

**PROJECT MANAGEMENT INFORMATION SYSTEM
PRACTICES AND PERFORMANCE OF ROADS
CONSTRUCTION PROJECTS IN KENYA**

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**Project Management Information System Practices and
Performance of Roads Construction Projects in Kenya**

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the Degree of Doctor of Philosophy in Project Management of the
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DECLARATION

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

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DEDICATION

To my mother, **Fatuma Hassan Amin (Mamiyow)**, whose steadfast support, guidance, and encouragement have been instrumental in my academic journey. This work is a testament to your enduring influence and unwavering belief in my potential.

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ACRONYMS AND ABBREVIATIONS

AI	Artificial Intelligence
AVE	Average Variance Explained
BIM	Building Information Modelling
EMEA	Europe, Middle East, and Africa regions
GDP	Gross Domestic Product
GST	General System Theory
KeNHA	Kenya National Highways Authority
KeRRA	Kenya Rural Roads Authority
KPIs	Key Performance Indicators
KURA	Kenya Urban Roads Authority
LSEC	Land Survey Engineering Consultancy
NACOSTI	National Commission for Science, Technology and Innovation
NIIMS	National Integrated Identity Management System
PMIS	Project Management Information System
UAE	United Arab Emirates
IPD	Integrated Project Delivery
SMART	Specific, Measurable, Achievable, Relevant, and Time-Bound
NGOs	Non-governmental Organizations

FMCG	Fast Moving Consumer Goods
SCM	strategic cost management
TQM	Total Quality Management
EFA	Exploratory Factor Analysis
NCCG	Nairobi City County Government
EPC	Engineering Procurement and Construction
PPP	project planning practices
ICT	Information Communication Technology
KIs	Key Informants
SEM	Structural equation modeling
RBV	Resource-Based View
IDT	Innovation Diffusion Theory
TOC	Theory of Constraints
ToC	Theory of Change

DEFINITION OF OPERATIONAL TERMS

Cost Estimation This is the process of is the process of predicting the financial resources required for a project by evaluating factors such as labor, materials, equipment, and time to support effective budgeting, resource management, and project success within financial constraints.

Cost Management Practices These refer to the systematic processes of cost estimation, budgeting, and cost control aimed at optimizing resource utilization, minimizing financial risks, and enhancing overall project performance.

Data Acquisition This refers to the process of collecting and measuring accurate, relevant data from various sources, often in real time, using sensors, instruments, or software tools to support analysis and decision-making.

Data Integration Practices These encompass data acquisition, storage, analysis, and sharing, enabling the combination of information from multiple sources into a unified view that supports comprehensive project understanding, issue identification, and data-driven decision-making.

Financial Capacity This refers to the ability of an organization, individual, or project to secure, manage, and utilize financial resources effectively to achieve its goals.

Performance of Construction Projects This is the successful delivery of a project through timely completion, adherence to the allocated budget, and ensuring the required quality standards are met.

Project management information system practices These refer to the processes and tools used to support project planning, execution, and control by integrating resource management, data

integration, cost management, and project planning practices to ensure timely and accurate decision-making.

Project Monitoring This is the continuous process of identifying indicators, reporting on project progress, and utilizing results to track performance and ensure alignment with project goals.

Project Planning Practices These involve identifying stakeholders, defining project objectives, and outlining the project scope to provide a clear framework for successful project execution.

Project Scope This is the detailed description of the work required to achieve a project's objectives, outlining deliverables, tasks, milestones, and boundaries by specifying what is included and excluded from the project's activities.

Project Team Expertise This is the combination of specific skills, knowledge, and experience, including technical abilities, industry-specific knowledge, and problem-solving skills that each member contributes to achieving project goals and overall project success.

Resource Management Practices These involve leveraging project team expertise, technological capacity, and financial capacity to optimize resource allocation, minimize waste, and ensure successful achievement of project goals.

ABSTRACT

Road construction projects in Kenya face significant cost overruns of 45 percent, delays averaging 21 months, and quality issues, and despite PMIS adoption, overall project performance remains unsatisfactory. Therefore, the general objective of the study was to investigate the influence of project management information system practices on the performance of roads construction projects in Kenya and the moderating effect of project monitoring. The study was anchored on resource based view theory, innovation diffusion theory, theory of constraints, general system theory and theory of change. The study adopted a positivist research philosophy, cross-sectional survey design and explanatory research design. The target population was 262 contractors, 262 resident engineers, 262 quantity surveyors, 54 Kenya Urban Roads Authority (KURA) officials, 45 Kenya National Highways Authority (KeNHA) officials, and 42 Kenya Rural Roads Authority (KeRRA) officials working in the headquarters. The sample size was 279 respondents selected by use of stratified random sampling. The study used both primary and secondary data. Primary data was collected by use of a structured questionnaire, which generated both quantitative and qualitative data. Thematic analysis was used to analyze qualitative data. Descriptive and inferential statistics were used in analyzing quantitative data. Diagnostic tests were conducted to assess the assumptions of the regression model. The study found that resource management practices, data integration practices, cost management practices, project planning practices have a positive and significant effect on the performance of road construction projects. In addition, project monitoring had a moderating effect on the relationship between project management information system practices and performance of road construction projects. The study recommends that road agencies implement comprehensive financial management, promote knowledge-sharing, establish real-time expenditure monitoring, and adopt a formal change management process for scope adjustments. Policymakers should enforce resource management standards and strengthen monitoring to improve efficiency and performance in Kenyan road construction projects.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Infrastructural development, particularly through the construction of new roads and the maintenance of existing ones, plays a vital role in the economic growth and development of any nation. Roads serve as the backbone of transportation networks, facilitating trade, commerce, and mobility, which are crucial for societal progress. In 2020, it was reported that 69% of global roads were paved (African Development Bank, 2020), reflecting the extensive efforts made globally to improve road infrastructure. Over the past two decades, many countries have heavily invested in road construction projects, aiming to expand their road networks and improve connectivity (Caniëls & Bakens, 2020). These investments are seen as essential for boosting economic activities and ensuring access to basic services, especially in developing regions. However, despite these significant investments, many road construction projects have faced challenges that hinder their success. Issues such as budget and cost overruns, delays, poor communication, and substandard quality have plagued the industry, preventing many projects from achieving their full potential.

