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FACULTY OF THE BUILT ENVIRONMENT AND DESIGN

AN EVALUATION OF THE EXTENT AND IMPACT OF THE APPLICATION OF ENTERPRISE RESOURCE PLANNING (ERP) SYSTEMS IN THE KENYA CONSTRUCTION INDUSTRY

(A CASE STUDY OF NAIROBI COUNTY)

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DECLARATION

This research project is my original work and has not been presented for examination in any university.

Signed: .... Date: ..09.08.2023............

Michael K. Murimi

B53/11975/2018

This research project has been submitted for examination with my approval as the university supervisor.

Signed: .... Date: ..11 – 08 – 2023

Qs. Robert Oduor

DEDICATION

This research is dedicated to my family for their prayers, encouragement and support throughout the study. God bless you.

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To the Almighty God, I return all the glory.

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ACRONYMS

CBA – Cost Benefit Analysis

CPM – Critical Path Method

GDP – Gross Domestic Product

ERPs – Enterprise Resource Planning Systems

KNBS – Kenya National Bureau of Statistics

MMS – Material Management Systems

NCA – National Construction Authority

PMBOK – Project Management Body of Knowledge

PMI – Project Management Institute

RFID – Radio Frequency Identification Device

SPSS – Statistical Package for Social Sciences

RII – Relative Importance Index

WBS – Work Breakdown Structure

ABSTRACT

The performance of construction projects depends on how best resources are managed. Lack of effective resource management through planning techniques is likely to lead to higher project costs, schedule overruns, and poor quality. The goal of this research was to evaluate the extent and impact of ERP systems in Kenya's construction industry. This study mostly employed a survey research approach, through the use of questionnaires to gather information from contractors. The survey achieved 59% response rate from the contractors. The study location was Nairobi County, and the target population was NCA 1-3 contractors. Random sampling was used in identifying the 123 respondents. Descriptive statistics, linear regression analysis, thematic analysis, Pearson's correlation analysis, and Spearman's correlation analysis were used in analyzing the data collected.

The study concluded that, though majority (74%) of the contractors were familiar with the ERP systems, the uptake of these tools was very low. Oracle prime projects was established to be the most adopted software, followed by sage 200, Vista, Epicor project management and Maestro. Additionally, there were two more softwares identified by the respondents that were not listed in the questionnaire. This included In4Velocity and Focus softnet. The major challenges that hinder the adoption of these tools and techniques were established to be: high cost of acquisition, complexity to master usage, and lack of formal training of project participants. The research established that the usage of ERP systems as a management tool significantly improves construction project performance.

The study recommends that firms be sensitized to the use of ERP systems to enjoy the benefits of reduced project completion period, quality improvement, as well as improved project cost control. The study further recommends that institutions of higher learning that train manpower for the construction industry be encouraged to train on the use and benefits of ERP systems. This will lead to improvement in the efficiency of the management of construction projects.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

The construction industry accounts for about 10% of the world's gross domestic product (styhre, 2009). According to the Global Construction 2030 research, it is estimated the construction production volume will increase by 85 percent to $15.5 trillion worldwide by the year 2030, with India, the US, and China considered to be at the forefront of this boom at 57 percent (Muldoon, 2014).

According to the Economic Survey of 2020 conducted by the Kenya National Bureau of Statistics, the construction sector experienced growth of 6.4% in 2019, resulting in an increase in employment division from 218,300 jobs in 2018 to 221,600 jobs in 2019. This growth was attributed to the country's rising population. The survey further showed that, the total development expenditure in the sector was expected to grow from Ksh 96.7 billion in 2018/19 to Ksh 111.7 billion in 2019/20 reflecting a 15.5% growth (KNBS, 2020). This underscores the significant role that the construction industry continues to play in contributing to the growth and development of the economy at a national level. The industry is not without its challenges, the most important of which is time overruns, which cost the economy enormous losses in lost revenue from incomplete facilities and extended construction budgets.

In the construction industry, time and cost overruns on projects are common occurrences. In Kenya, project delays are considered to be a common and re-occurring phenomenon and are experienced in any sector that delivers services through project construction. The Kenya government and other developing partners allocate huge financial resources to infrastructure development. However, due to poor project implementation, the intended benefits of the developments are only partially or never realized. This is usually caused by poor project management practices (Moronge, 2016).

The most important success parameters for every project in the construction industry are time, cost, and quality (Kerzner et al. 2004). However, these criteria have been criticized on the grounds that they do not go far enough (Yu et al. 2005). According to

Gwaya (2015), the successful completion of a project involves a great deal more than just meeting the standards set out for its cost, time, and quality. Furthermore, the success criteria can differ from one project to another. It's also critical to note that effective project management is essential for the construction industry's success. Planning effectively is frequently the key to efficiency. Planning involves creating a road map to follow in executing a project endeavor. It involves the allocation of the 4Ms namely manpower, money, machinery and materials (Muldoon, 2014). It is possible to argue that planning is the most significant role a project manager performs during a construction project. ERP systems involve the integration of different project roles, such as the design role, costing and estimating role, valuation role, material supply role, machine scheduling role, and human resource management role, during project execution to ensure proper utilization of available resources (Addo-Tenkorang, 2011).

According to Harris and McCaffer (2005), contractors in developed countries have started implementing enterprise resource planning because the results of a well-planned, carefully monitored, and regulated contract directly impact the performance and profitability of the contract and the organization. The ERP system adopted in North America, Europe, and Asia's construction industry amounts to 66 percent, 22 percent, and 9 percent respectively of the Enterprise Resource Planning (ERP) software that has been adopted globally (Stewart & Mohamed, 2003). According to Jalil (2016) in a trade journal, South African ERP systems are being used in construction projects to increase responsiveness by integrating all stakeholders into one system, which strengthens supply chain partnerships, increases organizational flexibility on the job site, improves decision-making skills, and shortens the time it takes to complete the project while also cutting costs. These systems are designed to integrate and partially automate many of the project management processes such as cost management, time management, quality management, and information management.

In Kenya, construction firms attempt to use enterprise resource planning (ERP) systems as a tool to aid in the management of construction projects. However, the extent of use of these tools in managing construction projects in Kenya is largely unknown and this may include, whether proper tools are being used to improve the quality of their construction project management process. This is despitethe fact that the performance of the construction industry is quite crucial to the Kenyan economy. Therefore, It is of great interest for the construction industry to evaluate the extent and impact of the application7of ERP systems on project success in the construction industry in Kenya.

1.2 Problem Statement

Construction is a complex industry due to the various stakeholder groups that have a main objective of successfully delivering projects. When construction projects are finished on schedule, within budget, and to the satisfaction of stakeholders, they are considered to have been successful. However, many projects end up exceeding their initial cost, get abandoned before they are finished, or don't perform as promised (Burns, 2008). According to Kihoro (2015), in Kenya, 10% of the building projects in Nairobi County were entirely stalled while 48% were still incomplete. Mose and Moronge (2016) found that 48 percent of Kenyan construction projects performed poorly in terms of on-time completion, cost overruns, and customer satisfaction. According to Wamelink, Stoffelem, and Der (2002), the main reason projects fail is due to insufficient management of the building processes. Furthermore, these difficulties can call for fundamental adjustments to conventional project management and communication methods. While significant amounts of time and resources are spent on the selection and design of projects, it is crucial that once initiated, projects be adequately managed if they are to achieve their performance objectives.

Previous studies show that a majority of building projects in Kenya are delayed due to difficulties either in the early phases of planning or in the control of the plans throughout the execution phase (Kimani, 2004). Enterprise resource planning systems may be used as an effective tool for efficient planning, carrying out, and monitoring construction projects. This may improve the performance of such projects by optimizing the resources available. This is achieved by keeping track of the resource graph as the project continues and levelling where necessary to reduce wastage and maintain the allocated budget (Romney, 2012).

The trend worldwide is for construction projects to use these systems to integrate project roles through the different features they offer, which include data integration, online paper trail, cloud-based repository and a more interactive user interface. These features benefit construction projects in areas such as information and document management, cost management, time management, risk management, and equipment scheduling. This improves project efficiency by allowing for better resource management and utilization. There haven't been a lot of studies done in Kenya to determine if construction firms have embraced the ERP system and the challenges encountered in doing so. Therefore, there is a need to close this knowledge gap and provide pertinent information that would aid key players in the construction industry

Therefore, the purpose of this study is to evaluate the extent and the impact of the application of ERP systems on projects success in the construction industry in Kenya.

1.3 Research questions

The study was guided by the following research questions:

i. What is the extent of adoption of Enterprise Resource Planning systems as a management tool in the construction industry in Kenya?
ii. Where it is used, what is the impact of the Enterprise Resource Planning system on the performance of construction projects in Kenya?
iii. What challenges do construction firms face in using the ERP systems in Kenya?

1.4 Objectives of the study

This study was guided by the following objectives:

i. To establish the extent of adaption of Enterprise Resource Planning systems as a management tool in the construction industry in Kenya
ii. To determine the impact of Enterprise Resource Planning systems on the performance of construction projects in Kenya.
iii. To establish the challenges construction firms experience in using Enterprise Resource Planning systems

1.5 Significance of the Study

Many stakeholders in the construction industry will find this study useful. The findings of this study will provide information on the challenges that are traditionally encountered in construction projects due to insufficient building process management and a lack of proper communication and collaboration tools among the various participants. It also describes in detail how these challenges can be overcome by implementing an ERP system, as well as the additional benefits that can be obtained.

To the construction managers, this study will promote a critical examination of planning tools currently in use for management of construction projects. The study will also provide information on the potential benefits of implementing ERP systems. Construction managers can take advantage of the integration and automation aspects of the technology to plan effectively and track progress across multiple projects. This could help better manage project costs and reduce project duration.

For the contractors, construction projects could be completed on time and within budget by eliminating manual, time-consuming, and labour-intensive processes, allowing contractors to keep their profit margins and, as a result, gain a competitive advantage in order to obtain new business opportunities. Accurate project data could help contractors plan for inputs on time to avoid delays.

For consultants, ERP systems will enable easier shared access to project documents such as requests for information, shop drawings, daily field reports, checklists and project plans. This integration leads to enhanced production, including a shorter processing time for documents and reports, ultimately improving performance. Furthermore, through its cloud-based document repository feature, ERP systems will ensure that all project participants are using uniform details to deliver their expected deliverables.

The study will be beneficial to academic institutions as it expands the already existing literature related to Enterprise Resource Planning. It will also acts as an archival resource for libraries and researchers, who value its contribution to the construction industry's overall performance.

1.6 Limitations

Due to financial and time constraints, the study was limited geographically to construction firms registered under NCA 1-3 operating in Nairobi. The majority of lower-class contractors work on small projects that may not use Enterprise Resource Planning tools and due to limited resources, the lower-class contractors are less likely to install sophisticated management systems in their firms. In addition, the capital city of Kenya, Nairobi is the center of construction activity in the country. According to the NCA register accessed on 13th December 2021 via *https://nca.go.ke/contractors/search-registered-contractors*, there are 43,535 registered companies, of which 24,446 are registered in Nairobi, with only a few spread over the other major towns. This translates to 56 percent, which makes it a rich source of data.

Given the nature of construction work, construction firms can operate in any part of the country, although their headquarters may be based in Nairobi. The findings can thus be generalized to the whole country.

1.7 Assumptions

By making participation optional and maintaining anonymity and confidentiality for all information submitted, the research assumed that participants' replies were honest and genuine. In addition, the study assumed the respondents were knowledgeable on the area of study.

1.8 Scope of the study

In the course of undertaking this study, focus was on the construction firms since they are the planners and the actual executors of a construction project. They were therefore the unit of observation and analysis.

Geographically, the study was undertaken in Nairobi County. This is due to the fact that over 56% of the registered building and civil engineering firms are concentrated in the city. Nairobi was also a favorable area of study due to resource constraints, especially on time and finances. It would be too costly and time consuming to conduct a survey that included construction companies located across the country The appropriate size of construction firms that are more likely to implement ERP planning tools were deemed to be those in NCA 1-3. This was due to the fact that the value of the work undertaken by these firms was reasonably high hence they pose the best opportunity and capacity to use and appreciate ERP systems in their projects.

The study sampled size consisted of one hundred and twenty three (123) construction companies. The scope of ERP systems utilization in the study was limited to the planning tools applicable during the construction phase. Additionally, the research established the impact of ERP systems on the performance of construction projects and further assessed the factors that affect ERP adoption levels.

1.9 Definition of terms

Project; An activity that has a start and an end, consisting of activities that occur sequentially and most importantly, requiring resources (Project Management Institute, 2013).

Resource; Skilled manpower, materials, money or machinery (Kihoro, 2015).

Resource Planning; This includes determining what resources people, equipment, materials, etc. are needed to complete project activities in the most efficient manner possible before project commencement (Kumari & Vikranth, 2012).

ERP; Enterprise Resource Planning: it's a packaged business innovation software product that involves strategizing on the best means and methods of executing the project to achieve optimum use of available resources through integration of different department functions (Davenport, 2000).

Systems; A group of things that work together as part of a mechanism or interconnected network (Wilkinson, 2010).

Construction project performance; an undertaking that is completed on schedule, on budget, and in accordance with the specifications set out in the original contract (Nyanga, 2016).

1.10 Organisation of the study

The study consists of five chapters. Chapter One provides an introduction to the study and discusses the study's objectives and problems. It also articulates the study's justification, scope, and significance.

As theoretical and practical pillars for the investigation, chapter two provides a review of the books, journals, and studies linked to the research topic. For the purpose of recognizing and comprehending the concept of Enterprise Resource Planning systems as a planning tool in construction project management, the theories and concepts in the literature study serve as the foundation knowledge. Other areas highlighted include the benefits of ERP systems in monitoring project performance and the challenges experienced in the adoption of these planning tools.

Chapter three explores the methodology used in the study, particularly in the sample and sampling procedure, data collection instruments and their reliability and validity, data analysis procedures, and ethical considerations.

In chapter four, results from the research survey phase are presented and examined. The methodology directs the analysis of the raw data collected by the research instrument, and the findings are reported in accordance with the research objectives.

Chapter five summarizes the study's major findings and provides several recommendations for further research.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter reviews the available literature on ERP systems. Enterprise Resource Planning is a technological business process innovation that can be used to enhance certain business benefits and processes. Consequently, the study looks at what necessitates inventions and innovations and their benefits in human endeavours. The study dives into a number of theories and models, such as the Technology Acceptance Model (TAM), Diffusion Innovation Theory (DOI), and Technology-Organization-Environment (TOE) Model that serve as a guide for the research. It further underpins the benefits of Enterprise Resource Planning systems under technological inventions andinnovations. The research heavily relied on written books, journals, previously related research, and various articles on the internet in undertaking the literature review.

2.1 Pure theory of technological inventions and innovation

Technology, according to Neumann (2006), is the application of scientific knowledge to practical issues, particularly in business and industry. Technology, according to Alberto and Fernando (2007), is the sum of all techniques, skills, methods, and procedures employed in the creation ofproducts and services as well as the achievement of goals like scientific research. Technology can be the understanding of methods and procedures or it can be a feature built into machinery that enables use without detailed knowledge of how they function. The three key stages of technology development are invention, innovation, and dissemination, according to Gardiner (2010). Technology starts with invention and is improved through innovation. A new product, system, or method that has never been developed before and is discovered via research and testing is referred to as an invention (Brey, 2009). The original concept for an invention may evolve while it is being developed. The invention could become more straightforward, more useful, grow, or even take on a whole new form. Working on one invention might inspire ideas for others as well. Invention is prioritary, meaning that only a new or previously unknown discover can be considered an invention, as opposed to the development of an already existing one.

Innovation is defined as the enhancement or redesign of an existing product or technique to meet the needs of the present market (Neumann, 2006). According to Cooper (2007), innovation is the act of first putting a newly found substance, a newly developed process, or a newly formed organized market for a new product into regular production. Since innovation often works with criteria, qualities, or amounts that are known, it is normally less dangerous than invention. Therefore, despite the fact that they often return full circle to inspire new ideas, innovations could not have happened without some prior imaginative discovery.The relationship between invention and innovation often be comes a synergistic circular flow that reproduces inventive talent for new and va ried purposes (ibid).

Product invention is the process of developing new goods or services for the international market (Vadastreanu, 2015).It entails developing something fresh to satisfy the demands of customers in a certain nation. A company may be able to patent the design or copyright ideas used in the creation of these regardless of whether they are entirely new and untested or if they are derived from earlier items if they have enough innovative features or technical characteristics Neumann (2006). Product innovation is an incremental process where an existing product is improved, as opposed to product invention, which involves the production of a new final product. In order to increase market share, new product features or designs are often introduced to a product line.These include considerable advancements in technical requireme nts, parts and materials, software integration, user-friendliness, and other functional aspects. By distinguishing its manufacturing and enhancing the quality and divers ity of its products, product innovation offers an organization a competitive edge that enables it to increase demand and create new growth prospects (Vadastreanu, 2015).

