 Sampling Frame

A sampling frame is a list of all population from which the sample can be drawn (Nyaguthii & Oyugi, 2013). A sample frame could be seen as a means of representing elements of the population. It refers to the source of the population. A perfect sampling frame is one in which every element of the population is represented once but only once. In this research, the sampling frame comprised of all NCA1 to NCA3 building contractors operating within Nairobi. Random sampling method was used to select the respondents.

3.4.2 Sample Size

A suitable sample size was determined using the following formula extracted from Ankrah (2007) and originally postulated by Czaja and Blair (1996). The same formula has also been adopted by Mugenda and Mugenda (1999). This formula is applicable when the population ranges from 10,000 to infinity.

Equation 3.1: Sample size formula for infinite population

$$N = \frac{z^2 x\, p(1-p)}{c^2}$$

Where:

N = sample size

z = standardized variable (standard normal deviate usually set at 1.96 which corresponds to 95% confidence level)

p = percentage picking a choice, expressed as a decimal (Proportion of the target population estimated to have a particular characteristic. If there is no reasonable estimate, 50% or 0.5 is used.)

1- p = proportion of the target population not having the particular characteristics.

c = confidence interval, expressed as a decimal (degree of accuracy required, usually set at 0.05)

According to Ankrah (2007), most researchers commonly adopt a confidence level of 95%. The same was adopted for this research. This means that the significance level of $\alpha = 0.05$ and $z = 1.96$. There is always the need to strike a balance between level of precision required, resource availability and reliability of the findings (Israel, 1992). It is for this reason that a confidence interval (c) of ±10% was assumed. According to Czaja and Blair (1996), when determining the sample size for any given level of accuracy, the worst case percentage picking a choice (p) should be assumed; this is given as 50% or 0.5. The sample size was then determined based on these assumptions.

Therefore;

$$N = \frac{1.96^2 \text{x } 0.5(1 - 0.5)}{0.05^2}$$

$$N = 384$$

The above sample size is for infinite population and therefore there is always need to correct the figure based on the actual size of the population. Adopting the formula proposed by Ayoub and McCeun (2000) and cited in Ibrahim (2014), correction for finite population ought to be:

Equation 3.2: Sample size formula for finite population

$$n = \frac{N}{1 + \frac{N-1}{Pop}}$$

Where;

n = New sample size

N = sample size = 384

Pop = population size = 145 (NCA 1 - NCA 3 contractors based within Nairobi)

Therefore;

$$New\ n = \frac{384}{1 + \frac{384-1}{145}}$$

$$New\ n = 105\ contractors$$

A formula cited in Kass (2012) shows that a sample size can be calculated using the following equation for 95% confidence level.

Equation 3.3: Sample size formula

$$n = \frac{n'}{1 + (n'/N)}$$

Where:

n = sample size from finite population

n' = sample size from infinite population = S^2/V^2; where S^2 is the variance of the population elements and V is a standard error of sampling population. (Usually S = 0.5 and V = 0.06)

N = total number of the population

Therefore;

$$n = \frac{n'}{1 + (n'/N)}$$

$$n' = \frac{S^2}{V^2}$$

$$n' = \frac{0.5^2}{0.06^2}$$

$$n' = 69.44$$

$$n = \frac{69.44}{1 + (69.44/145)}$$

$$n = 47\ contractors$$

Yamane (1967) provides a simplified formula which can be used in calculating the sample size (Israel, 1992);

Equation 3.4: Sample size calculation formula

$$n = \frac{N}{1 + N(e)^2}$$

Where;

(n) is the sample size,

(N) is the population size and

(e) is the level of precision (confidence level, usually set at 0.05)

Therefore;

$$n = \frac{145}{1 + 145(0.05)^2}$$

$$n = 106\ contractors$$

Having compared the three sample sizes provided by the three different formulae, a sample size of 106 contractors was arrived at. This is because two of the formulae produced sample sizes with a difference of a single unit (105 and 106). The sample size provided by the formula cited in Kass (2012) was significantly different from the rest and was also considered to be too low to be a representative of the entire population. The respondents were selected randomly as earlier described herein.

3.5 Data Collection Instruments

A letter of introduction was obtained from Jomo Kenyatta University of Agriculture and Technology and given to respondents from different sites which were visited. The data was collected using administration of questionnaires.

3.5.1 Questionnaires

These were used to obtain primary data. Both open ended and close ended questions were used in the questionnaires. Close ended questionnaires are simple for the respondents, provide data which can easily be analyzed and are economical in terms of time and money (Mugenda & Mugenda, 1999). Open ended questions were used in instances where more elaborate details were necessary. These questions are used to give an insight into the feelings of the respondent, hidden motivation, background, interests and decisions (Mugenda & Mugenda, 1999). The questionnaires were designed using simple English with the aim of ensuring the respondents do not give incorrect responses due to failure to understand the content of the questionnaires.

The questionnaire was structured in four sections namely Section A, Section B, Section C and section D. The first section sought to collect demographic data regarding the respondents and their firms. Such data included; respondent's role in the project, educational specialization, management level within the organization, experience (years) in practice, type of projects currently undertaking, personnel capacity of the firm and the NCA category.

Section B and C cover resource planning and leveling respectively. The extent of carrying out resource planning and levelling together with the factors affecting the same was covered in these sections. It is also in these sections where the challenges, barriers and benefits associated with resource leveling have been covered. A rating scale was used in these questions to measure the perception, values, attitude and behaviour of the respondents. This scale was numerical and thus helped minimize subjectivity while making it possible to use quantitative analysis in these sections. The questions were designed on a likert scale of 1 to 5 indicating the presence or absence of the attribute being measured. The scale also measures the level of significance of various characteristics. The introductory questions in Section C (1, 2 and 3) were used to gauge whether the respondent had understood the concepts of resource planning and leveling. The researcher would relate the responses given in these questions and those given in some of the other questions with the aim of validating the findings.

Section D sought the opinions of the contractors and their representatives regarding the practice of resource planning and leveling and their effects on construction project performance. Two open-ended questions were provided in the last section to allow the respondents express their views regarding the possible methods which can be used to overcome the challenges of resource planning and leveling and also explain how resource leveling can or cannot contribute to project success. This data would be analysed qualitatively as opposed to all other previous questions which were close-ended and which were to be analysed quantitatively.

3.6 Measurement of Variables

According to Field (2000), there are four types of scale that can be used to measure any kind of data. These include; nominal, ordinal, interval and ratio. Under nominal scale, numbers are used to specify categories or types of things (Griffith, 2010). All the data obtained in Section A of the questionnaire was of nominal scale. A few questions in Section B were also categorised under nominal measure. Field, (2000) asserts the only permissible statistics for this kind of data is mode and chi-square data analysis.

In ordinal scale, numbers are used to specify the position (in terms of order) of something in a list (Griffith, 2010). Majority of the questions in the questionnaire produced data of ordinal measure. Numbers 1,2,3,4 and 5 were used to indicate the presence or absence of the attribute being measured.

The Relative Importance Index (RII) was used to determine: the level of extent to which contractors practise resource planning; level of importance of various aims of undertaking resource planning and leveling; level of extent of influencing factors of resource planning; level of extent of practising resource leveling; level of extent usage of various resource leveling techniques; level of effectiveness of resource leveling techniques; level of significance of challenges and benefits associated with resources planning and leveling; and the level of extent to which resource planning and leveling affects project performance.

The following formula as cited from Iyer & Jha (2005) was used to calculate the Relative Importance Index (RII);

Equation 3.5: Relative Importance Index Calculation

$$RII = \frac{\Sigma W}{A \; x \; N}$$

Where,

W is the *weighting given to each statement by the respondents and ranges from* 1 *to* 5;

A is *Highest response (integer* 5); *and*

N is the *total number of respondents.*

3.7 Data Collection Procedure

The researcher distributed the questionnaires to respective respondents with the help of assistants. The purpose of personally administering questionnaires to respondents was to establish rapport with the respondents while introducing the research, providing any clarifications sought by respondents and collecting the questionnaires soon after they were completed (Juma, 2015).

An appendix was provided to the questionnaire explaining all the terminologies which were deemed technical. It is also important to note that majority of the questionnaires were administered by the researcher personally. This helped ensure that any questions regarding the technical terms were addressed by the researcher himself. As for the questionnaires delivered by the research assistants, the researcher's contacts were provided in the letter of introduction. This allowed the respondents to reach out to the researcher for any clarifications regarding the questions.

It is also worth noting that the researcher gauged the technical and academic competence in deciding the choice of the respondent. This means that for any contracting firm identified as a unit of observation in the research, the researcher sought to get the most possible qualified person to fill out the questionnaire. Since the research had been limited to contractors within categories NCA 1 to NCA 3, it was not hard to get those particular people within the firms to respond to the questionnaire.

3.8 Pilot Study/Pre-testing of Questionnaire

Mugenda and Mugenda (1999) argue that once a questionnaire has been formulated, it should be tried out in the field before the actual administration. Naoum (2007) agrees and further states that a pilot study provides a trial run for the questionnaire, which involves testing the wording of the questions, testing the technique to be used for data collection and measuring the effectiveness of the method of reaching the respondents. A pilot study ensures zero difficulties for respondents in completing the questionnaire during the main study by ensuring the wording and format of questions is easily understood (Bell, 1996). The sample chosen for the pretesting exercise was similar to the actual sample. Comments made and which were deemed necessary were hence incorporated in the questionnaire for the main study.

3.9 Data Analysis

According to Polit and Hungler (1997), data analysis could be described as organizing, providing structure and elicit meaning to collected data. Data analysis for this research involved checking the data for erroneous entries which were corrected. Coding was then carried out where the various responses were given certain values and then grouping was done. Data entry then followed. Data was converted for viewing and analyzing using tables and graphs. Data was analyzed using both quantitative and qualitative techniques.

In summary, data analysis exercise was carried out in the following sequence: data collection, data categorization, data summarization, describing and classifying of the data and interpretation thereof. The data was then presented in the form of a research report based on tables, graphs and statistical reports.

3.9.1 Quantitative Data Analysis

Quantitative data was analyzed using the Statistical Package for Social Scientists (SPSS v.21). This is computer based statistical analysis software which is capable of analyzing

quantitative data. IBM SPSS Statistics is a piece of software that takes in raw data and combines them into new statistics that can be used as predictors (Griffith, 2010). To avoid instances where the software generates incorrect analysis, the researcher ensured that the correct data was fed into the system.

3.9.1.1 Descriptive statistics

Descriptive statistics according to Naoum (2007), is the simplest method of analysis and it provides a general overview of the obtained results. Descriptive analysis comprises of (i) measures of distribution i.e. percentages and frequencies, (ii) measures of central tendencies i.e. mean, mode and median, and (iii) measures of variability i.e. standard deviation and variance (Mugenda & Mugenda, 1999). Since data from Section A was mainly nominal or categorical, descriptive statistics (frequencies and percentages) were mainly used to analyze data obtained from this section. There was also minimal use of descriptive statistics to analyse data from Sections B, C and D. Use of descriptive statistics enabled the researcher to thoroughly understand the nature of the data while providing the summary descriptions of the contractors under study. Geisler (2004) points out that descriptive statistics are not only useful on their own, but are also used as a basis for making inferences about a population based on data obtained from a sample of that population.

Over and above the descriptive statistics executed, and where appropriate, inferential statistics were carried out to establish more meaning from the data obtained. Inferential statistics were carried out for the following purposes: to enable the researcher to make infer values about the entire population based on data from the selected sample; produce new information by making predictions and generalizations based on the sample; and use obtained data to make estimates about the population from where the population came from.

3.9.1.2 Relative Importance Index Analysis

Data in sections B and C consisted of a mixture of nominal and ordinal scales and thus a number of statistical procedures were employed in the analyses of the data beginning with basic descriptive statistics to more complex procedures such as the Relative Importance Index (RII) and analysis of correlations between the variables. The main aim of carrying out Relative Importance Index (RII) was to calculate the significance of the findings by determining the weights of each of the attributes. It was thus used to evaluate variables such as Aims of undertaking Resource Planning and Leveling; Factors influencing Resource Planning; Challenges of Resource Planning and Leveling; and finally benefits associated with Resource Planning and Leveling.

3.9.1.3 Spearman's Correlation Analysis

Analysis of correlations was carried out to establish and review the strength of possible relationships between variables. Since the data was mainly ordinal, the non-parametric Spearman's correlation coefficient was used to measure the strength of such relationships instead of the Pearson's product moment correlation coefficients which is appropriate when both variables have measured at an interval level (Ankrah, 2007). Variables can either be positively related, negatively related or not related at all. According to Field (2009) , the correlation coefficient (r) falls between –1 and +1. Ankrah (2007) asserts that when the coefficient is close to +1 or -1, the variables have an almost perfect linear relationship. Kombo and Tromp (2006) agree with this assertation by saying that the correlation coefficient is a number ranging from 1 (which creates a perfect positive relationship) through 0 (no exising relationship between the variables) to -1 (which creates a perfect negative relationship). However, according to the same author, there is little or no correlation when the coeffiecient is close to zero. Weir, (2003) further gives more details on interpretation of spearmans correlation coefficient values: 0.0-0.19, "very weak"; 0.20-0.39, "weak"; 0.40-0.59, "moderate"; 0.60-0.79, "strong"; 0.80-1.0, "very strong".

3.9.1.4 Multiple regression

Multiple regression is the process of deriving a regression model with two or more independent variables usually known as predictors (Ankrah, 2007). It enables a researcher to study the effects and their magnitude of these independent variables on a dependent variable. The coefficients in the model signify the various weights of the independent variables to the overall prediction (Hair, *et al*, 1998).

According to Field (2000), there are three main methods used to determine which independent variables to be included in the regression model. These are; hierarchical, forced entry, and stepwise methods. Hierarchical regression relies on past research in determining predictors which are then entered into the model depending on their importance. New predictors can only be entered after these known variables are already in the model (Field, 2009). This method could not be relied upon in this research due to lack of strong empirical evidence ranking such predictors. In the second method, all perceived predictors are forced into the model. The stepwise method relies on a mathematical criterion. Predictors are entered into the model based on whether they their significance in an F-test is ≤ 0.05 (Field, 2009). This research used both forceful entry and stepwise methods. Results for the F-test are shown in Appendix 6.

3.9.2 Qualitative Data analysis

According to Schutt and Chambliss (2013), the "text" that qualitative researchers analyze is most often transcripts of interviews or notes from participant observation sessions, but text can also refer to pictures or other images that the researcher examines. Since the qualitative data are text-based, the corner stone of analyzing these data is the coding process (Hilal & Alabri, 2013). A code represents a certain phenomenon (Mugenda & Mugenda, 1999). However according to Kombo and Tromp (2006), qualitative data can also be analysed thematically. This method of data analysis involves categorising data into related topics. It is from such categories that themes are identified and discussed.

Qualitative data was only found in the last section of the questionnaire where the respondents were required to suggest possible methods which could be used to overcome the challenges associated with Resource Planning and Leveling. Respondents were also asked to give an opinion as to whether Resource Leveling was a contributor or hindrance to project success and explain why they held that view. Data obtained from this section was read thoroughly to enable the researcher familiarize with the information. The researcher perused through data obtained from these questions again and identified information which was relevant to the research objectives. Major topics covered were then classified by establishing patterns.

3.10 Data Presentation

3.10.1 Graphs

They are a form of visual display of data, showing the relationship between the various variables. Bar graphs were used to represent the analyzed data. The Dependent variable is usually on the X axis while the Independent variable is on the Y axis. Data obtained from Section A and some sections of Section B of the questionnaire was mainly presented in bar graphs and pie charts.

3.10.2 Tables

They were used to present figures obtained from the data and from the checklist. They provided data in a sequential form and were also used to represent data on the graphs.

3.11 Reliability of the Instrument

According to Drost (2011), reliability can be described as the extent to which measurements are capable of being repeated when different persons perform the same measurements, in different conditions and under different circumstances or occasions. Reliability can also be defined as the extent to which a test consistently measures whatever it is required to measure (Gay, 1987). Bollen (1989) sums it up by saying that reliability is the consistency of measurement. Since the main aim of this research was to

Table 3.1: Questionnaire Factor Categories Cronbach's Scores

S/N	Factor category	Cronbach's α	Reliability Status
1	Demographic data	0.522	Sufficient
2	Extent of resource planning in the firm	0.767	Good
3	Aims of undertaking resource planning and leveling	0.861	Good
4	Influencing factors of resource planning	0.795	Good
5	Effects of delayed materials, lack of labour and lack of equipment on project implementation	0.880	Good
6	Extent of resource leveling carried out in the firm	0.786	Good
7	Usage of various resource leveling techniques	0.712	Good
8	Effectiveness of various resource leveling techniques	0.765	Good
9	Challenges associated with resource planning and leveling	0.622	Sufficient
10	Benefits associated with resource planning and leveling	0.735	Good
11	Effect of resource planning and leveling on project performance	0.548	Sufficient

Source: Author, (2016)

gain a better and clear understanding of the situation, it was therefore necessary for the data presented in the research to be reliable. Assertions and inferences could then be comfortably made based on the data analyzed and generalized on the entire population.

In this research, in order to achieve reliability, questions presented in questionnaires were carefully designed to cover all research objectives and questions which had been formulated to address the problem adequately. Further, the respondents identified in every site were capable of answering the questions presented to them without difficulties.

This ensured the answers provided were reliable for data analysis. Furthermore, during any assistance to the respondents in answering the questionnaires, the researcher was neutral so as to allow respondents to express their answers freely.

In order to measure the reliability of the questionnaire, the researcher used the internal consistency test. According to Field (2009) and as cited in Hof (2012), the simplest method which can be used to measure the internal consistency of any questionnaire is by dividing the scores a participant received on a questionnaire in two sets with an equal amount of scores and calculating the correlation between these two sets. A high correlation would signal a high level of internal consistency. This study however used Cronbach's alpha (α) to tests its internal consistency. According to Ogwueleka (2011) and as cited by Ibrahim (2014) asserts that the minimum acceptable value for Cronbach’s alpha is from 0.5.

3.12 Validity of the Instrument

According to Drost (2011), validity is concerned with the meaningfulness of research components. It is the extent to which a test measures what it is supposed to measure. Mugenda and Mugenda (1999) assert that validity is the degree to which results obtained from the data analysis represent the phenomenon under study. Content validity is a measure of the extent to which a measuring instrument provides adequate coverage of the topic under study *(*Mucheru *et al*., 2013). Construct validity on the other hand is

the degree to which data obtained from the research instrument can meaningfully and accurately represent the theoretical concept (Mugenda & Mugenda, 1999). According to Borg and Gall (1985) and as cited in Mucheru *et al*. (2013), validity of a research instrument is improved through expert judgment.

To ensure content validity of the research instrument used, the researcher presented the questionnaire to five experts. These were; two contractors, two lecturers from Jomo Kenyatta University of Agriculture and Technology and a practising professional in construction project management. Given that the two academicians consulted were also practising in the Kenyan construction industry, the researcher obtained comments and input relevant to the proposed area of study. Remarks made by these experts together with those obtained from the pilot study were taken into consideration when making adjustments to the final questionnaire.

3.13 Ethical Considerations

According to Kombo and Tromp (2006), researchers whose subjects are people or animals must consider the conduct of their research, and give attention to the ethical issues associated with carrying out their research.

Regarding consent, the participants were informed about the nature of the study. All of the aspects of the research that were likely to affect their willingness to become participants were disclosed. This included the time the session was likely to take.

Confidentiality was treated with utmost regard. The author conformed to data protection guidelines, which meant that information obtained from any research participant was confidential (unless there was an agreement in advance that this was not to be the case). In this regard, the author took care to ensure data obtained from participants remained anonymous. To do this, the researcher avoided putting down any names (whether for the respondents or their companies) on the questionnaire sheets. It was also ensured that no subject knew the identity of any other subject.

3.14 Data collection constraints

A number of challenges were experienced by the researcher in the process of data collection. These included: unresponsive respondents and lack of academically competent personnel on some sites to respond to the questionnaire. These resulted in a reduced response rate for the questionnaire. However, the response rate did not fall below the required threshold.

CHAPTER FOUR

4.0 DATA ANALYSIS AND DISCUSSIONS

4.1 Introduction

This chapter covers data analysis and interpretation. The main objective of this chapter was to validate the earlier proposed conceptual model (Figure 2.12). Analysis and interpretation of data was based on literature review and the questionnaire survey. While the literature review was critical in identifying the variables which would then be subjected to the survey, the questionnaire survey covered information such demographic profiles of respondents and their firms, usage of resource planning, aims of undertaking resource planning, influencing factors of resource planning, usage of resource leveling, techniques applied in resource leveling and their effectiveness, challenges and benefits associated with resource planning and leveling, and the views of contractors regarding the influence of resource planning and leveling on project performance. In depth analysis was carried out on the data obtained from the survey to enable the researcher make valid conclusions and recommendations.

4.2 Response to Questionnaires

4.2.1 Respondents' Response Rates

Out of a total of 106 questionnaires distributed to respondents, only 81 were returned. This was equivalent to a response rate of 76%. The National Science Foundation (2011) argues that bias resulting from a low response rate is likely going to affect the quality of data gathered by any survey. This is because non-response may not be random. Fowler (2002) as cited in Saldivar (2012) stated that “there is no agreed-upon standard for a minimum acceptable response rate.” However according to Richardson (2005) and Babbie (1973) as cited by Nulty (2008), a response rate of 50% is deemed acceptable in social research postal surveys. Richardson (2005) asserts that generally, response rates

of 60% or more are not only desirable but also achievable. The response rate from this survey was deemed adequate to allow the researcher to carry out data analysis based on the received questionnaires. It would then be possible for the researcher to easily make inferences about the entire target population based on the responses obtained.

Since all the received questionnaires were adequately completed, all data contained therein was entered in the data analysis software (SPSS v21) and used for the process of data analysis.

4.2.2 Margin of Error

Inferential statistical analysis can only be undertaken on large samples of respondents (Ankrah, 2007). It is widely accepted that as a rule of thumb, any sample size greater than 30 (n > 30) should be considered as a large sample (Munn & Drever, 1990; Sutrisna, 2004). It is for this reason that the achieved sample size of 81 was deemed sufficient for purposes of inferential statistical analysis.

The margin of error is calculated using the following formula cited from Ankrah, (2007):

$$m = z\sqrt{\frac{p(1-p)}{n}}$$

Where: m = margin of error; z = standard random variable; p = estimated variance; n = sample size; For a significance level of $\alpha = 0.05$, $z = 1.96$.

According to Sutrisna, (2004) and as cited by Ankrah, (2007) maximum variance occurs when p = 5.

Based on these assumptions, the margin of error was computed as follows:

$$m = z\sqrt{\frac{p(1-p)}{n}}$$

$$m = 1.96\sqrt{\frac{0.5(1-0.5)}{81}}$$

$$m = 10.89\%$$

A margin of error based on z=1.96, p=0.5 and a sample size of 81 respondents was established to be 10.89%. This can be interpreted to mean that there is a 95% (since z=1.96) probability that results obtained from this survey lie within a ± 10.89% range.

4.2.2 Missing Values/Data Editing

In an attempt to ensure that the research produced minimal missing values the researcher ensured that questionnaires were administered to academically competent respondents who would adequately respond to the questions. In spite of such measures being taken by the researcher, there was still some missing data in the questionnaires received from respondents. However this is not unique to this survey as Crafford (2007) argues that missing values in questionnaires are inevitable. Cases with missing values pose a big challenge because typical modeling procedures in SPSS simply discard these cases from the analysis (IBM, 2014).

Though it was the opinion of the researcher that the responses from this survey produced negligible missing values the researcher spent time in ascertaining the severity of the missing values using SPSS software. The SPSS v.21 Missing Values Analysis option was used to ascertain the nature of patterns of missing data. The results have been presented as Appendix 5 (Missing Values Analysis). According to IBM (2014), when there are only a few cases (less than 5%) of missing values which are not random then results and inferences from the analysis are not compromised.

There are several alternatives which can be used to replace the missing values but substitution with the mean is the most common (Xiao, 2002). Hair *et al.* (1998) agree that it is best single replacement value. In instances where a variable doesn't have

missing values to the tune of 50% and more, such variable should not be excluded from data analysis. Results from analysis of missing values showed that of all the variables, the highest recorded percentage of missing data was 12.3%. It is for this reason that the researcher saw no need to replace them with the mean of the valid responses.