Uwitonze (2024) highlight that the common problems in road construction projects include not only cost and time overruns but also low beneficiary satisfaction and compromised quality, which severely impact the overall success of the projects. In Africa, Abbasbhai and Somabhai (2020) observe that road construction is often marred by delays and quality issues, which frequently lead to escalating costs and wasted resources. These challenges are not isolated, as many nations face similar issues in their road construction efforts. To address these persistent challenges, scholars such as Caniëls and Bakens (2020) suggest that the integration of information technology and the automation of key processes could significantly enhance the performance of road construction projects. By leveraging modern tools like project management software, building information modelling (BIM), and advanced materials technology, road construction projects can improve accuracy,

efficiency, and quality control. Moreover, automation could help in reducing human errors, speeding up construction timelines, and ensuring that the projects are completed within the approved budgets. The adoption of such innovative approaches has the potential to revolutionize road construction and ensure that these critical infrastructure projects deliver long-term benefits to societies worldwide.

The adoption of Project Management Information System (PMIS) practices has grown across industries such as manufacturing, construction, telecommunications, software development, and defence, providing critical information to managers and stakeholders for effective decision-making throughout the project lifecycle (Park, Lee & Kim, 2021; Mutwiri & Yusuf, 2022). By integrating data and streamlining communication, PMIS enhances performance, reduces inefficiencies, and supports management of the triple constraints of scope, time, and cost. It ensures project activities are well-documented, roles clearly defined, and progress tracked in real time, fostering coordination and execution. Successful adoption, however, depends on factors like organizational culture, resource allocation, expertise, and structure, with organizations valuing technology and resource investment benefiting most (Purohit, Chopra & Dangwal, 2022). PMIS practices span resource management, data integration, cost management, and project planning, collectively optimizing performance, collaboration, and timely delivery within budget and quality standards (Caniëls & Bakens, 2020).

Project Management Information Systems (PMIS) encompass a wide range of practices that support the efficient management and execution of projects. According to Varajão, Marques, and Trigo (2022), these practices include resource management, data integration, cost management, and project planning, which are essential for streamlining processes and ensuring project success. Similarly, Barang'a and Shale (2024) identified resource management, cost management, and data integration as critical PMIS practices that enhance performance and accountability in project delivery. Waithira and Muchelule (2024) also emphasized the importance of resource management, project planning, and cost management in shaping project outcomes. Guided by these insights, the current study focused on four key PMIS practices, resource management, data integration, cost

management, and project planning, considered vital for improving efficiency, ensuring proper resource utilization, and enhancing performance in road construction projects.

1.1.1 Global Perspective of PMIS Practices

Globally, project management processes have seen significant automation, primarily driven by the growing reliance on advanced software applications tailored for project management. Pan and Zhang, (2021) highlight that there is considerable emphasis placed on data accuracy, particularly concerning key performance indicators (KPIs) and the reports generated from these systems. This focus on accurate data is crucial, as it underpins effective decision-making and performance evaluation throughout the project lifecycle. Moreover, the utilization of suitable applications simplifies the execution of critical project management responsibilities, including the documentation of lessons learned. Alkatheeri, Alhosani and Alteneji (2023) indicate that by capturing insights and experiences from past projects, organizations can enhance future project planning and execution, leading to improved outcomes and greater efficiency in project delivery. In addition, the automation of project management processes not only streamlines workflows but also fosters a culture of continuous improvement within project teams.

In the United States, Project Management Information Systems (PMIS) have become integral to enhancing project management practices across various industries, including construction, IT, and healthcare (Grandage, 2022). Many organizations leverage PMIS to streamline workflows, improve communication, and facilitate collaboration among project teams. The systems typically feature advanced tools for project planning, resource allocation, risk management, and performance tracking, enabling project managers to make data-driven decisions. The rise of cloud-based PMIS solutions has further transformed how projects are managed, allowing for real-time updates and remote access, which is particularly beneficial in the context of increasingly dispersed workforces (Delavari, 2023). Furthermore, the integration of Artificial Intelligence (AI) and analytics into PMIS is gaining traction, helping organizations to predict project outcomes more accurately and optimize resource usage, thus enhancing overall project performance.

In Canada, the adoption of Project Management Information Systems (PMIS) is growing, particularly among organizations focused on improving efficiency and accountability in project delivery (Raymond & Bergeron, 2022). Canadian firms, especially in sectors such as natural resources, construction, and government projects, utilize PMIS to ensure compliance with stringent regulatory standards while effectively managing complex projects. The emphasis on sustainability and environmental considerations in project management has led to the development of specialized PMIS that incorporate metrics for measuring ecological impacts alongside traditional project performance indicators (Haloul, Bilema & Ahmad, 2024). Additionally, Canadian PMIS often emphasize user-friendliness and adaptability to cater to diverse project requirements and organizational cultures. As a result, Canadian organizations are increasingly recognizing the value of PMIS in enhancing project outcomes, facilitating better stakeholder communication, and fostering a culture of continuous improvement in project management practices.

In the Europe, Middle East, and Africa (EMEA) regions, the project management software market is experiencing intense competition from various established software solutions such as Oracle, Aconex, and Microsoft. These companies are renowned for their comprehensive software offerings that cater to diverse project management needs. Organizations within this region are increasingly investing in complex and sophisticated applications as part of their efforts to streamline project management processes and enhance operational efficiency. According to Adesina, Iyelolu and Paul (2024), the drive towards adopting advanced project management tools reflects a growing recognition of the need for better resource allocation, improved collaboration among teams, and effective tracking of project milestones. As organizations seek to adapt to dynamic project requirements, the competition among software providers is likely to spur innovation, resulting in enhanced features and functionalities that support project managers in delivering successful outcomes. This competitive landscape ultimately benefits organizations by providing them with a wider array of choices to meet their specific project management needs.

According to (Mutwiri and Yusuf, 2022), Project Management Information Systems (PMIS) are among the most widely utilized tools in South Korea and Japan, playing a crucial role in supporting and enhancing communication and collaboration within construction projects. These systems facilitate real-time information sharing and streamline workflows, ensuring that all stakeholders are aligned and informed throughout the project lifecycle. In England, the construction industry similarly leverages PMIS practices to improve project management efficiency and effectiveness. Alkhudary and Gardiner (2024) highlight that the adoption of PMIS in the UK construction sector leads to better resource management, timely decision-making, and improved project outcomes. By fostering transparency and accountability, PMIS not only enhances collaboration among project teams but also contributes to the overall success and sustainability of construction projects in both regions. The implementation of such systems shows a global trend toward digitalization in project management, aiming to meet the increasing complexities of modern construction endeavours.