According to Grasty (2017), a process is a series of sequential stages that must be carried out in order to establish a project, and its primary goal is to raise the project's quality. In order to help a business stay competitive and satisfy customer needs, process invention refers to the application or introduction of new technology or technique for acco mplishing something. This may be entirely new and untested, or it could be developed from earlier procedures with enough innovative characteristics and technological traits that a company could patent the development's design or copyright ideas (Addo-Tenkorang, 2011). Distinct features of process invention include that it must be an original idea and working in theory, requires scientific skills, and comes about when a scientist thinks of a new idea regarding a product or service Grasty, 2017).

When an organization creates a new process or solution that is significantly different from an existing one, it is referred to as process innovation. This type of innovation can be beneficial to the people who perform the process, as well as those who rely on it (Brey, 2009). Process innovation needs considerable adjustments to particular procedures, equipment, and software in order to reduce production and distribution costs, enhance the quality, manufacturing, or distribution of new or better goods, and reduce environmental concerns (Maier A, 2014). Process innovation distinguishes itself by requiring the practical implementation of a new idea; the idea must not only be workable but also economically feasible and fulfill a specific need; and the skills required include marketing, technical, and strategic skills (Grasty, 2017). Values resulting from process innovation, according to Gardiner (2010), include the ability to decrease the time it takes to produce a good or service. It can also increase the number of goods or services that are delivered in a given time. Product quality and service standards are two more areas that might see significant gains if innovative processes are used.

2.2 Enterprise Resource Planning (ERP)

Planning tools have evolved over time since the introduction of Gantt charts in 1900 (Bhavikatti, 2012). Currently, the most commonly used planning tools include the critical path method, spreadsheet applications, checklists, and Microsoft Project. However, these tools have no relationship with each other and offer entirely independent functions. During the execution of projects, it becomes difficult for a project manager to integrate the different project roles with these tools, creating the need for more advanced integrated management software (Ojala, 2013).

ERP systems qualify as process technological innovation as they offer more advanced functions that were not previously available with traditional tools. These software enable collaboration of different project roles during project execution. They enable close coordination between those planning resources in the offices and those managing resources on site. They also allow for the engagement of all work participants through the provision of a single platform, a feature that traditional planning tools lack, thereby creating a collaborative approach that fosters teamwork and better support (Addo-Tenkorang, 2011).

2.3 Theoretical Foundation

This section reviews the available literature on Enterprise Resource Planning Systems. The review delves into various theories of technology invention and models that guide the research, including Technology Acceptance model (TAM), Diffusion In novation Theory (DOI) and Technology-Organization-Environment (TOE) Model.

2.3.1 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a theoretical model that explains how users come to accept/adopt and use technology. Davis (1985) made the first TAM proposal in 1985. According to the concept, when a user is exposed to new technology, a variety of variables have a role in how and when they will utilize it. This includes how beneficial and simple it is judged to be to use. These major, critical success factors influence an organisations behavioral intentions to adopt ERP systems. In Davis’s study, two important constructs were identified; perceived usefulness a nd perceived ease of use. These views forecast how people feel about the system's adoption. Following that, the attitude gives rise to use intentions, and the intents result in real system utilization. Ajzen et al. (2010) emphasized the use of perceived usefulness and perceived ease of using ERP systems as the critical variables for determining the acceptance level of this technology. TAM assumes that perceived usefulness (the degree to which a person thinks that using a certain system will help them do their job better) and perceived ease of use (the degree to which a person believes that using a particular system won’t take much effort) along with the influence of pre-existing external variables are the primary determinants for adoption of new technology.

This theory aligns well with the discussion of ERP systems, as it proposes that the adoption of an ERP system is determined by its perceived usefulness and its perceived simplicity in the integration and automation aspects of its processes, and this influences both the behavioral intent to use the system and the actual usage of it.

2.3.2 Diffusion of Innovation (DOI) Theory

Rogers defines diffusion as the process through which a social society's members learn about innovation over time via certain channels (Rogers, 1995). ERP systems are process innovations, and their acceptance can be conceptualized using the theory of adoption and diffusion of innovation.

The DOI theory states that the diffusion rate is affected by various factors, such as innovation's observability, compatibility, and trialability. Rogers (1995) claims that relative advantage refers to how much innovation is perceived to be superior to its predecessor. The various challenges and advantages of ERP systems have been discussed in detail since Rodgers (1995) asserts that the adopters will want to ensure that the advantages of an innovation surpass those of a previous practice, in this case, the use of conventional planning tools. The compatibility of an innovation is determined by the extent to which it can be perceived to be compatible with the needs, values, experiences, and beliefs of adopters. The trialability of an idea is determined by the degree to which it can be experimented with. Finally, the observability of an innovation is the extent to which its effects can be observed (Rodgers, 1995).

DOI's theory can be conceptualized in the choosing of which ERP system to adopt since the functional superiority of every software increases its acceptability. This is linked to the user's desire to minimize costs by avoiding the adoption of more than one software to serve different functions, as Rodgers (1995) highlights.

2.3.3Technology-Organization-Environment(TOE)Model

Tornatzky and Fleischer developed the TOE model (1990). The technical context, organizational context, and environmental context are the three aspects that influence the process by which an organization adopts a technological innovation. Tiago and Maria (2011), claim that the TOE model is consistent with the DOI theory. The DOI model strongly emphasized a person's traits and organizational factors, both internal and external, as motivators for organizational innovation. But the TOE model also includes a new and important component, environment context.

According to Tornatzky and Fleischer (1990), a company's industry rivals and interactions with the government all fall under the umbrella of the environmental context. Competitive pressure from rivals tends to stimulate firms to look for new approaches to raise their efficiency and increase productivity, leading to firms achieving a competitive advantage. This can be contextualised to the usage of ERP systems, as most construction firms adopt more advanced planning tools to enable them to complete projects on time and within budget, allowing them to keep their profit margins and as a result, gain a competitive advantage to obtain new business opportunities. Most higher-class contractors have a huge labour force and complex managerial structure that necessitates the need for the adoption of sophisticated management systems, as highlighted by Tornatzky and Fleischer (1990), who state that organizational size, age, and resource availability are the major factors that stimulate firms to adopt technological innovation.

2.4 General benefits of technological inventions

A crucial benefit of technology innovation is that it allows for more efficient communication both internally and externally. Video conferencing and online meeting platforms like GoToMeeting, Zoom, and Skype offer organisations seamless communication with employees working remotely (Leung and Antypas, 2001). Employees now have a centralized location to read and change internal documents and contracts, as well as send essential data to other departments, thanks to social intranet software. Elvis (2017) further states that with streamlined communication, there is increased business capacity as it allows organisations to reach more people in less time thereby creating platforms for a wider market. Organisations can reach potential clients, suppliers, and customers in any part of the world through various technological communication mediums.

Elvis (2017) argues that, through process automation, including utilizing computer networking, an organization's managerial and operational processes are streamlined. This makes it more cost-effective for businesses to manage everyday operations since it allows them to do more with less money without sacrificing value or quality. Traditional files will always have a role in the corporate sector of any organization. However, when it comes to sensitive information, leaving a paper trail may not be the best course of action. With data security measures that come up with process innovation, such as the use of ERP systems, classified information is protected from unauthorised personnel through the use of access controls, encryption, and data masking, and therefore organisations are able to secure sensitive information from identity theft (Elvis and Aphu, 2017).

Teams may organize virtual meetings that bring together individuals from various places or businesses by using better collaboration technologies like video conferences or web conferencing via the internet. This decreases unnecessary travel time, encourages quicker decision-making, boosts output, and raises worker satisfaction. The regular operation and growth of all institutions are positively impacted by the efficient exploitation and usage of time (Elvis and Aphu, 2017).

A simplified workflow system, shared storage, and collaborative workspaces are the outcomes of technological breakthroughs like the usage of computer technology, computer telephony integration, and database systems. Because of this, organizations can become more efficient, and as a result, their employees can do a greater quantity of work in a shorter amount of time. Business management systems such as ERP systems have several potential applications, including automating routine processes, simplifying data processing, and storing data in a way that makes it simple to retrieve it later (Leung and Antypas, 2001).

According to Alberto & Fernando (2007), small company owners that utilize technology save on operating expenses. With the use of basic business software, companies are able to automate a variety of back-office processes, including record keeping, accounting, and payroll. Mobile technologies make it possible for field agents and home offices to interact in real-time with one another. Mobile apps can also be used by field agents to keep track of daily expenditures as they are incurred and can then sync their data with accounting software located back in the office. The infrastructure of ERP technology allows for the centralization of duplicate activities. To save personnel expenses, a major corporation could concentrate its payroll operation in one place. Moving high-cost tasks online is another way to achieve financial efficiencies. Businesses could provide e-mail support to customers, which is often more cost-effective than direct interaction with a customer service representative in person (Alberto & Fernando, 2007).

Technology innovation allows businesses to reach new economic markets. Instead of only supplying consumer goods or services to customers in the immediate area, small businesses have the ability to reach markets on a regional, national, and even international scale. Innovations like the utilization of the internet allow businesses to establish websites that serve as low-cost alternatives that customers may use around the clock when they need to make a purchase of products or services. Through strategically positioned website banners, entrepreneurs may also employ online advertising to reach new markets and clients (Oloo, 2015).

2.5 ERP process technology as a planning tool

Planning is one of the management functions, which involves deciding beforehand what is to be done, when it is to be done, how it is to be done, and who is going to do it. It is an intellectual process that determines the objectives of an organization and generates many action plans to assist the company in reaching those goals. It lays out in detail the steps that must be taken in order to accomplish a certain goal (Madhani, 2010). By outlining the route and providing a steering mechanism, planning serves as a foundation for the other key management tasks which include organizing, leading, and managing (Madhani, 2010). Both plans and objectives are included in the planning function. A plan is a strategy utilized to try to attain the established objectives, while a goal is the desired outcome that an organization hopes to reach in the future.

The various planning tools used in management, according to Knight (2010), include the use of affinity diagrams, tree diagrams, matrix diagrams, activity network diagrams, bar charts, and process decision programs. The affinity diagram is a manual planning tool used to categorize enormous amounts of unorganized information according to how naturally they are related to one another and how closely their traits match. When dealing with problems that seem to be very complicated and hard to handle, it is often utilized (Hurst, 2010). An affinity diagram enables the generation, organization, and consolidation of knowledge about complex processes. Insight from the review and analysis of information enables the visualization and correlation of different data sets, making it easier to take informed decisions. However, the affinity diagram method is manual, making it temporal and fragile. It is very challenging to demonstrate how activities are interdependent using the affinity diagram.

According to Idoro (2012), the tree diagram is an advancement over the affinity diagram. It is a systematic planning method that outlines all the details needed to complete a given objective. It is used to break down complex processes into their smallest components. The tree diagram is a neat arrangement resembling a family tree or organizational chart. It aids in the understanding of a process by visually breaking down complicated processes into smaller levels of detail. In contrast to the affinity diagram, the dependencies of activities in the tree diagram are simpler to understand (ibid).

The matrix diagram is a planning tool that shows the connection or correlation between variables in a table format. By exposing interactions and dependencies between many aspects, it allows one to investigate relatively complex challenges. Compared to a tree diagram, a matrix diagram illustrates relationships between two or more groups of things in a manner that gives each item logical connections (Brey, 2009). A grid of rows and columns is used in the graphic to show the strength of the connections. At each point where a row and a column cross, a connection is either existent or not. As a result, it is possible to determine the existence and significance of links between two or more things. Depending on the factors being compared, one can weigh and determine which tasks to complete first for the success of the project (ibid).

An activity network diagram is a tool used to map out the sequential sequence of activities and tasks for a project. It shows how many groups, tasks, and activities are interconnected and how they all affect a project. These tasks, the connections between them, and the orderly progression of the overall process are shown using boxes and arrows. The diagram includes a time scale that represents the duration of activities, this enables one to identify the boundaries for the best case, worst case, and most likely project finish time (critical path). In contrast to earlier planning tools, this one allows for visual tracking of each project phase's progress through to the conclusion (Idoro, 2012).

The Gantt chart is a type of bar chart that provides a visual view of project tasks scheduled over time. Horizontal segments that indicate activities have lengths that correspond to the amount of time required to complete each activity (Bhavikatti, 2012). The Gantt chart is more efficient compared to the previous planning tools since it not only illustrates the progress of project tasks but also displays the resources needed for each activity. However, the Gantt chart does not show how the various activities are interconnected, making it difficult to see how a delay in one activity affects other activities. It also does not indicate which activity is critical, so managers and workers aren't aware of what attention should be given to the necessary activities (Krishnamurthy & Ravindra, 2010).

Microsoft Project is a project management software program that is used to create project plans, keep track of time, and manage resources. Microsoft Project enables project managers prioritise tasks, define the activities required for each, and then assign them to the relevant team members and equipments. Accurate time schedules that consider the various work items and their interrelations are produced, which helps determine how a delay in one task may affect others (Roberts and Wallace, 2004). However, Microsoft Project cannot integrate all project schedules into one system of schedules to evaluate and assign resources needed for respective project. This often results in a conflict of resources, such as over-allocation of resources on one project at the expense of another project. This causes fluctuations in the resource profile, which lead to variations in the utilization of resources. These fluctuations are not desired in any project, and the process of managing these fluctuations often becomes a difficult exercise (Hamilton,72001). Undesirable resource fluctuations often result in a negative impact on resource utilization efficiency. This affects projects' overall performance, productivity, and cost (Jun, 2010).

With the development of Enterprise Planning Softwares, there is integration of schedules to evaluate the resources needed for every site. This enables the project manager identify any overlap of resources that needs to be worked out (O'Leary, 2004). This ensures the resource usage for every project is levelled in a way that all projects require an approximately constant amount of resources. This is achieved by delaying non-critical tasks that are within the available float on one project and preference is given to the critical activities on another project. This ensures there is reduced fluctuations in resource demand for every project.

The conventional planning tools, which include the use of the affinity diagram, the tree diagram, matrix diagram, activity network diagram, Gantt chart, and Microsoft Project seem to have failed to effectively address the challenges of integration of schedules, internal and external resource management. This implies that other management tools, such as an ERP system, are needed to complement these tools. ERP systems minimize inefficient workflows and issues with cross-functional coordination that impede project integration through provision of a single platform where project team members can collaborate. (Langfield-Smith, 2015).

2.6 Universal application of ERP

In the manufacturing industry, ERP systems have widely been utilized as planning tools to maximize the efficiency of ordering and managing the inventory of mate rials required for the production processes by using forecast sales (Laudon & Laudon, 2002). This is made possible by the standardized data structure, which makes the information submitted by one department instantly accessible to authorized users across the company. This standardized framework aids in maintaining alignment across the organization. This has made it possible for industrial firms to gain a variety of advantages, such as high responsiveness to client requests and providing timely information to decision-makers (Jacobsen, 2007). A manual procedure that was prone to mistakes has been eliminated thanks to the integrated data structure. Using paper records is highly wasteful and dangerous since they are easily damaged and misplaced. Data security is not something that even hard drives can provide, particularly in situations when there are many users. According to Laudon & Laudon (2002), manufacturers are now able to access a variety of data via a single system thanks to ERP software.

Jilani (2014) demonstrated that ERP systems are the best tool for coordinating and integrating an organization's procurement processes due to their capacity for processing information more quickly, keeping track of orders and inventory control, automating the ordering and payment processes, lowering setup costs, shortening the order cycle, and avoiding errors. According to Langfield-Smith (2015), ERP systems have increased the accuracy of information gathered from all departments, which has increased the productivity of manufacturing organizations.

The emergence of ERP technologies in the banking industry has allowed banks to expand their functions internationally (Laudon and Dass, 2010). It facilitates the gathering of data from many departments into a single database, allowing workers to interact with colleagues both within and beyond the continent to share experiences and difficulties, work on a shared agenda from diverse places, and achieve their goals without difficulty (Dainty, 2011). Majority of studies have shown that implementing an ERP system inside a company enhances workflow compatibility across functional departments, and their performance, as well as improves the prediction of new business operations in different markets (Romney & Marshall, 2012).

Partnerships (2010) further states that these systems have many benefits, including improved efficiency, decreased manual effort, and lower risk of human error. These benefits allow management to enforce adherence to established business procedures, quickly spot deviations, and ensure increased information access by evaluating and supporting audit functions. The majority of banks have automated their systems for technical reasons, to increase service quality and information timeliness, budgeting, personnel monitoring, internal audits, accounting and finance, marketing, and technological literacy (Partnerships, 2010).