4.3 Demographic Profiles of Respondents and their Firms

4.3.1 Role of the Respondent in the Firm

Different professionals are hired by contracting firms depending on the nature of the activities carried out by the firm. For example, contractor doing a design and build project will require a wide range of services from different professionals ranging from architects (to produce the architectural drawings) , civil/structural engineers (to produce the structural drawings), quantity surveyors (to produce the bills of quantities), Construction Managers (to supervise the construction works), services engineer (to produce the mechanical, electrical and other drawings). Majority of these professionals are hired and kept in contractors' offices to offer services based on their specialty. Other personnel hired by contractors include site engineers, site agents, and foremen among others. These are mainly kept on sites to monitor and supervise the progress of construction work.

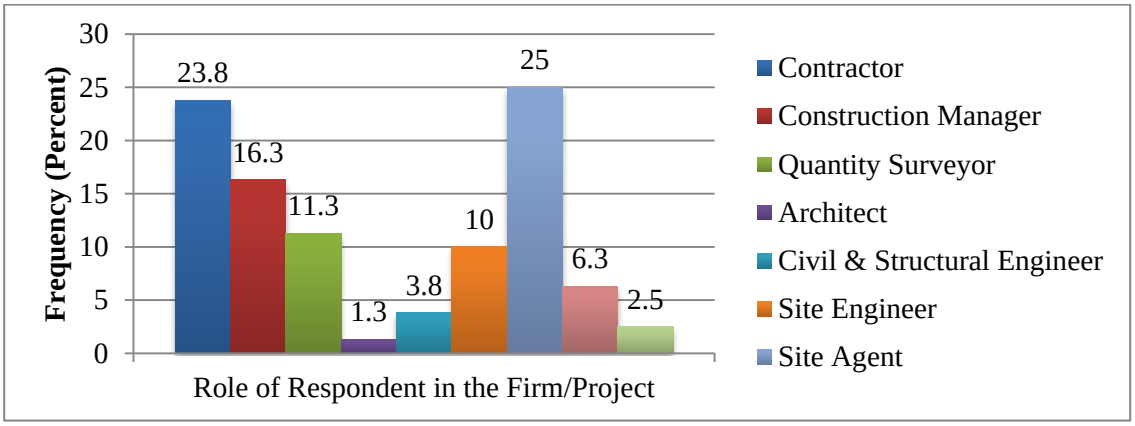

Figure 4.1: Role of Respondent in the Firm/Project

Source: (Author, 2016)

The figure above (4.1) indicates that the highest percentage (24.7%) of respondents were Site Agents while the lowest were Architects with a representation of 1.2%. The category of "Others" produced a variety of options including; a Cost Engineer, a Quality Assurance Analyst, a Surveyor, a Project Manager, and an Intern. These professionals were all working under the contractor.

4.3.2 Respondent's Educational Specialization

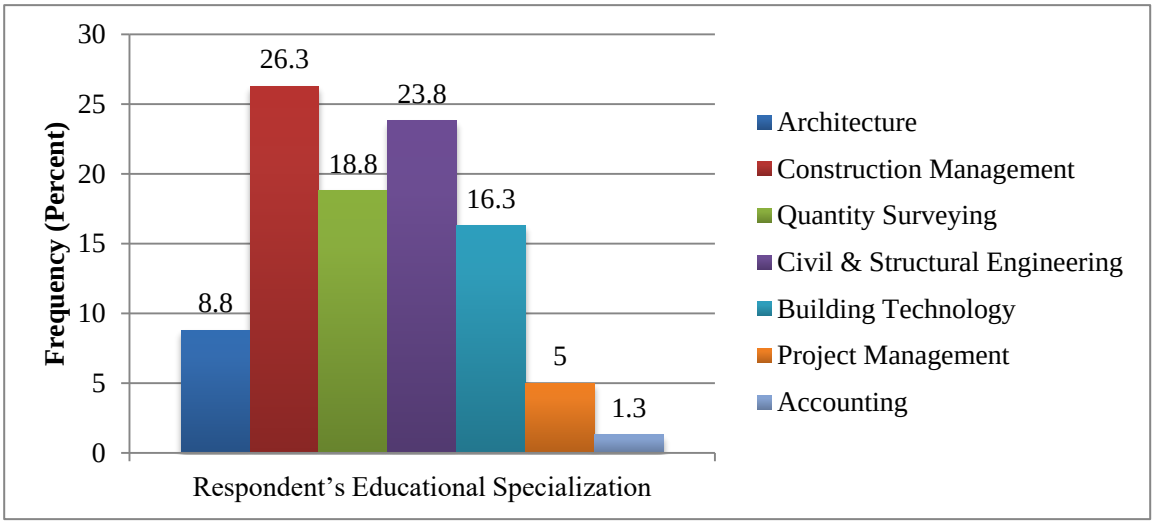

Figure 4.2: Respondent's Educational Specialization

Source: (Author, 2016)

Results shown in figure 4.2 indicated that Construction Management (25.9%) was the most popular academic background among the respondents while Accounting was the least popular (1.2%). Other educational specializations were represented as follows: Civil/Structural Engineering, 23.5%; Quantity Survey, 18.5%; Building Technology, 16%; Architecture, 8.6%; and Project Management, 4.9%. Contractors employ individuals with a background in Construction Management to be their eyes on the ground since such professionals have been trained in such a way that they can understand the language of Architects, Civil/Structural Engineers, Quantity Surveyors, and Services Engineers among others. While majority of contractors employ Accountants to offer their services in financial management, a low frequency was due to

the fact that the researcher preferred to engage respondents with a background in construction related courses as this would be easier for them to answer the questions presented to them.

4.3.3 Respondent's Management Level

The graph below illustrates the frequencies of the different levels of management currently held by the respondents in the contracting firms.

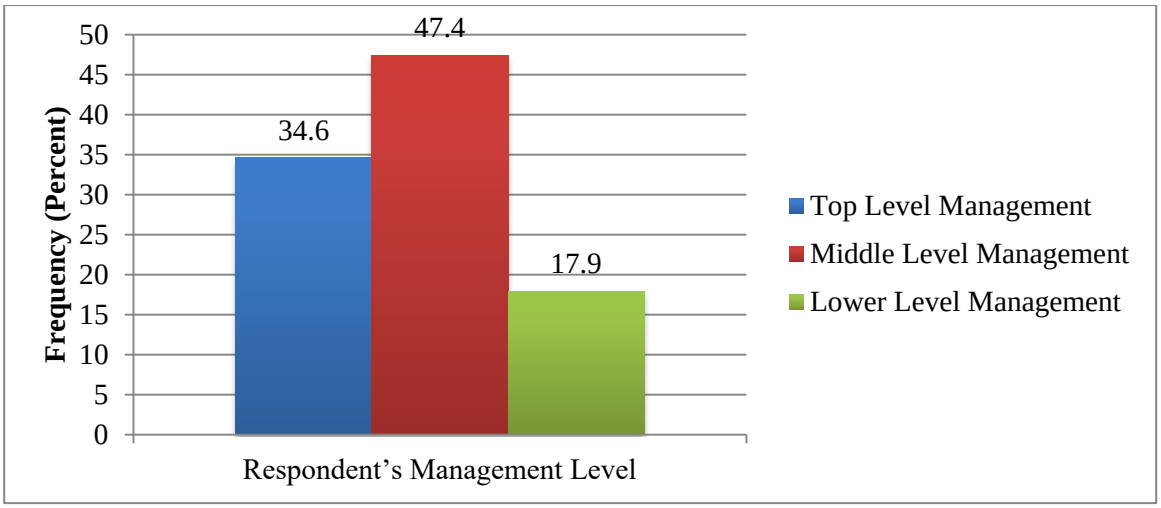

Figure 4.3: Respondent's Management Level

Source: (Author, 2016)

Majority (47.4%) of the respondents engaged in this survey indicated that they were in middle level management (as seen in figure 4.3). Those in top level management formed 34.6% of the respondents while those in low level management were 17.9%. Most of those who were in top level management had indicated that they were serving as "contractors" in the first question of the questionnaire which required them to indicate their role in the firm or project.

4.3.4 Type of Project

The graph below (figure 4.4) illustrates the frequencies of the different types of projects being executed by the contractors.

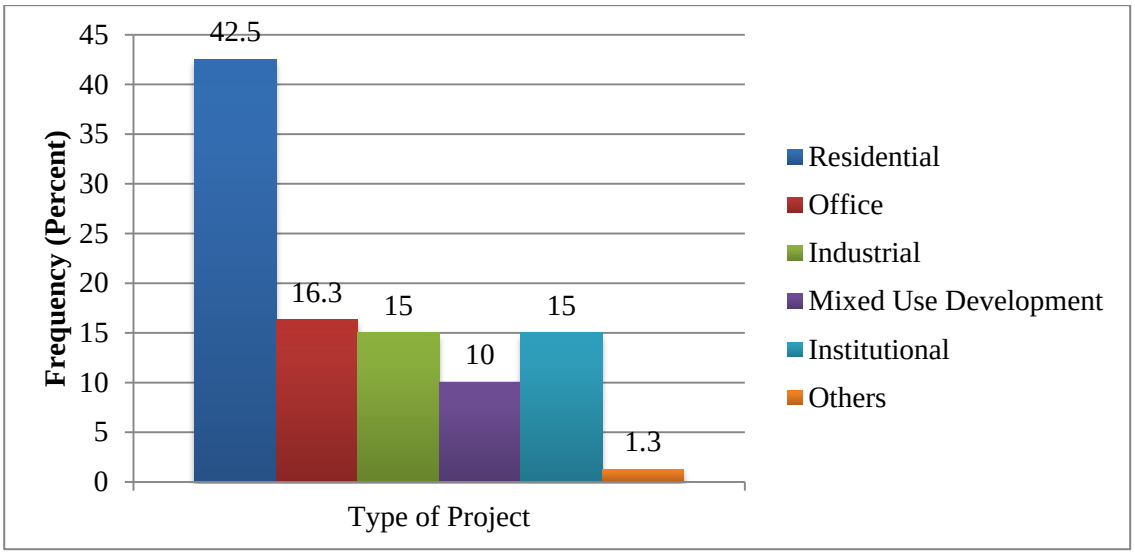

Figure 4.4: Type of Project

Source: (Author, 2016)

Contractors registered with the NCA in the class of Building works are allowed to undertake various projects such as Residential blocks, Office blocks, Industrial, Mixed Used Development, and Institutional among others. Results from the survey indicated that majority of the projects being undertaken by contractors were residential (42%). Office blocks had a frequency of 16% while both Industrial and Institutional had a frequency of 14.8%. Mixed use Developments and "Others" were least popular with frequencies of 9.9% and 1.2% respectively.

4.3.5 Age of the Firm

The table 4.1 below illustrates the frequencies of the periods for which the respondents' firms have been operating as contractors in the Kenyan construction industry.

The table shows that majority (60.1%) of the firms engaged in this survey have been operating in the Kenyan construction industry for a period of more than 6 years. When compared between the "local" and "foreign" contractors, a big proportion of those who were in the industry for less than 6 years were classified as "foreign".

Table 4.1: Age of the Firm

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**Up to 5 years**	32	39.5	40.0	40.0
	6 - 10 years	22	27.2	27.5	67.5
	11 - 15 years	9	11.1	11.3	78.8
	16 - 20 years	4	4.9	5.0	83.8
	More than 20 years	13	16.0	16.3	100.0
	Total	80	98.8	100.0	
Missing	**System**	1	1.2		
Total		81	100.0		

Source: (Author, 2016)

4.3.6 Number of full time staff

The graph below illustrates the frequencies of the number of full time staff engaged by contractors in their firms and projects.

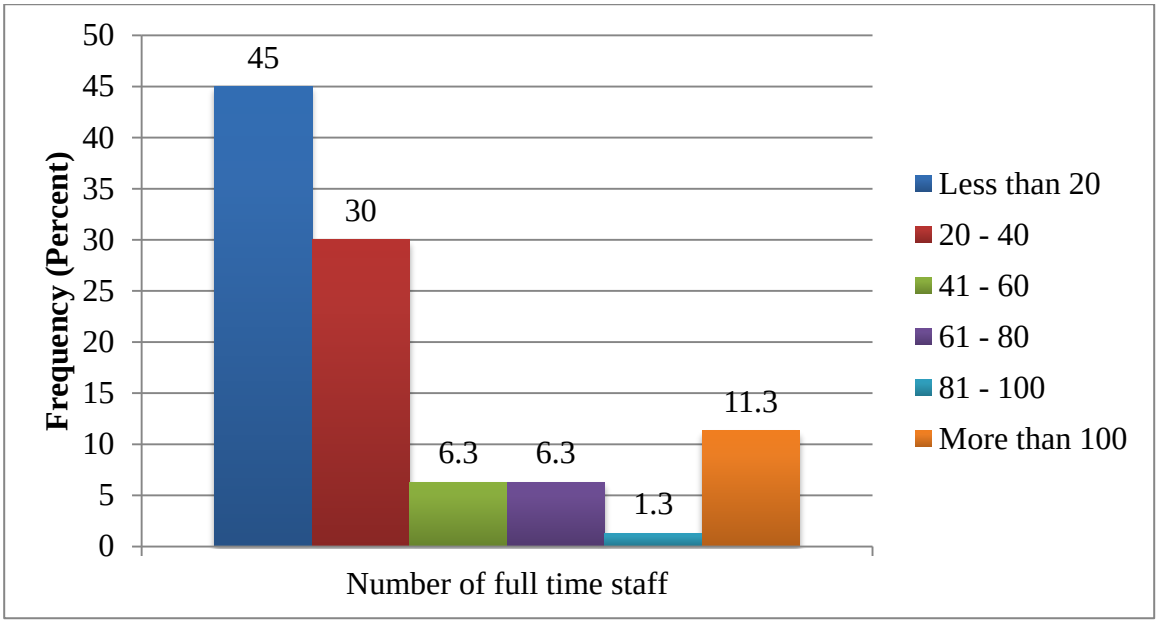

Figure 4.5: Number of full time staff

Source: (Author, 2016)

This study established that in majority (45%) of the contracting firms, the number of full time staff is less than 20. Other results were: 20-40 full time staff, 30%; more than 100 full time staff, 11.1%; 41-60 full time staff, 6.3%; 61-80 full time staff, 6.3% and 81-100 full time staff, 1.3%. This means that more than 74% of the contractors engaged in this study maintain a permanent workforce of less than 40 employees. It is clear from these results that majority of contractors maintain a lean permanent workforce. Labour is one of the most critical resources required in any construction project. The concept of resource leveling advocates for maintaining the lowest possible amount of resources in contractors' workplaces. While this will be confirmed or contradicted later in this study, but there seems to be signs of possible application of resource leveling concept.

4.3.7 Category of Firm

Construction projects of big magnitudes (over half a billion shillings) usually attract interest from not only local but also foreign contractors.

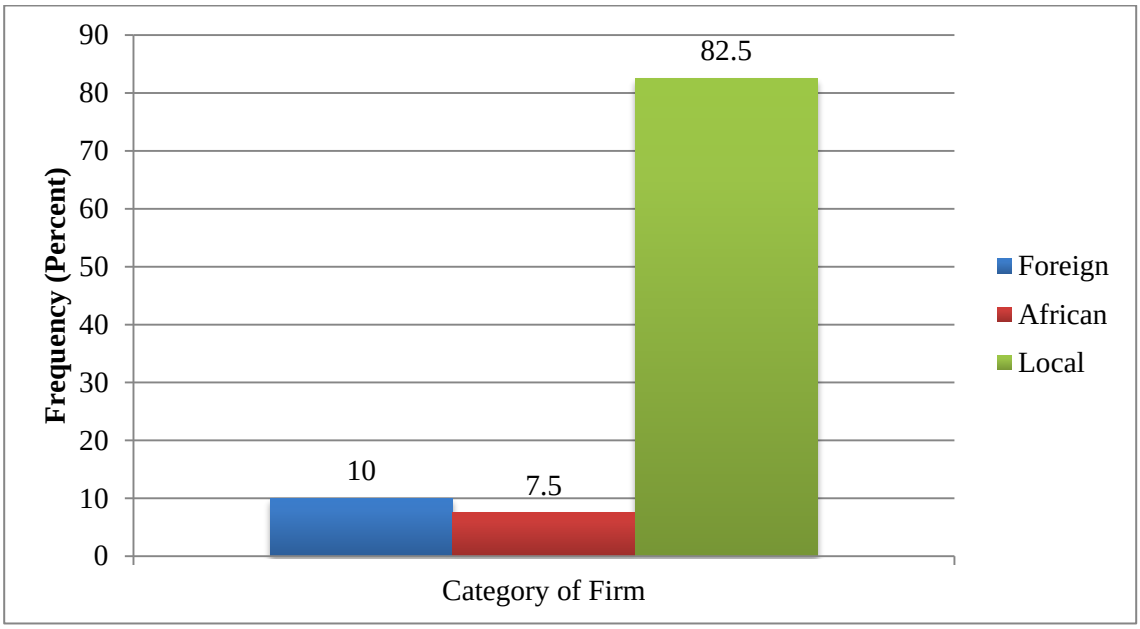

Figure 4.6: Category of Firm

Source: (Author, 2016)

Results indicated that Local contractors had the highest frequency of 81.5% followed by Foreign contractors with a frequency of 9.9% and the African contractors with a frequency of 7.4%. The construction industry is mainly composed of local firms. An exceptionally high frequency for Local contractors meant that the results of this study would comfortably reflect the views and position of local firms regarding resource planning and leveling.

4.3.8 NCA category

Results shown in figure 4.7 indicated that NCA 3 were the most popular (55%) among the respondents. NCA 1 and NCA 2 had frequencies of 30% and 15% respectively. All these contractors have the capability to execute projects worth more than three hundred million (300,000,000) shillings. This means that the projects they undertake involve resource planning and leveling complexities and hence were best suited to provide the researcher with the required data.

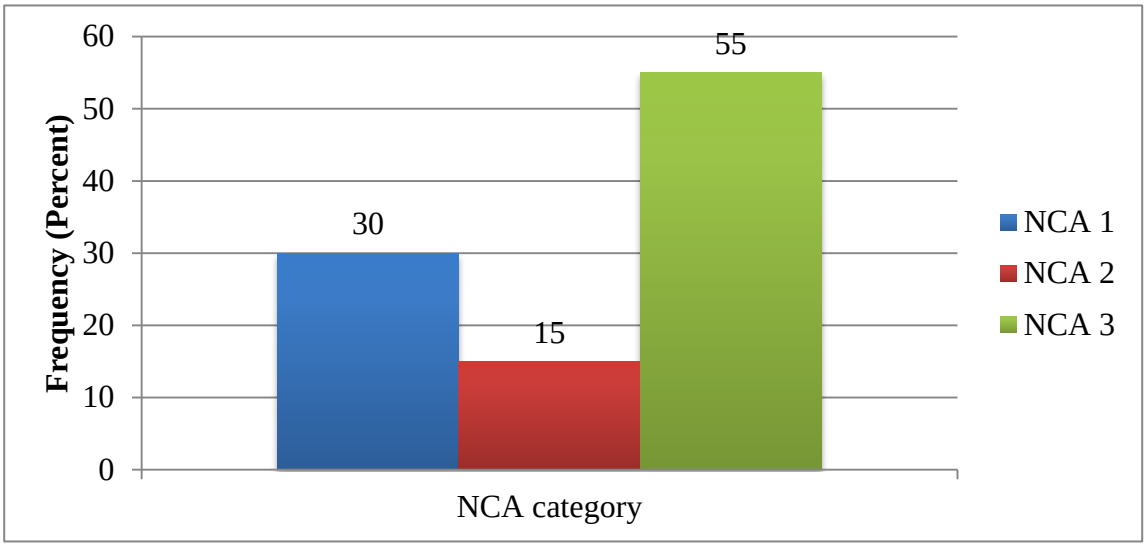

Figure 4.7: NCA category

Source: (Author, 2016)

4.4 Data Analyses for the Study Objectives

4.4.1 Objective 1: The practice of RP&L among contractors

A number of questions were included in the questionnaire to explore the practice of resource planning and leveling among contractors. These included: the extent to which they carry out resource planning and leveling; the kind of resource planning and leveling carried out by the contractors; extent of support by top management in executing resource planning; the person bestowed with the responsibility of carrying out resource planning, educational background of such person and their academic qualification; aims of undertaking resource planning and leveling; effect of delayed materials, lack of labour and equipment on project progress.

4.4.1.1 Extent of Equipment Planning

From the table 4.2 below, when respondents were asked to rate the extent to which they carry out Equipment Resource Planning, 2.6% responded "None", 11.5%, "Low", 29.5%, "Moderate", 29.5%, "High", and 26.9%, "Very High". These responses produced a mean of 3.67 as indicated in table 4.6. It is clear from this that majority of contractors in the country practice Resource Planning in the Equipment category.

Table 4.2: Extent of Equipment Planning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**None**	2	2.5	2.6	2.6
	Low	9	11.1	11.5	14.1
	Moderate	23	28.4	29.5	43.6
	High	23	28.4	29.5	73.1
	Very High	21	25.9	26.9	100.0
	Total	78	96.3	100.0	
Missing	**System**	3	3.7		
Total		81	100.0		

Source: (Author, 2016)

The cost of equipment in most building projects ranges between 20-30% of the total project cost. Kumari & Vikranth, (2012) point out that the equipment cost has to be controlled properly by allocating various items of equipment efficiently in different phases of the project. It is wise to consider the productivity of each equipment before procurement of such (Kumari & Vikranth, 2012). Kass (2012) asserts that equipment planning is necessitated by the need to establish the size and various types of equipment needed either on rent or outright purchase.

4.4.1.2 Extent of Labour Planning

From the table 4.3 below, when respondents were asked to rate the extent to which they carry out Labour Resource Planning, 5.1% responded "Low", 21.8%, "Moderate", 47.4%, "High", and 25.6%, "Very High". These responses produced a mean of 3.94 as indicated in table 4.6. It is clear from this that majority of contractors in the country practice Labour Resource Planning.

Table 4.3: Extent of Labor Planning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**Low**	4	4.9	5.1	5.1
	Moderate	17	21.0	21.8	26.9
	High	37	45.7	47.4	74.4
	Very High	20	24.7	25.6	100.0
	Total	78	96.3	100.0	
Missing	**System**	3	3.7		
Total		81	100.0		

Source: (Author, 2016)

Labour planning helps the organization maintain the right number of employees at the right time with the capability to execute tasks which are aimed at ensuring success of the project. Labour accounts for approximately up to 40% of construction cost in large projects and thus there is need to maximize labour productivity (Thomas *et al*, 2004)

4.4.1.3 Extent of Material Planning

From the table 4.4 below, when respondents were asked to rate the extent to which they carry out Material Resource Planning, 1.3% responded "None", 20.5%, "Moderate", 30.8%, "High", and 47.4%, "Very High". These responses produced a mean of 4.23 as indicated in table 4.6. It is clear from this that majority of contractors in the country practice Material Resource Planning.

Table 4.4: Extent of Materials Planning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**None**	1	1.2	1.3	1.3
	Moderate	16	19.8	20.5	21.8
	High	24	29.6	30.8	52.6
	Very High	37	45.7	47.4	100.0
	Total	78	96.3	100.0	
Missing	**System**	3	3.7		
Total		81	100.0		

Source: (Author, 2016)

The cost of materials in most building projects ranges between 60-70% of the total project cost. A study by Stukhart (1995) argues that the cost of installed materials is more than 50% of the total project cost. According to Kumari & Vikranth, (2012), material planning is necessary to fulfil the requirements of the project at different phases of the project while reducing wastage at the same time.

4.4.1.4 Comparison between Equipment, Labour and Material Planning

As seen in Table 4.5, the means for the extents of resource planning by contractors in the categories of Equipment/Plant, Labour and Materials were 3.67, 3.94 and 4.23 respectively. This means that highest level of resource planning by contractors is in the category of material resources. However, means of 3.67, 3.94 and 4.23 indicate that

contractors in the Kenyan construction industry carry out extensive resource planning in all major categories of resources.

Table 4.5: Extent of Resource Planning by Contractors.

	N	Min	Max	Mean	Std. Deviation	Rank
Extent of Equipment Planning	78	1	5	3.67	1.077	3
Extent of Labor Planning	78	2	5	3.94	0.827	2
Extent of Materials Planning	78	1	5	4.23	0.867	1

Source: (Author, 2016)

The reason why more emphasis is paid to Material Resource Planning compared to Labour Resource Planning and Equipment Resource Planning could be attributed to the fact that materials form 60-70% of the project cost. It is for this reason that contractors believe that most of their profits comes from materials and hence the need to properly plan to avoid wastages. As cited in Kass (2012), proper material management is critical since materials account for a substantial portion of the project's time and cost. According to Naief (2002), materials not only account for 50-60% of the total project cost, but also control 80% of its schedule.