In Iran, the adoption of Project Management Information Systems (PMIS) practices in construction projects has significantly contributed to project management success, as noted by (Ghorbani & Shafaghat, 2020). These systems facilitate better planning and enhance the accuracy of project scheduling, allowing project managers to allocate resources more effectively and optimize timelines. By enabling real-time monitoring and control, PMIS enhances the ability to regulate project activities and address issues as they arise, reducing delays and cost overruns. Furthermore, the implementation of PMIS fosters improved communication among stakeholders, ensuring that all parties are informed and coordinated throughout the project lifecycle. This holistic approach to project management ultimately leads to higher quality outcomes and greater overall efficiency in construction projects across Iran, positioning PMIS as a vital tool for modern project management practices in the region.

In India, Yadav and Paul (2024) identified Project Management Information Systems (PMIS) practices as crucial components in effective project management, significantly influencing key project metrics such as cost, schedule, and quality. The construction

industry, in particular, has witnessed a marked increase in the adoption of PMIS, which has been instrumental in enhancing project performance. Sharma, Jha and Gupta (2023) observed that by integrating quality performance management systems, quality performance tracking systems, and quality cost matrices, PMIS provides a structured approach to monitor and evaluate project activities. This integration allows project managers to identify potential issues early, adjust schedules as needed, and control costs effectively. Consequently, projects utilizing PMIS are better positioned to meet their objectives, ensuring that they are completed on time, within budget, and to the required quality standards, thereby contributing to overall project success in the Indian construction sector.

In Spain, Haloul, Bilema and Ahmad (2024) conducted a comprehensive study that highlighted the critical role of Project Management Information Systems (PMIS) in enhancing project performance. They found that not only does the quality of the PMIS itself significantly influence project outcomes, but the quality of the information output generated by these systems is equally important. High-quality PMIS provides accurate and timely data, which is essential for informed decision-making. Additionally, the effective utilization of PMIS by project teams plays a pivotal role in driving project success. Haloul, Bilema and Ahmad (2024) assert that by fostering better communication, facilitating collaboration, and improving access to vital project information, PMIS enhances the overall management process. Consequently, projects that leverage high-quality PMIS and prioritize effective usage tend to achieve higher performance levels, thereby leading to more successful project completions within the Spanish context.

In China, the Project Management Information System (PMIS) has emerged as a vital information technology application within the construction sector, significantly influencing management processes (Jang, Son and Yi, 2022). This system integrates various project-related tasks, facilitating better communication, coordination, and collaboration among stakeholders. Although PMIS alone cannot guarantee project success, its implementation has become essential for effective project management. The tool aids in tracking project progress, managing resources efficiently, and ensuring that

timelines and budgets are adhered to. As a result, construction firms that leverage PMIS are better equipped to navigate complexities and uncertainties inherent in large-scale projects. Liu, Wang and Xiao (2021) indicate that the adoption of PMIS reflects a growing recognition of the importance of technology in enhancing operational efficiency and project outcomes in the Chinese construction industry.

In the United Arab Emirates (UAE), the Project Management Information System (PMIS) has evolved into a strategic asset for project managers aiming to achieve optimal project performance (Al Khoori and Hamid, 2022). This technological tool provides a comprehensive platform for planning, executing, and monitoring construction projects, thereby enhancing decision-making processes. Research indicates a significant positive correlation between the quality of PMIS, the accuracy of information output, and the level of user engagement with project performance outcomes. When construction projects are implemented in the UAE, effective utilization of PMIS not only streamlines operations but also improves collaboration among stakeholders, ultimately leading to higher efficiency and success rates in delivering projects on time and within budget.

1.1.2 Regional Perspective of PMIS Practices

The importance of incorporating ICT into project management has been acknowledged, leading some African countries to develop policies and strategies that align with their national objectives and economic growth. In South Africa, construction companies increasingly adopt Project Management Information System (PMIS) practices to enhance their responsiveness to customer needs and strengthen partnerships within the supply chain (Chiloane, 2021). These systems are instrumental in facilitating real-time communication and collaboration among project stakeholders, enabling quicker responses to client requests and issues. The implementation of PMIS improves decision-making processes, contributing to reduced project completion times and overall costs. Furthermore, leveraging PMIS fosters greater organizational flexibility, allowing firms to adapt swiftly to changing project demands and market conditions. For PMIS to achieve its intended benefits, it is essential for the system to provide reliable and accurate

information, which empowers project teams to perform their tasks efficiently and effectively, ultimately leading to improved project outcomes and higher client satisfaction (Nyandongo & Lubisi, 2021).

In both South Africa and Zimbabwe, van Besouw (2021) highlighted that Project Management Information System (PMIS) practices have a significant impact on the performance of engineering projects. The adoption of PMIS technologies in these countries aims to enhance efficiency and improve the quality of project outcomes. With PMIS, project teams can streamline processes, ensuring that tasks are completed on time and within budget. Furthermore, the data generated from PMIS is invaluable for analyzing various aspects of project management. It provides insights into risk exposure, allowing teams to identify and mitigate potential issues before they escalate. In addition, PMIS facilitates better resource utilization, ensuring that materials and personnel are allocated efficiently, which contributes to higher profitability. Effective scheduling can also be achieved through PMIS, as it allows for more accurate planning and tracking of project timelines, thereby leading to improved overall project management and success rates.

In Ghana, a study conducted by David and Richard (2024) revealed that Project Management Information System (PMIS) practices are closely linked to enhanced project communication, resulting in improved project performance. The implementation of PMIS creates a centralized repository for essential project data, allowing for streamlined access and sharing of information among all stakeholders. Efficient communication among project team members, clients, and other parties involved in the project becomes possible with PMIS practices, as noted by Boateng (2021). This system helps ensure that all parties remain aligned and informed about the project's progress, including any challenges that may arise. Consequently, this improved communication can lead to timely problem-solving and better decision-making, ultimately fostering positive project outcomes and greater overall success in project execution.