In the hospitality industry, ERP has enabled the flow of information in real time between frontline employees and strategic-level executives of a hotel on a peer-to-peer basis through its cloud-based document repository feature. As a result, frontline staff may get real-time information on organizational performance via ERP, which significantly contributes to employee empowerment. To uncover the key advantages anticipated from adopting an ERP system, Davenport sent inquiries to top managers of various firms (Davenport, 2000). The quality of the information made accessible by the ERP system was significant, in the opinion of almost two-thirds of those managers. 61 percent of managers considered it very important in improving the decision-making process. 51 percent and 38 percent of managers, respectively, mentioned cutting costs and increasing efficiency, indicating that the deployment of an ERP system is seen as a chance for technical advancement.

2.7 Application of ERP in the construction industry

Compared to other industries, the construction industry has been slow in the uptake of ERP systems. However, in organisations where it has been implemented, it has enabled management of various ongoing projects, allowing reporting and forecasting of progress status, cost status, profitability, and potential problems like falling behind schedule and incurring excessive costs so that appropriate measures can be taken before problems occur (Dominguez, 2010). Additionally, these technologies have made it possible for project progress data to be immediately and routinely summarized and reported to the project manager in time, reflecting the overall position of the company as far as financing requirements, cash flow, purchasing, equipment, and human resources are concerned. If there are conflicts among projects, such as competition for the same resources, project management decisions are easily made by maximizing the overal interest of the company (ibid).

Site managers on various projects within a corporation do multiple managerial duties at the same time, as Jonathan (2003) attests. With the software-integrated system employing parallel and distributed technology, the project manager can update the system with recently completed data, which a quantity surveyor can access from the same database to determine the bid price of a new project.

2.8 General functions of ERP as a management tool

Planning tools are broadly classified into two, disparate planning tools and integrated systems. Disparate planning tools are stand-alone tools that offer entirely independent functions (Knight, 2010). They include bar charts, the critical path method, spreadsheet applications, checklists, and Microsoft Project. Stand-alone tools are simpler and cheaper compared to integrated software. However, these tools don't offer a single platform where project team members can collaborate. With the emergence of projects with a high complexity rating and correspondingly high risk, more sophisticated but efficient software is required to integrate these project roles on one platform. Enterprise resource planning systems are specialized software solutions that integrate various aspects of construction project (Ojala, 2013). These software help implement resource planning by integrating the different project roles needed to run a project into a single system. These software allow project team members to communicate and share information and documents more easily (Olson, 2004). Project documents such as working drawings, requests for information, transmittals, shop drawings, material data, daily field reports, checklists and daily field reports are easily uploaded to a cloud-based repository system which is easy to access.

These software offer interactive Gantt charts in which a construction project manager may merge the schedules from all the projects they are working on into a single set of schedules to determine the resources needed for each site (O'Leary, 2004). Construction project managers can use these system schedules to determine whether there are resource overlaps that need to be resolved and also identify any over or under allocation of resources (Oracle, 2012). The project manager can easily ensure the resource usage for every project is levelled in such a way that all projects require an approximately constant amount of resources. This is achieved by delaying non-critical tasks that are within the available float on one project while giving preference to critical activities on another project. This ensures there is reduced fluctuations in resource demand for every project (O'Leary, 2004).

ERP software functions vary; some have a wide range of functionalities, whereas others are focused on a specific management solution (Kasim, 2005). Oracle software offers solutions tailored to a number of focus areas including document management, risk management, cost management, time management, and equipment scheduling. Vista and Sage 200 have a strong focus on cost management, quality management, equipment scheduling, and human resource management, while Maestro and Epicor focus on time management and human resource management respectively.

2.8.1 Human Resource management

Construction projects are challenging by nature, and they require a lot of manual labour and planning. These demands also necessitate specializations. According to Dainty et al. (2011), the contractor would need to hire supervisors and foremen, develop an incentive system or a sophisticated monitoring system inside the site organization structure to guarantee that employees perform as expected, and check the quality of output. All of these arrangements are costly due to the unique nature of construction projects, which prohibits the replication of the same system for all projects. It is for this reason that the industry heavily relies on subcontracting for the majority of its production effort (Gwaya, 2015). However, over time, there have been challenges with information sharing and a lack of collaborative tools between the main contractor and respective sub-contractors.

According to Johansen and Porter (2003), main contractors and subcontractors that operate under the traditional construction rocurement structure do not interact to plan and create the project work schedule once a project has been awarded. This lack of collaboration, unfortunately, leads to incorrect and presumed durations of significant tasks since suitable and thorough information was not obtained. This always has the potential to cause programmes to fail, resulting in delays in projects. On conventional construction projects, these important project partners often trade accusations and endless counter blame. Main contractors and subcontractors have found it challenging to carry these ideas through to project completion, even on projects where clients support the concept of cooperation. Relationships between construction companies deteriorate when potential profits are threatened. This can happen without recourse to established ties. (Johansen and Porter, 2003).

Currently, project documents such as shop drawings, material data, samples, product data, daily field reports, and checklists are paper-based. The approval process and feedback to the respective subcontractors take longer, which results in conflict between the two parties because of the tight schedule provided. Dainty et al. (2011) advocate a system that facilitates the exchange of information should be established to ensure its continuous flow. Subcontractors and main contractors should be aware of how information sharing can be impeded or affected, which can affect their level of trust.

The use of ERP systems, in particular the Maestro software, allows subcontractors of the team to see what has already been discussed and stay up-to-date with developments through the online paper trail and cloud-based repository. When working with multiple subcontractors at once, it can be difficult to organize tasks and monitor the progress of the projects. When using subcontractors, one of the biggest issues is the project's timeline. If a task is behind schedule and affects everyone involved, it can quickly become a major issue. With the help of Maestro software, users can easily distribute tasks and view project timelines. It also provides reminders so that everyone is held accountable for their actions. (maestro, 2014). It digitizes paperwork so that workers can be monitored while they're on-site. It also allows one to store backups and retrieve data from anywhere. Having the same software system can make it easier to keep track of various tasks, and it can help everyone stay organized.

Through Sage 200, subcontractors can easily manage their tasks and communicate with their managers. They can also upload photos of their completed work to show that they've finished their obligations. This complete record of the work performed by a subcontractor shows that they were able to complete their tasks on time, and the site manager signed off on them. This information can then be submitted along with invoices to help minimize delays. Vista construction software streamlines everyday human resources management and efficiently facilitates complex construction payroll processes using Vista’s integrated construction HR management and payroll processes. The open database structure of Vista allows for the sorting and reporting of data. Organize all employee data, records, and tracking information in a secure, private virtual file cabinet that can be accessed and updated in real time. To concentrate on those who demand more attention, the software automates complicated union payroll procedures and contractual construction payroll obligations (Vista, 2006).

2.8.2 Equipment scheduling

According to Bhavikatti (2012), construction equipments are the most crucial and critical resource for a construction company. Construction equipments are one of the most capital-intensive long-term investments a construction company can make. They are also prerequisites for the timely completion of all construction projects. Construction schedulers have unique difficulties when dealing with projects that call for a significant number of machines. To be integrated into the typical project schedule, tasks like preventive maintenance, backup vehicles, and multiple shift operation need specialized expertise. Most construction projects, if not all of them, have contractual completion deadlines that, if missed, either result in liquidated damages or late completion penalties that materially affect the project's financial viability (Chitkara, 2012). Researchers and practitioners seem to have had strong confidence that the creation and implementation of improved scheduling approaches may improve project management and project success (Gwaya, 2015).

Bar charts and the critical path approach have been the sole approaches utilized in resource scheduling for decades (Baily et al., 2008; Harris & McCaffer, 2005; Seeley, 1986). The bar chart provides a simple and practical approach to recording project progress, scheduling workers and equipment, and monitoring task progress (Bhavikatti, 2012; Krishnamurthy & Ravindra, 2010). Bar charts, however, have several drawbacks that render them inefficient for the planning and management of building projects (Krishnamurthy & Ravindra, 2010). Its shortcomings are: it does not show how the various activities are interconnected, making it difficult to see how a delay in one activity will affect other activities, it does not indicate which activity is critical, managers and workers aren't aware of what attention should be given to the necessary activities; the exact progress of the task isn't shown; and its management does not work effectively where there are uncertainties in the expected duration of an activity (Krishnamurthy & Ravindra, 2010). These shortcomings make it difficult to schedule these equipments for the different activities.

The Critical Path Method (CPM) is a deterministic method for project planning that takes into account the predicted duration of activity. (Roberts & Wallace, 2004). The CPM helps planners determine the required amount of time to finish a project. It also predicts the possible start and end dates for the activities (Bhavikatti, 2012; Roberts & Wallace, 2004). The CPM highlights crucial tasks, allowing management to focus on them in order to keep the construction schedule on track. However, the CPM approach has come under fire for being labour and time intensive, requiring a lot of work to utilize, and limiting upper-level management's capacity to participate in decision-making (Kerzner, 2004). It is difficult to break down crucial tasks into simpler tasks with CPM. This makes it difficult to schedule these equipment for the different activities.

Microsoft Project is commonly used for larger projects with more complicated task interdependencies. With Microsoft Project, project managers can prioritize their tasks and assign them to the appropriate team members and equipment. Accurate time schedules that consider the various work items and their interrelations are produced, and this helps determine how a delay in one task may affect other ones (Roberts and Wallace, 2004). With Microsoft Project, a project manager can automatically level the resources depending on their task types and dependencies. This ensures that there are no over or under allocations. By using the resource consumption view option, it is also possible to allocate equipments needed for every activity (Kastor & Sirakoulis, 2009). However, Microsoft Project is unable to integrate the schedules for all projects into one system of schedules to evaluate and assign resources needed for respective projects. Scheduling the equipment to the various sites becomes difficult as a result.

With Vista construction software, the project manager is able to accurately calculate how much time an expected task will take, so one can plan accordingly for project needs. This may be done while keeping an eye out for challenges that can cause the project's deadline to be extended. Creating a project calendar definitely has a great impact on the thoughtful planning of equipments. It also makes it possible to determine how a delay in one task may affect other ones. Additionally, the project manager may monitor the development of any construction project from any location at any time. One may monitor RFIs (requests for information), equipment status, and field notes as they arrive, whether they are in the office or on the job site through its cloud service. This makes it possible to see potential impediments before they appear (Vista, 2006).

Additionally, Vista construction software allows project managers to easily identify when equipment usage and maintenance costs exceed the replacement cost of an asset. It offers a single-step data entry method, customizable rates, category allocations, and revenue categories that make it easy to keep track of equipment utilization and location. Additionally, it allows for the viewing of fixed asset schedules and monthly estimates of book depreciation. The software also makes it simple to arrange preventive maintenance for your fleet of equipment and provides notifications when maintenance or repairs are required, giving you the authority to safeguard your company's most valuable capital assets (Vista, 2006).

With Oracle Prime Projects' interactive Gantt charts, construction project managers may merge the schedules from all the projects they are working on into a single set of schedules to determine the resources needed for each site. They may use this to determine whether there are resource overlaps that need to be resolved (Oracle, 2012). Actual schedules may differ from the projected ones. Oracle Prime Project may assess its sequence of operations to determine if they can rent or hire if they discover that a piece of equipment won't be accessible for the next work because the task is taking longer than expected.

2.8.3 Document management

To create, collect, and utilise information that is necessary for the company to fulfill its commitments and satisfy the expectations of its stakeholders, strong information management practices are important (Wamelink, 2002). Currently, project documents such as RFIs (requests for information), transmittals, shop drawings, material data, samples, product data, daily field reports, checklists, and project plans are paper-based. This traditional document management is susceptible to consequent nontraceability, possible loss, information fragmentation, and strenuous accessibility to information.

When suppliers submit their invoices for delivery of materials, supplies, and equipments to the job site, these documents must be cross-referenced with the ones on site to ensure their validity. When managing a large number of projects, using physical papers makes it challenging to sift through a bunch of documents. This problem has been solved and users are now able to consolidate documentation for construction projects into a single source, thanks to Oracle's cloud-based document repositories. Additionally, the cloud-based document repositories make it simpler and quicker to update documents and synchronize changes with other project participants (Oracle, 2017). Project managers may set alarms to meet deadlines, have an audit trail to keep people responsible, have all relevant papers and email communications in one place, and have an audit trail to hold individuals accountable in the event of any future litigation (Kinuthia, 2014). The ability of a software system to handle construction documents helps in controlling hazardous worksite items as well. These materials are easily traceable, testable, and transferable to handling locations.

As part of the Oracle cloud-based document repository, all parties involved in the construction project are able to track the progress of the whole project, and all relevant information can be sent between the various stakeholders. However, it is crucial that the paperwork be subjected to internal control measures. Each person should use the software to look for the most recent version of a document. The document must be downloaded into the company's project folder structure for that specific project work, utilized, renamed, and uploaded into the correct folder of the software if it is required as a foundation for another one to be created. Only completed papers may be uploaded by a single person. It is necessary to keep a document in the company's folder structure while one is still working on it until it is ready to be submitted (Oracle, 2017). Controlling access, distribution, and change of documents ensures that information can be easily accessed and avoids the loss of papers.

2.8.4 Cost management

Planning, estimating, budgeting, and cost control are all parts of cost management, which enables a project to be finished within the approved budget (PMI, 2013). The common techniques that have been adopted by construction firms for cost estimation are expert judgment, bottom-up estimating, and analogous estimating (Sheen, 2012). People with expertise in resource estimate and allocation are consulted when making expert decisions. These individuals include people who have performed related work in the past. If the expert is easily reliable and dependable, this strategy is simple to apply. The estimate is built by the expert according to their knowledge of the project's requirements. (Berkeley, 2006). This method is ideal for handling uncertain tasks as it is quick and accurate if the expert is competent. The main disadvantage of this approach, however, is that the expert may provide false information or may even not be available (Sheen, 2012).

Bottom-up estimating refers to breaking down tasks into smaller work units. It basically entails breaking down large difficult tasks into smaller units and determining the resource requirements for each unit. Muldoon (2014) asserts that bottom-up estimation depends on the WBS's lower level components. Individual activity resource requirements or costs are estimated, and these figures are then added to get a total estimate. Although the accuracy of the bottom-up estimation method depends on the provided estimates at the scheduling stage, it can be very time-consuming to complete. Due to the preciseness of the estimates, it takes a long time to get them into the correct calculations. (Berkeley, 2006). Its drawback, however, is that it takes a lot of time and may not be able to break down tasks that are difficult to identify (Sheen, 2012).

When information is unknown at the start of the project, analogous estimation is often employed. This requires taking into account earlier identical actions West and Daigle (2004). In essence, analogous estimation compares a current project with previous projects of a similar kind. Estimates for the present project are produced by extrapolating values from previous projects. Although fast and simple, it is not particularly accurate (Muldoon, 2014). This method is most suited for situations where the kind and nature of the task, as well as the resources utilized to carry it out, are identical. However, this method only works if the tasks and durations of the projects are similar.

The concept of parametric estimating refers to an approach to estimating that involves utilizing an algorithm to calculate a project's duration or cost based on historical information (PMI, 2013). The parametric approach estimates various factors such as the duration, budget, and cost, using historical data with statistical connections. The outcome of each project is added to the historical knowledge with Oracle project costing, forming a database for actual durations and costs from previous projects. This software generates a formula estimating the required resources to carry out a project's tasks. This enables the project manager to set up parametric estimation models for future projects. As project managers complete more projects and compile more data, they improve the accuracy of their estimations (ORACLE, 2017). This method of cost estimation is very accurate and simple, especially in complex and diverse projects. Although parametric estimating is ideal for the planning stage, it can also work well at other phases of a project. This method provides a more coherent view of the project's life cycle. (Jucan & Sprague, 2013).

According to Hamilton (2001), the use of spreadsheet applications has been the most popular tool for tracking construction costs due to its easy-to-use utility and user-friendliness. The estimated budget expenditure is compared to the actual expenditure; the difference forms the cost variance. In the event of an unfovarable variance, analysis is done to know where to start when it comes to developing solutions. Spreadsheets are also used in cash flow management with the use of formulas to automatically calculate invoice payment dates according to defined maturities. Its drawback, however, is that it is a stand-alone tool that one needs to keep up-to-date, which is laborious in the case of more complex scenarios (Jonathan, 2003). The lack of ownership of documents in spreadsheets can make them prone to errors, especially when used by multiple people. It's also impossible to tell if the formulas are correct or if the data has been overwritten or accidentally replaced (Sheen, 2012). Muldoon (2014) further argues that spreadsheets do not have the necessary tools to collaborate, such as task lists, file sharing, and discussion boards. Team members can't keep track of a task's status or identify the next steps.

By using a spreadsheet-like interface for budgeting and forecasting, Oracle Prime Projects Cloud Service enables project managers to minimise the risk of going over budget. In order to determine the optimal portfolio mix for capital projects, extensive "what if" scenario modeling capabilities are available in Oracle Prime (ORACLE, 2017). The use of transaction controls limits the number of expenditures users can charge to specific projects using the expenditure category. These controls help prevent site managers from charging incorrect or excessive costs to a project without justification. Excessive costs incurred in a project can be flagged as a variation or extra work and managed in time (Wong et al. 2014). Different control levels can be set up to impose hard or soft restrictions on what can be charged to the project. In-depth comparisons between actual costs and project budgets are also provided by Oracle Project Costing. Actual and outstanding commitments are compared to the original and current budgets and drilled down from the summary of project costs to see the cost details at the task or transaction level. The project manager may simply examine cost patterns and rapidly spot any issue areas for all levels of the project by having aggregated and comprehensive project cost information in a single repository (Oracle, 2017).