4.4.1.4 Nature of Resource Planning

The researcher sought to establish the nature of resource planning carried out by contractors. The graph below represents frequencies regarding the nature of resource planning carried out by contractors.

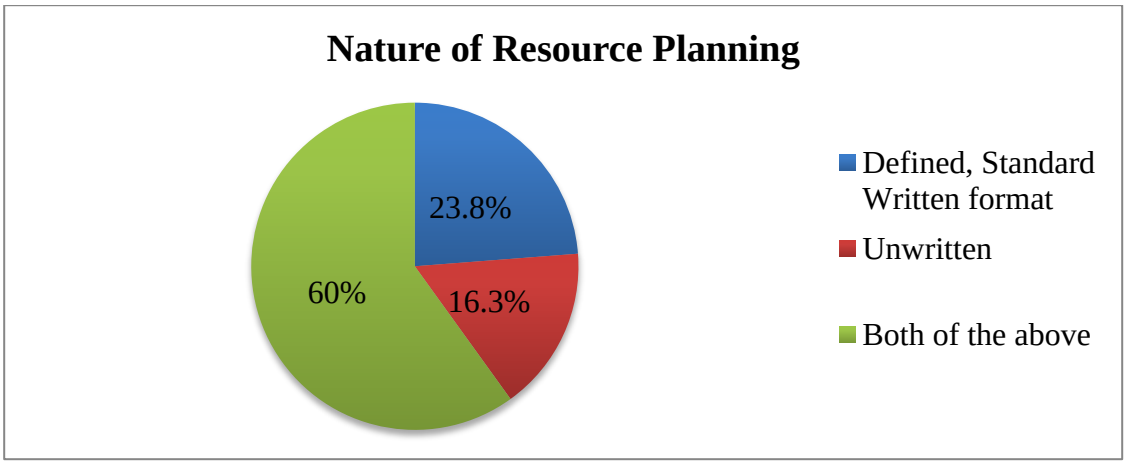

Figure 4.8: Nature of Resource Planning

Source: (Author, 2016)

The pie chart above (figure 4.8) clearly shows that while 16.3% and 23.8% of the contractors surveyed carry out unwritten and defined/standard resource planning respectively, a big proportion 60% of the contracting firms practise both unwritten/informal and defined/formal resource planning. While it may seem that majority of the contractors carry out defined/formal/standard resource planning, this may be misleading since according to the researcher's judgement, majority of those who said they practise both unwritten/informal and defined/formal resource planning do more of the unwritten/informal than the defined/formal resource planning. This because majority of the respondents failed to provide evidence of any material (soft or hard) that they used to carry out the defined/formal resource planning.

Therefore, it would be correct to conclude that majority of the contractors in the Kenyan construction industry practise an informal/unwritten method of resource planning.

4.4.1.5 Extent of support by Top Management

The table below (4.6) shows frequencies for the extent of support given or showed by the top level management in regard to resource planning through policies and guidelines.

Table 4.6: Extent of support by Top Management (Frequencies)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**None**	9	11.1	11.3	11.3
	Low	12	14.8	15.0	26.3
	Moderate	14	17.3	17.5	43.8
	High	30	37.0	37.5	81.3
	Very High	15	18.5	18.8	100.0
	Total	80	98.8	100.0	
Missing	**System**	1	1.2		
Total		81	100.0		

Source: (Author, 2016)

Table 4.7: Extent of support by Top Management (Mean)

	N	Minimum	Maximum	Mean	Std. Deviation
Extent of support from top management	80	1	5	3.38	1.267

Source: (Author, 2016)

While it is clear that majority (56.3%) of respondents responded with “high” and “very high” regarding the extent to which the top management supports resource planning though policies and guidelines, the researcher also noted that comparatively, majority of the contractors’ representatives on sites and offices gave lower levels of top management support compared to contractors. Since those who responded as “contractors” in the question regarding the role in the firm automatically fell in the category of top level management, they claimed to provide a lot of support regarding resource planning while this was contradicted by their representatives.

In light of the above, a mean of 3.38 as seen in table 4.7 would therefore be considered to be low.

4.4.1.6 Responsibility of Resource Planning

The chart below (Figure 4.9) shows results regarding those bestowed upon the responsibility of carrying out resource planning in their respective firms.

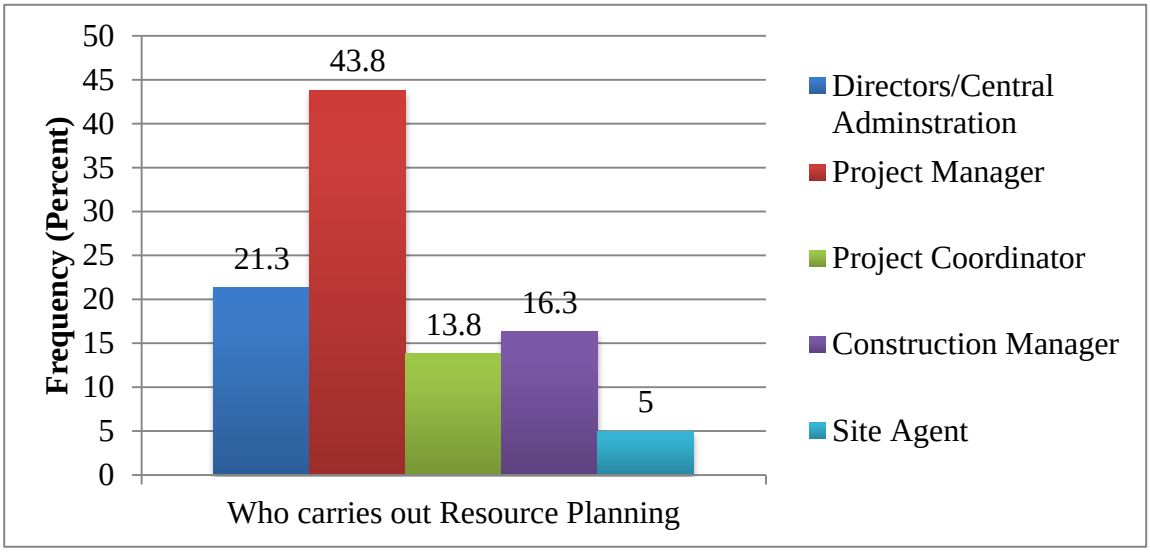

Figure 4.9: Responsibility of Resource Planning

Source: (Author, 2016)

As seen from the chart above (Figure 4.9), Project Managers were the most popular preferred choices for carrying out Resource planning with a frequency of 43.8% (N=35). Other results were: Directors/Central administration, 21.3% (N=17); Construction Manager, 16.3% (N=13); Project Coordinator, 13.8% (N=11); and Site Agent, 5.0% (N=4). These results are reflective of what Mendoza, (1995) asserts by saying that it is the responsibility of the project manager to identify and schedule project needs in a manner that efficient utilization can be made of resources available.

Since majority of Project Managers, Project Coordinators and Central administration are based in offices, it would be correct to assert that much of the Resource Planning carried out by contractors is office based. These results are supported by Clough & Sears, (1991) who argue that the main objective of carrying out resource planning and

resource allocation is to support the field operations so that the project can meet its time and cost objectives.

4.4.1.7 Academic qualifications

The chart below (Figure 4.10) shows frequencies for the academic qualifications of those bestowed upon the responsibility of carrying out resource planning in their respective firms.

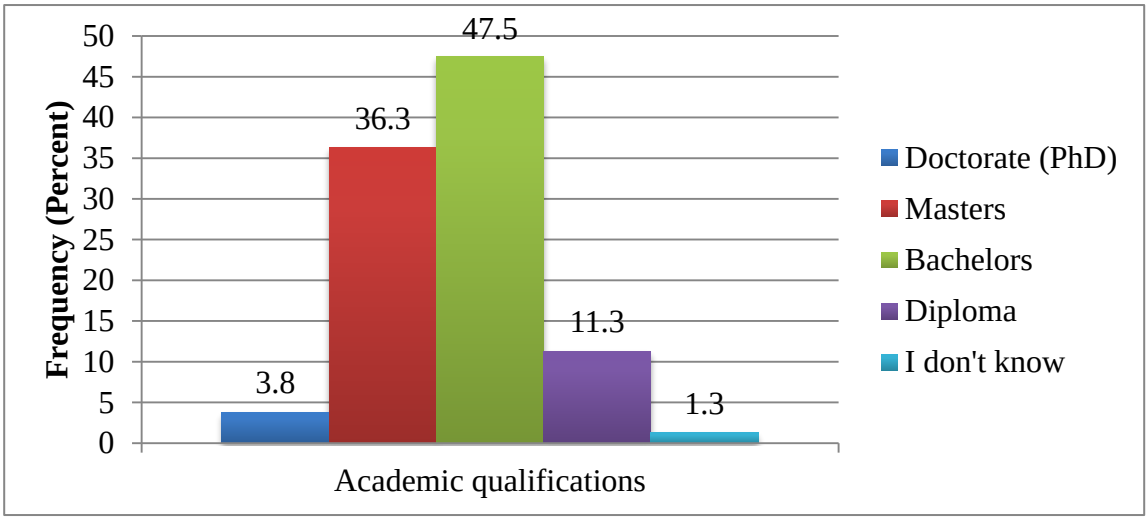

Figure 4.10: Academic qualifications of the person carrying out Resource Planning
Source: (Author, 2016)

As seen from the chart above (Figure 4.10), the most popular academic qualification of those given the responsibility of carrying out resource planning was bachelor's degree with a frequency of 38 (47.5%). Other results were: Masters, 36.3% (N=29); Diploma, 11.3% (N=9); Doctorate, 3.8% (N=3). 1.3% (N=1) did not know the academic qualification of the person carrying out resource planning.

4.4.1.8 Educational background

The chart below (Figure 4.11) shows frequencies for the academic backgrounds of those carrying out resource planning in their respective firms.

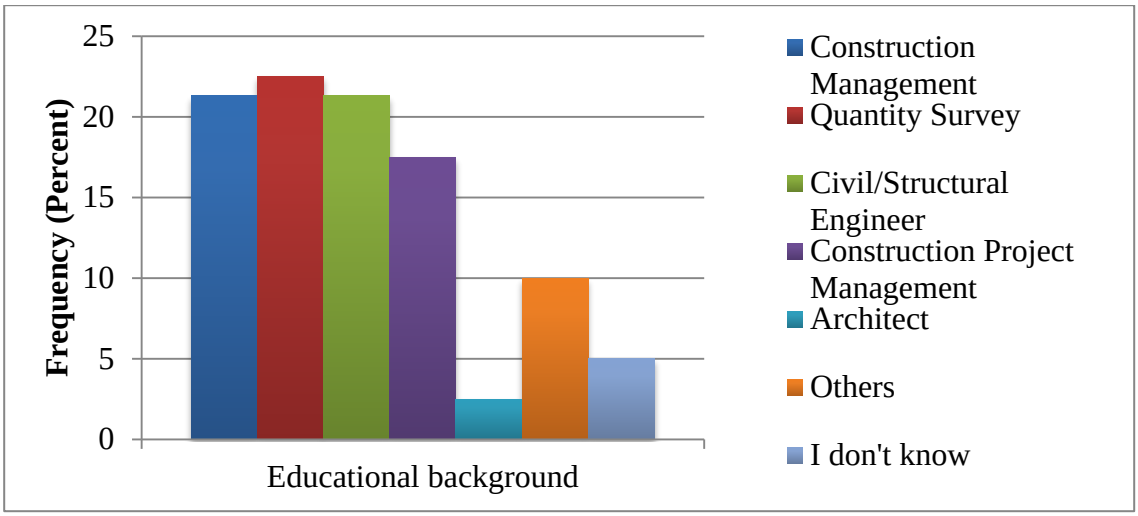

Figure 4.11: Academic qualifications of the person carrying out Resource Planning

Source: (Author, 2016)

Majority of those carrying out Resource Planning had academic backgrounds of Quantity Survey (22.5%, N=18), Civil/Structural Engineer (21.3%, N=17), Construction Management (21.3%, N=17) and Construction Project Management (17.5%, N=14). Other results were: Architect (2.5%, N=2); Others (10%, N=8); and I don't know (5%, N=4). It is interesting to note that 100% of those termed to be in the "Others" category had an educational background in Building Construction/Technology.

4.4.1.9 Aims of undertaking Resource Planning & Leveling

Resource Planning and Leveling can be carried out for various means. A number of aims were presented to the respondents to express views on their significance based on a likert scale (5-Very Important; 4-Important; 3-Fairly Important; 2-Least Important; 1-Not Important). The results were tabulated in the tables below.

As per table 4.8, and based on means, "Identify the total amount of materials needed" was the most significant with a mean of 4.49 while "Identify the number of people required to fill each role" and "Identify the types and quantities of equipment needed" were the second most significant with a mean of 4.38. The fourth and fifth factors were

"Identify the Items of equipment to be used and their purposes" and "Identify the roles and key responsibilities for each labor type" with means of 4.35 and 4.31 respectively. However it is important to note that all these factors were all ranked highly by majority of the respondent as it is evident in the small differences between the means.

Table 4.8: Aims of undertaking Resource Planning (Comparison of Means)

S/No.		Mean	Std. Deviation	N	Rank
1	Responsibilities of each labour	4.31	0.851	80	5
2	Number of people required	4.38	0.832	80	2
3	Items of equipment required	4.35	0.781	80	4
4	Quantities of equipment	4.38	0.769	80	2
5	Amount of materials	4.49	0.779	80	1

Source: (Author, 2016)

Table 4.9: Aims of undertaking Resource Planning (Relative Importance Index)

S/No.		N	RII	Rank
1	Responsibilities of each labour	80	0.8625	4
2	Number of people required	81	0.8765	2
3	Items of equipment required	81	0.8716	5
4	Quantities of equipment	81	0.8765	2
5	Amount of materials	81	0.8988	1

Source: (Author, 2016)

The researcher also carried out an analysis of these factors using the Relative Importance Index. The results, as per table 4.9 indicated that the most significant factor considered when carrying out Resource Planning and Leveling was "Identify the total amount of materials needed" with a RII of 0.8988. Other factors in descending order were: "Identify the types and quantities of equipment needed" (RII=0.8765); "Identify the number of people required to fill each role" (RII=0.8765); "Identify the roles and key responsibilities for each labor type" (RII=0.8625) and lastly "Identify the Items of equipment to be used and their purposes" (RII=0.8716)

Both methods of analysis ranked identification of total amount of materials required as the most important aim of carrying out Resource Planning and Leveling. This reflects the earlier result (Table 4.6) which indicated that Material Resource Planning was the most practised (mean=4.23) compared to Labour Resource Planning (mean=3.94) and Equipment Resource Planning (mean=3.67). The ranking for the first three factors was similar in both methods of analysis. However, there was a difference in ranking of the last two factors with the method of means indicating "Identify the roles and key responsibilities for each labor type" as the least significant while the RII method showed "Identify the Items of equipment to be used and their purposes" as the least significant.

A difference was also noted in the N values between the calculation of mean values and the Relative Importance Index calculations. This is because while the calculations for the RII included all data provided by the respondents, the SPSS software only considered questionnaires which had complete data sets for all the factors provided for consideration by the respondents.

Since the questionnaire gave the option of respondents suggesting other aims which they considered to be relevant, a number of factors were obtained from the study. These were: identify time needed to complete a specific task; determine rate of labour and equipment in terms of time; to identify which trade of labourers would be to be laid off as the amount of work decreased; identify and prioritize procurement of resources time wise; to assist in planning accordingly; to ensure the project has the right skills and materials at the right time; identifying the cost of the project; identifying the time needed and timely planning.

4.4.1.10 Effect of delayed materials on project progress

Respondents were asked to indicate (on a likert scale) how often the progress in their projects was affected by delayed supply of materials. From the table 4.10 below, 2.5%

responded “None”, 32.1%, “Low”, 32.1%, “Moderate”, 18.5%, “High”, and 14.8%, “Very High”. These responses produced a mean of 3.11 as indicated in table 4.14.

Table 4.10: Effect of delayed materials on project progress

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**None**	2	2.5	2.5	2.5
	Low	26	32.1	32.1	34.6
	Moderate	26	32.1	32.1	66.7
	High	15	18.5	18.5	85.2
	Very High	12	14.8	14.8	100.0
	Total	81	100.0	100.0	

Source: (Author, 2016)

When all other factors are held constant, it would be correct to assert that proper material resource planning would result to minimal negative impact on project progress due to delayed or lack of material on site. This means that there was little or no material resource planning for those projects where the respondents indicated that there was a very high likelihood of the progress of such projects to be affected by lack or delayed materials. It could also mean that methods being employed in carrying out material resource planning and leveling are ineffective or even the persons undertaking the material resource planning and leveling are incompetent.

Non-availability of materials when required on site has a number of detrimental effects: reduced productivity, suspension of works, increased cost of idle labour and equipment among others. All these effects ultimately result into project delays and increased project cost. According to Jose (2004) and as cited in Kass (2012), special attention ought to be given to flow of materials once procured from suppliers.

4.4.1.11 Effect of lack of labour on project progress

Respondents were asked to indicate (on a likert scale) how often the progress in their projects was affected by lack of labour on sites. The results are tabulated below.

Table 4.11: Effect of lack of labour on project progress

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**None**	9	11.1	11.3	11.3
	Low	40	49.4	50.0	61.3
	Moderate	12	14.8	15.0	76.3
	High	6	7.4	7.5	83.8
	Very High	13	16.0	16.3	100.0
	Total	80	98.8	100.0	
Missing	**System**	1	1.2		
Total		81	100.0		

Source: (Author, 2016)

It is expected that proper planning of labour resources should result to minimal negative impact on project progress due to lack of labour on site to carry out works, assuming there are no other detrimental factors. This means that there was little or no labour resource planning for those projects where the respondents indicated that there was a very high likelihood of the progress of such projects to be affected by lack of labour on site. It could also mean that methods being employed in carrying out labour resource planning and leveling are ineffective or even the persons undertaking the labour resource planning and leveling are incompetent.

4.4.1.12 Effect of lack of equipment on project progress

Respondents were asked to indicate (on a likert scale) how often the progress in their projects was affected by lack of equipment on sites. The results are tabulated in table 4.12.

It is expected that proper planning of equipment resources should result to minimal negative impact on project progress due to lack of equipment on site to carry out works, assuming there are no other detrimental factors. This means that there was little or no equipment resource planning for those projects where the respondents indicated that there was a very high likelihood of the progress of such projects to be affected by lack of equipment on site. It could also mean that methods being employed in carrying out equipment resource planning and leveling are ineffective or even the persons undertaking the equipment resource planning and leveling are incompetent.

Table 4.12: Effect of lack of equipment on project progress

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**None**	5	6.2	6.2	6.2
	Low	42	51.9	51.9	58.0
	Moderate	17	21.0	21.0	79.0
	High	8	9.9	9.9	88.9
	Very High	9	11.1	11.1	100.0
	Total	81	100.0	100.0	

Source: (Author, 2016)

4.4.1.13 Effects of resource unavailability on project progress.

Although this research has already established that contractors pay more attention to material resource planning compared to labour resource planning and equipment resource planning, the table below indicates that projects carried out by respondents' firms were more likely (3.11) to be affected by delayed material compared to lack of labour (2.68) and lack of equipment (2.68). This means that more needs to be done with regard to material resource planning if building projects are to proceed more smoothly.

However it could also be argued that material resources is an extensive area which involves many external project participants in the name of suppliers. This means that even though proper plans may be put in place to ensure materials are on site every time

they're needed, it is hard to control parties (suppliers) who are not on site and whose activities are also affected by other parties (manufacturers).

Table 4.13: Effects of resource unavailability on project progress.

	N	Min	Max	Mean	Std. Deviation
Delayed materials	81	1	5	3.11	1.095
Lack of labour	80	1	5	2.68	1.261
Lack of equipment	81	1	5	2.68	1.105

Source: (Author, 2016)

Projects were less affected by lack of labour and lack of equipment as depicted by lower means compared to that of materials. This could be attributed to the fact that labour and equipment contribute to only 30-40% of the project cost. It could also be attributed to the fact that since this study was based on NCA 1- NCA 3 contractors, majority of such contractors owned much of the equipment required to execute building projects hence it was easy to avail such equipment whenever needed on site. However according to Kass (2012), unavailability of materials when required on sites is the most frequent cause of delay in construction projects.

4.4.1.14 Extent of Equipment Leveling

From the table 4.14 below, when respondents were asked to rate the extent to which they carry out Equipment Resource Leveling, 0.0% responded "None", 7.4%, "Low", 28.8%, "Moderate", 40.0%, "High", and 23.8%, "Very High". These responses produced a mean of 3.80 as indicated in table 4.17. It is clear from this that majority of contractors in the country practice Resource Leveling in the Equipment category.

There is a small difference (0.13) between the mean for the extent of Equipment Resource Leveling (3.80) and the mean obtained in table 4.5 for the extent of Equipment Resource Planning (3.67).

Table 4.14: Extent of Equipment Leveling

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**Low**	6	7.4	7.5	7.5
	Moderate	23	28.4	28.8	36.3
	High	32	39.5	40.0	76.3
	Very High	19	23.5	23.8	100.0
	Total	80	98.8	100.0	
Missing	**System**	1	1.2		
Total		81	100.0		

Source: (Author, 2016)

4.4.1.15 Extent of Labour Leveling

From the table 4.15 below, when respondents were asked to rate the extent to which they carry out Labour Resource Leveling, 5.0% responded "Low", 23.8%, "Moderate", 38.8%, "High", and 32.8%, "Very High". These responses produced a mean of 3.99 as indicated in table 4.17. It is clear from this that majority of contractors in the country practice Labour Resource Leveling.

Table 4.15: Extent of Labour Leveling

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**Low**	4	4.9	5.0	5.0
	Moderate	19	23.5	23.8	28.8
	High	31	38.3	38.8	67.5
	Very High	26	32.1	32.5	100.0
	Total	80	98.8	100.0	
Missing	**System**	1	1.2		
Total		81	100.0		

Source: (Author, 2016)

There is a small difference (0.05) between the mean for the extent of Labour Resource Leveling (3.99) and the mean obtained in table 4.6 for the extent of Labour Resource Planning (3.94).

4.4.1.16 Extent of Material Leveling

From the table 4.16 below, when respondents were asked to rate the extent to which they carry out Material Resource Leveling, 5.0% responded "None", 2.5%, "Low", 15.0%, "Moderate", 36.3%, "High", and 41.3%, "Very High". These responses produced a mean of 4.06 as indicated in table 4.17. It is clear from this that majority of contractors in the country practice Material Resource Leveling.

Table 4.16: Extent of Material Leveling

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**None**	4	4.9	5.0	5.0
	Low	2	2.5	2.5	7.5
	Moderate	12	14.8	15.0	22.5
	High	29	35.8	36.3	58.8
	Very High	33	40.7	41.3	100.0
	Total	80	98.8	100.0	
Missing	**System**	1	1.2		
Total		81	100.0		

Source: (Author, 2016)

The above mean for the extent of Material Resource Leveling (4.06) is lower than the mean obtained in table 4.5 for the extent of Material Resource Planning (4.23). this means that even though 4.06 is still high, not all contractors who practice resource planning in materials resources category go further to carry out leveling of such resources.

4.4.1.17 Comparison between MRL, LRL and ERL

The table 4.17 below shows a comparison between the means for the extents to which contractors carry out resource leveling in the three main categories of resources namely; materials, labour and equipment.

As seen in the table 4.17, the means for the extents of resource leveling by contractors in the categories of Equipment/Plant, Labour and Materials were 3.80, 3.99 and 4.06 respectively. This means that highest level of resource leveling by contractors is in the category of material resources. However, means of 3.80, 3.99 and 4.06 indicate that contractors in the Kenyan construction industry carry out extensive resource leveling in all major categories of resources.

Table 4.17: Comparison between MRL, LRL and ERL

	N	Min	Max	Mean	Std. Deviation	Rank
Extent of Equipment Leveling	80	2	5	3.80	0.892	3
Extent of Labour Leveling	80	2	5	3.99	0.879	2
Extent of Material Leveling	80	1	5	4.06	1.060	1
Average				**3.95**		

Source: (Author, 2016)

A comparison between the means obtained above for resource leveling and those seen in table 4.5 for resource planning produces similar ranking with materials being in first position followed by labour and equipment in that order.