Oyekunle (2024) highlight that the implementation of Project Management Information System (PMIS) practices plays a crucial role in significantly reducing project failure rates

within the Nigerian Construction Industry. The adoption of PMIS enhances various aspects of project management, such as planning, execution, monitoring, and evaluation, which collectively contribute to improved project outcomes. With PMIS, construction firms can streamline their processes, ensuring that resources are allocated efficiently and timelines are adhered to more rigorously. Furthermore, this system facilitates better communication among project stakeholders, enabling quick identification and resolution of potential issues before they escalate into major problems (Unegbu, Yawas & Dan-Asabe, 2022). As a result, the use of PMIS is instrumental in driving project success, enhancing both the quality of construction projects and the overall sustainability of the industry in Nigeria.

In Tanzania, Rahul (2023) established that Project Management Information Systems (PMIS) have become essential tools that significantly enhance the success of projects across various sectors. The implementation of PMIS has transformed traditional project management practices, enabling more efficient planning, execution, and monitoring of activities. Access to real-time data and analytics empowers project managers to make informed decisions regarding resource allocation, risk management, and scheduling. Moreover, Kilinga, Singh and Ahmad (2024) indicate that the system fosters improved communication and collaboration among project stakeholders, ensuring that everyone involved remains aligned with project goals and timelines. Streamlined processes and enhanced transparency contribute to minimizing delays and reducing costs, ultimately leading to higher project success rates in Tanzania's dynamic environment.

The adoption of Project Management Information Systems (PMIS) in Uganda's construction projects has gained momentum as stakeholders seek to enhance efficiency, communication, and accountability (Bosco & Jesse, 2023). PMIS provides essential tools for planning, scheduling, budgeting, and real-time monitoring, which are crucial for managing the complexities of construction. By centralizing project data, PMIS fosters collaboration among contractors, architects, engineers, and clients, ensuring all parties are informed of project developments. Despite its benefits, challenges such as limited technical skills, inadequate investment in technology, and resistance to change persist.

Overcoming these hurdles through targeted training and government support can significantly improve project delivery and outcomes in Uganda's expanding construction industry.

1.1.3 Local Perspective of PMIS Practices

In Kenya, Nyakarengo and Wanjiku (2023) identified that Project Management Information Systems (PMIS) practices play a crucial role in equipping project managers with vital information related to various project parameters, including cost, time, and performance. By leveraging PMIS, managers can access real-time data that enhances their ability to make informed decisions throughout the project lifecycle. This access to essential information allows for better budget management, ensuring that financial resources are allocated efficiently and monitored effectively to prevent overruns. Furthermore, the integration of PMIS attributes significantly influences project performance by streamlining processes, improving communication among stakeholders, and facilitating timely reporting. Such systems foster a more organized approach to project execution, which ultimately leads to higher success rates and improved overall outcomes in project delivery.

In addition, Mwangi and Muchelule (2023) emphasizes the importance of Project Management Information Systems (PMIS) practices in enhancing project performance, particularly regarding the quality of software, the accuracy of information output, and the influence of user engagement. These elements collectively contribute to the effectiveness of PMIS in managing projects efficiently. The integration of high-quality software ensures that project managers have access to reliable tools that facilitate planning, monitoring, and reporting. Moreover, the quality of information generated by these systems is crucial for informed decision-making, as it directly impacts project execution. User influence plays a vital role, as well; when users are adequately trained and engaged with the system, they can leverage PMIS capabilities to navigate project constraints effectively and achieve set objectives, ultimately leading to project success.

In South Rift, Barang'a and Noor (2024) identified a significant relationship between Project Management Information System (PMIS) practices and project performance, particularly concerning project cost, time management, and risk control. The efficiency of PMIS software, along with the quality of information output and user knowledge, are critical factors influencing project performance. Effective project management requires accurate data to make informed decisions, and when PMIS practices are properly implemented, they provide essential insights that help manage costs and timelines effectively. Furthermore, integrating PMIS practices enables construction companies to enhance their operational efficiency and effectiveness, allowing them to proactively identify and mitigate risks. As such, adopting PMIS practices becomes essential for companies aiming to achieve optimal project outcomes and maintain competitive advantage in the construction industry.

Further, Kosgei and Nyang'au (2024) indicate that various aspects of Project Management Information System (PMIS) practices significantly influence project performance. The effectiveness of the PMIS is determined not only by the quality of the information it provides but also by the capabilities of the system user and the manner in which the system is utilized. High-quality information is essential for informed decision-making, while well-trained users can leverage the system's functionalities to enhance project execution. Additionally, the extent of system use plays a crucial role in determining overall project success. When PMIS practices are effectively integrated into project management processes, they facilitate better planning, communication, and monitoring, ultimately leading to improved performance outcomes in projects.

In addition, Wairimu and Ngugi (2023) highlights that the utilization of Project Management Information System (PMIS) practices in road projects within Nairobi County significantly enhances project performance. This improvement is achieved while strictly adhering to critical project constraints, including time, budget, and quality specifications. The effective implementation of PMIS allows project managers to monitor progress in real-time, ensuring that the project stays on schedule and within financial limits. Moreover, PMIS facilitates better communication among project stakeholders,

enabling quick identification and resolution of potential issues that may arise during the project lifecycle. Also, the systematic application of PMIS practices ensures that project objectives are met efficiently, contributing to overall project success and sustainability in the region's infrastructure development efforts.

Kamau and Pedo (2021) established that the implementation of Project Management Information System (PMIS) practices significantly impacts project performance in commercial banks located in Nairobi County. Their study emphasizes several critical components, including the expertise of the project team, the involvement of end users, effective risk management, and comprehensive project monitoring and evaluation. Each of these factors contributes to enhancing overall project outcomes, ensuring that projects are not only completed on time and within budget but also meet the desired quality standards. The expertise of the project team ensures that tasks are executed efficiently, while active involvement from end users fosters greater alignment with stakeholder needs. Furthermore, diligent risk management identifies potential issues early on, allowing for proactive solutions, and robust monitoring and evaluation practices provide valuable insights throughout the project lifecycle, facilitating continuous improvement and accountability.