One cannot overstate the importance of having a payment management system that does away with manual, paper-intensive, and disconnected operations. The Vista Payment Management Cloud Service enables genuine cooperation among the many payment stakeholders on construction projects by bringing payment process participants, papers, and data together in one shared online platform. The system provides stakeholders with electronic payments, doing away with the need to cut and send paper checks, saving more money and time, and decreasing payment delays. Additionally, the Vista system automates payment freezes and warnings for compliance failures, avoiding erroneous cash distribution (Vista, 2006).

2.8.5 Time management

Late delivery of projects is a common issue encountered in the construction industry. It can affect the entire project team and its various participants (Diagle, 2004). This is particularly true for company owners since a delayed project handover delays the expected revenue and raises the project costs. Depending on the commitment accepted and the contract's delivery date, the owner might face various additional challenges (Idoro, 2012). Extending the project's execution period can cause contractors to encounter cost overruns. These can be caused by various factors, such as the rising cost of materials, the increased cost of management personnel, and the payment of contract penalties. In addition, not finishing a job on time can damage a contractor's reputation, making it harder for them to secure new contracts.

Kinuthia (2014) states that Microsoft Project and the critical path approach are currently the common project planning tools most construction companies have adopted for project schedule management. The Critical Path Method is a deterministic method that aims to predict the activity durations of projects. It uses forecasts that are generally accurate (Roberts & Wallace, 2004). The CPM process is utilized to determine the amount of time that it would take to finish a project. It also helps in estimating the project's start and finish dates (Bhavikatti, 2012; Roberts & Wallace, 2004). The CPM highlights crucial tasks, allowing management to focus on them in order to keep the construction schedule on track. However, the CPM approach has come under fire for being labour and time-intensive, requiring a lot of work to utilize, and difficult to estimate the project completion time, especially in bigger projects (Kerzner, 2004).

With the emergence of computer planning programs that allow users to create time schedules that take into account the various tasks and their interrelationships, accurate time schedules have been developed. These programs help users complete their work tasks more efficiently. In this case, productivity refers to the output of a work session over a certain period of time. In order to create a precise time schedule, experience is required. Also, accurate data on the productivity of various resources such as plants, labour, and materials is essential (Roberts and Wallace, 2004). A combination of bar charts and network diagrams enables effective communication of the project plan. Its drawback, however, is that Microsoft Project is a file-based software where a single individual creates and maintains a document for Microsoft Project and it is then pushed to the project team to be followed. (Baily et al. 2008).

With the use of ERP systems, in particular Oracle Primavera, there is an engagement of all work participants through its collaborative approach that creates teamwork and better support. The project manager, site manager, design lead, and client representative provide their input, and this creates a good workflow between the project stakeholders and reduces the need for re-work (Nyabioge, 2019). Oracle Primavera allows users to access the program from any computer with internet access, making it easier for managers to track and compare planned versus actual timelines (Oracle, 2017).

With the use of Epicor project management software, it's simpler and more flexible to divide jobs into smaller deliverables with defined roles. This makes it possible for field personnel to choose the most effective way to do their task with the least amount of waste (Nyabioge, 2019). Using Epicor project management interactive Gantt charts, construction project managers may give a more accurate and complete visual representation of a project's progress in real-time (Epicor, 2021). Epicor project management makes it easy for the project team to discover the fundamental causes of delays and incomplete work as the project team logs in the reasons for missed commitments.

2.8.6 Risk management

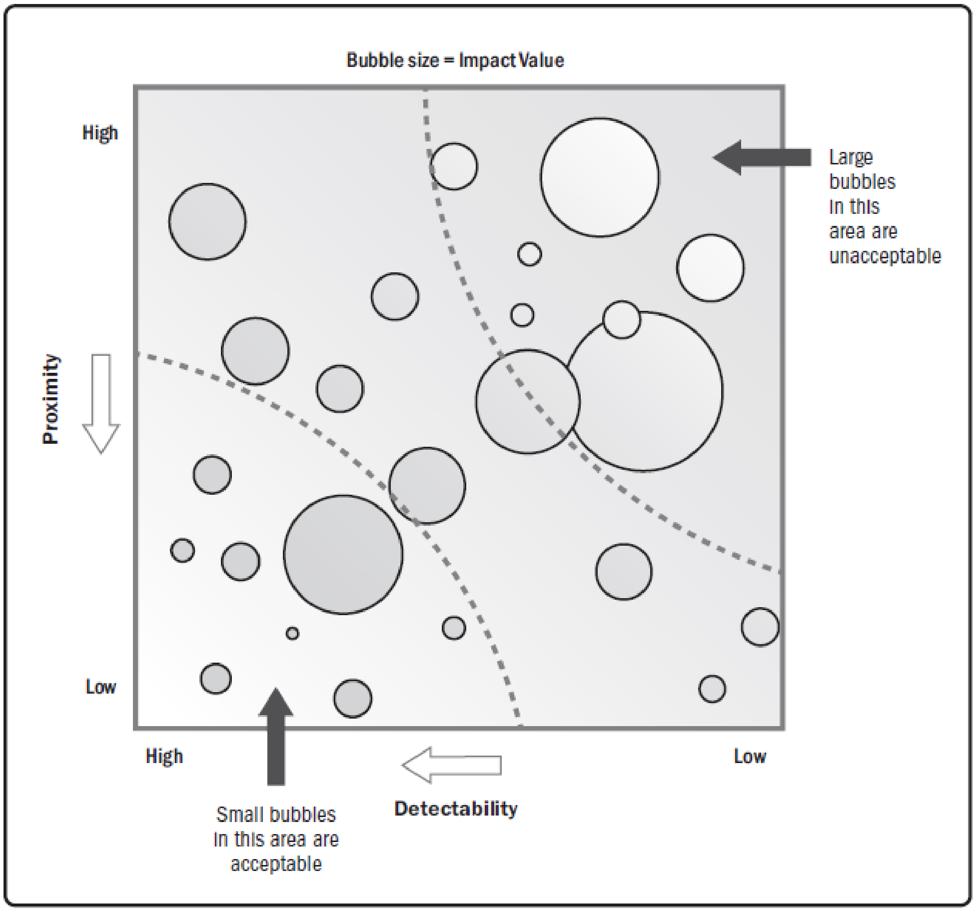
According to Gwaya (2015), no construction project is completely devoid of risk; in fact, every construction project carries some level of risk. Regardless of the project's magnitude, there is always a degree of risk and unpredictability. Project risk management is a process that involves planning, identifying, monitoring, and controlling activities. This process can be carried out through multiple steps (PMI, 2013). When it comes to developing a risk management strategy, one of the most often utilized tools is the RBS (Risk Breakdown Structure). It enables the project team to examine the whole spectrum of causes from which unique project risks occur. In most cases, this comes in handy when trying to figure out how to classify potential risks. Custom risk categorization frameworks, which might take the shape of a basic list of categories or an organization-specific structure, are often utilized in organizations that do not have a generic RBS in place. A project-specific RBS from Oracle Prime Projects Cloud guarantees that any issues are identified early enough, allowing the appropriate individuals to respond and reduce the damage before it gets too serious. Management of a project becomes easier, more efficient, and more cost-effective if risks are managed before they arise.

A qualitative risk analysis is a process that involves identifying and prioritizing the various risks that can affect a project. This process is carried out to further investigate and take action on these risks (PMI, 2013). Common qualitative risk analysis methods include the use of expert judgment, data collection, and specialist meetings (Broadhurst 2012). Individual project risks are discussed at a specialized meeting. These meetings are often used to examine previously identified risks, estimate their chance of occurring, and evaluate their potential effect. First, the scales used for analysis may be reviewed to ensure that they are both accurate and meaningful. Expert judgment can be obtained through interviews or risk workshops. Experts should be considered from people or organizations that have previously worked on similar projects and have specific expertise in qualitative analysis. Qualitative risk analysis also makes use of data collection. Interviews are one data collection strategy that may be employed in this procedure. Individual risks are evaluated through structured or semi-structured interviews.

Projects that are developing with new technology have high risk and complexity ratings. Due to the vast number of possible combinations of these risks, it is important to use statistical models to evaluate them one at a time. However, the use of these models has rarely been seen in the Kenyan building industry (Gichunge, 2000). With the help of Oracle Prime risk management, a probability and effect matrix can be created to map the likelihood of each risk occurring and its influence on project goals. Using this matrix, one may categorize different types of project risks based on their relative importance and the likelihood that they will occur. Prioritizing risks for further investigation and risk response planning is possible, depending on likelihood and effect. Each project risk is assessed for its likelihood of occurrence and its potential effect on one or more project goals if it were to occur, according to the risk management plan's definitions of probability and impact. Using a probability impact matrix, each project hazard is given a priority level based on its evaluated likelihood and effect (Oracle, 2017).

A risk analysis can be carried out on a project basis by creating a variety of effect and likelihood matrices for each of its goals. As an alternative, it may devise methods to assign each risk a single overall priority level. By combining evaluations for many purposes or by prioritizing the most important one regardless of whether the objective is affected. The probability and effect matrix cannot be utilized when risks have been classified using more than two factors; instead, alternative graphical representations, such as bubble charts, are needed. Each risk is depicted as a disk (bubble) in this chart, which shows three dimensions of data. The x-axis value, the y-axis value, and the bubble size are used to indicate the three parameters.

Figure 2. 1 Bubble chart showing Detectability, Proximity, and Impact Value



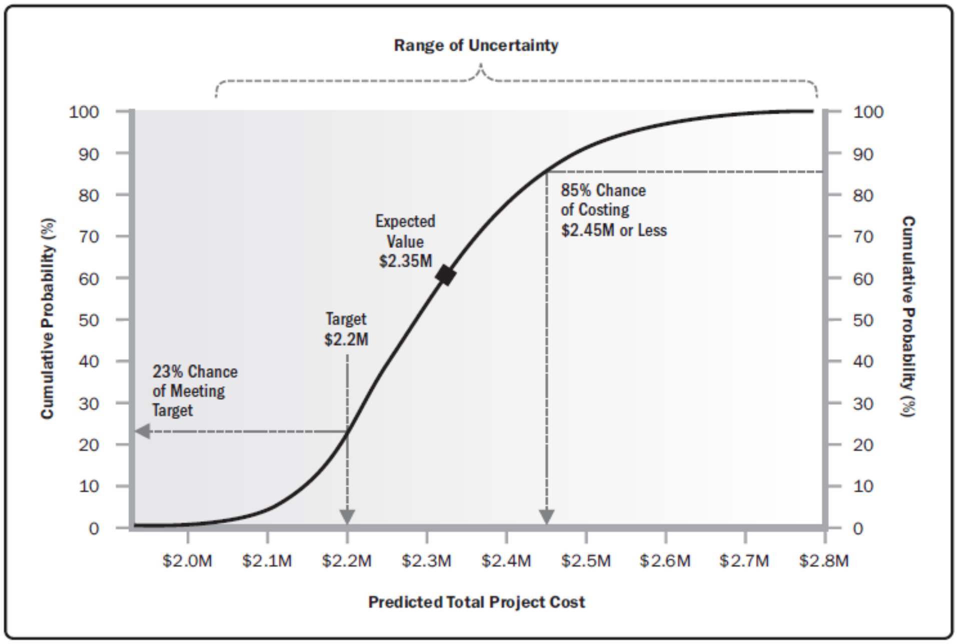
Source: Oracle 2017

The process of risk quantification aims to determine the total impact of a project's various risks and uncertainties on its overall objectives. One of the primary advantages of this procedure is that it may give more quantitative risk information to enhance risk response planning while also quantifying total project risk exposure (PMI, 2013).

Decision tree analysis is currently the most popular quantitative risk analysis method. The decision tree analysis is used to facilitate choosing the optimal course of action among numerous alternatives. The decision tree is an illustration of multiple potential ways to complete the project by making use of branches that stand for different options or events. Each of these potential ways through the project may be connected with costs and unique project risks (including both threats and opportunities). The branch endpoints on the decision tree represent the outcomes of selecting that particular path, which may be positive or negative depending on the circumstances. The decision tree is evaluated by calculating the predicted financial value of each branch. This allows for the selection of the most appropriate action to take (Raftery, 2018).

Oracle Prime Risk Management allows a project manager to simulate the various outcomes that could occur during a given project. The output of the simulation helps the team members determine the likelihood of an event happening in a particular range or a combination of events. Oracle Prime Risk Management also conducts iterations numbering in the tens of thousands on the quantitative risk analysis model. At the beginning of each iteration, a random selection is made to determine which of the input variables (cost estimates, time estimates, or the incidence of probabilistic branching) will be used. The project's outputs indicate the range of potential outcomes, including the project's finish date and final cost. Typical outputs include histograms showing the simulation iterations that resulted in a particular outcome. The S-curve is a statistical representation of the likelihood of a given outcome occurring. The results of this process help the team members identify the areas of the project where they can improve its overall time performance.

Figure 2.2: S-Curve from Quantitative Cost Risk Analysis



Source: Oracle 2017

The project team then develops a risk mitigation strategy after identifying and assessing the potential risks. This plan entails eliminating or reducing the impact or severity of an unexpected event. The focus is to employ reasonable and practicable means to eliminate or mitigate the risk. Where a risk cannot be eliminated, it is minimized by choosing the best control for the situation. The better the control, the lower the risk (William, 2006). Oracle Prime's risk management tools help the team create risk-response plans, which are designed to follow the post-response possibilities. Additionally, schedules and risk data can be combined to create histogram curves (Monte Carlo analysis) that display projected time and cost outcomes as well as the likelihood that each one will be realized.

2.8.7 Quality management

According to Kezner (2013), the process of quality management involves overseeing the various tasks and activities that must be completed to achieve a certain level of excellence. This can be accomplished by establishing and implementing a quality policy and procedures. Currently, the common tool for quality control is the use of a checklist. It is usually a list of items, actions, or points to be considered. Checklists are created based on historical knowledge and information that has been gathered from previous initiatives of a similar kind as well as from other information sources (PMI, 2013). A checklist is updated by organizations based on their own finished projects and other sources of information. Though a checklist might be fast and easy to use, it's hard to create an extensive one, so caution should be taken to ensure it's not used in place of properly identifying risks. Sage 200 has a check sheet, sometimes referred to as tally sheets, that is intended to arrange data in a way that makes it easier to get insightful information about possible quality issues. Defect frequencies and their consequences are documented and archived for future reference (Sage, 2020). The provision of automated audit checks of incoming materials and work done also ensures the agreed quality standards are adhered to (Ozumba & Shakantu, 2018).

Its cloud-based document repository also makes it possible to centralize all documents for construction projects into a single source. This makes it simpler to modify documents on the fly and instantly synchronize changes with other project members (Sage, 2020). Project managers may assess and discover best practices, come up with recommendations for improvement, and establish a standard for measuring performance using an online paper trail. Benchmarked projects may be located within or outside of the performing company, benchmarking allows organizations to compare their quality initiatives across different application domains or businesses. The project manager may also use Sage 200 to calculate the strengths and weaknesses of options from cost-benefit analysis in order to choose one that offers the most advantages. Project managers can also perform a cost-benefit analysis to determine the effectiveness of their quality initiatives. Achieving quality standards has several benefits, the most important of which are decreased amounts of rework, higher levels of productivity and stakeholder satisfaction, decreased amounts of expenses, and enhanced levels of profitability. In a cost-benefit analysis, the cost of a quality step is weighed against the expected benefit of that step. This analysis is performed for each quality activity.

Lee et al. (2004) examined Sage 200's performance. It was discovered that by automating the majority of the repetitive transactions and requiring less labor to complete the activities, it might be possible to reduce the MMS (Material Management System) procurement cycle. The individual job enhancements provided by the system, which include integration of internal and external processes, automation, and integration of an ERP system, can help boost the efficiency of the materials cycle by up to 5.2%. (Lee et al., 2004).

2.8.8 Health and safety management

According to Muiruri and Mulinge (2014), construction sites are considered risky due to the high frequency and severity of accidents that occur as well as the associated health risks for workers, medical professionals, and end users. At the workplace, safety inspections and report filing are constant processes that are nevertheless, still mostly manual and this makes it hard for most construction firms to get their workforce to report health and safety incidents in a timely way (Nyabioge, 2019). Use of Oracle Prime Projects cloud service enables centralization and automation of essential administration and resource-intensive tasks, such as scheduling inspections, addressing safety concerns, and completing the punch list. These tasks include everything from scheduling inspections to closing out the checklist list. Oracle Prime Projects cloud service provides employees with a guided safety tool they can access from any device. Employees can capture critical event information in real time with minimal data entry required. Once an incident has been reported, the health and safety personnel can easily digest the information to understand the issue at hand, initiate an investigation with guided questionnaires and drive follow-up actions and alerts to engage the senior officers all using one service (Oracle, 2017).