4.4.1.18 Nature of Resource Leveling

The researcher sought to establish the nature of resource leveling carried out by contractors. The table below frequencies regarding the nature of resource leveling carried out by contractors.

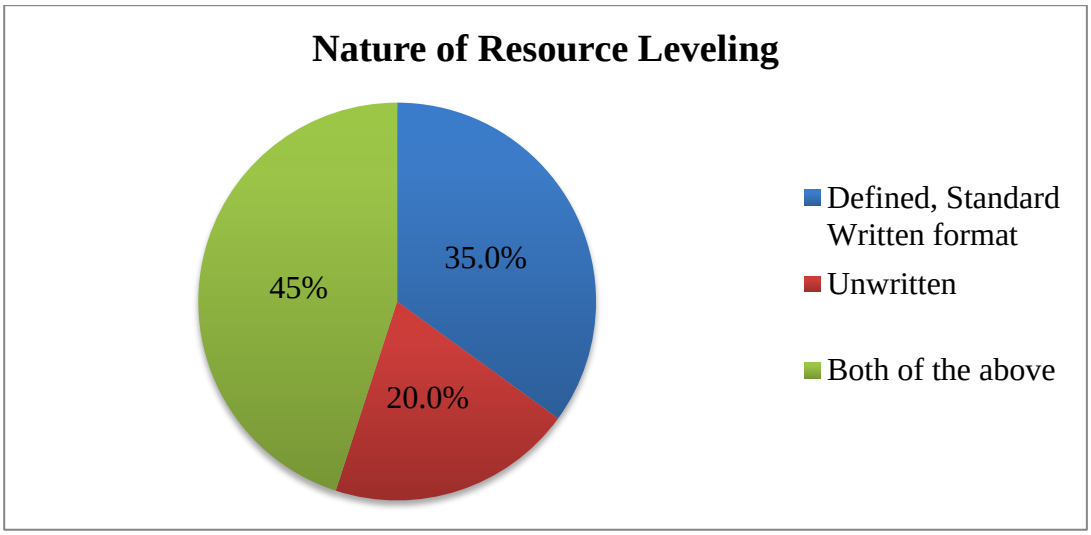

Figure 4.12: Nature of Resource Leveling

Source: (Author, 2016)

The figure above (4.12) clearly shows that while 20.0% and 35.0% of the contractors surveyed carry out unwritten and defined/standard resource leveling respectively, a big proportion 45% of the contracting firms practise both unwritten/informal and defined/formal resource leveling.

A flashback to the results obtained in figure 4.8 regarding the nature of resource planning carried out by contractors, there is a significant increase (23.8%-35%) in the percentage of contractors carrying out defined/standard resource leveling compared to those practising defined/standard resource planning. This could be attributed to the fact that resource leveling being a more complex exercise compared to resource planning requires formal approach rather than an informal strategy. These results are validated by Reddy & Nagaraju, (2015) when they claim that many organisations have a structured hierarchy of resource levelling.

4.4.1.19 Relationship between Age of Firm, Extent of ERP, LRP and MRP

A Spearman's correlation was run to determine the relationship between the age of the firm, extent of carrying out Equipment Resource Planning (ERP), extent of carrying out

Labour Resource Planning (LRP) and extent of carrying out Material Resource Planning (MRP).

Table 4.18: Correlation between Age of Firm, Extent of ERP, LRP and MRP

			Age of firm	Extent of Equipment Planning	Extent of Labor Planning	Extent of Materials Planning
Spearman's rho	**Age of firm**	Correlation Coefficient	1.000	.225*	.108	.172
		Sig. (2-tailed)	.	.048	.348	.132
		N	80	78	78	78
	Extent of Equipment Planning	Correlation Coefficient	.225*	1.000	.543**	.485**
		Sig. (2-tailed)	.048	.	.000	.000
		N	78	78	78	78
	Extent of Labor Planning	Correlation Coefficient	.108	.543**	1.000	.564**
		Sig. (2-tailed)	.348	.000	.	.000
		N	78	78	78	78
	Extent of Materials Planning	Correlation Coefficient	.172	.485**	.564**	1.000
		Sig. (2-tailed)	.132	.000	.000	.
		N	78	78	78	78

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Source: (Author, 2016)

Table 4.18 indicates a spearman's correlation coefficient of 0.225 between the age of firms and extent of carrying out Equipment Resource Planning (ERP). This result indicates a weak positive monotonic correlation between the variables meaning that the extent of carrying out Equipment Resource Planning (ERP) increases with an increase in the age of the firm. Since the correlation is statistically significant at 0.05, therefore, any correlation of ≤0.05 is significant. The correlation significance in this relationship is 0.048 which makes it significant.

The table also indicates a spearman's correlation coefficient of 0.108 between the age of firms and extent of carrying out Labour Resource Planning (LRP).

This result indicates a very weak positive relationship between the variables meaning that the extent of carrying out Labour Resource Planning (LRP) increases with an increase in the age of the firm. Since the correlation is statistically significant at 0.05, therefore, any correlation of ≤0.05 is significant. The correlation significance in this relationship is 0.348 which makes it statistically insignificant.

Further, the above table 4.18 indicates a spearman's correlation coefficient of 0.172 between the age of firms and extent of carrying out Material Resource Planning (MRP). This result indicates a very weak positive relationship between the variables meaning that the extent of carrying out Material Resource Planning (MRP) increases with an increase in the age of the firm. Since the correlation is statistically significant at 0.05, therefore, any correlation of ≤0.05 is significant. The correlation significance in this relationship is 0.132 which makes it statistically insignificant.

Apart from seeking to establish the nature and strength of relationship between age of firm and the various extents of equipment, labour and material resource planning, the researcher also analysed the relationships between the individual extents of Resource Planning. The results are also presented in table 4.18.

A spearman's correlation was run to assess the correlation between the extent of Equipment Resource Planning (ERP) and the extent of extent of Labour Resource Planning (LRP) produced a spearman's correlation coefficient of 0.543 as seen in table 4.18. This indicates a moderate positive monotonic relationship between the variables. This means that the higher the contractors tended to practice Equipment Resource Planning (ERP) the also higher they exercised Labour Resource Planning (LRP). Since SPSS reported the p-value for this analysis as being .000 the researcher concluded that the relationship was highly significant.

A spearman's correlation was also run to assess the correlation between the extent of Equipment Resource Planning (ERP) and the extent of extent of Material Resource Planning (MRP) produced a spearman's correlation coefficient of 0.485 as seen in table 4.18. This indicates a moderate positive monotonic relationship between the variables. This means that the higher the contractors tended to practice Equipment Resource Planning (ERP) the also higher they exercised Material Resource Planning (MRP). Since SPSS reported the p-value for this analysis as being .000 the researcher concluded that the relationship was highly significant.

When the test was also used to analyse the correlation between the extent of Labour Resource Planning (LRP) and the extent of extent of Material Resource Planning (MRP) produced a spearman's correlation coefficient of 0.564 as seen in table 4.18. This indicates a moderate positive monotonic relationship between the variables. This means that the higher the contractors tended to practice Labour Resource Planning (LRP) the also higher they exercised Material Resource Planning (MRP). Since SPSS reported the p-value for this analysis as being .000 the researcher concluded that the relationship was highly significant.

4.4.1.20 Relationship between Age of Firm, Extent of ERL, LRL and MRL

The table 4.19 below shows a correlation between the age of the firm, extent of carrying out Equipment Resource Leveling (ERL), extent of carrying out Labour Resource Leveling (LRL) and extent of carrying out Material Resource Leveling (MRL).

Table 4.19: Correlation between Age of Firm, Extent of ERL, LRL and MRL

			Age of firm	Extent of Equipment Leveling	Extent of Labour Leveling	Extent of Material Leveling
Spearman's rho	**Age of firm**	Correlation Coefficient	1.000	.075	.109	.050
		Sig. (2-tailed)	.	.514	.338	.661
		N	80	79	79	79
	Extent of Equipment Leveling	Correlation Coefficient	.075	1.000	.492**	.470**
		Sig. (2-tailed)	.514	.	.000	.000
		N	79	80	80	80
	Extent of Labour Leveling	Correlation Coefficient	.109	.492**	1.000	.663**
		Sig. (2-tailed)	.338	.000	.	.000
		N	79	80	80	80
	Extent of Material Leveling	Correlation Coefficient	.050	.470**	.663**	1.000
		Sig. (2-tailed)	.661	.000	.000	.
		N	79	80	80	80

**. Correlation is significant at the 0.01 level (2-tailed).

Source: (Author, 2016)

When the spearman's rank-order correlation was run to determine the relationship between the age of firms and extent of carrying out Equipment Resource Leveling (ERL), a spearman's correlation coefficient of 0.075 was obtained as seen in table 4.19. This symbolised a very weak positive relationship between the variables and which was not statistically significant since p = 0.514.

A spearman's rank-order correlation between age of firms and extent of carrying out Labour Resource Leveling (LRL) produced a spearman's correlation coefficient of 0.109 as seen in table 4.19. This depicted a very weak positive relationship between the variables and which was not statistically significant since p = 0.338. Further, table 4.19 indicates a spearman's correlation coefficient of 0.050 between the age of firms and extent of carrying out Material Resource Leveling (MRL). This result indicates a very weak positive relationship between the variables which was not statistically significant since p = 0.661.

4.4.1.21 Relationship between Top Management Support and Age of Firm

A spearman's correlation was run to measure the relationship between Top Management Support and Age of Firm. The results were tabulated below.

Table 4.20: Correlation between Top Management Support and Age of Firm

			Extent of support from top management	Age of firm
Spearman's rho	**Extent of support from top management**	Correlation Coefficient	1.000	-.038
		Sig. (2-tailed)	.	.736
		N	80	80
	Age of firm	Correlation Coefficient	-.038	1.000
		Sig. (2-tailed)	.736	.
		N	80	80

Source: (Author, 2016)

Table 4.20 above indicates that the spearman's correlation coefficient of top management Support versus age of firm is -0.038. This shows that there is weak negative monotonic relationship between the variables. This means that the higher the age of the firm, the less the extent of support from top management. However, a correlation significance value indicates that the correlation coefficient obtained in this analysis is statistically insignificant.

4.4.1.22 Relationship between Top Management Support and Extent of RP

The table below shows a correlation between top management support, extent of carrying out Equipment Resource Planning (ERP), extent of carrying out Labour Resource Planning (LRP) and extent of carrying out Material Resource Planning (MRP).

Table 4.21: Correlation between Top Management Support and Extent of RP

			Extent of support from top management	Extent of Equipment Planning	Extent of Labor Planning	Extent of Materials Planning
Spearman's rho	**Extent of support from top management**	Correlation Coefficient	1.000	.275*	.079	.162
		Sig. (2-tailed)	.	.015	.494	.156
		N	80	78	78	78

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Source: (Author, 2016)

Table 4.21 indicates a spearman's correlation coefficient of 0.275 between the extent of top management support and extent of carrying out Equipment Resource Planning

(ERP). This result indicates a weak positive monotonic correlation between the variables meaning that the extent of carrying out Equipment Resource Planning (ERP) increases with an increase in the extent of top management support. The correlation coefficient in this case is statistically significant since the correlation significance is 0.048

The above table also indicates a spearman's correlation coefficient of 0.079 between the extent of top management support and extent of carrying out Labour Resource Planning (LRP). This result indicates a very weak positive relationship between the variables meaning that the extent of carrying out Labour Resource Planning (LRP) slightly increases with an increase in the extent of support from top management. Since the correlation is statistically significant at 0.05, therefore, any correlation of ≤0.05 is significant. The correlation significance in this relationship is 0.494 which makes it statistically insignificant.

Further, the above table (4.22) indicates a spearman's correlation coefficient of 0.162 between the extent of top management support and extent of carrying out Material Resource Planning (MRP). This result indicates a very weak positive relationship between the variables meaning that the extent of carrying out Material Resource Planning (MRP) slightly increases with an increase in the extent of support from top management. Since the correlation is statistically significant at 0.05, therefore, any correlation of ≤0.05 is significant. The correlation significance in this relationship is 0.156 which makes it statistically insignificant.

4.4.1.23 Relationship between Top Management Support and Extent of RL

A spearman's correlation was run to measure the relationship between Top Management Support Extent of ERL, LRL and MRL. The results were tabulated below.

The table indicates a spearman's correlation coefficient of 0.257 between the extent of top management support and extent of carrying out Equipment Resource Leveling (ERL). This result indicates a weak positive monotonic correlation between the

variables meaning that the extent of carrying out Equipment Resource Leveling (ERL) increases with an increase in the extent of top management support. The correlation coefficient in this case is statistically significant since the correlation significance is 0.022.

Table 4.22: Correlation between Top Management Support and Extent of RL

			Extent of support from top management	Extent of Equipment Leveling	Extent of Labour Leveling	Extent of Material Leveling
Spearman's rho	**Extent of support from top management**	Correlation Coefficient	1.000	.257*	.230*	.245*
		Sig. (2-tailed)	.	.022	.041	.029
		N	80	79	79	79

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Source: (Author, 2016)

Results from the above table also indicate a spearman's correlation coefficient of 0.230 between the extent of top management support and extent of carrying out Labour Resource Leveling (LRL). This result indicates a weak positive monotonic correlation between the variables meaning that the extent of carrying out Labour Resource Leveling (LRL) increases with an increase in the extent of top management support. The correlation coefficient in this case is also statistically significant since the correlation significance is 0.041.

The above table indicates a spearman's correlation coefficient of 0.245 between the extent of top management support and extent of carrying out Material Resource

Leveling (MRL). This result indicates a weak positive monotonic correlation between the variables meaning that the extent of carrying out Material Resource Leveling (MRL) increases with an increase in the extent of top management support. The correlation coefficient in this case is statistically significant since the correlation significance is 0.029.

4.4.1.24 Relationship between Affected Project Progress due to Lack of Equipment and Extent of ERP

A Spearman's correlation was run to determine the relationship between affected project progress due to lack of equipment and extent of Equipment Resource Planning. As seen in table 4.23, it was established that there was almost no correlation between the variables. (rho= 0.028, n = 78, p = 0.811).

Table 4.23: Correlation between Project Progress and Extent of ERP

			Lack of equipment	**Extent of Equipment Planning**
Spearman's rho	**Lack of equipment**	Correlation Coefficient	1.000	.028
		Sig. (2-tailed)	.	.811
		N	81	78
	Extent of Equipment Planning	Correlation Coefficient	.028	1.000
		Sig. (2-tailed)	.811	.
		N	78	78

Source: (Author, 2016)

4.4.1.25 Relationship between Project Progress and Extent of MRP

A Spearman's correlation was also run to determine the relationship between affected project progress due to delayed materials and extent of Material Resource Planning. There was a weak, negative monotonic correlation between the variables. (rho= -0.201, n = 78, p = 0.078).

Table 4.24: Correlation between Project Progress and Extent of MRP

			Delayed materials	Extent of Materials Planning
Spearman's rho	**Delayed materials**	Correlation Coefficient	1.000	-.201
		Sig. (2-tailed)	.	.078
		N	81	78
	Extent of Materials Planning	Correlation Coefficient	-.201	1.000
		Sig. (2-tailed)	.078	.
		N	78	78

Source: (Author, 2016)

These results could be interpreted to mean that increased material planning results to fewer delays of projects due to delayed materials.

4.4.1.26 Relationship between Project Progress and Extent of LRP

When a spearman's correlation was also run to determine the relationship between affected project progress due to lack of labour on site and extent of Labour Resource Planning, it was established that there was a weak, negative monotonic correlation between the variables. (rho= -0.223, n = 78, p = 0.051).

Table 4.25: Correlation between Project Progress and Extent of LRP

			Lack of labour	Extent of Labor Planning
Spearman's rho	**Lack of labour**	Correlation Coefficient	1.000	-.223
		Sig. (2-tailed)	.	.051
		N	80	77
	Extent of Labor Planning	Correlation Coefficient	-.223	1.000
		Sig. (2-tailed)	.051	.
		N	77	78

Source: (Author, 2016)

These results could be interpreted to mean that increased labour planning results to fewer delays of projects due to lack of labour on site.

4.4.2 Objective 2: Factors influencing Resource Planning

4.4.2.1 Significance of Factors influencing resource planning

A number of factors influencing Resource Planning were presented to the respondents to express views on their significance based on a likert scale (5-Very High; 4- High; 3-Moderate; 2-Low; 1-None). The results were presented in the tables below.

Table 4.26: Factors Influencing Resource Planning (Comparison of Means)

S/No.		Mean	Std. Deviation	N	Rank
1	Adequacy of labour	4.15	0.940	75	2
2	Adequacy of plants and equipment	4.15	0.833	75	2
3	Compliance with safety procedures	3.60	0.959	75	7
4	Contractor's ICT Compliance	2.96	1.108	75	10
5	Presence of qualified personnel	4.07	0.890	75	4
6	Level of project documentation	3.69	1.065	75	6
7	Financial status of the contractor	4.19	0.896	75	1
8	Weather	3.09	1.221	75	9
9	Prompt honoring of payments certificates	3.97	0.972	75	5
10	Type of procurement system	3.52	1.143	75	8

Source: (Author, 2016)

As per Table 4.26, and based on means, "Financial status of the contractor" was the most significant with a mean of 4.19 while "Adequacy of labour" and "Adequacy of plant and equipment" were the second most significant with a mean of 4.15. The fourth and fifth factors were "Presence of qualified personnel" and "Prompt honoring of payments certificates" with means of 4.07 and 3.97 respectively. "Level of project documentation" and "Compliance with safety procedures" were the sixth and seventh most important factors with means of 3.69 and 3.60 respectively. The eighth factor was

the “Type of procurement system” with a mean of 3.52. The last two factors were “Weather” and “Contractor’s ICT Compliance” with means of 3.09 and 2.96 respectively.

Table 4.27: Factors Influencing Resource Planning (Summary of Means)

	Mean	Min	Max	Range	Maximum / Minimum	Variance	N of Items
Item Means	3.739	2.960	4.187	1.227	1.414	.199	10

Source: (Author, 2016)

There was a huge difference of 1.23 (as seen in table 4.26) in the means of the highest and lowest ranked factors. This meant that while some factors were considered to be key in influencing Resource Planning, others were not very convincing among the respondents. It is important to note that the first nine factors were all ranked highly by majority of the respondents. However, the last factor seemed to be less influential due to its low mean. Generally, all the factors presented to the respondents can be said to be critical in influencing Resource Planning since they have an overall mean of 3.739 as seen in the table 4.27.

The researcher further carried out an analysis of the same factors using the Relative Importance Index. The results, as per table 4.28 indicated that the most significant factor considered when carrying out Resource Planning and Leveling was “Financial status of the contractor” with a RII of 0.8390. Other factors in descending order were: “Adequacy of labour” (RII=0.8308); “Adequacy of plant and equipment” (RII=0.8304); “Presence of qualified personnel” (RII=0.8152); “Prompt honoring of payments certificates” (RII=0.7901); “Level of project documentation” (RII=0.7410); “Compliance with safety procedures” (RII=0.7154); “Type of procurement system” (RII=0.6949); “Weather” (RII=0.6127) and lastly “Contractor’s ICT Compliance” (RII=0.5897)

Table 4.28: Factors Influencing Resource Planning (Relative Importance Index)

S/No.		N	RII	Rank
1	Adequacy of labour	78	0.8308	2
2	Adequacy of plants and equipment	79	0.8304	3
3	Compliance with safety procedures	78	0.7154	7
4	Contractor's ICT Compliance	78	0.5897	10
5	Presence of qualified personnel	79	0.8152	4
6	Level of project documentation	78	0.7410	6
7	Financial status of the contractor	77	0.8390	1
8	Weather	79	0.6127	9
9	Prompt honoring of payments certificates	81	0.7901	5
10	Type of procurement system	78	0.6949	8

Source: (Author, 2016)

Both methods of analysis ranked financial status of the contractor and contractor's ICT Compliance as the most and least important factors influencing Resource Planning respectively. The ranking for all factors was similar in both methods of analysis.

A difference was also noted in the N values between the calculation of mean values and the Relative Importance Index calculations. This is because while the calculations for the RII included all data provided by the respondents, the SPSS software only considered questionnaires which had complete data sets for all the factors provided for consideration by the respondents.

Since the questionnaire gave the option of respondents suggesting other factors which they considered to be influential in Resource Planning, only one more factor was proposed and that was top management support.

4.4.2.2 Regression Analysis between Resource Planning and Influencing Factors

In order to measure the extent to which various factors affected the Extent of Resource Planning by contracting firms, a regression procedure was carried out with Extent of

Resource Planning as the dependent variable and: Adequacy of Labour; Adequacy of plant and equipment; Compliance with safety; ICT compliance; Qualified personnel; Level of project documentation; Financial status; Weather; Prompt payments and Type of procurement.

Table 4.29: Regression analysis results for RP and Influencing Factors (Model Summary)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.821[a]	0.674	0.426	0.815

a. Predictors: (Constant), Adequacy of Labour, Adequacy of plant and equipment, Compliance with safety, ICT compliance, Qualified personnel, Level of documentation, Financial status, Weather, Prompt payments, Type of procurement

Source: (Author, 2016)

Table 4.30: Regression analysis results for RP and Influencing Factors (ANOVA)

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	46.839	26	1.801	2.710	0.003[b]
	Residual	22.604	34	.665		
	Total	69.443	60			

a. Dependent Variable: Extent of Resource Planning

b. Predictors: (Constant), Adequacy of Labour, Adequacy of plant and equipment, Compliance with safety, ICT compliance, Qualified personnel, Level of documentation, Financial status, Weather, Prompt payments, Type of procurement

Source: (Author, 2016)

The value of R^2 for the model generated is 0.426; this implies that 42.6% of the variation in the Extent of Resource Planning is explained by the independent variables included in the model.

The essence of ANOVA is to establish whether the model is significant. The results in this case indicated that F=2.710 and p=0.003. This means that the proposed model significantly improves the prediction of Resource Planning. A significance figure higher than 0.05 would have rendered the model useless in predicting the dependent variable.

Table 4.31: Regression analysis results for RP and Influencing Factors (Coefficients)

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.957	1.589		-.602	.551
	Adequacy of Labour	.137	.330	-.089	-.416	.680
	Adequacy of equipment	.591	.372	.374	1.592	.007
	Compliance with safety	-.517	.235	-.436	-2.199	.035
	ICT compliance	.287	.190	.286	1.507	.141
	Qualified personnel	-.318	.218	-.239	-1.462	.153
	Level of documentation	.245	.185	.230	1.326	.194
	Financial status	.158	.206	.126	.767	.049
	Weather	-.028	.124	-.032	-.227	.822
	Prompt payments	.222	.206	-.182	-1.075	.290
	Type of procurement	.098	.178	.097	.551	.586

a. Dependent Variable: Extent of Resource Planning

Source: (Author, 2016)

The table above reveals that some of the independent variables are statistically significant while others are not. Those predictors found to be statistically significant

were: Adequacy of equipment (p=0.007); Compliance with safety (p=0.035); Financial status (p=0.049). All the other variables were found to be statistically insignificant. The equation below was obtained from the above multiple regression. Unstandardized Coefficients were used instead of the standardized Coefficients they provide a y-intercept as well as a slope term.

RP=-0.957+0.137AL+0.591AE-0.517CS+0.287ICT-0.318QP+0.245LD+0.158FS-0.028W+0.222PP+0.098TP+e

Where: RP=Extent of Resource Planning; AL=Adequacy of Labour; AE=Adequacy of equipment; CS=Compliance with safety; ICT=ICT compliance; QP=Qualified personnel; LD=Level of documentation; FS=Financial status; W=Weather; PP=Prompt payments; TP=Type of procurement and e=Error

The multiple regression analysis revealed that higher levels of Resource Planning are associated with higher levels of adequacy of labour and equipment, ICT compliance, high level of project documentation, high financial status, prompt payments, type of procurement, identifying the number of people required, establishing quantities of equipment, quantification of amount of materials. The analysis also revealed that higher levels of Resource Planning are associated with lower levels of Compliance with safety and bad weather.

4.4.3 Objective 3: Resource leveling techniques employed by contractors.

The aim of objective three was to identify and evaluate the various resource leveling techniques employed by contractors.

4.4.3.1 Comparison among various Resource Leveling Techniques

Respondents were asked to indicate the extent to which various Resource Leveling techniques were used in their firms based on a likert scale (5-Very High; 4- High; 3-Moderate; 2-Low; 1-None). The results were tabulated below.