The integration of Project Management Information Systems (PMIS) in the performance of public school construction projects in Kajiado County plays a vital role in enhancing efficiency and transparency. Mutwiri and Yusuf (2022) indicates that by facilitating real-time data sharing and communication among stakeholders, PMIS streamlines project planning, execution, and monitoring processes. This technology enables project managers to track progress, manage resources effectively, and address issues promptly, leading to improved project timelines and budget adherence. Moreover, the integration of PMIS supports better decision-making through data-driven insights, ultimately resulting in higher-quality construction outcomes. However, challenges such as inadequate training, limited access to technology, and resistance to change must be addressed to fully leverage the potential of PMIS in Kajiado County's public school construction initiatives.

The implementation of the National Integrated Identity Management System (NIIMS) project in Kenya heavily relies on the effective components of a Project Management Information System (PMIS) (Murira & Muchelule, 2022). Key components such as data management, communication tools, and reporting mechanisms play a crucial role in ensuring the project's success. Data management facilitates the collection, storage, and analysis of personal information, which is vital for creating a comprehensive national identity database. Communication tools enable seamless interactions among stakeholders, including government agencies, private sector partners, and the public, ensuring transparency and accountability. Furthermore, robust reporting mechanisms assist in monitoring project progress and evaluating performance against set objectives. However, the successful implementation of these PMIS components requires addressing challenges such as data privacy concerns, technological infrastructure, and stakeholder engagement to foster trust and ensure the effectiveness of the NIIMS project in enhancing national security and service delivery in Kenya.

1.1.4 Performance of Road Projects in Kenya

Performance of road construction projects in Kenya has not been adequate, particularly considering the prevalence of potholes that afflict many roads across the country (Macharia, Osano & Mwea, 2023). Despite significant investments from the government of Kenya aimed at improving infrastructure, these road construction projects continue to face numerous performance challenges (Njeru & Kirui, 2022). The situation is exacerbated by a lack of effective project management practices that could help streamline processes and enhance accountability. Ndurya and Bii (2021) indicates that a staggering 30% of all road construction projects in Kenya stagnate, which show the need for a more rigorous approach to project management in the construction sector. Furthermore, the persistence of issues such as poor planning, inadequate resource allocation, and insufficient stakeholder engagement continues to hinder the successful completion of road projects.

The challenges faced in the implementation of road construction projects in Kenya are reflected in various statistics that reveal troubling trends. For example, Ndurya and Bii (2021) reported that around 50% of road projects exceed their estimated costs and completion timelines, with only 20% being completed on time and within budget. Such discrepancies point to systemic inefficiencies that not only waste public resources but also affect the overall quality of infrastructure. The Thika Super Highway project serves as a notable case, with its costs escalating by 23.25% and implementation time extending by 20% (Mwita, 2020). Originally scheduled for completion in July 2011, the deadline was revised to July 2013, further illustrating the challenges faced in managing large-scale road projects. These delays and cost overruns not only impact project stakeholders but also have long-term repercussions on economic growth and development in the region.

According to the Beldinne and Gachengo (2022), a significant portion of ongoing road projects continues to lag behind schedule. Reports indicate that 76% of the 29 road projects under the Kenya National Highways Authority (KeNHA) in the financial year 2021-22 were not on track to meet their deadlines. This disconcerting statistic highlights the urgent need for improved project management practices across the board. The integration of project management information system (PMIS) practices in these construction projects is essential for enhancing oversight and facilitating better communication among stakeholders. Gitonga (2022) indicates that effective PMIS can aid in real-time monitoring of project progress, budget tracking, and resource allocation, which are crucial elements in ensuring timely and successful project delivery. Ultimately, addressing the inefficiencies in road construction projects in Kenya through the implementation of PMIS practices can lead to improved infrastructure quality and better public service delivery.

1.2 Statement of the Problem

In an ideal scenario, road construction projects would be completed efficiently, on time, and within budget, delivering enhanced transportation infrastructure and economic benefits to the country (Kisavi, 2020). However, many road construction projects face

challenges such as cost overruns, delays, and poor quality, which adversely affect their performance. The utilization of Project Management Information Systems (PMIS) is expected to address these challenges by enhancing project planning, improving stakeholder coordination, and enabling more effective monitoring and management of resources. By mitigating these issues, PMIS has the potential to significantly improve the performance of road construction projects in Kenya, reducing delays, cost overruns, and quality concerns. However, despite the adoption of PMIS in road construction projects, performance is still wanting.

Ndurya and Bii (2021) indicates that 30% of all road construction projects in Kenya stagnate, 50% exceed their estimated cost and estimated completion time, and only 20% are completed within timeline and budget. Ochieng and Ochieng (2021) found that cost overruns and delays were prevalent in Kenyan road construction projects, with an average cost overrun of 45% and an average delay of 21 months. For instance, the cost of Thika Super Highway project increased by 23.25% from 26.44 billion to 34.45 billion (Mwita, 2020). In addition, the initial deadline of the project was July 2011 and was revised to July 2013. Moreover, the Kenya Roads Board submits that 76% of the 29 roads projects under implementation by KeNHA in 2018-19 Financial Year were behind schedule. According to the Kenya Urban Roads Authority (KURA) December 2018 projects progress report, 9 out of 24 projects which is equivalent to 37.5% of road construction projects that were expected to be completed by December 2018, had exceeded their set contractual completion dates. For instance, The Upgrading of Outering road exceeded its completion time by 24.8% from September 2017 to July 2018. The quality of the road works has also suffered leading to shortened life (sustainability) of public works. This has been ascribed to inadequacies in the system for supervising the construction projects (World Bank, 2017). This indicates that road construction projects continue to underperform despite the adoption of PMIS, pointing to a persistent gap between system utilization and project performance.