It is possible to complement Oracle Prime risk management with RFID technology to monitor workers' health and safety on building sites since the device provides information on all personnel as well as their locations. Supervisors would therefore be aware of everyone's whereabouts in real-time in the case of an emergency, allowing for a safe evacuation. RFID tags may be attached to site workers' helmets and anchors fixed in secured locations to act as reference points. Construction workers can be alerted to potential risks by the tags, which vibrate or make a particular sound when exposed to certain situations (Nyabioge, 2019). Even the highest and most inaccessible construction may be closely observed by drones, which can also assist site managers in making sure that all work is done in accordance with the strictest health and safety rules (Parsons, 2017). Construction teams may anticipate health and safety issues and devise solutions by using drones outfitted with survey equipment that precisely recreates a digital 3D depiction of a location.

2.9 Challenges facing construction firms in the adaptation of ERP systems

i. High Cost & Complexity

Chen (2001) states that, the whole cost of an ERP system which includes hardware, software, consulting fees, and internal staff costs, may easily reach 2 to 3 percent of a company's revenue. According to Kasim et al. (2005), personnel accounts for 14% of the implementation expenses for ERP system integration, with software accounting for 16%. Hardware, 32% while system integration accounts for 38% of the total expenditure cost. Although the cost of consultants is included in the overall cost breakdown, it is not highlighted. Doherty (2012) suggests that the cost of the software to the cost of the consultant is a ratio of 1 to 7, suggesting the major influence of the cost of employing a consultant.

There is a significant amount of additional indirect and intangible expenses associated with the aforementioned direct ERP installation cost elements, which have an impact on an organisation. Companies that are not sufficiently prepared to handle the cost issue from a capital point of view undoubtedly run into problems that might ultimately result in the collapse of the entire implementation process. Since they are complicated systems, ERP implementation calls for outside assistance. According to Doherty (2012), consultants often recommend managers carry out some degree of re-engineering of important processes prior to purchasing ERP systems, which increases the complexity and political nature of the projects.

ii. Lack of expertise

Expert knowledge in the utilization of ERP systems is required for successful implementation. The system is considered intricate and delicate. Lack of knowledge and skill in ERP poses a challenge to the implementation of ERP as a project management tool. The success of an ERP system depends on the involvement of all its users. This means that only those who are involved can realize its potential. (Tsung, 2004). Therefore, the provision of adequate training, documentation, and support to the project team is crucial to ensure smooth onboarding and maximize the system's potential.

iii. Time Scale

According to Negahban (2008), implementing an ERP system can take a long time especially for the construction industry standards.By its very nature, the construction projects are temporal. Results need to be achieved in a short period of time. A significant issue for the industry to solve is investing in something that would result in the creation of extra advantages long after completion of a project. According to Frisk (2004), an article that was published in Business Week (Coy & Mullaney, 2003) argues that the performance of American firms had improved as a direct result of investments that were made in information technology seven to eight years ago. A study conducted in 2003 by Ahmed, Azhar, and Malikarjuna revealed that the implementation time of an ERP system should be between 1.5 and 5 years.

According to West and Daigle (2004), it takes time to reap the benefits of ERP. Frisk (2004), states that the main issues with ERP benefit management is the timeline for realizing its advantages. She states that benefits evolve over time, which implies that they are not stable. This makes compiling a thorough list of prospective advantages very challenging

iv. Lack of enough work to justify use of ERP systems

Tsung (2004), states that most companies engaged in small projects do not use ERP systems due to their complexity. They also believe that their workload is not enough to justify the use of such systems.

2.10 Research gap

Although many authors have researched the advantages of implementing an ERP system in the construction industry, there is a knowledge gap regarding the subject in the Kenyan construction industry. There are various factors that contribute to this gap.Research has been done on ERP systems and cited by Chen (2001); Lee *et al. (*2004); Tsung (2004) Muldoon (2014); Ozumba&Shakantu (2018). However, these research has been done by authors in developed countries for their construction industry. This means using their research for the Kenyan industry would be misleading.

The literature review has also revealed the local content to be scanty and weak especially with respect to ERP systems. e.g. Kinuthia (2014) addressed the issue of construction management softwares and Mutungi (2018) discussed the influence of resource planning and leveling. None of these studies combined a framework to the factors being studied. These glaring gaps necessitated the need to evaluate the extent and impact of the application ERP systems in construction projects

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The chapter presents the procedures involved in carrying out the study. It also discusses the various tools utilized, the target population, and the data cleaning process. It provides a clear methodology of the research approach used.

3.2 Research Design

A survey design was used for this study as it was thought to be the most appropriate considering the study objective. The research employed survey methodology in which participants completed well-structured questions. This approach is often used in descriptive or explanatory research where written self-administered questionnaire or during interview where responses are recorded (Neuman, 2003). According to Broadhurst, Holt, and Doherty (2012), survey research techniques used to gather data include questionnaires, interviews (structured or loosely structured), observation, document analysis, and unobtrusive methods. The researcher chose this research approach because the study aims to determine the extent of ERP systems' application in Kenya's construction industry.

3.3 Target population

The target population consists of groups of people, things, or events having comparable observable characteristics that may serve as a substantial foundation for the collecting of research data.Target population is the total number of people who meet a certain criteria (Mugenda and Mugenda, 2003). The target population for the study included construction firms registered under National Construction Authority. Construction firms were preferred because ERP systems integrate different plans during project execution, which is usually the mandate of the contractor. Data on registered contractors was obtained from National Construction Authority (NCA) database and it comprised of all contractors in categories NCA1 to NCA3 operating within Nairobi County The reasons used to arrive to this target population were: A lot of time and resources would be needed for this study if all classes of contractors were included which are limited to this research. Second, the majority of lower-class contractors work on small projects that may not use enterprise resource planning tools. Furthermore, due to limited resources, lower-class contractors are less likely to implement sophisticated management systems in their businesses.

According to the NCA register accessed on 13th December 2021 via *https://nca.go.ke/contractors/search-registered-contractors*, there were 43,535 contractors enlisted for all categories, for all classes of works. Out of these, 16,059 were registered under building works and 15,134 for civil engineering works as shown in the table below.

Table 3.1 : Population of building and civil engineering construction firms

Classification of construction firms (NCA1-8)	Total in Kenya
Building works contractors'	16,059
Civil engineering contractors'	15,134
Total no. of registered firms	**31,193**

Source: Adapted from NCA list of registered contractors, 2021

The total number of contractors in categories NCA1 to NCA3 for building works and civil engineering works in Kenya was 1709. The table below shows the construction firms operating in Kenya that are registered under the NCA 1-3 framework.

Table 3.2 : Classification of NCA 1-3 contractors in Kenya

Firm's Class	Category	No. registered in Kenya	Total number
Building and civil engineering works	NCA 1	489	1709
	NCA 2	418	
	NCA 3	802	

Source: Adapted from NCA list of registered contractors, 2021

The study was conducted on construction companies operating under the NCA1-3 framework for civil engineering and building projects. This is attributed to the fact that these companies have higher turnover which allows them to embark on large-scale projects. Therefore, these firms have the ability to use Enterprise Resource Planning systems in their projects. The target population was drawn from construction firms registered in Nairobi under NCA 1-3 for building works and civil works. Nairobi was chosen as the area of study because it is the most dynamic and fast growing city in kenya and this makes it a hub for construction activities. According to the NCA register accessed on 13th December 2021 via *https://nca.go.ke/contractors/search-registered-contractors*, there are 43,535 registered companies, of which 24,446 are registered in Nairobi, with only a few spread over the other major towns. This translates to 56 percent, which makes it a rich source of data. The total target population was 1094 firms. This represented 64 percent of all construction firms registered in these categories in Kenya.

Table 3.3: Classification of NCA 1-3 contractors in Nairobi

Firm's Class	**Category**	**No. registered in Nairobi**	**Total number**
Building and civil engineering works	NCA 1	376	1094
	NCA 2	281	
	NCA 3	437	

Source: Adapted from NCA list of registered contractors, 2021

3.4 Sample and Sampling Procedure

Due to the limited budget and time available, the research was only conducted on a subset of the targeted population. A random sampling design was utilized to gather a representative sample of the various categories of respondents from the construction firms in Nairobi. The study's design was based on the simple random method, which ensures that the sample selection was done by chance. This method helps improve the representativeness of the sample.

To determine the appropriate sample size for the survey, the study used the formula stated below

$$n = \frac{(z*z)(p*q)N}{e*e(N-1)+(z*z)(p*q)}$$

Where n = sample size

z = standard normal deviation at a confidence level of 95% which is 1.96

p = % target population assumed to have Similar characteristics (taken as 90%,)

q = 1-p (0.1)

N = population size

e = confidence level (margin of error (0.05)

This is consistent with the statistical method used by Mugenda & Mugenda (2003) to select a sample from a population of less than ten thousand. Using the above formulae, the number of construction firms sampled was as calculated below.

$$n = \frac{(1.96)\,(1.96)*(0.09)(1094)}{0.0025)\,(1094-1) + (1.96)(1.96)*(0.09)}$$

$n = 123.09$

$n = 123$

By apportioning the registered and licensed building and civil engineering firms in every stratum, the number of registered and licensed firms to be sampled in every stratum was calculated as follows;

NCA 1: (376), 376/1094 x 123 = 42

NCA 2: (281), 281/1094 x 123 = 32

NCA 3: (437), 437/1094 x 123 = 49

This gave a total of 123. Table 3.4 shows the sample distribution of the number of registered construction and civil engineering firms.

Table 3.4: Sample distribution of construction firms

Firm's Class	Category	Target population	Sample size	Total number
Building and civil engineering works	NCA 1	376	42	123
	NCA 2	281	32	
	NCA 3	437	49	

Source: Author, 2021

3.5 Sources of data

The study used both secondary and primary data sources. The respondents provided primary data that was analyzed to give the study's conclusions, while secondary sources were crucial in gathering results from earlier, comparable research. Journals and archival records of earlier research that focused on the ERP system were sources for some of the secondary data on those investigations.

3.6 Data collection instrument

The research utilized a questionnaire to collect data from construction companies. Questionnaires were sent via email. Due to the quantitative nature of the data collected from respondents for this research, structured questionnaires were used. This made sure the questions were answered consistently. The study's objectives and the results of the literature review guided the design of the questionnaires, which were used to collect information from the chosen firms on identifying the planning systems adopted by construction firms, the extent of adoption, their impact on performance of construction projects in Kenya and challenges experienced in using these softwares. Questionnaires were the cost effective way7of obtaining7data due to the sample size selected. Due to the busy7nature7of respondents7in the7construction7firms, questionnaires were sent with the option for respondents to reply at their convenience. Following the distribution of the questionnaires, the respondents were contacted to confirm receipt and request the contact information of the person with whom to follow up later. The participants were given two weeks to respond to the questionnaire. They were then asked to email back their responses. A follow-up survey was then conducted after three weeks.

3.7 Reliability and Validity of data collection instruments

3.7.1 Validity

Validity is defined by Kimberlin and Winterstein (2008) as the extent to which a test interpretation is supported by the purpose for which the test is designed. Li (2016) supports this by defining validity as the degree of accurate measurement of objects by an instrument.

The pilot study was conducted to ensure the validity of the research tools, such as questionnaire. It helped the investigator test the wording, highlight ambiguous questions, and provide an indication of the required time to complete the survey. Pre-testing aided in ensuring the authenticity of the data collection tool. According to Kothari (2004), a pre-test sample should range from 1 to 10%, depending on the sample size. In this research, 13 questionnaires were sent to the same target demographic of construction companies in NCA1-3. 6 questionnaires were returned, yielding a 46 percent response rate. The companies' remarks were taken into account when adjusting the final questionnaire.

3.7.2 Reliability

According to Mugenda and Mugenda (2003), reliability is a measure of how consistent a research instrument's results are after repeated trials. Reliability can also be defined as how an instrument consistently shows similar results. Internal consistency, test-retest reliability, and inter-rater reliability may all be used to quantify it (Li, 2016).

Data was collected for the research using well tested and accepted procedures that have produced consistent results on similar studies. Data reliability was checked using the test-retest procedure. Test-retest evaluations gauge consistency across time. During the pilot study, the research questionnaires were administered twice to the same group of people. The questionnaires were modified accordingly until the results were consistent, and the scores similar.

3.8 Data Analysis Procedures

The collected data from the field through questionnaires was transformed into a format that can be used for analysis. Before the analysis was conducted, the data was categorized and correlated to address the study's concerns. A quantitative data analysis procedure was also carried out. Windows-based software, SPSS was utilized to analyze the data collected from the questionnaires. The results were presented in bar graphs and frequency charts.

3.9 Ethical considerations

In order to gather the necessary data, the researcher obtained a letter from the university to show there was need to collect data for this study. The researcher also requested permission to distribute the questionnaires to the staff. The researcher also made sure that participant's data was kept confidential. The researcher did this by not writing any names on the questionnaire. With the approval of the respondents, the information was exclusively used for academic reasons and treated with utmost confidentiality.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF FINDINGS

4.1 Introduction

This chapter presents the results of the analysis and discusses the findings to develop a conclusion and recommendation to the study. The literature study and the questionnaire survey served as the foundation for the analysis and interpretation of the findings. The specific area of interest covered in the study included finding out the ERP techniques and tools currently being used by construction firms in Kenya, the extent of their adoption, their impact on the performance of construction projects in Kenya, challenges experienced in using these planning tools and to explore strategies to increase the adoption ERP systems in management of construction projects.

4.2 Response Rate

Only 72 of the 123 surveys that were issued to respondents were returned. This amounted to a 59 percent response rate. Mugenda and Mugenda (2003) as cited by Kimani (2016) recommends that, a response rate of 50% is fairly adequate,therefore, a response rate of 59 percent in this instance was deemed to be representative of the research population.

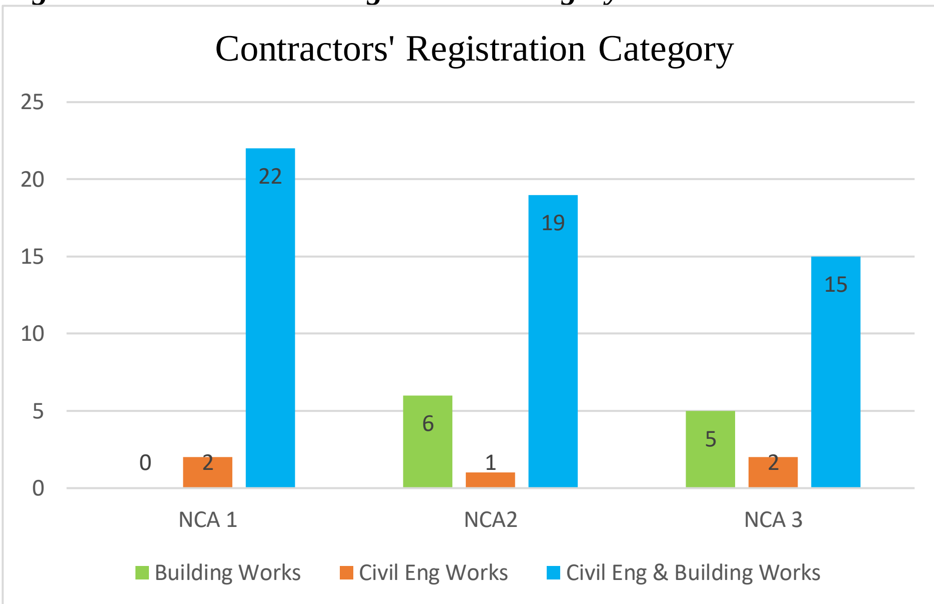
4.3 General Information of Construction Firms

4.3.1 Contractors Registration Category

There were more responses from firms in the NCA 2 category, very few firms were engaged in either building or civil engineering projects. It was noted that a good number of the firms in these categories reported to be undertaking both civil and building works since they were registered in both categories.