Table 4.32: Resource Leveling Techniques (Comparison of Means)

S/No.		Mean	Std. Deviation	N	Rank
1	Doing nothing	1.66	0.996	64	13
2	Delay non-critical tasks within available float	3.03	1.038	64	9
3	Extend non-critical task durations within the available float	3.13	1.062	64	7
4	Add resource of equal or greater capability	3.34	0.963	64	6
5	Substitute resource of equal or greater capability	3.44	0.974	64	4
6	Delay critical path tasks	2.17	1.047	64	12
7	Extend critical path task durations	2.77	1.065	64	10
8	Splitting tasks into non sequential pieces	2.73	0.996	64	11
9	Authorize Overtime	3.45	1.068	64	3
10	Crashing	3.36	1.226	64	5
11	Fast tracking	3.78	0.917	64	1
12	Microsoft Project	3.59	1.205	64	2
13	Modify the scope	3.13	1.148	64	7

Source: (Author, 2016)

The most popular Resource Leveling Technique employed by contractors was found to be “Fast tracking” with a mean of 3.78. The second and third most popular techniques were “Microsoft Project” and “Authorize overtime” with means of 3.59 and 3.45 respectively. “Substitute resource of equal or greater capability”, “Crashing” and “Add resource of equal or greater capability” were the fourth, fifth and sixth with means of 3.44, 3.36 and 3.34. The seventh most popular techniques were “Modify the scope” and “Extend non-critical task durations within the available float” with a mean of 3.13.

“Delay non-critical tasks within available float” and “Extend critical path task durations” were the ninth and tenth in the ranking with means of 3.03 and 2.77 respectively. The last three techniques were “Splitting tasks into non sequential pieces”, “Splitting tasks into non sequential pieces” and “Doing nothing” with means of 2.73, 2.17 and 1.66.

While the first six techniques (fast tracking, Microsoft project, authorizing overtime, substituting resources of equal or greater capability, crashing, and addition of resource of equal or greater capability”) in the ranking could be said to be highly used in the Kenyan construction industry due to their high means (3.78, 3.59, 3.45, 3.44, 3.36 and 3.34), the last seven techniques (Modify the scope, Extend non-critical task durations within the available float, Delay non-critical tasks within available float, Extend critical path task durations, Splitting tasks into non sequential pieces, Splitting tasks into non sequential pieces and Doing nothing) were found to be rarely used by a majority of the contractors due to their lower means (3.13, 3.13, 3.03, 2.77, 2.73, 2.17 and 1.66).

4.4.3.2 Effectiveness of various Resource Leveling Techniques

Respondents were asked to indicate the effectiveness of various Resource Leveling techniques as used in their firms based on a likert scale (5-Very Effective; 4- Effective; 3-Fairly Effective; 2-Least Effective; 1-Not Effective). The results were tabulated below.

The top 3 most effective techniques were: “Fast tracking”, “Microsoft Project” and “Substitute resource of equal or greater capability” with means of 4.21, 4.08 and 4.00 respectively. “Add resource of equal or greater capability”, “Authorize Overtime” and “Crashing” were the fourth, fifth and sixth most effective techniques with means of 3.93, 3.87 and 3.77. The seventh, eighth and ninth techniques in the ranking were: “Modify the scope”, “Splitting tasks into non sequential pieces” and “Extend non-critical task durations within the available float” with means of 3.43, 3.34 and 3.23 respectively. “Delay non-critical tasks within available float”, “Extend critical path

task" and "Delay critical path tasks" were the tenth, eleventh and twelfth most effective techniques with means of 3.15, 2.92 and 2.69 respectively. The least effective techniques was found to be "Doing nothing" with a mean of 1.84.

Table 4.33: Effectiveness of various RL techniques (Comparison of Means)

S/No.		Mean	Std. Deviation	N	Rank
1	Doing nothing	1.84	1.319	61	13
2	Delay non-critical tasks within available float	3.15	1.123	61	10
3	Extend non-critical task durations within the available float	3.23	1.055	61	9
4	Add resource of equal or greater capability	3.93	0.910	61	4
5	Substitute resource of equal or greater capability	4.00	0.775	61	3
6	Delay critical path tasks	2.69	1.218	61	12
7	Extend critical path task durations	2.92	1.159	61	11
8	Splitting tasks into non sequential pieces	3.34	0.964	61	8
9	Authorize Overtime	3.87	0.974	61	5
10	Crashing	3.77	1.023	61	6
11	Fast tracking	4.21	0.777	61	1
12	Microsoft Project	4.08	1.038	61	2
13	Modify the scope	3.43	1.056	61	7

Source: (Author, 2016)

When a comparison was done based on the rankings in tables 4.33 and 4.34, only five techniques retained similar positions (Fast tracking, 1; Microsoft Project, 2; Modify the scope, 7; Delay critical path tasks, 12; and Doing nothing, 13) in both analyses meaning that the degree to which they were employed by the contractors depended on their effectiveness as experienced by the contractors. Other methods were found to be more

popular but less effective based on the same comparison. These were: Authorize Overtime (Positions 3 and 5); Crashing (Positions 5 and 6); Extend non-critical task durations within the available float (Positions 7 and 9); Delay non-critical tasks within available float (Positions 9 and 10); and Extend critical path tasks (Positions 10 and 11). Techniques found to be less popular but more effective were: Substitute resource of equal or greater capability (Positions 4 and 3); Add resource of equal or greater capability (Positions 6 and 4); and Splitting tasks into non sequential pieces (Positions 11 and 8).

It is interesting to note that fast tracking and Microsoft project were found to be the most popular and most effective techniques while delaying critical path tasks and doing nothing were found to be the least popular and the least effective techniques by the contractors.

4.4.4 Objective 4: Challenges and benefits associated with RP&L

The fourth objective sought to identify and evaluate challenges and benefits associated with resource planning and leveling.

4.4.4.1 Challenges associated with Resource Planning and Leveling.

A number of challenges associated with Resource Planning and Leveling were presented to the respondents to express views on their significance based on a likert scale (5-Strongly Agree; 4- Agree; 3-Undecided; 2-Disagree; 1-Strongly Disagree). The results were presented in the tables below. As per table 4.34, and based on means, “Technical incompetence” was the most significant with a mean of 4.38 while “Project delays” and “Materials shortages or late delivery” were the second and third most significant with means of 4.32 and 4.26 respectively. The fourth and fifth challenges were “Contract disputes” and “Plants, equipment’s & machine breakdown/inadequacy” with means of 3.94 and 3.93 respectively. “Poor work definition; inadequate project documentation” and “Project risks & uncertainty” were the sixth and seventh most important factors with means of 3.87 and 3.85 respectively. The eighth and ninth

challenges were “Lack of commitment by top level management” and “Tedious exercise” with means of 3.72 and 3.62. The last three challenges were “Contractors ICT compliance challenges”, “Absenteeism of workers/shortage of craftsmen” and “Site storage constraints” with means of 3.43, 3.35 and 3.26 respectively.

Table 4.34: Challenges associated with RP&L (Comparison of Means)

S/No.		Mean	Std. Deviation	N	Rank
1	Technical incompetence; lack of knowledge	4.38	0.624	68	1
2	Tedious exercise	3.62	0.962	68	9
3	Materials shortages or late delivery	4.26	0.840	68	3
4	Project delays	4.32	0.657	68	2
5	Lack of commitment by top level management	3.72	1.063	68	8
6	Site storage constraints	3.26	1.060	68	12
7	Project risks & uncertainty	3.85	0.851	68	7
8	Plants, equipment’s & machine breakdown/inadequacy	3.93	0.816	68	5
9	Poor work definition; inadequate project documentation	3.87	1.091	68	6
10	Contract disputes	3.94	1.006	68	4
11	Absenteeism of workers/shortage of craftsmen	3.35	1.117	68	11
12	Contractors ICT compliance challenges	3.43	1.041	68	10

Source: (Author, 2016)

Low values of standard deviations meant that there was consistency among contractors regarding their views on the perceived challenges. Generally, all the challenges presented to the respondents can be said to be critical since they had an overall mean of 3.8275 as seen in the table 4.35 below.

Table 4.35: Challenges associated with RP&L (Summary of Means)

	Mean	Min	Max	Range	Variance	N of Items
Item Means	3.8275	3.260	4.380	1.120	0.199	12

Source: (Author, 2016)

Table 4.36: Challenges associated with RP&L (Relative Importance Index)

S/No.		N	RII	Rank
1	Technical incompetence; lack of knowledge	78	0.8564	2
2	Tedious exercise	74	0.7108	9
3	Materials shortages or late delivery	77	0.8390	3
4	Project delays	77	0.8597	1
5	Lack of commitment by top level management	77	0.7584	8
6	Site storage constraints	78	0.6564	11
7	Project risks & uncertainty	76	0.7684	7
8	Plants, equipment's & machine breakdown/inadequacy	77	0.7922	4
9	Poor work definition; inadequate project documentation	77	0.7688	6
10	Contract disputes	78	0.7872	5
11	Absenteeism of workers/shortage of craftsmen	78	0.6538	12
12	Contractors ICT compliance challenges	78	0.6692	10

Source: (Author, 2016)

The researcher also carried out an analysis of the same challenges using the Relative Importance Index. The results, as per table 4.36 indicated that the most significant challenge faced by contractors when carrying out Resource Planning and Leveling was "Project delays" with a RII of 0.8597. Other factors in descending order were: "Technical incompetence; lack of knowledge" (RII=0.8564); "Materials shortages or late delivery" (RII=0.8390); "Plants, equipment's & machine breakdown/inadequacy" (RII=0.7922); "Contract disputes" (RII=0.7872); "Poor work definition; inadequate project documentation" (RII=0.7688); "Project risks & uncertainty" (RII=0.7684); "Lack of commitment by top level management" (RII=0.7584); "Tedious exercise"

(RII=0.7108) “Contractors ICT compliance challenges” (RII=0.6692); “Site storage constraints” (RII=0.6564) and lastly “Absenteeism of workers/shortage of craftsmen” (RII=0.6538). These results indicate that all the respondents’ are in agreement that the assessed factors are significant challenges encountered in Resource Planning and Leveling.

A comparison between the two methods of analysis showed that though technical incompetence was the most significant challenge based on the mean ranking, project delays was the most significant based on the RII ranking. The least significant challenge according to the method of means was site storage constraints while absenteeism of workers was the least significant challenge using the RII analysis. However, both methods of analysis produced the same top three and last three significant challenges though not in the same order.

4.4.4.2 Benefits associated with Resource Planning and Leveling.

A number of benefits associated with Resource Planning and Leveling and obtained form literature review were presented to the respondents to express views on their significance based on a likert scale (5-Strongly Agree; 4- Agree; 3-Undecided; 2-Disagree; 1-Strongly Disagree). The results were presented in the tables below.

Table 4.37 indicates that “Establishing plans for material delivery” was the most significant benefit with a mean of 4.61 while “Balanced resources, reducing over allocations or overtime” and “Determines or predicts resources needed” were the second and third most significant with means of 4.60 and 4.58 respectively. The fourth and fifth challenges were “Helps maintain the lowest uniform number of employees to perform the work”, “Reduced project costs” and “Enhanced overall organizational strategic planning” with means of 4.31 and 4.26 respectively. “Reduction of errors” and “Increased workers’ morale due to guaranteed job security” were the seventh and eighth most important factors with means of 4.12 and 3.95 respectively.

Table 4.37: Benefits associated with RP&L (Comparison of Means)

S/No.		Mean	Std. Deviation	N	Rank
1	Balanced resources, reducing over allocations or overtime	4.60	0.494	77	2
2	Determines or predicts resources needed	4.58	0.522	77	3
3	Helps maintain the lowest uniform number of employees to perform the work.	4.31	0.782	77	4
4	Establishing plans for material delivery.	4.61	0.517	77	1
5	Reduced project costs	4.26	0.834	77	5
6	Reduced cost of learning and improved learning curve	3.86	0.823	77	9
7	Enhanced overall organizational strategic planning	4.26	0.696	77	5
8	Reduction of errors	4.12	0.873	77	7
9	Increased workers' morale due to guaranteed job security	3.95	0.916	77	8

Source: (Author, 2016)

The last benefit based on this method of ranking was "Reduced cost of learning and improved learning curve" with a mean of 3.86. These results revealed that the assessed factors were unanimously acknowledged by majority of contractors to be significant benefits for Resource Planning and Leveling. This is further supported by table 4.38 below which shows an overall mean of 4.2833 of all the assessed benefits.

Table 4.38: Benefits associated with RP&L (Summary of Means)

	Mean	Min	Max	Range	Variance	N of Items
Item Means	4.2833	3.860	4.600	0.740	0.199	9

Source: (Author, 2016)

Table 4.39: Benefits associated with RP&L (Relative Importance Index)

S/No.		N	RII	Rank
1	Balanced resources, reducing over allocations or overtime	79	0.9165	2
2	Determines or predicts resources needed	79	0.9139	3
3	Helps maintain the lowest uniform number of employees to perform the work.	79	0.8557	4
4	Establishing plans for material delivery.	79	0.9215	1
5	Reduced project costs	79	0.8456	6
6	Reduced cost of learning and improved learning curve	78	0.7667	9
7	Enhanced overall organizational strategic planning	78	0.8513	5
8	Reduction of errors	78	0.8256	7
9	Increased workers' morale due to guaranteed job security	79	0.7772	8

Source: (Author, 2016)

The researcher further carried out an analysis of the same benefits using the Relative Importance Index. The results, as per table 4.39 above indicated that the most significant benefit realized by contractors when carrying out Resource Planning and Leveling was "Establishing plans for material delivery" with a RII of 0.9215. Other benefits in descending order were: "Balanced resources, reducing over allocations or overtime" (RII=0.9165); "Determines or predicts resources needed" (RII=0.9139); "Helps maintain the lowest uniform number of employees to perform the work" (RII=0. 0.8557); "Enhanced overall organizational strategic planning" (RII=0. 0.8513); "Reduced project costs" (RII=0.8456); "Reduction of errors" (RII=0.8256); "Increased workers' morale due to guaranteed job security" (RII=0.7772) and lastly "Reduced cost of learning and improved learning curve" (RII=0.7667) These results indicate that all the respondents' are in agreement that the assessed factors are significant benefits realized in Resource Planning and Leveling.

A comparison between the two methods of analysis showed similar ranking in the first four and last three benefits presented to the respondents. While the method of means produced a tie in the fifth position, the RII ranking did not.

4.4.5 Objective 5: Views of construction industry players.

The aim of objective five was to seek the views of the construction industry players regarding the impact of resource planning and leveling on construction project performance.

4.4.5.1 Effect of Resource Planning and Leveling on Cost of a Project.

Respondents were asked to indicate to what extent Resource Planning and Leveling contributed to reduced cost of a project. The results were tabulated below.

Table 4.40: Effect of RP&L on Cost of a Project (Frequencies)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**Moderate**	4	4.9	5.0	5.0
	High	34	42.0	42.5	47.5
	Very High	42	51.9	52.5	100.0
	Total	80	98.8	100.0	
Missing	**System**	1	1.2		
Total		81	100.0		

Source: (Author, 2016)

From the table 4.40 above, when respondents were asked to rate the extent to which they thought Resource Planning and Leveling contributed to reduced cost of a project, 5.0% responded “Moderate”, 42.5%, “High”, and 52.5%, “Very High”. These responses produced a mean of 4.48 as indicated in table 4.41 below. It is clear from this that an overwhelming majority of contractors in the country share similar opinion that Resource Planning and Leveling contributes to reduced cost of a project.

Table 4.41: Effect of RP&L on Cost of a Project (Mean)

	N	Minimum	Maximum	Mean	Std. Deviation
Reduced project cost	80	3	5	4.48	.595

Source: (Author, 2016)

As discussed in the literature review, project cost is one of the parameters used to measure project performance. Reduced cost of a project translates to an improved project performance.

4.4.5.2 Effect of RP&L on Duration of a Project.

From the table 4.42 below, when respondents were asked to indicate to what extent Resource Planning and Leveling contributed to reduced completion period of a project , 15.0% responded “Moderate”, 40.0%, “High”, and 45.0%, “Very High”.

Table 4.42: Effect of RP&L on Duration of a Project (Frequencies)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**Moderate**	12	14.8	15.0	15.0
	High	32	39.5	40.0	55.0
	Very High	36	44.4	45.0	100.0
	Total	80	98.8	100.0	
Missing	**System**	1	1.2		
Total		81	100.0		

Source: (Author, 2016)

These responses produced a mean of 4.30 as indicated in table 4.43. It is clear from these results that majority of contractors in the country are of the opinion that Resource Planning and Leveling (RP&L) contributes to reduced completion period of a project.

Table 4.43: Effect of RP&L on Duration of a Project (Mean)

	N	Min	Max	Mean	Std. Deviation
Reduced completion period	80	3	5	4.30	.719

Source: (Author, 2016)

4.4.5.3 Effect of RP&L on Quality of a Project.

Respondents were asked to indicate to what extent Resource Planning and Leveling contributed to improved quality of a project. The results were tabulated below.

Table 4.44: Effect of RP&L on Quality of a Project (Frequencies)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**None**	1	1.2	1.3	1.3
	Moderate	9	11.1	11.3	12.5
	High	43	53.1	53.8	66.3
	Very High	27	33.3	33.8	100.0
	Total	80	98.8	100.0	
Missing	**System**	1	1.2		
Total		81	100.0		

Source: (Author, 2016)

Table 4.45: Effect of RP&L on Quality of a Project (Mean)

	N	Min	Max	Mean	Std. Deviation
Improved project quality	80	1	5	4.19	.731

Source: (Author, 2016)

From the table 4.44 above, when respondents were asked to rate the extent to which they thought Resource Planning and Leveling contributed to improved quality of a project, 1.3% responded “None”, 11.3%, “Moderate”, 53.8%, “High”, and 33.8%, “Very High”. These responses produced a mean of 4.19 as indicated in table 4.45

above. It is clear from these results that most contractors in the country share similar opinion that Resource Planning and Leveling contributes to improved quality of a project.

4.4.5.4 Effect of RP&L on Overall Performance of a Project.

Atkinson, (1999) and Lim & Mohamed, (1999) agree that cost, time and quality are the three most important success indicators of construction projects. When both reduced project time and cost are achieved without compromising on the quality of the works, the project is said to be a success.

Table 4.46: Effect of RP&L on Overall Project Performance

Items	Mean	Min	Max	Range	Variance	N
Reduced project cost ;Reduced completion period; Improved project quality	4.321	4.18	4.47	0.288	0.021	3

Source: (Author, 2016)

Results above (table 4.46) therefore indicate that when contractors practised Resource Planning and Leveling in their respective projects, there was improved performance.

4.4.5.5 Overcoming challenges associated with RP&L

Respondents made 97 suggestions as possible solutions to overcoming challenges associated with Resource Planning and Leveling (RP&L). The researcher critically reviewed these solutions and grouped them into themes namely: technical; financial; resource management; project planning and control; top management involvement; communication and others. The classification of respondents' suggestions was as follows: technical, 50 (52%); financial, 3 (3%); resource management, 7 (7%); project planning and control, 14 (14%); top management involvement, 7 (7%); communication, 3 (3%) and others, 13 (13%).

a) Technical factors

As suggested by Chonge (2016), technical capability involves the availability of technical personnel to execute works and the availability of plant and equipment to aid in the process of undertaking the works. The researcher established 57 suggestions which could be grouped under technical issues. Out of these suggestions 20 of them (33%) were directly related to technical capacity in terms of personnel. Majority of these suggestions touched on staff training and engagement of technically qualified employees to carry out works.

The following is a list of all suggested solutions proposed by respondents and listed by the researcher under technical factors. All these factors seemed to be addressing the first challenge (technical incompetence) in the questionnaire presented to the respondents.

Some of the solutions under this category include: Integration of all levels of employees in the resource planning and train them in preparation of the same, both manually and using software; Employment of skilled workers with ability to use PM tools such as MS project; Employment of trained qualified Construction Managers to run sites; Ensuring involvement of qualified professionals in the project delivery process who appreciate the importance of resource planning and leveling; Engagement of a qualified person who understands the construction processes and concepts, and has the technical know-how to be doing resource planning and levelling; Staff training on planning software; Retaining of qualified personnel and operatives for future projects; Establishment of an effective training program.

Other factors include: Document completed projects accordingly and use them as case studies to predict and forecast similar projects accordingly; Using simple tools such as site records and daily updates opposed to MS Project; Quality control through detailed instructions on output; Competent site manager and regular site visits for self-assessment; Improve ICT skills in contractor firms to learn resource planning tools; Delegate the role of resource planning and levelling to specific people in a firm as this

will make it less tedious since it will be the duty of the specific persons and not everyone's responsibility; Use of Project Management Software such as MS Project in resource planning and levelling to make it less tedious; Consideration of several alternative analyses when doing resource planning and levelling; Critical path method; Optimizing method; Incorporating Project Managers in construction companies with administrators following up decisions made by Project Managers; Increased involvement by project coordinators and site agents in planning; Proper documentation of site progress reports; Proper delegation of works; Well defined scope of project at the commencing stage of project and Scenario forecasts.

The following solutions were also suggested by the respondents in this study: Increased I.C.T Compliance; Disclosure of project details to the project manager especially resources as it gives a better analysis of possible ways to solve shortages in resource; Undertake resource mapping; Keenly going through the project scope and identify all resources involved and have them in good time for every project task/activity; Developing a detailed risk, resource, financial and quality plan during project planning phase; strategizing on principles for developing, utilizing and conserving human resources Identification of strengths and weaknesses of labor force; Overall participation by core project management team members to ensure all aspects of the project are taken care of; Proper project definition to ascertain the exact resources requirements and especially where resources are shared among several projects; Companies to come up with their own systems of resource planning and leveling, educate and make strict follow-ups of the same to their employees.

b) Financial factors

The following suggestions were made by respondents as possible solutions to financial related challenges: Prompt payment to the contractor; Minimizing delays in payment of workers and also guarantee the job security so as to increase their morale; Develop financial management and budgetary skills and finally giving incentives to workers.

c) Resource Management factors

The respondents highlighted the following to be solutions to problems related to resource management issues: Adherence to the resource leveling and planning strategies set; Having surplus materials (which can still be used in future areas of project) on site for unseen; Reliance on multiple sources for materials; Ensuring availability of resources at all times for effective planning; Frequent servicing of equipment and machines to avoid unnecessary breakdowns and having sufficient site managers and supervisors.

d) Project planning and control factors

A number of factors listed by the respondents were grouped into project planning and control factors category. These included: Proper coordination between the drafters and implementers; Ensuring there is full cycle cooperation during resource planning among various departments in a contractor's office such as procurement, accounts, project management and site team; Keeping track of the resource graph as the project continues to level where necessary; Constant vigilance in monitoring project schedules; Consistent periodic reviews on the trends and immediate necessary actions; Follow up in planning so that it's not all in vain; Timely planning; Breaking down the tasks into simple actionable activities for foremen on site for ease of execution and follow up; Grouping tasks that require similar resources; Breakdown of the whole project into workable, realistic, strategic and sequential work breakdown structure for easy planning and levelling of resources; Developing adequate project brief in early stages of the project; Proper planning; Having contingency plans and advance planning of activities in future using the programme of works.

e) Management related factors

Factors related to management involvement included: Ensuring there is full cooperation and commitment by management; Sensitize top level management on the importance of investing in a program of works and organized resource allocation

reports; Involve clients and top management and administration in the RP&L process. This way, it will be adapted by all at any level of management thus making it easy for the whole firm to adapt these techniques; Ensure that the top management are skilled and have knowledge about the work to be done.

f) Communication related factors

Factors categorised under communication included: Raising any issues immediately they occur and addressing them with all parties to come up with solution and creating more awareness about the subject matter.

g) Other factors

Factors which could not be grouped in any of the above themes included: Ensuring that resource planning is carried out before projects, during the projects and after the projects to ensure it is effective; The resource planning should be conclusive and carried out on all areas that affect the projects; Prepare early enough for the project to be undertaken; Good site records on resources; Proper procurement schedules; Consistency during implementation; Planning earlier before site activities commence; Increased awareness within all industry practitioners on the importance, and hence emphasis on Resource Planning and Leveling; Emphasis on incorporation of the same at the early stages of project conception, scope identification and planning to enable benefits trickle down from the very beginning of project implementation; Introduce course units on the same at undergraduate level; Mandatory and statutory enforcement from local and national authorities; and sensitization of construction industry players.