Various studies have indeed been conducted in Kenya on the influence of project management information system (PMIS) practices on project performance. For instance,

Njeru and Kirui (2022) examined the relationship between PMIS user knowledge and performance of construction projects in South Rift; Kamau and Pedo (2021) investigated the link between PMIS and project performance in commercial banks in Nairobi County; while Barang'a and Shale (2024) focused on the relationship between PMIS and performance of World Bank-funded projects in Nairobi County. These studies illustrate that PMIS has been adopted across different project contexts, whether in donor-funded projects, the banking sector, or regional infrastructure projects such as those under KeRRA. However, the degree of PMIS integration appears to vary depending on the nature of the project and the implementing agency. World Bank-funded projects, for example, often emphasize standardized monitoring, reporting, and accountability mechanisms, making PMIS adoption more structured and mandatory. In contrast, projects in South Rift under KeRRA may rely on locally tailored PMIS practices that address regional infrastructure and resource limitations, potentially resulting in less sophisticated system use compared to Nairobi projects. Similarly, Nairobi-based projects, especially donor-funded ones are more likely to leverage advanced digital systems due to proximity to headquarters, availability of technical expertise, and stronger oversight frameworks. This study sought to address a knowledge gap by exploring the effects of PMIS practices on the performance of road construction projects in Kenya and the potential impact on the country's economy.

1.3 Objectives of the Study

The study was guided by both general and specific objectives.

1.3.1 General Objective

The general objective of the study is to investigate the influence of project management information system practices on the performance of roads construction projects in Kenya.

1.3.2 Specific Objectives

The following specific objective guided the study:

- i. To examine influence of resource management practices on performance of road construction projects in Kenya
- ii. To determine if data integration practices affect performance of road construction projects in Kenya
- iii. To explore the influence of the cost management practices on performance of road construction projects in Kenya
- iv. To asses influence of project planning practices on performance of road construction projects in Kenya
- v. To determine the moderating effect of project monitoring on the relationship between project management information system practices and performance of road construction projects in Kenya.

1.4 Research Hypotheses

H₀₁: Resource management practices have no significant influence on the performance of roads construction projects in Kenya.

H₀₂: Data integration practices have no significant influence on the performance of roads construction projects in Kenya.

H₀₃: Cost management practices have no significant influence on the performance of roads construction projects in Kenya.

H₀₄: Project planning practices have no significant influence on the performance of roads construction projects in Kenya.

H₀₅: Project monitoring has no significant moderating effect on the relationship between PMIS practices and performance of roads construction projects in Kenya.

1.5 Significance of the Study

This study makes an important academic contribution by expanding knowledge on how Project Management Information System (PMIS) practices influence the performance of road construction projects in Kenya. While existing studies highlight project delays, cost overruns, and inefficiencies, limited attention has been given to the role of PMIS in addressing these challenges. The findings enrich literature in project management by providing empirical evidence on PMIS-based practices such as resource management, data integration, cost management, and planning. Scholars and academicians can use the results to build theoretical models, identify research gaps, and guide future investigations in similar contexts.

For policymakers and the Government of Kenya, the study provides insights useful in designing and strengthening policies that promote effective adoption of PMIS in road construction. By integrating PMIS into regulatory frameworks, decision-makers can address recurring issues of cost escalation, delays, and poor quality in infrastructure development. The findings highlight areas where digital systems can improve accountability, efficiency, and transparency in project implementation. This evidence can support the creation of national standards and enforcement mechanisms that ensure consistent use of PMIS across all public sector road projects.

The study is equally significant for project managers responsible for implementing road construction projects. It provides practical insights into how PMIS practices can be applied strategically to enhance efficiency and decision-making. By using PMIS for planning, resource allocation, and monitoring, project managers can better coordinate activities, track performance, and ensure timely delivery of outcomes. The findings also offer guidance on overcoming challenges related to data integration and cost control. Ultimately, project managers can leverage these results to improve project performance and align implementation processes with international best practices.

Construction firms and engineering professionals stand to benefit from evidence on how PMIS enhances operational capacity. The study shows that digital systems support budgeting, financial tracking, compliance, and quality control throughout the project lifecycle. Firms can apply these practices to improve cost efficiency, reduce risks of non-compliance, and scale operations by managing multiple projects effectively. Engineers, surveyors, and technical staff also gain from streamlined workflows, real-time data access, and improved collaboration. This fosters accuracy in technical tasks, minimizes errors, and strengthens productivity, thereby enhancing both project outcomes and organizational competitiveness in the construction sector.

Finally, the study has broader social and economic significance for local communities and end-users. Road projects managed effectively with PMIS are more likely to be completed on time, within budget, and to higher quality standards. This improves road safety, enhances transport efficiency, and reduces the inconvenience of prolonged construction works. Reliable infrastructure also facilitates business activity, lowers vehicle operating costs, and improves accessibility to markets and services. By supporting the timely delivery of sustainable infrastructure, PMIS contributes directly to community welfare and economic development, reinforcing its importance beyond the technical and managerial spheres.

1.6 Scope of the Study

The study aims to examine the influence of project management information system integration on the performance of road construction projects in Kenya. The research focused on four practices of project management information system practices which are resource management practices, data integration practices, cost management practices and project planning practices. According to Varajão et al. (2022), Barang'a and Shale (2024) and Waithira and Muchelule (2024), PMIS practices include resource management, data integration, cost management and project planning. The dependent variable was performance of road construction projects and the moderating variable was project monitoring. The study was conducted in Kenya. This study focused on road construction

projects in Kenya because roads are used to carry about 80% of passengers and cargo within the country and hence the government has been increasing its investment on road projects on annual basis. The unit of analysis in this study was 68 road construction projects by KeNHA, 90 projects by KURA and 104 projects by KeRRA in Kenya for the financial year 2019/2020, 2020/2021 and 2021/2022 (Kenya Roads Board, 2023). This three-year period was selected because it reflects recent performance trends, aligns with the government's intensified investment in infrastructure, and provides sufficient data for assessing the impact of PMIS integration on project delivery within a consistent timeframe. The unit of observation was contractors, resident engineers, quantity surveyors as well as KURA officials and KeNHA officials working in the headquarters. The target population for the study consists of 262 contractors, 262 resident engineers, 262 quantity surveyors, 54 KURA officials, 45 KeNHA officials, and 42 KeRRA officials working in the headquarters, totalling 927 individuals. The study was conducted between June 2023 and August 2023.

1.7 Limitations of the Study

This study employed questionnaires to collect data, which relies on respondents' ability to recall past experiences accurately. This approach is subject to recall bias, as respondents may not remember details accurately or might overlook certain aspects of their project management information system (PMIS) practices and project outcomes. In addition, a pilot study was conducted to assess the validity and reliability of the research instruments. In addition, some respondents expressed hesitation in participating, fearing potential repercussions or victimization. This reluctance could result in a lower response rate or overly cautious responses. To address this issue, the study assured confidentiality and anonymity, emphasizing that individual response would not be linked to specific projects or personnel. Additionally, permissions were sought from relevant authorities to build trust and encourage open participation.