According to Figure 4.1, contractors' registration categories are shown in a graphical form

Figure 4. 1: Contractors Registration Category



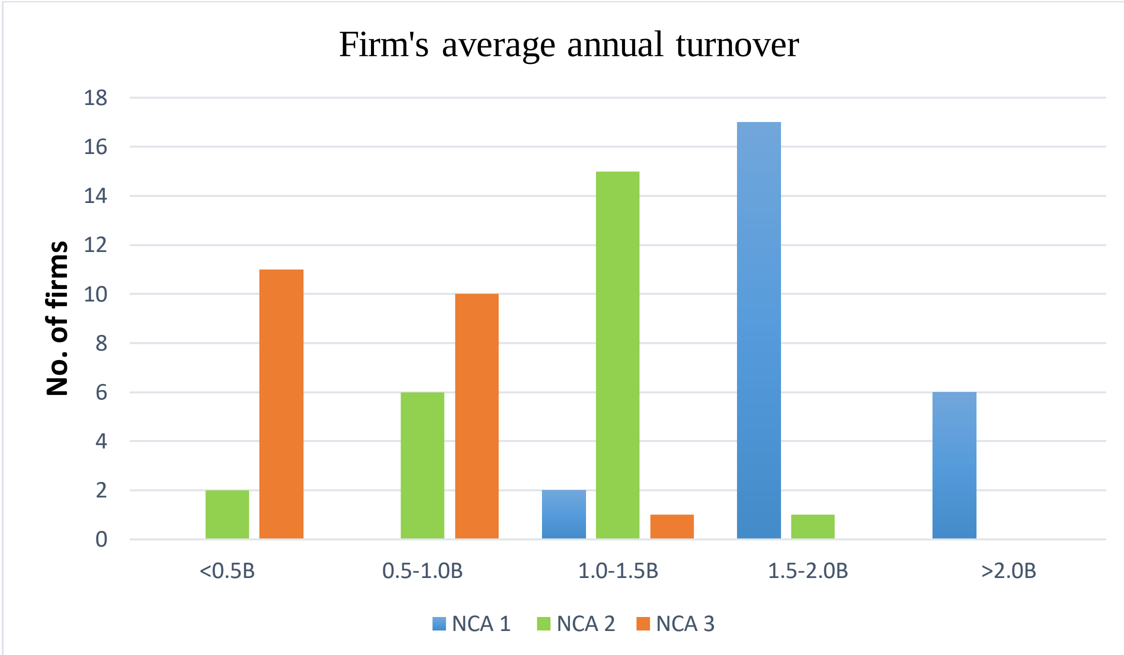
Source; Author, 2022

4.3.2 Response by average firm's turnover

Based on the registration criteria, the three categories of firms studied had annual turnovers ranging from less than 0.5 billion to more than 2 billion for each category. Most firms with NCA 3 registrations had an annual turnover of 0.5 billion and below. Firms registered under NCA 1 category had majority of firms with annual turnovers in the range of 1.5 billion to 2.0 billion and above whereas firms registered under NCA 2 category had a majority of firms with revenue in the range of 0.5 billion to 1.5 billion. The majority of these contractors are capable of carrying out projects worth more than five hundred million (500,000,000) shillings. This means that the projects they work on involve complexities in resource planning and are thus best suited to provide the researcher with the necessary data.

Figure 4.2 depicts the average yearly turnover of a company's response:

Figure 4 2: Response by average firm's turnover



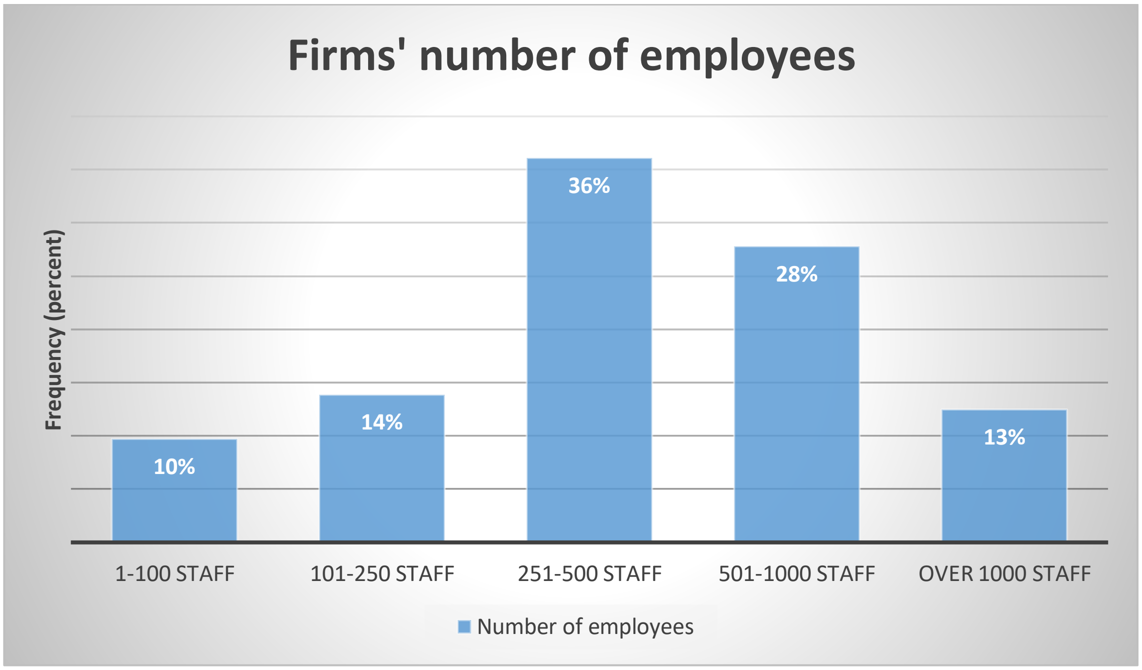
Source; Author, 2022

4.3.3 Response by number of employees

This study established that majority (36%) of the construction firms, the number of employees engaged in different projects was between 251–500, while 28% had employees between 501–1000. 14% of the firms had employees between 101-250 engaged in different projects, while 13% and 10% had over 1000 employees and between 1-100 employees, respectively. The results of the study revealed that over 77% of the contractors had a workforce exceeding 251 workers. This indicates that the majority of them have a large number of employees, which makes it important for planners to have more integrated tools.

4.3 shows graphical representation of firms' response by the number of employees they have:

Figure 4. 3: Response on firms' employees



Source; Author, 2022

4.4 Adoption of Enterprise Resource Planning system

4.4.1 Awareness of ERP system

The majority of respondents, 74% reported that they knew what ERP systems are. The bulk of the respondents were found to be conversant with ERP systems based on the replies. This means that knowledge and understanding of ERP only play a minimal role in the barriers to adoption of ERP systems, since only a minority of people do not understand what ERP is.

Table 4.1: Awareness of ERP

	Frequency	Percent	Cumulative Percent
Yes	53	73.6	73.6
No	19	26.4	100.0
Total	72	100.0	

Source; Author, 2022

4.4.2 ERP adoption levels

Table 4.2: ERP adoption levels

	Frequency	Percent	Cumulative Percent
Yes	16	22.2	22.2
No	56	77.8	100.0
Total	72	100.0	

Source; Author, 2022

The findings revealed that 22% of respondents have adopted ERP systems for managing construction projects. Despite the fact that most respondents were familiar with ERP systems, it seems from the results above that there is a relatively poor adoption of the techniques.The study further sought to dertermine the connection between knowledge of ERP methods and its' adaption.

To establish the connection between adoption and knowledge of ERP systems, a cross tabulation was undertaken.

Table 4.3: Cross tabulation on knowledge versus adoption of ERP systems

		Have adopted ERP		Total
Know what ERP techniques are		No	Yes	
No	Count	19	0	19
	% within adopted ERP	100.0%	0.0%	100.0%
Yes	Count	37	16	53
	% within adopted ERP	69.8%	30.2%	100.0%
Total	Count	56	16	72
	% within adopted ERP	77.8%	22.2%	100.0%

Source; Author, 2022

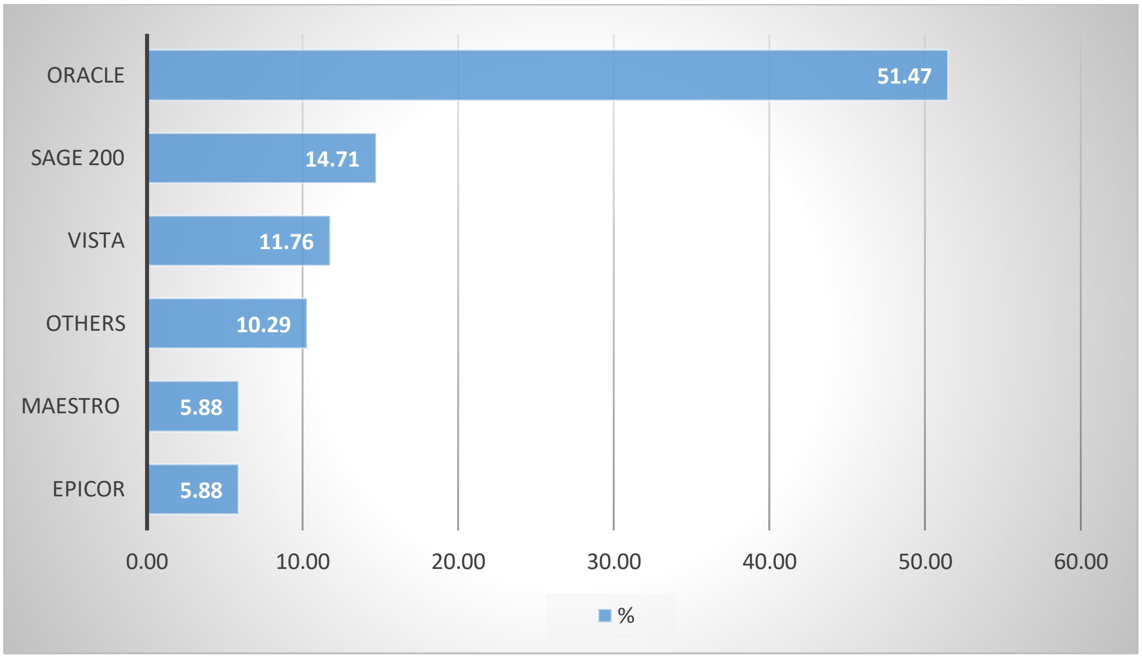
The findings showed 100% of the respondents not familiar with ERP systems, none of them had adopted them for project management purposes. Only 30.2% of the total respondents—73.6 percent—who understood what ERP systems are,were using them for project management in their company.These findings are supported by Susan K. Lippert and Chittibabu Govindarajulu (2006), who noted that while the advantages of ERP systems appear obvious, their adaption within the construction sector has been gradual and their present use has not been to their full potential.

This shows that that the majority of construction firms in Kenya do not use ERP systems even though their advantages are known. This raises questions about the quality of construction project management across the country. This is a concern that should be addressed in order to ensure that construction projects are managed properly. In addition to improving the efficiency of their operations, these systems can help them reduce errors and improve the productivity of their workers.

The study further sought to find out which Enterprise Resource Planning softwares have been adopted by construction firms in Kenya as shown in the figure 4.4 below. Out of the 16 respondents who had adopted the ERP softwares.51.47% of them were using the Oracle followed by 14.71 % sage 200, 11.76 % Vista, 5.88% Epicor project management and Maestro. Additionally, 10.29% of the respondents identified other softwares not listed in the questionnaire. This included In 4 Velocity and Focus softnet. This was attributed by the fact that, while the functions of the other softwares were only limited to time, cost and human resource management, Oracle software was capable of managing project risks and storage of information through its Oracle prime risk management and cloud based document repository feature respectively.

This was highlighted by Roger (1995) in7the7literature review who emphasized the fact that an innovation's relative benefit or functional superiority will increase its acceptability. This may be linked to the user's desire to minimize costs by avoiding the adoption of more than one software to serve different functions.

Figure 4. 4: Assessment of ERP softwares adopted



Source; Author, 2022

4.4.3 Relationship of the characteristics of respondents and adoption of ERPs

4.4.3.1 Relationship between contractors' registration company and adoption of ERPs

To measure the relationship between registration category of the firm and their adoption of ERP software, a Pearson's correlation analysis was carried out. The results were tabulated below.

Table 4.4: Correlation between contractors' registration company and adoption of ERPs

		Firm category	ERP Adoption
Firm category	Pearson Correlation	1	.428**
	Sig. (2-tailed)		.000
	N	71	71
ERP Adoption	Pearson Correlation	.428**	1
	Sig. (2-tailed)	.000	
	N	71	71

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

Source; Author, 2022

Table 4.4 above indicates that the Pearson's correlation coefficient of contractor's registration company and adoption of ERP systems is 0.428. This demonstrates that the variables have a moderate positive monotonic relationship. This means the higher the registration category of the firm the more likely it is for adoption of ERP softwares. The correlation coefficient in this case is statistically significant since the correlation significance is 0.428 at p=0.000.

This may be explained by the fact that companies with higher registration categories are more likely to have understood the necessity for such software since they have extensive experience in management of construction projects.

4.4.3.2 Relationship between firm's annual turnover income and adoption of ERPs

A Pearson's correlation was run to measure the relationship between the firm's annual turnover income and adoption of ERP systems. The results were tabulated in table 4.5 below.

Table 4.5: Correlation between firm's annual turnover income and adoption of ERPs

Control Variables		ERP Adoption	Turnover Income
ERP Adoption	Correlation	1.000	.497**
	Significance (2-tailed)	.	.026
	df	0	71
Turnover Income	Correlation	.497**	1.000
	Significance (2-tailed)	.026	.
	df	71	0

**. Correlation is significant at the 0.01 level (2-tailed).
Source; Author, 2022

Table 4.5 above shows that the Pearson's correlation coefficient of the firm's annual turnover income and adoption of ERP systems is 0.497. This demonstrates that there is a moderate positive monotonic relationship between the variables. This indicates that the higher the company's annual turnover the more likely it is for adoption of ERP softwares. The correlation coefficient in this case isstatistically significant since the correlation significance is 0.497 at p=0.000.

Oloo (2015) state that firms that undertake large projects have high turnover income, large projects have significant variations which need to be tracked and managed in time. This could be the attributing factor to adoption of these systems.

4.4.3.3 Relationship between number of employees in a firm and adoption of ERP systems

A Pearson's correlation was run to measure the relationship between the number of employees in a firm and adoption of ERP softwares. The results were tabulated in table 4.6 below.

Table 4.6: Correlation between the number of employees in a firm and adoption of ERP softwares

		ERP Adoption	Number of employees
ERP Adoption	Correlation	1.000	.130**
	Significance (2-tailed)	.	.018
	Df	0	71
Number of employees	Correlation	.130**	1.000
	Significance (2-tailed)	.018	.
	Df	71	0

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

Source; Author, 2022

Table 4.6 above shows that the Pearson's correlation coefficient of the firm's number of employees and adoption of ERP softwares is 0.130. This demonstrates that there is a weak positive monotonic relationship between the variables. This indicates that the likelihood of a company adopting ERP softwares increases in proportion to the number of workers working there. Given that the correlation significance is 0.130 at p=0.000, we may conclude that this particular correlation coefficient satisfies the criteria for statistical significance.

This can be ascribed to the fact that manual scheduling of labour is prone to errors especially to firms with huge labour workforce. Modern technology can help address this issue of project management which is a major problem that many construction companies face. (Dainty et al. 2011). The low correlation coefficient, on the other hand, indicates that this association is not very strong, and it may presumably reflect that some of the organizations with comparatively fewer workers have adopted the usage of software tools much quicker than was predicted.

4.5 Extent of ERP adaption in the construction industry

The research sought to identify the extent of adoption of ERP systems in management of the following construction management aspects: Human resource management, health and safety management, document and information management, risk management, cost management, time and quality management. A five-point Likert scale was used to determine the adoption rate with 5-Extremely frequent being the most common 4-very frequent 3-moderately frequent 2-slightly frequent 1- least frequent. The findings were presented in the tables below.

4.5.1 Adoption rate of ERP in human resource management

Table 4.7: Tools and techniques used in planning and scheduling labour

	N	Mean	Std. Deviation	Rank
Expert judgement	72	4.40	0.833	3
Excel spreadsheet (assigning of labour)	72	4.61	0.761	2
Ms Project (scheduling of work activities matching with required labour force)	72	4.63	0.844	1
Organizational labour charts	72	3.14	0.680	4
Sage 200 (integrated labour timesheets and payment details)	72	2.01	1.477	5
Oracle (for distribution of tasks in alignment to project timelines)	72	2.56	1.555	6

Source; Author, 2022

As per table 4.7 and based on means, “Ms Project” was the extremely frequent tool used in planning and scheduling labour with a mean of 4.63 followed closely by “Excell spreadsheets” with a mean of 4.61 and “Expert judgement” with a mean of 4.40.Use of

“Organizational charts” was moderately used with a mean of 3.14 while the least used tools included “Oracle” and “Sage 200” with means of 2.56 and 2.01 respectively.

These findings are supported by Dainty et al. (2011) who opines that even though the construction industry is labour intensive, the current tools used in sub-contractor management are not efficient in ensuring coordination between the main contractor and sub-contractors especially when working with multiple sub-contractors, and there is need to adopt more integrated softwares that offer improved information sharing and better collaborative tools between the main contractor and respective sub-contractors.