4.4.5.6 Is RP&L a contributor or hindrance to project success?

When respondents were asked to give their opinion on whether Resource Planning and Leveling a contributor or hindrance to project success, 98% of supported the idea that (RP&L) was a contributor to project success. The remaining 2% claimed that it was both a contributor and hindrance depending on how much emphasis is paid to the process. Respondents with this opinion claimed that too much emphasis on Resource

Planning and Leveling may have a negative impact on the project. Projects always take a life of their own so adaptability of the plans should keep up. They also argued that implementing a strict resource leveling plan on site may cause working conditions to be too constrained for project success. This argument has been supported by Love, (2008) by asserting that investing in planning activities beyond an optimum point results in an increase in overall project costs.

Respondents were also asked to explain how Resource Planning and Leveling contributed or hindered project success. 69 reasons were given to support the fact that Resource Planning and Leveling contributes to project success. These factors were analysed thematically under the following project aspects.

a) Scope management factors

Scope management involves ensuring all the client requirements are met as stipulated in the project brief and that there is no deviation from such. Factors listed under this category included: Clear definition of project path with respect to resources; It defines the most efficient procedural process to adapt so as to deliver a project successfully; It helps stick to the project scope and it clearly outlines the scopes and timelines thus helping avoid overstretching or under stretching the project's scope.

b) Schedule management factors

Schedule management is concerned with ensuring that the project is completed on time. Factors raised by respondents and related to schedule management include: It helps develop a large scope of plan for work activities ahead of time hence resources can be planned for in advance hence reducing delays; Enhances timely completion of projects by ensuring less or no delays in details or material delivery; Resource levelling is a major contributor to project success as it ensures all activities and events and milestones are met within the specified time limits; Helps avoid overrun in time and also straining of resources; Required man power and equipment is determined at an early stage thus reducing waste of time; Resource Leveling is a contributor to project success through

development of stable and efficient use and distribution of resources over project time; It provides a framework through which the project will completed using the least available resources and in the shortest time possible; Helps the project manager avoid delays caused by bad allocations; Helps the project manager identify and take advantage of unused times by analysing task dependencies; Brings scheduling flexibility; Availability of resources at the required times ensures smooth flow of work; It reduces project delays thus minimising contract disputes between client and contractor; and lastly it helps define clear timelines for successful completion of any project

c) Cost management factors

Cost management related factors included: Enhances proper allocation of labour and equipment hence cutting down the cost of production; Given the method minimizes resource fluctuations, its therefore cost effective; By better and efficient use of resources which will bring a financial saving and easy work flow for the contractor and eventually the client; and reduced wastage of materials.

d) Quality management factors

Respondents claimed that very high improved workmanship in conjunction with proper supervision and that RP&L contributes to project success by ensuring better quality of work.

e) Integration management factors

Resource Planning and Leveling ensures that each employee is aware of their role thus enabling smooth coordination of project.

f) Stakeholder management factors

Resource leveling contributes to a project's success through enabling top management to avail enough funds for a given period in order to achieve targets for certificate application.

g) Risk management factors

Risk management associated factors included: Forecasting hence identification of probable risks; it's a contributor to project success, for the simple reason that planning reduces uncertainty or help mitigate the effect of risks of delays or lack of resources. When resources are unplanned, project execution is largely left to the idiosyncrasies of individual managers with real potential of detrimental effect; It contributes to success by foretelling likely problems to be encountered thereby enabling the management to prepare well; It's a contributor to project success since a project manager is able to identify risks and resolve them earlier, hence the project will be complete on time as per the initial schedule.

h) Resource management factors

Resource Planning and Leveling enables improved resource management through: Reduced wastage of resources; With resource leveling, a project utilizes resources allocated to a maximum; It also reduces downtime; It also enables the project manager to track labour depending on the clustered tasks at hand; It ensures that resources are available at the required time for project use; By carrying out resource levelling, maximum utilization of available resources is achieved, reducing wastage and maintaining the allocated budget; Helps in balancing skilled labor, material being delivered in time and ensuring machines are in good condition; It enables proper planning of resources, minimizes waste and idle resources and enable optimization of available resources; It helps make the most of available resources thus ensuring utilization of resources consistently throughout the project; Identifies project resource gap according to resource numbers, skills and work hours; Creates a realistic estimation of your project resource needs; help in avoiding overutilization/underutilisation of specific resources; It ensures optimal allocation of resources to the tasks at hand and thus avoiding wastage (idle labour/plant); When resources are well planned, they are available at the right time, right quantity minimizing wastage and extra costs, right type, quality hence leading to success; It increases efficiency when undertaking the project by

utilizing the available resources to the maximum and lastly RP&L helps avoid straining of resources.

i) Others

Factors grouped under this category included: it enhances efficiency and improve delivery in a project; Creates competence within the project; Acts as an enhancer and tracker to project resources ensuring balanced and effective flow to success; Helps in management of cash flow & prioritization of critical path deliverables; A very important tool for contract administration; A Contributor due to higher level of organization and allocation of resources; and it ensures any unforeseen challenges can be corrected through fast tracking, crashing or increasing labour among other methods to level the resources

4.4.5.7 Optimal Resource Planning and Leveling strategy

An optimal Resource Planning and Leveling Strategy (RP&LS) has been presented in Figure 4.13. The strategy comprises of three major phases namely; pre-planning, resource planning and resource leveling. A number of activities should be undertaken at each of those stages.

a) Pre-Planning Phase

This involves the activities which ought to be carried out before the actual Resource Planning. These include a number of factors (not in any order) which should be considered even before a firm decides to undertake Resource Planning. The first consideration would be top management support. Most of the respondents agreed that without top management support, the Resource Planning exercise would be impossible. This is confirmed in the results from table 4.21 which showed a positive relationship between the extent of top management support and the extent of Resource Planning.

The second factor to be considered in this stage would be the firm's technical capacity. Technical incompetence was considered a major challenge in the process of undertaking

Resource Planning and Leveling. As seen in Table 4.34, respondents ranked it as the most significant challenge with a mean of 4.38. It was not surprising that majority of the solutions provided by respondents were geared towards improving the technical capacity of the firm.

The four most prevalent considerations under technical capacity as raised by respondents were; academic qualifications, training, experience and personnel integration into the Resource Planning and Leveling process. Before a contractor can decide to undertake Resource Planning and Leveling, they should ensure that they have personnel who are academically qualified, properly trained, possess adequate experience and have been fully integrated into the system such that they are fully aware of all resource management aspects.

ICT compliance is another major consideration in this stage. Microsoft Project was ranked the second most popular Resource Leveling technique with a mean of 3.59 as seen in table 4.32. As seen in table 4.33, respondents also ranked it as the second most effective Resource Leveling technique with a mean of 4.08. With this in mind, it would only then be prudent for the contractor to be ICT compliance since Microsoft Project is an ICT based software.

Most respondents indicated that the level of project documentation was an important factor influencing the process of Resource Planning with a mean of 3.69 as seen in table 4.26. Andersen *et al.* (2006) as cited by Tabish and Jha (2011) observed that when projects are properly documented and understood by the contractor, the managerial ability to deliver results improves and this results into improved cost performance of the project. Detailed documentation of a project during the planning stage enables the contractor to understand all aspects related to resource management and execute it efficiently.

The type of procurement used in any project has an influence on the process of Resource Planning and Leveling. Procurement methods which involve an overlap in the design and construction phases may limit the extent to which Resource Planning and Leveling is carried out. Respondents in this study considered the type of procurement to be a significant factor influencing Resource Planning with a mean of 3.52 as shown in table 4.26.

b) Resource Planning Phase

Effective Resource Planning can only be achieved once all the requirements mentioned in the pre-planning stage are considered and fulfilled. This stage has been broken down into two phases; knowledge of Resource Planning techniques and execution of actual Resource Planning. The contractor needs to understand the benefits obtained from executing Resource Planning as this would be key in motivating the contractor to invest heavily (in terms of time and resources) in the process. The contractor should also be aware of the challenges likely to be encountered and the possible solutions to such challenges.

Effective execution of Resource Planning can only be done if the contractor has identified possible challenges and established solutions. Resource Planning should be carried out in all the main categories of resources namely; equipment, labour and materials. Two critical factors established from the results obtained from respondents were adequacy and reliability of the resources. These results are in line with the line of thinking adopted by Mendoza, (1995) when he suggests that if any project plan and schedule are to be achieved, then it is necessary to ensure that the required labour, material and equipment will be available when required and in the right quantities.

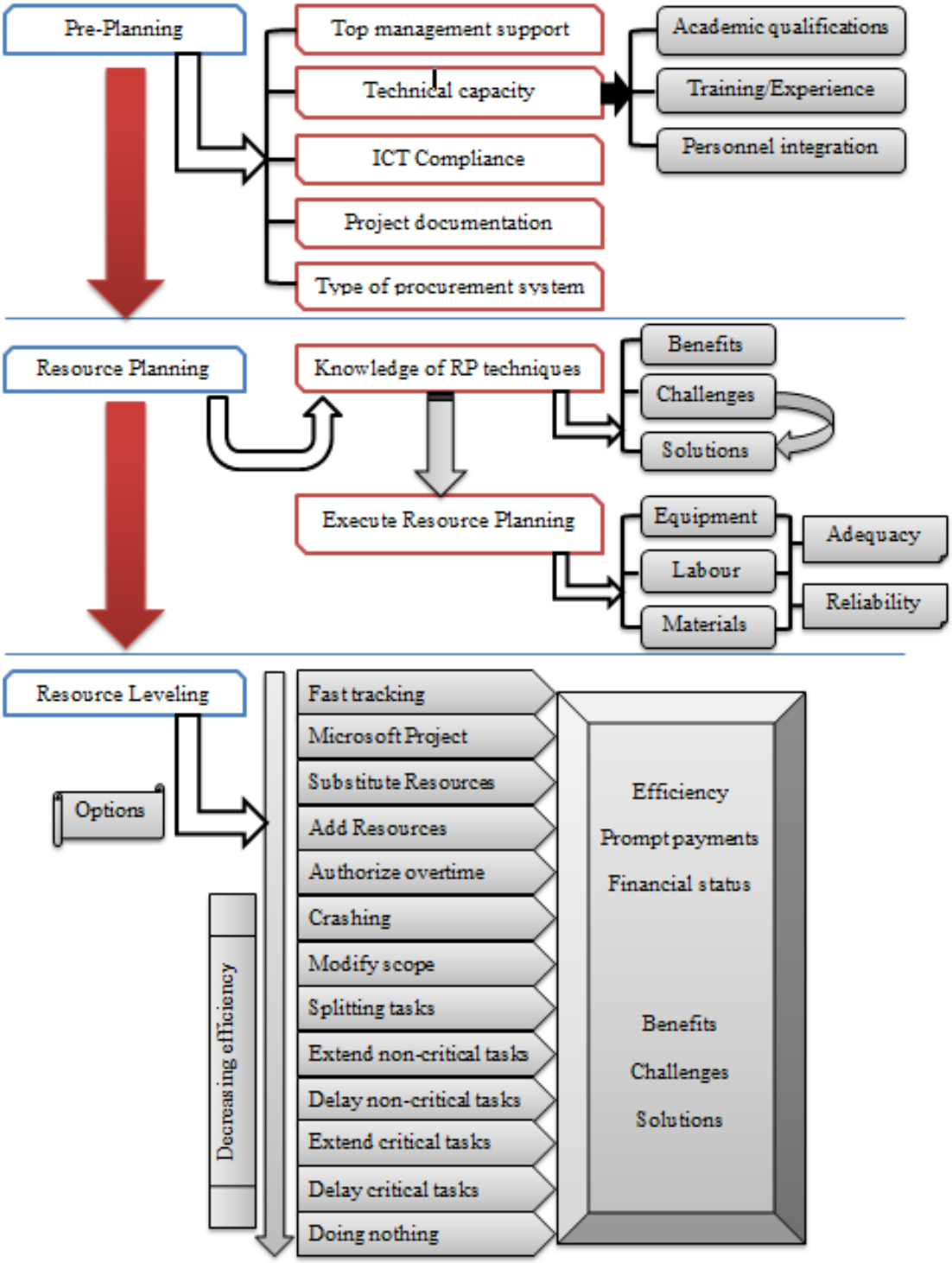

Figure 4.13: Optimal resource planning and leveling strategy (RP&LS)

Source: (Author, 2016)

a) Resource Leveling Phase

Once the Resource Planning has been carried out, the contractor should not stop there. Instead, he should go further and carry out Resource Leveling. This ensures that resources are balanced, not strained and maximum use is made of them. The contractor should be aware of the various alternatives available for Resource Leveling and these include (in descending order of effectiveness as suggested by contractors): fast tracking; Microsoft project; substitute resources; add resources; authorizing overtime; crashing; modifying scope; splitting tasks; extending non-critical tasks; delaying non-critical tasks; extend critical tasks; delay critical tasks and doing nothing.

The contract should be aware of the benefits, challenges and solutions to those challenges associated with Resource Leveling process. The contractor should also understand the various efficiencies associated with different Resource Leveling techniques to be able to make a wise decision. The financial status of a contractor determines the method employed by the contractor in leveling resources. Financial status of the firm was considered to be the most significant factor influencing Resource Planning and Leveling with a mean of 4.19 and a RII of 0.8390 as seen in tables 4.27 and 4.29 respectively. Prompt payments in projects was also found to be an important factor influencing Resource Planning and Leveling with a mean of 3.97 as seen in table 4.26.

Consideration of the above factors (benefits, challenges, solutions, efficiency, financial status and prompt payments) by contractors is extremely important if they are to settle at the best-suited Resource Leveling techniques for their firms.

4.4.5.7.4 Evaluation of Suggested Framework

The proposed framework or strategy was evaluated by a panel of experts in the field to establish its effectiveness through a Delphi process. The Delphi technique is an extensively used and accepted method for obtaining data from professionals within their

domain of expertise (Hsu & Ohio, 2007). According to the same authors, this technique has been used in a wide range of fields such as policy determination, needs assessment, program planning and resource utilization to correlate judgements on a topic. It is for this reason that the researcher settled for this type of evaluation for the proposed strategy.

The experts for participation in the Delphi process were selected based on a number of criteria. These included:

a) Participation in the pilot study; based on this criterion, three contractors were selected.
b) Participation in the main data collection; four contractors were selected
c) More than 10 years of experience in the construction industry; three consultants (Project Managers) were selected

On a likert scale, the following attributes were presented to the experts for their review of the developed framework: applicability, suitability, simplicity, relevance, clarity, adaptability and universality. The following results were obtained.

Table 4.47: Delphi process results

No.	Attribute	N	Min.	Max.	Mean
1	Applicability	10	4	5	4.23
2	Suitability	10	3	5	4.08
3	Simplicity	10	3	5	3.88
4	Relevance	10	4	5	4.35
5	Clarity	10	4	5	4.11
6	Adaptability	10	3	5	3.98
7	Universality	10	4	5	4.33

Source: (Author, 2016)

Given the high means obtained from analysis of results obtained from the Delphi process, the author therefore concluded that the developed framework was applicable, suitable, simple, relevant, clear, adaptable and universal for use in the Kenyan construction industry for resource planning and leveling.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The purpose of this research was to study the resource planning and leveling (RP&L) approaches adopted by contractors in Kenya and the factors influencing the adoption of such techniques. The study was structured in five objectives namely: to explore the practice of resource planning and leveling among contractors in Nairobi; to evaluate significant factors influencing resource planning in projects by contractors; to evaluate the various resource leveling techniques employed by contractors; to evaluate challenges and benefits associated with resource planning and leveling and to explore the views of the construction industry players regarding the impact of resource planning and leveling on construction project performance.

To achieve the above listed objectives, a survey research design was adopted by the researcher whereby questionnaires were used to collect data from randomly selected respondents. The data obtained from these questionnaires was both quantitative and qualitative and was thus analysed quantitatively and qualitatively respectively. This chapter comprises of conclusions and recommendations based on these analyses of data obtained for the field.

5.2 Summary of Findings

5.2.1 Objective 1: The practice of RP&L among contractors

As seen in table 4.6, the means for the extents of resource planning by contractors in the categories of Equipment/Plant, Labour and Materials were 3.67, 3.94 and 4.23 respectively. This indicates that contractors in the Kenyan construction industry carry out extensive resource planning in all major categories of resources. However, from the results given in figure 4.8 and the explanation given in the previous chapter, it would be

correct to conclude that majority of the contractors in the Kenyan construction industry practise an informal/unwritten method of resource planning. The mean for the extent of support from top management regarding Resource Planning was 3.38 as seen in table 4.8. This was considered to be low for the reasons given in chapter four.

Project Managers were the most popular preferred choices for carrying out Resource planning with a frequency of 43.8%. the academic qualification of those bestowed the responsibility of Resource planning was found to be adequate since 87.6% of the firms interviewed engaged professionals with a bachelor's degree as the minimum qualification. Regarding the educational background, 85.1% of the firms were found to engage personnel who had a background in construction related education in Resource planning.

Considering the relative importance index (RII) figures of 0.8625 (Identify the roles and key responsibilities for each labor type), 0.8765 (Identify the number of people required to fill each role), 0.8716 (Identify the Items of equipment to be used and their purposes), 0.8765 (Identify the types and quantities of equipment needed) and 0.8988 (Identify the total amount of materials needed) as seen in table 4.18, it would only be fair to suggest that all respondents were in agreement that all factors presented to them were critical reasons for undertaking Resource Planning & Leveling.

Results in table 4.14 indicated that projects carried out by respondents' firms were more likely (3.11) to be affected by delayed material compared to lack of labour (2.68) and lack of equipment (2.68). This means that contractors need to employ strategies which ensure that materials are availed to sites in good time to avoid negative impact on the project schedule.

Contractors performed well in relation to the extent they carried out Resource Leveling. This is shown by an impressive overall mean of 3.95 as shown in table 4.18. Majority of these contractors were also found to carry out structured Resource Leveling.

Table 4.19 in chapter four indicated a spearman's correlation coefficient of 0.225 between the age of firms and extent of carrying out Equipment Resource Planning; 0.108 between the age of firms and extent of carrying out Labour Resource Planning and 0.172 between the age of firms and extent of carrying out Material Resource Planning. This means that older construction firms practice more Resource Planning compared to younger firms. The same conclusion could be made regarding Resource Leveling as seen in table 4.19.

Results shown in table 4.21 indicated a spearman's correlation coefficient of 0.275 between the extent of top management support and extent of carrying out Equipment Resource Planning; 0.079 between the extent of top management support and extent of carrying out Labour Resource Planning and 0.162 between the extent of top management support and extent of carrying out Material Resource Planning. These results revealed that increased Resource Planning can only be achieved if there is increased support from top management. Increased Resource Leveling in the industry will also be realised if the top management in firm is willing to support the exercise.

Results from table 4.24 indicated a negative relationship between affected project progress due to delayed materials and Extent of Material Resource Planning. This means that increased planning of material resources results to reduced delays resulting from delayed material deliveries on sites. Similar relationship between affected project progress due to lack of labour and Extent of Labour Resource Planning was interpreted to mean that increased planning of labour resources results to reduced delays resulting from lack of labour on sites.

5.2.2 Objective 2: Factors influencing RP in projects by contractors.

There seemed to be consensus among the respondents regarding the following factors influencing Resource Planning: Financial status of the contractor (RII=0.8390); adequacy of labour (RII=0.8308); adequacy of plant and equipment (RII=0.8304); presence of qualified personnel (RII=0.8152); prompt honouring of payments

certificates (RII=0.7901); level of project documentation (RII=0.7410); compliance with safety procedures (RII=0.7154); type of procurement system (RII=0.6949); weather (RII=0.6127) and contractor's ICT Compliance (RII=0.5897). The most significant factor was financial status while the least important was contractor's ICT Compliance.

5.2.3 Objective 3: RL techniques employed by contractors

The three most popular Resource Leveling techniques employed by contractors were found to be fast tracking, Microsoft Project and authorizing overtime. The three least popular Resource Leveling techniques were found to be splitting tasks into non sequential pieces, splitting tasks into non sequential pieces and doing nothing.

The three most effective Resource Leveling techniques as experienced by contractors were found to be fast tracking, Microsoft Project and substituting resource of equal or greater capability. The three least effective Resource Leveling techniques were found to be extending critical path tasks, delaying critical path tasks and doing nothing.

Contractors were generally found to be aware of the different available options for Resource Leveling. The techniques found to be least effective in practice are theoretically known to have the highest negative impact on the project schedule. This reinforces the idea that contractors are not only aware of the various resource leveling techniques existing in theory but also understand their effects on the project performance.

5.2.4 Objective 4: Challenges and benefits associated with RP&L.

Contractors were found to experience serious challenges in their quest to execute Resource Planning and Leveling in their projects. The challenges established from this study in order of reducing severity are: project delays; technical incompetence; materials shortages or late delivery; plants, equipment's & machine breakdown/inadequacy; contract disputes; poor work definition & inadequate project

documentation; project risks & uncertainty; lack of commitment by top level management; tedious exercise; contractors ICT compliance challenges; site storage constraints and lastly absenteeism of workers/shortage of craftsmen. These results indicate that all the respondents' are in agreement that the assessed factors are significant challenges encountered in Resource Planning and Leveling.

A number of benefits were found to entice contractors to carry out Resource Planning and Leveling in their projects. The most important benefits in descending order were: establishing plans for material delivery; balanced resources, reducing over allocations or overtime; determines or predicts resources needed; helps maintain the lowest uniform number of employees to perform the work; enhanced overall organizational strategic planning; reduced project costs; reduction of errors; increased workers' morale due to guaranteed job security and lastly reduced cost of learning and improved learning curve.

The multiple regression analysis revealed that higher levels of Resource Planning are associated with higher levels of adequacy of labour and equipment, ICT compliance, high level of project documentation, high financial status, prompt payments, type of procurement, identifying the number of people required, establishing quantities of equipment, quantification of amount of materials.

The analysis also revealed that higher levels of Resource Planning were associated with lower levels of Compliance with safety, unqualified personnel, bad weather, technical incompetence, perception that it is a tedious exercise, materials shortage, project delays, lack of commitment, site storage constraints, project risks, equipment breakdown, poor documentation, contract disputes, absenteeism of workers and ICT challenges.

5.2.5 Objective 5: Views of construction industry players.

An overwhelming majority of contractors in the country shared similar opinion that Resource Planning and Leveling contributes to reduced cost of a project, reduced completion period of a project and improved quality of a project. This means that

Resource Planning and Leveling generally contributes to improved performance of construction projects.

Qualitative data obtained from open ended questions was analysed thematically. A total of 97 possible solutions were suggested by respondents as solutions to overcoming challenges associated with Resource Planning and Leveling. These solutions were grouped into a number of themes namely: technical (52%); financial, (3%); resource management, (7%); project planning and control, (14%); top management involvement, (7%); communication, (3%) and others, (13%).

98% of the contractors suggested that RP&L was a contributor to project success. The remaining 2% claimed that it could both be a contributor and hindrance depending on how it was carried out. Contractors proposed different ways in which RP&L could contribute to project success. These were also analysed thematically under the following topical areas: scope management (6%); schedule management (28%); cost management (14%); quality management (3%); integration management (1%); stakeholder management (1%); risk management (7%); resource management (23%) and others (16%).

5.2.6 Optimal Resource Planning and Leveling strategy

The proposed framework takes cognisance of the prevailing conditions in the Kenyan construction industry and how these conditions correlate. The strategy integrates a number of factors and various methodologies available for Resource Planning and Leveling to provide a road map for contractors in executing efficient resource management. Use of this framework will go a long way in ensuring contractors accomplish projects efficiently and profitably.

This strategy can be applied by all contractors in the Kenyan construction industry as it was proven to be adaptable and universal. The only limitation which could be attributed to this model is that a technically competent person is required to manage and

customize the model to suit any unique conditions relating to a particular project. However, the above limitation can easily be overcome since one of the ingredients of this model is employment of technically competent personnel to run and manage projects.

5.3 Conclusions

The following general conclusions were made from the summary of findings.