As the study depended on self-reported data from project managers, engineers, and other stakeholders, there was a risk of respondent bias, where some participants may have

unintentionally overstated PMIS effectiveness or downplayed challenges, thus affecting objectivity. To reduce this potential bias, the questionnaires were designed with both positive and negative indicators of PMIS performance. Additionally, triangulation was carried out by collecting responses from different categories of stakeholders, namely project managers, engineers, and contractors, and then cross-verifying their views to identify consistencies and discrepancies. This approach ensured that no single group's perception dominated the findings, thereby enhancing the reliability of the results. Another limitation was variability in responses due to differences in roles and experiences, which could influence perceptions. To address this, data from different project categories (large-scale and small-scale projects) were compared to identify patterns and mitigate individual response biases. Furthermore, the study used a stratified sampling method to ensure adequate representation of different project types and regions.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of literature on project management information system practices on the performance of roads construction projects. It covers, theoretical review, conceptual framework, empirical literature, critique of existing literature, summary of the literature and research gaps.

2.2 Theoretical Review

A theory is a coherent group of tested general propositions, commonly regarded as correct, that can be used as principles of explanation and prediction for a class of phenomena (Bell, 2022). The role of a theory in research is to identify the starting point of the research problem and to establish the vision to which the problem is directed. This study is anchored on resource based view theory, innovation diffusion theory, theory of constraints, general system theory and theory of change.

2.2.1 Resource Based View Theory

The Resource-Based View (RBV), initially conceptualized by Birger Wernerfelt in the 1990s, offers a strategic managerial framework for identifying and leveraging a firm's unique resources to gain a competitive advantage. This theory emphasizes that an organization's sustainable advantage stems from its ability to execute operations in a superior manner, characterized by the development of distinctive capabilities and resources (Kaur, 2023). According to the RBV, effective talent management practices are essential for achieving strategic goals. These practices encompass identifying key resources within the firm, assessing whether these resources meet specific criteria of value, rarity, imperfect imitability, and non-substitutability. Such assessments enable organizations to cultivate, nurture, and safeguard valuable resources, ultimately leading

to enhanced operational efficiency and effectiveness in achieving project objectives (Haque, 2023).

Valuable resources form the foundation for executing strategies that drive organizational performance. Resources classified as rare possess qualities that are not easily accessible to competitors, thereby providing a strategic edge. The imperfect imitability criterion emphasizes that these resources should not be easily replicated, ensuring that the firm maintains its unique position in the marketplace. Non-substitutability refers to the difficulty of replacing these resources with alternatives, further solidifying the firm's competitive advantage (Albert, 2022). Effective management of these resources enables organizations to optimize their capabilities, leading to better project outcomes and overall business performance. The RBV framework thus underscores the importance of resource identification and management as pivotal components in sustaining competitive advantage and achieving long-term success in an increasingly competitive environment (Furr & Eisenhardt, 2021).

The resource-based view offers strategists a means of evaluating potential factors that can be deployed to confer a competitive edge. A key insight arising from the resource-based view is that not all resources are of equal importance, nor possess the potential to become a source of sustainable competitive advantage. The sustainability of any competitive advantage depends on the extent to which resources can be imitated or substituted. Kaur (2023) points out that understanding the causal relationship between the sources of advantage and successful strategies can be very difficult in practice. Thus, a great deal of managerial effort must be invested in identifying, understanding and classifying core competencies. In addition, management must invest in organizational learning to develop, nurture and maintain key resources and competencies (Haque, 2023).

Despite its widespread adoption, the Resource-Based View (RBV) faces several criticisms. One major critique is its tendency to overemphasize internal resources at the expense of external factors, such as market dynamics and competitive behavior, which can significantly impact a firm's success. Collins (2022) argues that RBV may lead

organizations to become insular, focusing too much on internal capabilities without adequately addressing the need for adaptability to changing environments. Additionally, Lubis (2022) indicates that the RBV framework can be seen as overly simplistic, as it may not account for the complexities of resource management and the interplay between various resources. Moreover, the difficulty in identifying and measuring the true value of resources can hinder its practical application. Despite these criticisms, the RBV remains in use due to its valuable insights into the importance of leveraging unique resources and capabilities for competitive advantage. Its focus on sustainable advantages encourages organizations to foster innovation and continuous improvement, making it a relevant and practical approach in strategic management.

Resource-Based View Theory was used to explain the effect of PMIS-based resource management practices on performance of road construction projects in Kenya. RBV theory has served as a pivotal framework in numerous studies examining resource management practices within the construction sector. For instance, Ogunlana et al. (2021) investigated the impact of unique resources such as skilled labor and advanced technology on project performance in Thailand, demonstrating that the effective leverage of these resources could yield competitive advantages in terms of project delivery and cost efficiency. Their research revealed that organizations that focused on enhancing their resource base were better equipped to meet project demands and overcome challenges. Similarly, Zhang and Chen (2020) highlighted the importance of organizational capabilities in the Chinese construction context, showing how superior resource allocation strategies enabled firms to mitigate risks and enhance project outcomes. This body of work underscores the significance of developing firm-specific resources that align with project management practices to drive successful outcomes.

Further applications of the RBV Theory are evident in the research by Cheng et al. (2023), who examined sustainable construction practices in Malaysia, emphasizing how the integration of unique resources, such as green technologies, can improve both environmental performance and overall project success. The study found that organizations adopting sustainable practices not only fulfilled regulatory requirements but

also gained a competitive edge by enhancing their reputation and stakeholder relationships. Additionally, Mokhber and Javanmard (2022) assessed the role of internal resources, including management expertise and technological capabilities, in influencing project efficiency in Iran. Their findings suggested that companies that strategically managed these resources experienced better project outcomes. Similarly, Mouatt and Choudhury (2024) explored the strategic management of physical, human, and technological resources in Indian construction projects, indicating that effective resource management is crucial for achieving organizational success. Collectively, these studies illustrate the importance of strategically managing resources to enhance project performance in the construction industry, highlighting the RBV Theory's relevance in contemporary resource management research.