Table 4.8: Tools used in tracking work progress

	N	**Mean**	**Std. Deviation**	**Rank**
Field daily reports	72	4.62	0.879	1
Checklist of activities to be undertaken in a given period of time	72	4.38	0.813	2
Gantt charts (planned vs baseline)	72	4.04	0.846	3
Shared access electronic audit trail	72	2.67	1.222	4

Source; Author, 2022

As per table 4.8, and based on means, “Field reports” was the extremely frequent tool used in tracking work progress with a mean of 4.62 followed closely by “Checklist of activities to be undertaken” with a mean of 4.38 and “Gantt charts” with a mean of 4.04. The least used was “shared access electronic audit trail” with a mean of 2.67.

These findings are supported by Ross (2009) who states that, most construction firms prefer use of manual tools in tracking work progress as compared to use of ERP systems. This is attributed to the fact that ERP implementation requires an extensive level of business process re-engineering, what this implies is that current business processes are re-engineered to take full use of the system's capabilities.

4.5.2 Document and information management

Table 4.9: information distribution

	N	Mean	Std. Deviation	Rank
Phone calls	72	1.96	0.941	4
Emails	72	4.65	0.790	1
Text messages/Whatsapp	72	3.15	0.494	3
Hard copy documents	72	3.82	0.924	2
Video conferencing	72	1.43	0.668	5

Source; Author, 2022

As per table 4.9, and based on means,use of "Emails" was the extremely frequent tool used in distribution of information in projects with a mean of 4.65. "Hard copy documents" and use of "Text messages/Whatsapp" was moderately used with a mean of 3.82 and 3.15 respectively while the least used tools was use of "Video conferencing" with a mean of 1.43.

Bowden (2004) backs up these results, stating that paper-based files, such as drawings, data collection forms, correspondence, progress reports, and specifications, are the primary form of information that on-site construction staff receive and send. A construction site involves a great deal of coordination and administration, which necessitates numerous interactions between project participants and must be handled promptly and effectively in order to minimize costly issues like delay, rework, and waste (Miah et al., 2018). This can only be achieved through adoption of Enterprise Resource Planning systems.

Table 4.10: storage of project documents

	N	Mean	Std. Deviation	Rank
Manual Filing system	72	3.61	0.545	1
Cloud based repository	72	1.32	0.646	4
Hard drive	72	2.81	1.083	2
Flash drive	72	2.28	0.633	3

Source; Author, 2022

4.5.3 Adoption rate of ERP in risk management

Table 4.11: Tools used in managing project risk

	N	Mean	Std. Deviation	Rank
Risk breakdown structure	72	4.06	0.977	3
Expert judgement	72	4.61	0.912	1
Benchmarking	72	3.86	0.793	4
Simulation	72	2.21	1.074	8
Decision tree analysis	72	1.99	1.555	9
Use of risk assessment Checklist	72	4.35	0.906	2
Probability and impact matrix	72	2.43	1.481	6
Variance and trend analysis	72	2.25	1.371	7
Oracle prime risk management	72	2.79	1.443	5

Source; Author, 2022

As per table 4.11 and based on means, use of "Expert judgement" was the extremely frequent tool used in managing of project risks with a mean of 4.61 followed closely by "use of risk assessment checklist" with a mean of 4.35 and "Risk breakdown structure" with a mean of 4.06. Use of "Benchmarking" was moderately used with a mean of 3.86 while the least used tools included "Oracle prime risk management", "Probability impact matrix", "simulation" and "Decision tree analysis" with means of 2.79, 2.43 and 1.99 respectively.

The results presented above allow one to draw the conclusion that the majority of construction companies use Expert judgment, manual risk breakdown structure and risk assessment check list in managing risk but are yet to embrace other available ERP softwares such as Oracle prime risk management, Simulation, Probability and impact matrix and variance and trend analysis which provide development of risk-response plans where post-response scenarios are compared with pre-response results. This enables better insight and unified reporting (Broadhurst, 2012).

4.5.4 Adoption rate of ERP in cost management

Table 4.12: Tools used in managing project costs

	N	Mean	Std. Deviation	Rank
Expert judgement	72	3.71	1.238	3
Excel spreadsheet (recording project cost)	72	4.58	0.884	1
Quick books	72	4.25	0.978	2
Vista (to offer Shared access electronic audit trail)	72	2.72	1.738	4
Sage 200 (to track income &expenses, monitor cash flo w &generate reports)	72	2.04	1.272	6
Oracle prime projects(to perform forecast analysis & predict impending expenses)	72	2.62	1.614	5

Source; Author, 2022

As per table 4.12 and base on means, use of “Excel spreadsheet” was the extremely frequent tool used in managing of project costs with a mean of 4.58 followed closely by “Quick books” with a mean of 4.25. “Expert judgement” was moderately used with a mean of 3.71 while the least used tools included “Vista”, “Oracle prime projects” and “Sage 200” with means of 2.72, 2.62 and 2.04 respectively.

Contractors need to be educated about the importance of ERP softwares in order to increase their adoption rate. These software systems not only aid in estimating but also help monitor project spending thus one is able to know whether the budget is on track or off-track and therefore have corrective measures in place before extreme cost overruns.

4.5.4 Adoption rate of ERP in quality management

Table 4.13: Tools used in managing quality of projects

	N	Mean	Std. Deviation	Rank
Field daily reports	72	3.79	0.649	2
Checklist (inspection criteria list)	72	4.02	0.689	1
Gantt chart (planned vs baseline)	72	2.54	0.580	3
Shared access electronic audit trail	72	1.39	0.742	4

Source; Author, 2022

As per table 4.13 and based on means, use of "Inspection checklist" was the extremely frequent tool used in managing of project quality with a mean of 4.02. "Field daily reports" was moderately used with a mean of 3.79 while the least used tools included use of "Gantt charts" and "Shared access electronic audit trail" with means of 2.54 and 1.39 respectively.

The finding from my study confirms Jonathan (2003) findings who states that, there is a low commitment level among construction companies to the use of technology in quality control. This is because they don't understand its importance. Implementing an ERP system can help improve the efficiency of a company and ensure that the work is completed on time through provision of automated audit and checks of incoming materials and work done to ensure they meet the agreed quality standards (Ozumba & Shakantu, 2018). Contractors need to be sensitized on these benefits to encourage the adoption of these tools.

4.5 Impact of ERP systems on construction project performance

4.5.1 Project cost control

Respondents were asked to indicate extent to which ERP systems contributed to improvement of project cost control.The findings are shown in table 4.14 below.

Table 4.14: Project cost control (Frequencies)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**Moderate**	4	5.4	5.0	5.0
	High	12	16.6	17.0	22.0
	Very High	56	77.8	78.0	100.0
Total		72	100.0	100.0	

Source; Author, 2022

When asked to rate the extent to which they believed ERP techniques and its softwares contributed to the enhancement of project cost management, respondents gave the following responses: 5.0 percent responded "Moderate," 17.0 percent, "High," and 78.0 percent, "Very High." These responses produced a mean of 4.49 as shown in table 4.15 below. It is evident from this that the vast majority of contractors have the same opinion that ERP systems have an extreme influence on improving project cost management.

These findings confirm Wong (2014) findings in the literature review, who states that transaction controls provided by ERP systems limit the number of expenditures users can charge to specific projects using the expenditure category, which helps prevent site managers from charging incorrect or excessive costs to a project without justification. while excessive costs incurred in a project can be flagged as a variation or extra work and managed in time (Wong et al. 2014).

Table 4.15: Project cost control (mean)

	N	Minimum	Maximum	Mean	Std. Deviation
Project cost control	72	3	5	4.49	.872

Source; Author, 2022

4.5.2 Reduction in project completion time

Table 4.16 below shows the extent to which respondents agree on the effects of ERP systems on the reduction of project completion time.

Table 4.16: Impact on project completion time (Frequencies)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**Moderate**	7	9.7	10.0	10.0
	High	26	36.1	36.0	46.0
	Very High	39	54.2	54.0	100.0
Total		72	100.0	100.0	

Source; Author, 2022

When asked to rate the extent to which they believed ERP techniques and its softwares contributed to the reduction of project completion time, respondents replied in the following order: 10.0 percent "Moderate," 36.0 percent "High," and 54.0 percent "Very High." This responses produced a mean of 4.35, as shown in table 4.17 below. It is evident from this that the vast majority of contractors have the same opinion that ERP systems have an extreme influence on reduction of project completion time.

These findings are supported by Nyabioge (2019), who indicates that, with the use of ERP systems, all work participants have improved engagement through a collaborative approach that creates teamwork and better support. The project manager, site manager, design lead, and client representative provide their input. This creates a good workflow between the project stakeholders, reduces the need for re-work and enables projects to be completed on time.

Table 4. 17: Impact on project completion time (mean)

	N	Minimum	Maximum	Mean	Std. Deviation
Completion time	72	3	5	4.35	.932

Source; Author, 2022

4.5.3 Quality improvement in a project

Table 4.18 below shows the extent to which respondents agree on the effects of ERP systems on improvement of quality in a project

Table 4.18: Influence on improvement of quality (Frequencies)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**Slightly**	6	8.3	8.0	8.0
	Moderate	13	18.1	18.0	26.0
	High	32	44.4	44.0	70.0
	Very High	21	29.6	30.0	100.0
Total		72	100.0	100.0	

Source; Author, 2022

When asked to rate the extent to which they believed ERP techniques and its softwares contributed to the improvement of project quality, respondents replied in the following order: 8.0 percent of respondents responded "Slightly," 18.0 percent "Moderately," 44.0 percent "High," and 30.0 percent "Very High." The mean of these responses 3.84, is shown in table 4.19 below. It is evident from this that the vast majority of contractors have the same opinion that ERP systems have a significant impact on improvement of project quality.

These findings are supported by Ozumba & Shakantu (2018), who opines that with the use of ERP systems, there is the provision of automated audit checks for incoming materials and work done, and this ensures the agreed quality standards are adhered to, leading to quality improvement.

Table 4.19: Influence on improvement of quality (mean)

	N	Minimum	Maximum	Mean	Std. Deviation
Quality improvement	72	2	5	3.84	.813

Source; Author, 2022

4.5.4 Overall performance of a project

Cost, time, and quality are considered to be the three most crucial success factors for building projects, according to Atkinson (2013) and Lim & Mohamed (2019). A project is considered successful when it reduces both project time and cost without compromising quality of the work.

Table 4.20: Impact on overall project performance

Items	Mean	Min	Max	Range	Variance	N
Reduced completion period: Reduced project cost: Improved quality	4.165	3.84	4.49	0.647	0.042	3

Source, Author, 2022

Data from the table above revealed that the use of Enterprise Resource planning systems was highly and significantly correlated with performance in terms of reduction in completion time, improvement in quality and better management of project cost. This therefore means that use of Enterprise Resource planning systems Contributes to improved project performance.

These findings are in line with observations by Masu (2006) and cited by Mutungi (2018) that construction projects are deemed successful when they are completed on time, within budget and set quality standards. Achievement of these performance measures can only be realised through optimizing resources available through the use of effective planning tools (Mutungi, 2018). As a planning tool, these software help implement resource planning by integrating the different project roles needed to run a project into a single system. This improves efficiency by allowing for better resource management and utilization. This results in better management of project costs, improved quality, and a reduction in completion time, thereby improving the overall project performance (Addo-Tenkorang, 2011).

4.6 Challenges in adopting the usage of Enterprise Resource Planning tools and techniques

The respondents were presented with a number of challenges related with adoption of Enterprise Resource Planning tools and processes in order for them to rate their relevance on a Likert scale (5-Strongly Agree; 4- Agree; 3-Undecided; 2-Disagree; 1-Strongly Disagree). The findings are shown in the tables below.

According to table 4.21, the most significant challenge was the "High cost of acquisition and complexity," with a mean of 4.17, followed by "Complexity to master use," with a mean of 4.12. The third and fourth challenges were “Lack of formal training of project participants” and “Takes long to achieve the benefits” with means of 3.90 and 3.73 respectively. “Difficulty in customization of ERP to organizational needs; Lack of enough work to justify the use ERP and its softwares” and “Disjointedness and complexity of construction industry” were the fifth, sixth and seventh most important factors with means of 3.33, 3.27 and 3.16 respectively. The last challenge was “Lack of information about ERP and its softwares with a mean of 2.85.

Table 4.21: Challenges in adoption of ERP systems (Comparison of Means)

	Mean	**Std. Deviation**	**N**	**Rank**
High cost of acquisition and complexity	4.17	0.740	72	1
Complexity to master usage	4.12	0.833	72	2
Lack of formal training of project participants	3.90	0.959	72	3
Takes long to achieve the benefits	3.73	0.972	72	4
Lack of information about ERP and its softwares	2.85	1.143	72	8
Lack of enough work to justify the use ERP and its softwares	3.27	1.221	72	6
Difficulty in customization of ERP to organizational needs	3.33	0.896	72	5
Disjointedness and complexity of construction industry	3.16	0.737	72	7

Source, Author, 2022

These findings indicate that high cost of acquisition and complexity to master usage, are significant factors hindering uptake of ERP systems by construction firms by contractors with a mean of 4 and above. The slow adoption of ERP by different construction firms is attributed to a variety of financial constraints, according to Egbu and Botterill (2002). Neumann (2006) also supports these findings, opining that the failure of ERP implementation is not due to a lack of awareness but rather to a high degree of complexity resulting from the significant changes ERP causes in organizations.

Low standard deviation values indicated that contractors' opinions on the identified difficulties were consistent. Since the issues the respondents faced had an aggregate mean of 3.5663 (see table 4.22 below), it can be argued that all of them were critical.

Table 4.22: Challenges in adoption of ERP systems (Summary of Means)

Item	**Mean**	**Min**	**Max**	**Range**	**Variance**	**N**
Means	3.5663	2.85	4.17	1.32	0.232	8

Source, Author, 2022

4.6.1 Minimizing barriers into the adoption of Enterprise Resource Planning tools and techniques

The study sought to establish what strategies could be employed to encourage the adoption of ERP planning tools and techniques. The respondents were presented with a variety of strategies necessary to promote the use of Enterprise Resource Planning tools and techniques and they were asked to rank their significance using a Likert scale (5-Strongly Agree; 4- Agree; 3-Undecided; 2-Disagree; 1-Strongly Disagree). The findings are shown in the tables below.

As per table 4.23, and based on means, "Developing ERP softwares that are user friendly" was the most significant strategy to aid the adoption of ERP systems with a mean of 4.37 while "Reducing cost of acquisition and maintenance" was the second most significant with a mean of 4.32. The third and fourth strategy were "Better marketing strategies of ERP softwares to encourage acceptance by project stakeholders" and "Improving training programs on ERP softwares" with means of 3.93 and 3.87 respectively. The last strategy was "Developing legal framework that encourages use ERP and its softwares" with a mean of 2.92.

Table 4.23: Minimizing barriers into the adoption of ERP systems (Comparison of Means)

	Mean	Std. Deviation	N	Rank
Reducing cost of acquisition and maintenance	4.32	0.790	72	2
Improving training programs on ERP softwares	3.93	0.851	72	3
Developing ERP softwares that are user friendly	4.37	0.624	72	1
Developing legal framework that encourages use ERP and its softwares	2.92	1.056	72	5
Better marketing strategies of ERP softwares to encourage acceptance by project stakeho lders	3.87	0.813	72	4

Source, Author, 2022

Low standard deviation values indicated that contractors' opinions on the perceived tactics to promote the use of ERP systems and procedures were consistent. Since the stategies given to the respondents had an overall mean of 3.882 (see table 4.24 below), it can be argued that all of them were important.

Table 4.24: Minimizing barriers into the adoption of ERP systems (Summary of Means)

Item	Mean	Min	Max	Range	Variance	N
Means	3.882	2.92	4.37	1.45	0.339	5

Source, Author, 2022

4.6.2 Relationship between ERP adoption challenges and encouragement strategies

A Spearman's correlation was run to determine the degree of relationship between challenges of adopting ERP and posited strategies to encourage adoption of ERP.

Table 4.25: Correlation between Developing ERP softwares that are user friendly and complexity to master usage

			Developing ERP softwares that are user friendly	Complexity to master usage
Spearman's rho	Developing ERP softwares that are user friendly	Correlation Coefficient	1.000	.345**
		Sig.(2-tailed)	.	.003
		N	72	72
	Complexity to master usage	Correlation Coefficient	.345**	1.000
		Sig.(2-tailed)	.003	.
		N	72	72

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

Source, Author, 2022

As per table 4.25 above, the Spearman's correlation coefficient between creating user-friendly ERP software and complexity to master usage is 0.345. This demonstrates that the variables have a moderate positive monotonic relationship. This implies that one of the most important elements that needs attention to increase the adoption level of ERP systems is the development of user-friendly ERP softwares. The correlation coefficient in this case is statistically significant since the correlation significance is 0.345 at p=0.003.