- Resource Planning and Leveling is practiced more in older firms and in firms where there is support from the top management.
- Despite contractors carrying out Resource Planning, construction projects' progress continue to be affected by delayed materials, lack of labour and lack of equipment at the points of need.
- The three most important factors influencing Resource Planning by contractors are; financial status of the contractor, adequacy of labour and adequacy of plant and equipment.
- Contractors are not only aware of the various resource leveling techniques existing in theory but also understand their effects on the project performance.
- Contractors face a number of challenges when undertaking Resource Planning and Leveling. The three most severe challenges are; project delays, technical incompetence and materials shortages or late delivery.
- Contractors are in consensus that Resource Planning and Leveling contributes to overall success of construction projects not only in the three main aspects of projects namely; time, cost and quality but also other dimensions such as scope management, integration management, stakeholder management, risk management, resource management among others.

5.4 Recommendations of the Study

The following recommendations were made

- All levels of employees should be integrated in the resource planning and leveling exercise. Labourers employed in construction sites should also be properly trained on the benefits of resource planning and leveling. This will help improve their morale.
- Projects should be properly documented before the construction phase. This will enable project planners to estimate accurately the project resource needs and prepare a reliable resource plan.
- In todays' changing times in terms of technology, contractors should work towards improving their ICT competence. They should also train their employees on planning software such as MS. Project.
- Contractors should be paid promptly by clients. This will give them the financial capability to obtain resources as ad when required in the resource plans.
- There should be close coordination between those undertaking the resource planning in offices and those managing the resources on site. This will ensure contractors work with realistic resource plans.
- Top management should be fully involved in the Resource Planning and Leveling process. This ensures resource plans prepared are followed through as finances are availed in good time to implement them.

5.5 Areas of further research

In the course of undertaking this research work, the researcher came across areas which he felt no academic work had been provided by researchers concerning them but could not be studied in this research since they did not fall within the scope of the objectives set out in chapter one of this document. These areas include;

1. A statistical correlation on the impact of Resource Planning and Leveling on construction project performance by contractors in Kenyan construction industry. While this study sought views of contractors regarding the impact of Resource Planning and Leveling on construction project performance, there is need for a study to establish statistically the relationship between these variables.
2. The effect of choice of project delivery method (procurement) on the process of Resource Planning and Leveling.
3. The impact of delayed interim payments on the process Resource Planning and Leveling by contractors in the Kenyan construction industry.
4. A longitudinal study in 5 years to establish patterns and trends in the Kenyan construction industry regarding Resource Planning and Leveling by contractors

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APPENDICES

Appendix 1: Questionnaire Cover Letter

JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY
SCHOOL OF ARCHITECTURE AND BUILDING SCIENCES (SABS)
DEPARTMENT OF CONSTRUCTION MANAGEMENT

18th July, 2016

TO WHOM IT MAY CONCERN

RE: REQUEST TO ADMINISTER MY QUESTIONNAIRE AT YOUR SITE

Dear Respondent,

I am a postgraduate student from the above mentioned institution pursuing a degree of Masters in Construction Project Management. I'm currently undertaking my research thesis titled *"**IMPACT OF RESOURCE PLANNING AND LEVELING ON CONSTRUCTION PROJECT PERFORMANCE**"*as a course requirement. The research aims at contributing to improved construction project performance for the benefit of all stakeholders within the industry.

This questionnaire is intended to help me collect information which is essential and will enable me successfully complete my study. You have been identified as a critical player in this field and a credible source of data. Your input in this study would be most valuable.

Kindly respond to the attached questionnaire as honestly and precisely as possible, to the best of your knowledge and understanding. You are not to include your personal data such your name and contacts.

Please note that as a respondent, you are guaranteed of confidentiality. Additionally, this questionnaire will be used for academic purposes only.

Thanks in advance.

Yours faithfully,

Shadrack Mutungi Simon,
Student, Masters in Construction Project Management.
(Cell Phone: 0735 659 232 or 0723 819 874; Email: mutungisimon72@gmail.com)

Appendix 2: Questionnaire

TITLE: FACTORS INFLUENCING ADOPTION OF RESOURCE PLANNING AND LEVELING AMONG CONTRACTORS IN THE KENYAN CONSTRUCTION INDUSTRY

SECTION A: DEMOGRAPHIC DATA

Please provide the following information about yourself and the firm. Kindly put a tick (√) in the box next to the selected response. ***An appendix has been provided at the end of the document defining all the technical terminologies***.

1) **Kindly tick your role in this firm/project?**

   [ ] Contractor [ ] Construction Manager [ ] Quantity surveyor [ ] Architect [ ] Civil & Structural Engineer [ ] Site Engineer [ ] Site Agent [ ] Foreman [ ] Others (state please)……

2) **Kindly tick your educational specialization?**

   [ ] Architecture [ ] Construction Management [ ] Quantity surveying [ ] Civil & Structural Engineering [ ] Building Technology [ ] Land surveying [ ] Business administration [ ] Project management [ ] Accounting [ ] Others (state please) …….

3) **Kindly indicate the management level of your status in the firm**

   [ ] Top Level management [ ] Middle Level management [ ] Lower Level management

   [ ] Others (state please)…….

4) **Please indicate the type of project currently undertaking**

   [ ] Residential [ ] Office [ ] Industrial [ ] Mixed Use Development [ ] Institutional

   [ ] Others (state please)……

5) **For how long has your firm been in the industry?**

[ ] Up to 5 years [ ] 6 - 10 years [ ] 11 - 15 years [ ] 16 - 20 years [ ] More than 20

6) **Please indicate the number of full time staff in your firm**

[ ] Less than 20 [ ] 20 – 40 [ ] 41 – 60 [ ] 61 – 80 [ ] 81 – 100 [ ] More than 100

7) **In which category does your firm belong?**

[ ] Foreign [ ] African [ ] Local

8) **Please check the NCA category that your firm belongs to.**

[ ] NCA 1 [ ] NCA 2 [ ] NCA 3

SECTION B: RESOURCE PLANNING

1) **To what extent do you carry out Resource Planning for the following categories in your firm for different projects?**

SN	Resource Category	Very High	High	Moderate	Low	None
1	Equipment					
2	Labour/Human Resources					
3	Materials					

2) **What kind of Resource Planning is carried out in your firm?**

[ ] Defined, Standard Written format [ ] Unwritten Form of Planning

[ ] Both of the above [ ] Other (state please) …….

3) **To what extent does the top management support Resource Planning through policies or guidelines from the head office?**

[ ] Very High (VH); [ ] High (H); [ ] Moderate (M); [ ] Low (L); [ ] None (N)

4) **Who carries out the Resource Planning in your firm?**

[ ] Directors/Central administration [ ] Project Manager [ ] Project Coordinator

[ ] Construction Manager [ ] Site Agent [ ] Other (state please) …….

5) **What is the academic qualification for the above stated person?**

[ ] Doctorate (PHD) [ ] Masters [ ] Bachelors [ ] Diploma [ ] Certificate

[ ] Secondary Education [ ] Primary Education [ ] Short term training [ ] None [ ] I don't know

6) **What is the educational Background for the above stated person?**

[ ] Construction Management [ ] Quantity Survey [ ] Civil/ Structural Engineer

[ ] Construction Project Management [ ] Architect [ ] Others (State please)……

[ ] I don't know

7) The table below indicates the main reasons for undertaking Resource Planning & Leveling. Kindly tick a number on each of the rank scale to show the level of significance of the resource planning process.

Rank scale: 5-Very Important **(VI)**; 4-Important **(I)**; 3-Fairly Important **(FI)**; 2-Least Important **(LI)**; 1-Not Important **(NI)**

SN	Aim of undertaking Resource Planning & Leveling	VI	I	FI	LI	NI
1	Identify the roles and key responsibilities for each labor type					
2	Identify the number of people required to fill each role					
3	Identify the Items of equipment to be used and their purposes					
4	Identify the types and quantities of equipment needed					
5	Identify the total amount of materials needed					
6	Others (specify)……..					

8) To what extent do the following factors influence Resource Planning in your firm?

Rank scale: 5-Very High (VH); 4- High (H); 3-Moderate (M); 2-Low (L); 1-None (N)

SN	Influencing factors of Resource Planning	VH	H	M	L	N
1	Adequacy of labour					
2	Adequacy of plants and equipment					
3	Compliance with safety procedures					
4	Contractor's ICT Compliance					
5	Presence of qualified personnel					
6	Level of project documentation					
7	Financial status of the contractor					
8	Weather					
9	Prompt honoring of payments certificates					

10	Type of procurement system
11	Others (State please)…….

SECTION C: RESOURCE LEVELING

1) **How often is the progress in your projects affected by delayed supply of materials?**

   [ ] Very High (VH); [ ] High (H); [ ] Moderate (M); [ ] Low (L); [ ] None (N)

2) **How often is the progress in your projects affected by lack of labour on site?**

   [ ] Very High (VH); [ ] High (H); [ ] Moderate (M); [ ] Low (L); [ ] None (N)

3) **How often is the progress in your projects affected by lack of equipment on site?**

   [ ] Very High (VH); [ ] High (H); [ ] Moderate (M); [ ] Low (L); [ ] None (N)

4) **To what extent do you carry out Resource Leveling for the following categories in your firm for different projects?**

SN	Resource Category	Very High	High	Moderate	Low	None
1	Equipment					
2	Labour/Human Resources					
3	Materials					

5) **What kind of Resource Leveling is carried out in your firm?**

   [ ] Defined, Standard Written format [ ] Unwritten Form of Planning
   [ ] Both of the above [ ] Other (state please) …….

6) **To what extent are the following Resource Leveling techniques used in your firm?**

Rank scale: 5-Very High (VH); 4- High (H); 3-Moderate (M); 2-Low (L); 1-None (N)

SN	Resource Leveling Techniques	VH	H	M	L	N
1	Doing nothing					
2	Delay non-critical tasks within available float					
3	Extend non-critical task durations within the available					

	float
4	Add resource of equal or greater capability
5	Substitute resource of equal or greater capability
6	Delay critical path tasks
7	Extend critical path task durations
8	Splitting tasks into non sequential pieces
9	Authorize Overtime
10	Crashing
11	Fast tracking
12	Microsoft Project
13	Modify the scope
14	Others (State please)…….

7) According to your experience, what is the effectiveness of the above techniques?

Rank scale: 5-Very Effective (VE); 4- Effective (E); 3-Fairly Effective (FE); 2-Least Effective (LE); 1-Not Effective (NE)

SN	Resource Leveling Technique	VE	E	FE	LE	NE
1	Doing nothing					
2	Delay non-critical tasks within available float					
3	Extend non-critical task durations within the available float					
4	Add resource of equal or greater capability					
5	Substitute resource of equal or greater capability					
6	Delay critical path tasks					
7	Extend critical path task durations					
8	Splitting tasks into non sequential pieces					
9	Authorize Overtime					
10	Crashing					
11	Fast tracking					
12	Microsoft Project					
13	Modify the scope					
14	Others (State please)……...					

8) The following challenges of Resource Planning & Leveling have been identified in theory. Please indicate to what extent you agree with identified challenges.

Rank scale: 5-Strongly Agree (SA); 4- Agree (A); 3-Undecided (UD); 2-Disagree (D); 1-Strongly Disagree (SD)

SN	Challenges of Resource Planning & Leveling	SA	A	UD	D	SD
1	Technical incompetence; lack of knowledge					
2	Tedious exercise					
3	Materials shortages or late delivery					
4	Project delays					
5	Lack of commitment by top level management					
6	Site storage constraints					
7	Project risks & uncertainty					
8	Plants, equipment's & machine breakdown/inadequacy					
9	Poor work definition; inadequate project documentation					
10	Contract disputes					
11	Absenteeism of workers/shortage of craftsmen					
12	Contractors ICT compliance challenges					
13	Others (State please)……					

9) The following Benefits of Resource Planning and Leveling have been identified in theory. Please indicate to what extent you agree with identified benefits.

Rank scale: 5-Strongly Agree (SA); 4- Agree (A); 3-Undecided (UD); 2-Disagree (D); 1-Strongly Disagree (SD)

SN	Benefits of Resource Planning and Leveling	SA	A	UD	D	SD
1	Balanced resources, reducing over allocations or overtime					
2	Determines or predicts resources needed					
3	Helps maintain the lowest uniform number of employees to perform the work.					
4	Establishing plans for material delivery.					
5	Reduced project costs					
6	Reduced cost of learning and improved learning curve					
7	Enhanced overall organizational strategic planning					
8	Reduction of errors					

9	Increased workers' morale due to guaranteed job security
10	Others (State please)……...

SECTION D: CONSTRUCTION INDUSTRY VIEWS ON THE IMPACT OF RESOURCE PLANNING & LEVELING ON COSTRUCTION PROJECT PERFORMANCE

1) **To what extent do you think proper resource planning and leveling contributes to reduced cost of a project?**

   [ ] Very High (VH); [ ] High (H); [ ] Moderate (M); [ ] Low (L); [ ] None (N)

2) **To what extent do you think proper resource planning and leveling contributes to reduced completion period of a project?**

   [ ] Very High (VH); [ ] High (H); [ ] Moderate (M); [ ] Low (L); [ ] None (N)

3) **To what extent do you think proper resource planning and leveling contributes to improved quality of a project?**

   [ ] Very High (VH); [ ] High (H); [ ] Moderate (M); [ ] Low (L); [ ] None (N)

4) **What are some methods to overcome the challenges of Resource Planning and Leveling?**

5) **Is Resource Leveling a contributor or hindrance to project success? How does Resource Leveling contribute to project success or failure?**

THANK YOU FOR YOUR TIME

Appendix 3: Coded Questionnaire

QUESTIONNAIRE

TITLE: FACTORS INFLUENCING ADOPTION OF RESOURCE PLANNING AND LEVELING AMONG CONTRACTORS IN THE KENYAN CONSTRUCTION INDUSTRY

SECTION A: DEMOGRAPHIC DATA

Please provide the following information about yourself and the firm. Kindly put a tick (√) in the box next to the selected response. ***An appendix has been provided at the end of the document defining all the technical terminologies***.

1) **(1)(A100)Kindly tick your role in this firm/project?**
   [ ] Contractor [ ] Construction Manager [ ] Quantity surveyor [ ] Architect [ ] Civil & Structural Engineer [ ] Site Engineer [ ] Site Agent [ ] Foreman [ ] Others (state please)……
2) **(2) (A200)Kindly tick your educational specialization?**
   [ ] Architecture [ ] Construction Management [ ] Quantity surveying [ ] Civil & Structural Engineering [ ] Building Technology [ ] Land surveying [ ] Business administration [ ] Project management [ ] Accounting [ ] Others (state please) …….
3) **(3) (A300)Kindly indicate the management level of your status in the firm**
   [ ] Top Level management [ ] Middle Level management [ ] Lower Level management
   [ ] Others (state please)…….
4) **(4) (A400)Please indicate the type of project currently undertaking**
   [ ] Residential [ ] Office [ ] Industrial [ ] Mixed Use Development [ ] Institutional [ ] Others (state please)……

5) **(5) (A500)For how long has your firm been in the industry?**

[ ] Up to 5 years [ ] 6 - 10 years [ ] 11 - 15 years [ ] 16 - 20 years [ ] More than 20

6) **(6) (A600)Please indicate the number of full time staff in your firm**

[ ] Less than 20 [ ] 20 – 40 [ ] 41 – 60 [ ] 61 – 80 [ ] 81 – 100 [ ] More than 100

7) **(7) (A700)In which category does your firm belong?**

[ ] Foreign [ ] African [ ] Local

8) **(8) (A800)Please check the NCA category that your firm belongs to.**

[ ] NCA 1 [ ] NCA 2 [ ] NCA 3

SECTION B: RESOURCE PLANNING

1) **(B100)To what extent do you carry out Resource Planning for the following categories in your firm for different projects?**

SN	Resource Category	Very High	High	Moderate	Low	None
1**(9) (B101)**	Equipment					
2**(10) (B102)**	Labour/Human Resources					
3**(11) (B103)**	Materials					

2) **(12) (B200)What kind of Resource Planning is carried out in your firm?**
[ ] Defined, Standard Written format [ ] Unwritten Form of Planning
[ ] Both of the above [ ] Other (state please) …….

3) **(13) (B300)To what extent does the top management support Resource Planning through policies or guidelines from the head office?**
[ ] Very High (VH); [ ] High (H); [ ] Moderate (M); [ ] Low (L); [ ] None (N)

4) **(14) (B400)Who carries out the Resource Planning in your firm?**
[ ] Directors/Central administration [ ] Project Manager [ ] Project Coordinator
[ ] Construction Manager [ ] Site Agent [ ] Other (state please) …….

5) **(15) (B500)What is the academic qualification for the above stated person?**
   [ ] Doctorate (PHD) [ ] Masters [ ] Bachelors [ ] Diploma [ ] Certificate
   [ ] Secondary Education [ ] Primary Education [ ] Short term training [ ] None [ ] I don't know

6) **(16) (B600)What is the educational Background for the above stated person?**
   [ ] Construction Management [ ] Quantity Survey [ ] Civil/ Structural Engineer
   [ ] Construction Project Management [ ] Architect [ ] Others (State please)……
   [ ] I don't know

7) **(B700)The table below indicates the main reasons for undertaking Resource Planning & Leveling. Kindly tick a number on each of the rank scale to show the level of significance of the resource planning process.**
   Rank scale: 5-Very Important **(VI)**; 4-Important **(I)**; 3-Fairly Important **(FI)**; 2-Least Important **(LI)**; 1-Not Important **(NI)**

SN	Aim of undertaking Resource Planning & Leveling	VI	I	FI	LI	NI
1**(17) (B701)**	Identify the roles and key responsibilities for each labor type					
2**(18) (B702)**	Identify the number of people required to fill each role					
3**(19) (B703)**	Identify the Items of equipment to be used and their purposes					
4**(20) (B704)**	Identify the types and quantities of equipment needed					
5**(21) (B705)**	Identify the total amount of materials needed					
6	Others (specify)……					

8) **(B800)To what extent do the following factors influence Resource Planning in your firm?**

Rank scale: 5-Very High (VH); 4- High (H); 3-Moderate (M); 2-Low (L); 1-None (N)

SN	Influencing factors of Resource Planning	VH	H	M	L	N
1**(22) (B801)**	Adequacy of labour					
2**(23) (B802)**	Adequacy of plants and equipment					
3**(24) (B803)**	Compliance with safety procedures					
4**(25) (B804)**	Contractor's ICT Compliance					
5**(26) (B805)**	Presence of qualified personnel					
6**(27) (B806)**	Level of project documentation					
7**(28) (B807)**	Financial status of the contractor					
8**(29) (B808)**	Weather					
9**(30) (B809)**	Prompt honoring of payments certificates					
10**(31) (B810)**	Type of procurement system					
11	Others (State please)…….					

SECTION C: RESOURCE LEVELING

1) **(32) (C100)How often is the progress in your projects affected by delayed supply of materials?**

   [ ] Very High (VH); [ ] High (H); [ ] Moderate (M); [ ] Low (L); [ ] None (N)

2) **(33) (C200)How often is the progress in your projects affected by lack of labour on site?**

   [ ] Very High (VH); [ ] High (H); [ ] Moderate (M); [ ] Low (L); [ ] None (N)

3) **(34) (C300)How often is the progress in your projects affected by lack of equipment on site?**

   [ ] Very High (VH); [ ] High (H); [ ] Moderate (M); [ ] Low (L); [ ] None (N)

4) **(C400)To what extent do you carry out Resource Leveling for the following categories in your firm for different projects?**

SN	Resource Category	Very High	High	Moderate	Low	None
1**(35) (C401)**	Equipment					
2**(36) (C402)**	Labour/Human Resources					

3**(37) (C403)**	Materials

5) (38) (C500)What kind of Resource Leveling is carried out in your firm?

[ ] Defined, Standard Written format [ ] Unwritten Form of Planning

[ ] Both of the above [ ] Other (state please) …….

6) (C600)To what extent are the following Resource Leveling techniques used in your firm?

Rank scale: 5-Very High (VH); 4- High (H); 3-Moderate (M); 2-Low (L); 1-None (N)

SN	Resource Leveling Techniques	VH	H	M	L	N
1**(39) (C601)**	Doing nothing					
2**(40) (C602)**	Delay non-critical tasks within available float					
3**(41) (C603)**	Extend non-critical task durations within the available float					
4**(42) (C604)**	Add resource of equal or greater capability					
5**(43) (C605)**	Substitute resource of equal or greater capability					
6**(44) (C606)**	Delay critical path tasks					
7**(45) (C607)**	Extend critical path task durations					
8**(46) (C608)**	Splitting tasks into non sequential pieces					
9**(47) (C609)**	Authorize Overtime					
10**(48) (C610)**	Crashing					
11**(49) (C611)**	Fast tracking					
12**(50) (C612)**	Microsoft Project					
13**(51)**	Modify the scope					

(C613)	
14	Others (State please)…….

7) (C700)According to your experience, what is the effectiveness of the above techniques?

Rank scale: 5-Very Effective (VE); 4- Effective (E); 3-Fairly Effective (FE); 2-Least Effective (LE); 1-Not Effective (NE)

SN	Resource Leveling Technique	VE	E	FE	LE	NE
1**(52)** **(C701)**	Doing nothing					
2**(53)** **(C702)**	Delay non-critical tasks within available float					
3**(54)** **(C703)**	Extend non-critical task durations within the available float					
4**(55)** **(C704)**	Add resource of equal or greater capability					
5**(56)** **(C705)**	Substitute resource of equal or greater capability					
6**(57)** **(C706)**	Delay critical path tasks					
7**(58)** **(C707)**	Extend critical path task durations					
8**(59)** **(C708)**	Splitting tasks into non sequential pieces					
9**(60)** **(C709)**	Authorize Overtime					
10**(61)** **(C710)**	Crashing					
11**(62)** **(C711)**	Fast tracking					
12**(63)** **(C713)**	Microsoft Project					
13**(64)** **(C713)**	Modify the scope					

14	Others (State please)……..

8) (C800)The following challenges of Resource Planning & Leveling have been identified in theory. Please indicate to what extent you agree with identified challenges.

Rank scale: 5-Strongly Agree (SA); 4- Agree (A); 3-Undecided (UD); 2-Disagree (D); 1-Strongly Disagree (SD)

SN	Challenges of Resource Planning & Leveling	SA	A	UD	D	SD
1**(65) (C801)**	Technical incompetence; lack of knowledge					
2**(66) (C802)**	Tedious exercise					
3**(67) (C803)**	Materials shortages or late delivery					
4**(68) (C804)**	Project delays					
5**(69) (C805)**	Lack of commitment by top level management					
6**(70) (C806)**	Site storage constraints					
7**(71) (C807)**	Project risks & uncertainty					
8**(72) (C808)**	Plants, equipment's & machine breakdown/inadequacy					
9**(73) (C809)**	Poor work definition; inadequate project documentation					
10**(74) (C810)**	Contract disputes					
11**(75) (C811)**	Absenteeism of workers/shortage of craftsmen					
12**(76) (C812)**	Contractors ICT compliance challenges					
13	Others (State please)……					

9) **(C900)The following Benefits of Resource Planning and Leveling have been identified in theory. Please indicate to what extent you agree with identified benefits.**

Rank scale: 5-Strongly Agree (SA); 4- Agree (A); 3-Undecided (UD); 2-Disagree (D); 1-Strongly Disagree (SD)

SN	Benefits of Resource Planning and Leveling	SA	A	UD	D	SD
1**(77) (C901)**	Balanced resources, reducing over allocations or overtime					
2**(78) (C902)**	Determines or predicts resources needed					
3**(79) (C903)**	Helps maintain the lowest uniform number of employees to perform the work.					
4**(80) (C904)**	Establishing plans for material delivery.					
5**(81) (C905)**	Reduced project costs					
6**(82) (C906)**	Reduced cost of learning and improved learning curve					
7**(83) (C907)**	Enhanced overall organizational strategic planning					
8**(84) (C908)**	Reduction of errors					
9**(85) (C909)**	Increased workers' morale due to guaranteed job security					
10	Others (State please)……....					