Table 4.26: Correlation between Improving training programs on ERP softwares and lack of formal training of project participants

			Improving training programs on ERP softwares	Lack of formal training of project participants
Spearman's rho	Improving training programs on ERP softwares	Correlation Coefficient	1.000	.461**
		Sig.(2tailed)	.	.001
		N	72	72
	Lack of formal training of project participants	Correlation Coefficient	.461**	1.000
		Sig.(2tailed)	.001	.
		N	72	72

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

Source, Author, 2022

As per table 4.26 above, Spearman's correlation coefficient between improving training programs on ERP softwares and Lack of formal training of project participants is 0.461. This demonstrates that the variables have a strong positive monotonic relationship. This means that Improving training programs on ERP softwares is one of the most significant factors that need attention in order to increase the uptake of ERP systems. The correlation coefficient in this case is statistically significant since the correlation significance is 0.461 at p=0.001.

Table 4.27: Correlation between Reducing cost of acquisition and maintenance and high cost of acquisition and maintenance

			Reducing cost of acquisition and maintenance	High cost of acquisition and maintenance
Spearman's rho	Reducing cost of acquisition and maintenance	Correlation Coefficient	1.000	.207
		Sig. (2-tailed)	.	.041
		N	72	72
	High cost of acquisition and complexity	Correlation Coefficient	.207	1.000
		Sig. (2-tailed)	.041	.
		N	72	72

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

Source, Author, 2022

As per table 4.27 above, Spearman's correlation coefficient between reducing cost of acquisition and maintenance and High cost of acquisition and maintenance is 0.207. This demonstrates that the variables have a weak positive monotonic relationship. This means one of the most critical factors that construction companies need to consider when it comes to adopting technology is the cost of acquisition. The correlation coefficient in this case is statistically significant since the correlation significance is 0.207 at p=0.041.

A comparison between the two methods of analysis showed that though developing ERP softwares that are user friendly was the most significant strategy to aid the adoption of ERP systems based on the mean ranking, improving training programs on ERP softwares was the most significant based on spearman's correlation. However, the top three most important strategies were produced by both methods though in a different order.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The purpose of this research was to study the extent of application of Enterprise Resource Planning (ERP) systems and their impact on the performance of construction projects in Kenya. To achieve this four main objectives were adopted; to underpin the benefits of Enterprise Resource Planning systems as a management facilitation and process technological innovation tool; to establish the extent of adaption of Enterprise Resource Planning systems as a management tool in the construction industry in Kenya; to determine the impact of Enterprise Resource Planning systems on the performance of construction projects in Kenya and to establish the challenges construction firms experience in using Enterprise Resource Planning systems. This chapter provides a summary of the research's findings, along with its conclusions and suggestions. This chapter does so by drawing on the data analysis and discussion presented in preceding chapters.

5.2 Summary of findings

5.2.1 ERP systems as a management tool used amongst construction firms in Kenya

The results showed that majority (73.6%) of7the contractors were familiar with the ERP systems. However, there was a very low uptake of these tools and techniques, despite the majority of the respondents being familiar with them. All the respondents who were not familiar with ERP techniques, none of them had adopted the techniques for project management purposes. Within the (73.6%) of the total respondents who knew what ERP techniques are, only (30.2%) were using it for management of projects in their organization. Oracle prime projects (51.47%) was the most adopted software followed by sage 200 (14.71%), Vista (11.76%), Epicor project management and Maestro at (5.88%). Additionally, (10.29%) of the respondents identified other softwares not listed in the questionnaire. This included In4Velocity and Focus softnet.

5.2.2 Adoption rate of ERP systems as a management tool in the construction industry

As seen in table 4.7 to 4.13, the means for extent of adoption of ERP systems by contractors in the management of cost, quality, human resource, risk and information management were below (2.80) this indicates a very low adoption rate amongst Kenyan construction firms. Project cost and risk management were the two areas where ERP systems were most often used. Average use was reported in human resources management, while information and quality management saw the least amount of utilization.

5.2.3 Impact of ERP systems on project performance

Most contractors shared similar opinion that ERP techniques and its softwares contributes to improvement of project cost control (mean of 4.49), reduced completion period of a project (mean of 4.35) and improved quality of a project (mean of 3.84). None of the most critical project success indicators had a score of less than 3.5, which is evident that Enterprise Resource Planning techniques and its softwares contributes to improved performance of construction projects.

5.2.4 Challenges in adoption of ERP systems

In their quest to incorporate Enterprise Resource Planning tools and techniques into their projects, contractors were found to face a several challenges. The challenges identified from this research listed in order of descending severity were; high cost of acquisition and complexity; complexity to master usage; lack of formal training of project participants; takes long to achieve the benefits; difficulty in customization of ERP to organizational needs; lack of enough work to justify the use ERP and its softwares; disjointedness and complexity of construction industry and lastly lack of information about ERP and its softwares. These findings showed that every respondent agreed that the assessed factors were considered to be significant challenges in adoption of ERP systems.

5.3 Conclusions

The uptake of ERP techniques was found to be very low despite majority of the respondents being familiar with the techniques. Oracle prime projects was the most adopted software. This was attributed to its superiority in serving different management functions. The extent of adoption of these techniques in management of project cost, quality, human resource, risk and information management was found to be very low. Most firms were found to prefer manual, paper-based processes. This raises questions about the quality of construction project management in the country, since these kinds of systems are supposed to help project managers perform their tasks more efficiently while also making it easier for the various workers who work on a construction project to work together.

The research established that the use of Enterprise Resource Planning tools and its softwares typically leads to better performance of construction projects in terms of timeliness, quality, and cost management. The research also established that the main obstacles to the adoption of ERP systems among construction firms are their high acquisition costs coupled with complexity to master usage and lack of formal training of project participant.

5.4 Recommendations

Based on the findings of this research, the following recommendations are made:

With the cost of acquisition remaining the most significant challenge to the adoption of ERP software, the government with its advantage of being the biggest employer in the construction industry, should encourage collaboration between the public, corporate, and academic sectors to foster technological innovations. Funding research institutions, awarding grants to universities and hosting innovation competitions can help with the development of more affordable but effective software.

The study revealed that the use of ERP systems improves project performance. This shows the need for a paradigm shift from traditional methods of construction project planning. This idea would be best implemented at the undergraduate training level.

ERP training should be incorporated into the curriculum of institutions of higher learning to develop construction graduates with an understanding of ERP.

Finally, construction companies in Kenya should be sensitized on the use of ERP software to enjoy the benefits of reduced project completion period, improved project cost control and improved project quality.

5.5 Areas of further research

This study concentrated on contractors in class NCA1 to NCA3, and the results drawn only reflected the views of these three classes. This suggests that further research is needed to gain a deeper understanding of the issues that small and medium-sized construction firms (NCA4–NCA8) face when adopting these software. To provide an unbiased assessment of the whole Kenyan construction sector, the research should also be broadened to include consultants, clients and academics.

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APPENDICES

APPENDIX A: QUESTIONNAIRE

INTRODUCTION

Dear Respondent,

My name is Michael Murimi. I am a master's student at the University of Nairobi, Department of Real Estate and Construction Management, currently at the thesis level of my M.A. Construction Management. I am conducting an academic research titled: A Study of the Existence and Extent of Application of Enterprise Resource Planning (ERP) Systems on the Performance of Construction Projects in Kenya: A Case Study of Nairobi County.

I humbly request your assistance with the details requested on the attached document. Your honest participation in the research would be highly appreciated, with an assurance of confidentiality and anonymity. Any identifiable information received via this survey will only be used at the data analysis stage. Your contribution to this study will contribute to greater understanding of ERP Systems adoption in the Kenyan Construction Industry.

UNIVERSITY OF NAIROBI

DEPARTMENT OF REAL ESTATE, CONSTRUCTION MANAGEMENT & QUANTITY SURVEYING

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Ref: B53/11975/2018 **Date:** 22nd March, 2022

To Whom It May Concern

Dear Sir/Madam,

RE: RESEARCH LETTER – MURIMI MICHAEL KAIRU

This is to confirm that the above named is a student in the Department of Real Estate, Construction Management & Quantity Surveying pursuing a course leading to the degree of M.A. in Construction Management.

He is carrying out a research *entitled* ***"A Study of the Existence and Extent of Application of Enterprise Resource Planning (ERP) Systems on the Performance of Construction Projects in Kenya"*** in partial fulfillment of the requirements for the degree programme.

The purpose of this letter is to request you to allow him access to any kind of material he may require to complete his research. The information will be used for research purposes only.

CHAIRMAN
DEPARTMENT OF REAL ESTATE
CONSTRUCTION MANAGEMENT
AND QUANTITY SURVEYING
UNIVERSITY OF NAIROBI

Arch. Peter Njeru,
Ag. Chairman & Lecturer,
Department of Real Estate, Construction Management
& Quantity Surveying

SECTION I: BASIC INFORMATION ON CONSTRUCTION FIRM

INSTRUCTIONS:

Please indicate with a tick (V) the appropriate answer and give reasons or explanations where necessary.

1. What is the firm registration category?

NCA CATEGORY (Tick appropriately)	**Building works**	**Civil Engineering works**
NCA 1	☐	☐
NCA 2	☐	☐
NCA 3	☐	☐

2. What is the firm's average annual turnover over?

Turnover (In Kshs)	**Tick appropriately**
Less than 0.5 Billion	☐
0.5 – 1.0 Billion	☐
1.0 - 1.5 Billion	☐
1.5 - 2.0 Billion	☐
Above 2.0	☐

3. How7many7employees7do7you7have7in7your7construction7firm7 (both in construction7sites7andoffices)?

Turnover (In Kshs)	**Tick appropriately**
1 - 100 employees	☐
101 - 250 employees	☐
251 - 500 employees	☐
501-1000 employees	☐
Over1000 employees	☐

SECTION II: ADOPTION OF ERP TECHNIQUES

4. Do you know what Enterprise Resource Planning (ERP) systems are?

Yes [ ]

No [ ]

5. Have you adopted ERP systems in your company?

Yes [ ]

No [ ]

6. Which ERP system(s) does your company implement? (Check all that apply)

Sage 200 [ ]

Epicor [ ]

Oracle [ ]

Maestro [ ]

Vista [ ]

Other, please specify:

SECTION III: EXTENT OF ADAPTION OF ERP TECHNIQUES

7. Human resource management

i. By ranking from **5 (extremely frequent), 4 (very frequent), 3 (moderately frequent), 2 (slightly frequent) to 1 (least frequent),** method/tools do you employ in planning and scheduling labour?

Tools for planning & scheduling labour	**5**	**4**	**3**	**2**	**1**
Expert judgment	☐	☐	☐	☐	☐
Excel spreadsheet (assigning of labour)	☐	☐	☐	☐	☐
MS Project (schedule work activities & matching with required labour force)	☐	☐	☐	☐	☐
Organizational labour charts	☐	☐	☐	☐	☐
Sage 200 (Integrated labour timesheets & payment details)	☐	☐	☐	☐	☐
Oracle (Distribution of tasks in alignment to project timelines)	☐	☐	☐	☐	☐
Other; (Please specify)					

…………………………………...	☐	☐	☐	☐	☐

ii. By ranking from **5 (extremely frequent), 4 (very frequent), 3 (moderately fre quent), 2 (slightly frequent) to 1 (least frequent),** which techniques/tools are used in tracking work progress in your projects?

Tools for tracking work progress	**5**	**4**	**3**	**2**	**1**
Field daily reports	☐	☐	☐	☐	☐
Checklist of activities to be undertaken in a given period of time	☐	☐	☐	☐	☐
Gantt charts (planned vs baseline)	☐	☐	☐	☐	☐
Shared access electronic audit trail	☐	☐	☐	☐	☐
Other; (Please specify) …………………………………...	☐	☐	☐	☐	☐

8. Document and information management

i. By ranking from **5 (extremely frequent), 4 (very frequent), 3 (moderately frequent), 2 (slightly frequent) to 1 (least frequent),** how are project documents stored in your company?

Storage7of Documents	**5**	**4**	**3**	**2**	**1**
Manual filing system	☐	☐	☐	☐	☐
Cloud based repository	☐	☐	☐	☐	☐
Hard drive	☐	☐	☐	☐	☐
Flash drive	☐	☐	☐	☐	☐
Other; (Please specify) …………………………………...	☐	☐	☐	☐	☐

ii. By ranking from **5 (extremely frequent), 4 (very frequent), 3 (moderately frequent), 2 (slightly frequent) to 1 (least frequent),** how is information distributed to project stakeholders.

Distribution of information	**5**	**4**	**3**	**2**	**1**
Phone calls					
Email					
Text messages/WhatsApp					
Hard copy documents					
Video conferencing					
Other; (Please specify) …………………………………...					

9. Risk management

i. By ranking from **5 (extremely frequent), 4 (very frequent), 3 (moderately frequent), 2 (slightly frequent) to 1 (least frequent),** how are project documents stored in your company?

Tools & techniques of risk management	**5**	**4**	**3**	**2**	**1**
Risk breakdown structure					
Expert judgment					
Benchmarking					
Simulation					
Decision tree analysis					
Use of risk assessment checklist					
Probability and impact matrix					
Variance and trend analysis					
Oracle prime risk management					
Other; (Please specify) …………………………………...					

10. Cost management

i. By ranking from **5 (extremely frequent), 4 (very frequent), 3 (moderately frequent), 2 (slightly frequent) to 1 (least frequent),** which techniques/tools are used in tracking variation costs in your projects.

Tools of tracking variation costs	**5**	**4**	**3**	**2**	**1**
Expert judgment	☐	☐	☐	☐	☐
Excel spreadsheet (recording project cost)	☐	☐	☐	☐	☐
Quick Books	☐	☐	☐	☐	☐
Shared access electronic audit trail	☐	☐	☐	☐	☐
Sage 200 (To track income & expenses, monitor cash flow & generate reports)	☐	☐	☐	☐	☐
Oracle Prime Projects (to perform forecast analysis & predict impending expenses)	☐	☐	☐	☐	☐
Other; (Please specify) …………………………………...	☐	☐	☐	☐	☐

11. Quality management

i. By ranking from **5 (extremely frequent), 4 (very frequent), 3 (moderately frequent), 2 (slightly frequent) to 1 (least frequent),** which techniques/tool s are used in managing quality of your projects?

Tools for managing quality	**5**	**4**	**3**	**2**	**1**
Field daily reports	☐	☐	☐	☐	☐
Checklist	☐	☐	☐	☐	☐
Gantt charts (planned vs baseline)	☐	☐	☐	☐	☐
Shared access electronic audit trail	☐	☐	☐	☐	☐
Other; (Please specify) …………………………………...	☐	☐	☐	☐	☐

SECTION IV: IMPACT OF ERP SYSTEMS ON CONSTRUCTION PROJECT PERFORMANCE

12. To what extent do ERP systems contribute to the improvement of project cost control?

[ ] Very High ; [ ] High ; [ ] Moderate ; [ ] Low ; [ ]None

13. To what extent do ERP systems contribute to the reduction of project completion time?

[ ] Very High ; [ ] High ; [ ] Moderate ; [ ] Low ; [ ]None

14. To what extent do ERP systems contribute to the improved quality of a project?

[ ] Very High ; [ ] High ; [ ] Moderate ; [ ] Low ; [ ]None

SECTION V: CHALLENGES IN ADOPTION OF ERP SYSTEMS

15. What are the challenges that your firm experiences in adopting the usage of ERP systems?

Barriers to adoption of ERP systems	**5**	**4**	**3**	**2**	**1**
i. High costs of acquisition and complexity	☐	☐	☐	☐	☐
ii. Complexity to master usage	☐	☐	☐	☐	☐
iii. Lack of formal training of project participants	☐	☐	☐	☐	☐
iv. Takes long to achieve the benefits	☐	☐	☐	☐	☐
v. Lack of information about ERP and its softwares	☐	☐	☐	☐	☐
vi. Lack of enough work to justify the use ERP and its softwares	☐	☐	☐	☐	☐
vii. Difficulty in customization of ERP to organizational needs	☐	☐	☐	☐	☐
viii. Disjointedness & complexity of construction industry	☐	☐	☐	☐	☐
Others (please state)…………………………………………… ………………	☐	☐	☐	☐	☐

16. In your opinion, how can the barriers to adoption of Enterprise Resource Planning systems be minimized?

Strategies to encourage ERP adoption	**5**	**4**	**3**	**2**	**1**
i. Reducing cost of acquisition and maintenance	☐	☐	☐	☐	☐
ii. Improving training programs on ERP softwares	☐	☐	☐	☐	☐
iii. Developing ERP softwares that are user friendly	☐	☐	☐	☐	☐
iv. Developing legal framework that encourages use ERP and its softwares	☐	☐	☐	☐	☐
v. Better marketing strategies of ERP softwares to encourage acceptance by project stakeholders	☐	☐	☐	☐	☐
Others (please state) …………………………………………………………………	☐	☐	☐	☐	☐