SECTION D: CONSTRUCTION INDUSTRY VIEWS ON THE IMPACT OF RESOURCE PLANNING & LEVELING ON COSTRUCTION PROJECT PERFORMANCE

1) **(86) (D100)To what extent do you think proper resource planning and leveling contributes to reduced cost of a project?**

   [ ] Very High (VH); [ ] High (H); [ ] Moderate (M); [ ] Low (L); [ ] None (N)

2) **(87) (D200)To what extent do you think proper resource planning and leveling contributes to reduced completion period of a project?**

[ ] Very High (VH); [ ] High (H); [ ] Moderate (M); [ ] Low (L); [ ] None (N)

3) **(88) (D300)To what extent do you think proper resource planning and leveling contributes to improved quality of a project?**

   [ ] Very High (VH); [ ] High (H); [ ] Moderate (M); [ ] Low (L); [ ] None (N)

4) **(89) (D400)What are some methods to overcome the challenges of Resource Planning and Leveling?**

5) **(90) (D500)Is Resource Leveling a contributor or hindrance to project success? How does Resource Leveling contribute to project success or failure?**

THANK YOU FOR YOUR TIME

Appendix 4: SPSS Code Book

SPSS CODE BOOK

TITLE: FACTORS INFLUENCING ADOPTION OF RESOURCE PLANNING AND LEVELING AMONG CONTRACTORS IN THE KENYAN CONSTRUCTION INDUSTRY

SN	Code	Name	Type	Label	Values	Measure
	SECTION A: DEMOGRAPHIC DATA					
(1)	**(A100)**	Role	Numeric	Role in the firm	1=Contractor, 2=Construction Manager, 3=Quantity surveyor, 4=Architect, 5=Civil & Structural Engineer, 6=Site Engineer, 7=Site Agent, 8=Foreman, 9=Others	Nominal
(2)	**(A200)**	Specialization	Numeric	Educational specialization	1=Architecture, 2=Construction Management, 3=Quantity surveying, 4=Civil & Structural Engineering, 5=Building Technology, 6=Land surveying, 7=Business administration, 8=Project management, 9=Accounting, 10=Others	Nominal
(3)	**(A300)**	Level	Numeric	Management level	1=Top Level management, 2=Middle Level management, 3=Lower Level management, 4=Others	Nominal
(4)	**(A400)**	Project	Numeric	Type of project	1=Residential, 2=Office, 3=Industrial, 4=Mixed Use Development, 5=Institutional, 6=Others	Nominal
(5)	**(A500)**	Age	Numeric	Age of firm	1=(Up to 5 years), 2=(6 - 10 years), 3=(11 - 15 years), 4=(16 - 20 years), 5=(More than 20 years)	Ordinal
(6)	**(A600)**	Staff	Numeric	Number of staff	1=(Less than 20), 2=(20 – 40) , 3=(41 – 60), 4=(61 – 80), 5=(81 – 100), 6=(More than 100)	Ordinal

(7)	**(A700)**	Category	Numeric	Firm category	1=Foreign, 2=African, 3=Local	Nominal
(8)	**(A800)**	NCA	Numeric	NCA class	1=(NCA 1), 2=(NCA 2), 3=(NCA 3)	Nominal
SN	**Code**	**Name**	**Type**	**Label**	**Values**	**Measure**
	SECTION B: RESOURCE PLANNING					
	(B100): Extent of Resource Planning for various categories of resources					
(9)	**(B101)**	Equipment	Numeric	Extent of Equipment Planning	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(10)	**(B102)**	Labour	Numeric	Extent of Labor Planning	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(11)	**(B103)**	Materials	Numeric	Extent of Materials Planning	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(12)	**(B200)**	Kind	Numeric	Kind of Resource Planning	1=(Defined, Standard Written format), 2=(Unwritten Form of Planning), 3=(Both of the above), 4=(Other)	Nominal
(13)	**(B300)**	Extent	Numeric	Extent of support from top management	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(14)	**(B400)**	Responsibility	Numeric	Who carries out Resource Planning	1=(Directors/Central administration), 2=(Project Manager), 3=(Project Coordinator), 4=(Construction Manager), 5=(Site Agent), 6=(Other)	Nominal
(15)	**(B500)**	Academic	Numeric	Academic qualifications	1=(Doctorate), 2=(Masters), 3=(Bachelors), 4=(Diploma), 5=(Certificate), 6=(Secondary Education), 7=(Primary Education), 8=(Short term training), 9=(None), 10=(I don't know)	Nominal
(16)	**(B600)**	Background	Numeric	Educational background	1=(Construction Management), 2=(Quantity Survey), 3=(Civil/ Structural Engineer), 4=(Construction Project Management),	Nominal

SN	Code	Name	Type	Label	Values	Measure
					5=(Architect), 6=(Others), 7=(I don't know)	
	(B700): Aims of undertaking Resource Planning & Leveling					
(17)	**(B701)**	Responsibilities	Numeric	Responsibilities of each labour	5=(Very Important), 4=(Important), 3=(Fairly Important), 2=(Least Important), 1=(Not Important)	Ordinal
(18)	**(B702)**	Number	Numeric	Number of people required	5=(Very Important), 4=(Important), 3=(Fairly Important), 2=(Least Important), 1=(Not Important)	Ordinal
(19)	**(B703)**	Items	Numeric	Items of equipment required	5=(Very Important), 4=(Important), 3=(Fairly Important), 2=(Least Important), 1=(Not Important)	Ordinal
(20)	**(B704)**	Quantities	Numeric	Quantities of equipment	5=(Very Important), 4=(Important), 3=(Fairly Important), 2=(Least Important), 1=(Not Important)	Ordinal
(21)	**(B705)**	Amount	Numeric	Amount of materials	5=(Very Important), 4=(Important), 3=(Fairly Important), 2=(Least Important), 1=(Not Important)	Ordinal
	(B800): Influencing factors of Resource Planning					
(22)	**(B801)**	Lbour	Numeric	Adequacy of Labour	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(23)	**(B802)**	Equpment	Numeric	Adequacy of equipment	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(24)	**(B803)**	Safety	Numeric	Compliance with safety	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(25)	**(B804)**	ICT	Numeric	ICT compliance	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(26)	**(B805)**	Personnel	Numeric	Qualified personnel	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(27)	**(B806)**	Documentation	Numeric	Level of documentation	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(28)	**(B807)**	Financial	Numeric	Financial status	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal

SN	Code	Name	Type	Label	Values	Measure
(29)	**(B808)**	Weather	Numeric	Weather	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(30)	**(B809)**	Payments	Numeric	Prompt payments	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(31)	**(B810)**	Procurement	Numeric	Type of procurement	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
	SECTION C: RESOURCE LEVELING					
(32)	**(C100)**	DelMaterials	Numeric	Delayed materials	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(33)	**(C200)**	LackLabour	Numeric	Lack of labour	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(34)	**(C300)**	LackEquip	Numeric	Lack of equipment	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
	(C400) : Extent of Resource Leveling for various categories of resources					
(35)	**(C401)**	Equipement	Numeric	Extent of Equipment Leveling	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(36)	**(C402)**	Labor	Numeric	Extent of Labour Leveling	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(37)	**(C403)**	Material	Numeric	Extent of Material Leveling	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(38)	**(C500)**	Kinds	Numeric	Kind of Resource Leveling	1=(Defined, Standard Written format), 2=(Unwritten Form of Planning), 3=(Both of the above), 4=(Other)	Nominal
	(C600): Usage of Resource Leveling Techniques					
(39)	**(C601)**	Nothing	Numeric	Doing Nothing	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(40)	**(C602)**	DelayNon	Numeric	Delay Non-Critical	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
SN	**Code**	**Name**	**Type**	**Label**	**Values**	**Measure**

(41)	**(C603)**	ExtendNon	Numeric	Extend Non-Critical	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(42)	**(C604)**	AddRes	Numeric	Add Resources	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(43)	**(C605)**	SubRes	Numeric	Substitute Resources	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(44)	**(C606)**	DelayCrit	Numeric	Delay Critical	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(45)	**(C607)**	ExtendCrit	Numeric	Extend Critical	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(46)	**(C608)**	SplitTasks	Numeric	Splitting tasks	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(47)	**(C609)**	Overtime	Numeric	Authorize overtime	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(48)	**(C610)**	Crashing	Numeric	Crashing	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(49)	**(C611)**	FastTrack	Numeric	Fast tracking	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(50)	**(C612)**	MSProject	Numeric	Microsoft Project	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(51)	**(C613)**	ModScope	Numeric	Modify Scope	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
	(C700): Effectiveness of Resource Leveling Techniques					
(52)	**(C701)**	Nothin	Numeric	Doing Nothing	5=(Very Effective), 4=(Effective), 3=(Fairly Effective), 2=(Least Effective), 1=(Not Effective)	Ordinal
(53)	**(C702)**	DelNon	Numeric	Delay Non-Critical	5=(Very Effective), 4=(Effective), 3=(Fairly Effective), 2=(Least Effective), 1=(Not Effective)	Ordinal
(54)	**(C703)**	ExtNon	Numeric	Extend Non-Critical	5=(Very Effective), 4=(Effective), 3=(Fairly Effective), 2=(Least Effective), 1=(Not Effective)	Ordinal
(55)	**(C704)**	AddReso	Numeric	Add Resources	5=(Very Effective), 4=(Effective), 3=(Fairly Effective), 2=(Least Effective), 1=(Not Effective)	Ordinal
SN	**Code**	**Name**	**Type**	**Label**	**Values**	**Measure**

(56)	**(C705)**	SubReso	Numeric	Substitute Resources	5=(Very Effective), 4=(Effective), 3=(Fairly Effective), 2=(Least Effective), 1=(Not Effective)	Ordinal
(57)	**(C706)**	DelCrit	Numeric	Delay Critical	5=(Very Effective), 4=(Effective), 3=(Fairly Effective), 2=(Least Effective), 1=(Not Effective)	Ordinal
(58)	**(C707)**	ExtCrit	Numeric	Extend Critical	5=(Very Effective), 4=(Effective), 3=(Fairly Effective), 2=(Least Effective), 1=(Not Effective)	Ordinal
(59)	**(C708)**	SplitTask	Numeric	Splitting tasks	5=(Very Effective), 4=(Effective), 3=(Fairly Effective), 2=(Least Effective), 1=(Not Effective)	Ordinal
(60)	**(C709)**	Overtme	Numeric	Authorize overtime	5=(Very Effective), 4=(Effective), 3=(Fairly Effective), 2=(Least Effective), 1=(Not Effective)	Ordinal
(61)	**(C710)**	Crash	Numeric	Crashing	5=(Very Effective), 4=(Effective), 3=(Fairly Effective), 2=(Least Effective), 1=(Not Effective)	Ordinal
(62)	**(C711)**	FasTrack	Numeric	Fast tracking	5=(Very Effective), 4=(Effective), 3=(Fairly Effective), 2=(Least Effective), 1=(Not Effective)	Ordinal
(63)	**(C712)**	Microsoft	Numeric	Microsoft Project	5=(Very Effective), 4=(Effective), 3=(Fairly Effective), 2=(Least Effective), 1=(Not Effective)	Ordinal
(64)	**(C713)**	ModScop	Numeric	Modify Scope	5=(Very Effective), 4=(Effective), 3=(Fairly Effective), 2=(Least Effective), 1=(Not Effective)	Ordinal
	(C800): Challenges of Resource Planning & Leveling					
(65)	**(C801)**	Technical	Numeric	Technical Incompetence	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(66)	**(C802)**	Tedious	Numeric	Tedious Exercise	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(67)	**(C803)**	Shortages	Numeric	Materials Shortage	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(68)	**(C804)**	ProjDelays	Numeric	Project Delays	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(69)	**(C805)**	LackCommit	Numeric	Lack of commitment	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
SN	**Code**	**Name**	**Type**	**Label**	**Values**	**Measure**
(70)	**(C806)**	StorageCons	Numeric	Site storage constraints	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal

(71)	**(C807)**	ProjRisks	Numeric	Project risks	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(72)	**(C808)**	Breakdown	Numeric	Equipment breakdown	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(73)	**(C809)**	PoorDoc	Numeric	Poor documentation	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(74)	**(C810)**	ContDisputes	Numeric	Contract disputes	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(75)	**(C811)**	Absenteeism	Numeric	Absenteeism of workers	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(76)	**(C812)**	ICTChall	Numeric	ICT challenges	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
	(C900): Benefits of Resource Planning & Leveling					
(77)	**(C901)**	Balanced	Numeric	Balanced resources	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(78)	**(C902)**	ResNeeded	Numeric	Predict resources needed	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(79)	**(C903)**	LowEmployees	Numeric	Lowest minimum workers	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(80)	**(C904)**	MatDelivery	Numeric	Establish material delivery plans	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(81)	**(C905)**	ProjCosts	Numeric	Reduced project costs	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(82)	**(C906)**	LearnCosts	Numeric	Reduced cost of planning	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(83)	**(C907)**	StratPlan	Numeric	Enhance strategic planning	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
(84)	**(C908)**	RedErrors	Numeric	Reduced errors	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal
SN	**Code**	**Name**	**Type**	**Label**	**Values**	**Measure**
(85)	**(C909)**	Morale	Numeric	Increased workers morale	5=(Strongly Agree), 4=(Agree), 3=(Undecided), 2=(Disagree), 1=(Strongly Disagree)	Ordinal

	SECTION D: CONSTRUCTION INDUSTRY VIEWS ON THE IMPACT OF RESOURCE PLANNING & LEVELING ON COSTRUCTION PROJECT PERFORMANCE				
(86)	**(D100)**	Cost	Reduced project cost	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(87)	**(D200)**	Period	Reduced completion period	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal
(88)	**(D300)**	Quality	Improved project quality	5=(Very High), 4=(High), 3=(Moderate), 2=(Low), 1=(None)	Ordinal

Appendix 5: Missing Values Analysis

Variable	N	Mean	Std. Deviation	Missing		No. of Extremes[a]	
				Count	Percent	Low	High
Role	80	4.21	2.694	1	1.2	0	0
Specialization	80	3.45	1.742	1	1.2	0	5
Level	78	1.83	0.710	3	3.7	0	0
Project	80	2.43	1.541	1	1.2	0	0
Age	80	2.30	1.453	1	1.2	0	0
Staff	80	2.23	1.630	1	1.2	0	9
Category	80	2.73	0.636	1	1.2	.	.
NCA	80	2.25	0.893	1	1.2	0	0
Equipment	78	3.67	1.077	3	3.7	0	0
Labour	78	3.94	0.827	3	3.7	0	0
Materials	78	4.23	0.867	3	3.7	1	0
Kind	80	2.36	0.846	1	1.2	0	0
Extent	80	3.38	1.267	1	1.2	0	0
Responsibility	80	2.40	1.143	1	1.2	0	4
Academic	80	2.76	1.094	1	1.2	0	1
Background	80	3.11	1.869	1	1.2	0	4
Responsibilities	80	4.31	0.851	1	1.2	2	0
Number	81	4.38	0.830	0	.0	3	0
Items	81	4.36	0.780	0	.0	2	0
Quantities	81	4.38	0.768	0	.0	2	0
Amount	81	4.49	0.777	0	.0	3	0
Lbour	78	4.15	0.941	3	3.7	3	0
Equpment	79	4.15	0.833	2	2.5	3	0
Safety	78	3.58	0.947	3	3.7	1	0
ICT	78	2.95	1.138	3	3.7	0	0
Personnel	79	4.08	0.888	2	2.5	3	0
Documentation	78	3.71	1.058	3	3.7	0	0
Financial	77	4.19	0.889	4	4.9	2	0
Weather	79	3.06	1.244	2	2.5	0	0
Payments	81	3.95	1.023	0	.0	0	0
Procurement	78	3.47	1.170	3	3.7	5	0

Variable	N	Mean	Std. Deviation	Missing		No. of Extremes[a]	
				Count	Percent	Low	High
DelMaterials	81	3.11	1.095	0	.0	0	0
LackLabour	80	2.68	1.261	1	1.2	0	13
LackEquip	81	2.68	1.105	0	.0	0	9
Equipement	80	3.80	0.892	1	1.2	0	0
Labor	80	3.99	0.879	1	1.2	0	0
Material	80	4.06	1.060	1	1.2	6	0
Kinds	80	2.10	0.894	1	1.2	0	0
Nothing	79	1.65	1.013	2	2.5	0	6
DelayNon	77	3.12	1.112	4	4.9	0	0
ExtendNon	77	3.26	1.069	4	4.9	0	0
AddRes	75	3.39	0.928	6	7.4	1	0
SubRes	76	3.41	0.982	5	6.2	2	0
DelayCrit	77	2.18	1.035	4	4.9	0	0
ExtendCrit	77	2.74	1.093	4	4.9	0	4
SplitTasks	72	2.75	0.975	9	11.1	0	4
Overtime	76	3.33	1.051	5	6.2	0	0
Crashing	73	3.30	1.232	8	9.9	0	0
FastTrack	75	3.83	0.891	6	7.4	0	0
MSProject	78	3.68	1.145	3	3.7	0	0
ModScope	73	3.12	1.092	8	9.9	0	0
Nothin	79	1.65	1.209	2	2.5	0	12
DelNon	77	3.09	1.194	4	4.9	0	0
ExtNon	77	3.22	1.096	4	4.9	0	0
AddReso	77	3.97	0.873	4	4.9	6	0
SubReso	77	3.95	0.809	4	4.9	.	.
DelCrit	74	2.50	1.230	7	8.6	0	0
ExtCrit	76	2.80	1.233	5	6.2	0	0
SplitTask	72	3.35	0.981	9	11.1	2	0
Overtme	76	3.91	0.926	5	6.2	0	0
Crash	73	3.70	1.063	8	9.9	2	0
FasTrack	72	4.17	0.787	9	11.1	2	0
Microsoft	75	4.04	1.058	6	7.4	0	0
ModScop	71	3.41	1.077	10	12.3	4	0
Technical	78	4.28	0.771	3	3.7	3	0

Variable	N	Mean	Std. Deviation	Missing		No. of Extremes[a]	
				Count	Percent	Low	High
Tedious	74	3.55	1.022	7	8.6	3	0
Shortages	77	4.19	0.859	4	4.9	5	0
ProjDelays	77	4.30	0.708	4	4.9	2	0
LackCommit	77	3.79	1.068	4	4.9	0	0
StorageCons	78	3.28	1.043	3	3.7	0	0
ProjRisks	76	3.84	0.849	5	6.2	1	0
Breakdown	77	3.96	0.785	4	4.9	.	.
PoorDoc	77	3.84	1.077	4	4.9	12	0
ContDisputes	78	3.94	0.972	3	3.7	0	0
Absenteeism	78	3.27	1.147	3	3.7	0	0
ICTChall	78	3.35	1.103	3	3.7	0	0
Balanced	79	4.58	0.496	2	2.5	0	0
ResNeeded	79	4.57	0.523	2	2.5	0	0
LowEmployees	79	4.28	0.816	2	2.5	3	0
MatDelivery	79	4.61	0.517	2	2.5	0	0
ProjCosts	79	4.23	0.862	2	2.5	5	0
LearnCosts	78	3.83	0.844	3	3.7	0	0
StratPlan	78	4.26	0.692	3	3.7	2	0
RedErrors	78	4.13	0.873	3	3.7	6	0
Morale	79	3.89	0.987	2	2.5	0	0
Cost	80	4.48	0.595	1	1.2	0	0
Period	80	4.30	0.719	1	1.2	0	0
Quality	80	4.19	0.731	1	1.2	1	0

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

Appendix 6: Multiple regression (F-Test Results)

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
Responsibilities of each labour	Between Groups	12.871	4	3.218	5.355	.001
	Within Groups	43.259	72	0.601		
	Total	56.130	76			
Number of people required	Between Groups	17.576	4	4.394	8.819	.000
	Within Groups	36.373	73	0.498		
	Total	53.949	77			
Items of equipment required	Between Groups	15.490	4	3.872	8.789	.000
	Within Groups	32.164	73	0.441		
	Total	47.654	77			
Quantities of equipment	Between Groups	17.725	4	4.431	11.461	.000
	Within Groups	28.224	73	0.387		
	Total	45.949	77			
Amount of materials	Between Groups	14.470	4	3.617	7.998	.000
	Within Groups	33.017	73	0.452		
	Total	47.487	77			
Adequacy of Labour	Between Groups	3.345	4	0.836	1.320	.271
	Within Groups	44.335	70	0.633		
	Total	47.680	74			
Adequacy of	Between	6.686	4	1.672	3.822	.007

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
equipment	Groups					
	Within Groups	31.050	71	0.437		
	Total	37.737	75			
Compliance with safety	Between Groups	1.711	4	.428	.497	.738
	Within Groups	60.289	70	.861		
	Total	62.000	74			
ICT compliance	Between Groups	10.506	4	2.627	2.262	.071
	Within Groups	81.281	70	1.161		
	Total	91.787	74			
Qualified personnel	Between Groups	2.693	4	.673	.971	.429
	Within Groups	49.241	71	.694		
	Total	51.934	75			
Level of documentation	Between Groups	1.869	4	.467	.435	.783
	Within Groups	75.251	70	1.075		
	Total	77.120	74			
Financial status	Between Groups	6.614	4	1.653	2.721	.036
	Within Groups	41.927	69	.608		
	Total	48.541	73			
Weather	Between Groups	13.933	4	3.483	2.342	.063
	Within Groups	105.593	71	1.487		
	Total	119.526	75			
Prompt payments	Between	4.971	4	1.243	1.210	.314

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
	Groups					
	Within Groups	74.977	73	1.027		
	Total	79.949	77			
Type of procurement	Between Groups	4.748	4	1.187	.848	.500
	Within Groups	97.972	70	1.400		
	Total	102.720	74			
Technical Incompetence	Between Groups	0.787	4	0.197	.311	.870
	Within Groups	44.333	70	0.633		
	Total	45.120	74			
Tedious Exercise	Between Groups	1.692	4	0.423	.388	.817
	Within Groups	72.027	66	1.091		
	Total	73.718	70			
Materials Shortage	Between Groups	4.408	4	1.102	1.512	.208
	Within Groups	50.308	69	0.729		
	Total	54.716	73			
Project Delays	Between Groups	4.703	4	1.176	2.477	.052
	Within Groups	32.756	69	0.475		
	Total	37.459	73			
Lack of commitment	Between Groups	1.757	4	0.439	.374	.826
	Within Groups	80.959	69	1.173		
	Total	82.716	73			
Site storage	Between	2.551	4	0.638	.577	.680

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
constraints	Groups					
	Within Groups	77.396	70	1.106		
	Total	79.947	74			
Project risks	Between Groups	5.174	4	1.293	1.800	.139
	Within Groups	48.854	68	0.718		
	Total	54.027	72			
Equipment breakdown	Between Groups	3.000	4	0.750	1.294	.281
	Within Groups	39.987	69	0.580		
	Total	42.986	73			
Poor documentation	Between Groups	1.555	4	0.389	.326	.860
	Within Groups	82.350	69	1.193		
	Total	83.905	73			
Contract disputes	Between Groups	.785	4	0.196	.198	.939
	Within Groups	69.561	70	0.994		
	Total	70.347	74			
Absenteeism of workers	Between Groups	9.839	4	2.460	1.994	.105
	Within Groups	86.348	70	1.234		
	Total	96.187	74			
ICT challenges	Between Groups	4.013	4	1.003	.792	.534
	Within Groups	88.653	70	1.266		
	Total	92.667	74			
Balanced resources	Between	3.565	4	0.891	4.230	.004

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
	Groups					
	Within Groups	14.961	71	0.211		
	Total	18.526	75			
Predict resources needed	Between Groups	1.033	4	0.258	.933	.450
	Within Groups	19.638	71	0.277		
	Total	20.671	75			
Lowest minimum workers	Between Groups	11.652	4	2.913	5.292	.001
	Within Groups	39.085	71	0.550		
	Total	50.737	75			
Establish material delivery plans	Between Groups	1.547	4	0.387	1.475	.219
	Within Groups	18.611	71	0.262		
	Total	20.158	75			
Reduced project costs	Between Groups	4.992	4	1.248	1.697	.160
	Within Groups	52.205	71	0.735		
	Total	57.197	75			
Reduced cost of planning	Between Groups	5.134	4	1.283	1.835	.132
	Within Groups	48.946	70	0.699		
	Total	54.080	74			
Enhance strategic planning	Between Groups	3.933	4	0.983	2.168	.082
	Within Groups	31.747	70	0.454		
	Total	35.680	74			
Reduced errors	Between	4.783	4	1.196	1.698	.160

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
	Groups					
	Within Groups	49.297	70	0.704		
	Total	54.080	74			
Increased workers morale	Between Groups	7.076	4	1.769	1.879	.124
	Within Groups	66.858	71	0.942		
	Total	73.934	75			

Appendix 7: Delphi Process Questionnaire

1) As a result of data analysis, the author has developed the attached framework for efficient and effective resource planning and leveling for use in the Kenyan construction industry. To what extent do you consider the framework,

No.	Attribute	Very High	High	Moderate	Low	None
a)	Applicable					
b)	Suitable					
c)	Simple					
d)	Relevant					
e)	Clear					
f)	Adaptable					
g)	Universal					