RBV theory was employed in this study to establish how resource management practices influence road construction projects' performance. This theory posits that competitive advantage derives from a firm's unique capabilities and resources, which play an essential role in crafting effective strategies and operations (Kruesi & Bazelmans, 2023). When organizations leverage available resources effectively, they can enhance the sustainability of their projects. Identifying and mobilizing necessary resources ensures that teams are adequately equipped to meet project demands. This strategic alignment allows for improved project outcomes, as it enables project managers to allocate the right resources at the right time, fostering an environment conducive to success in road construction projects.

Effective resource management entails a thorough assessment of resource requirements and allocation strategies to optimize project performance. Implementing RBV theory enables project managers to identify critical resources that directly contribute to achieving project goals and meeting operational targets (Chatterjee, Rana & Dwivedi, 2024). This theory underscores the importance of having a clear understanding of resource availability and the capabilities required to execute project tasks. A comprehensive approach allows for better planning and execution of road construction initiatives. Consequently, project managers should implement robust resource management practices that align with the

overall strategic objectives of the organization. In doing so, improvements in project performance occur, while also contributing to long-term sustainability and success within the competitive landscape of the construction industry.

2.2.2 Innovation Diffusion Theory

Innovation Diffusion Theory, introduced by Everett Rogers in 1962, provides a comprehensive framework for understanding how new ideas, practices, or technologies spread within a social system. This theory emerged from the field of communication, aimed at explaining the gradual adoption of innovations among various populations over time. According to Leeuwis and Aarts (2021), the process of diffusion involves individuals within a social system who eventually adopt a new idea, behavior, or product. Adoption signifies a change in behavior, meaning that individuals engage with a new product or method differently than they did previously. Central to this process is the perception of the idea or product as innovative, which facilitates its diffusion throughout the social structure. This perception acts as a catalyst, motivating individuals to seek out new practices and embrace the changes that come with innovation. Shaikh, Noordin and Shaikh (2023) indicate that as individuals begin to perceive a product or practice as beneficial and effective, the likelihood of widespread adoption increases. Therefore, understanding how social systems interpret and respond to innovations is crucial in predicting the success of new technologies and practices.

The adoption of innovations occurs through several distinct stages, beginning with the awareness of a need for change. Following this initial awareness, individuals must decide whether to adopt or reject the innovation (Guidolin & Manfredi, 2023). If they choose to proceed, they typically engage in initial use to test its effectiveness before committing to ongoing utilization. Notably, the adoption process is not instantaneous; it unfolds gradually, with certain individuals being more inclined to adopt innovations earlier than others (Kesharwani, 2020). This differential adoption can significantly influence how quickly and widely an innovation becomes accepted within a given community or market. Early adopters often serve as opinion leaders, shaping perceptions and encouraging

subsequent adoption among their peers. As these early adopters showcase the benefits and successes of the innovation, they help reduce uncertainty for later adopters, who may be more cautious (Acikgoz, Elwalda & De Oliveira, 2023). The nuances of this gradual process underscore the importance of social networks in the diffusion of innovation, highlighting that successful adoption often hinges on interpersonal relationships and community dynamics.

Several key factors shape the likelihood of innovation adoption, including relative advantage, compatibility, complexity, trialability, and observability. Relative advantage assesses how much better an innovation is perceived compared to its predecessor. Compatibility evaluates the alignment of the innovation with the values and needs of potential users (Uzumcu & Acilmis, 2024). Complexity refers to the perceived difficulty of understanding and using the innovation, while trialability allows potential adopters to experiment with the innovation before full commitment. Lastly, observability pertains to the extent to which the innovation's benefits are visible to others, facilitating further adoption (Niu, 2020). Together, these factors critically influence the diffusion process, shaping how innovations are adopted and integrated into social practices. For instance, innovations that demonstrate clear advantages over existing solutions are more likely to gain traction. Similarly, if an innovation aligns closely with users' values and experiences, its acceptance is more likely. Addressing issues of complexity and enhancing trialability can significantly lower barriers to adoption, making it essential for innovators to consider these factors when introducing new ideas and technologies.

While Innovation Diffusion Theory (IDT) provides valuable insights into the process of adopting new ideas and technologies, it is not without its criticisms. One significant limitation is its focus on the linear progression of the adoption process, which may oversimplify the complexities of real-world decision-making. Lyu, Chen and Guo (2023) argue that the theory often overlooks the social, cultural, and contextual factors that influence adoption behaviors, such as power dynamics, organizational culture, and external pressures. In addition, IDT primarily emphasizes individual decision-making, neglecting the role of collaborative networks and collective behavior in the diffusion

process. This narrow perspective can lead to an incomplete understanding of how innovations spread, particularly in diverse and dynamic environments (Al Breiki, Al Moosawi & Alburaiqi, 2023). Despite these criticisms, the theory continues to be relevant and widely used, as it serves as a foundational framework that encourages further exploration of the multifaceted nature of innovation adoption, prompting researchers and practitioners to investigate the nuanced interactions among various stakeholders involved in the diffusion process.

Innovation Diffusion Theory (IDT) has been instrumental in understanding the adoption and implementation of data integration practices within the construction industry. For example, Liu and Zhang (2021) explored the factors influencing the adoption of Building Information Modeling (BIM) in Chinese construction firms through the lens of IDT. Their findings indicated that perceived relative advantage, compatibility with existing systems, and ease of use significantly influenced the rate of BIM adoption, which is a critical component of data integration practices. The study emphasized that firms which effectively communicated the benefits of BIM experienced a faster diffusion of this innovation, leading to improved project outcomes. Similarly, Al-Hussein et al. (2022) applied IDT to investigate the integration of advanced data analytics in project management, noting that organizations that embraced these innovations were able to enhance collaboration, efficiency, and decision-making processes. Their research highlighted that understanding the attributes of innovations can facilitate better planning and implementation strategies in construction projects, ultimately leading to higher performance and productivity.

Furthermore, the application of IDT extends to the study of integrated project delivery (IPD) systems in construction. Ojo et al. (2023) utilized IDT to analyze how IPD practices can improve project efficiency and stakeholder satisfaction. Their study showed that the perceived benefits of IPD, such as increased transparency and reduced waste, led to greater acceptance and integration of these practices among project stakeholders. They emphasized that organizations must address the communication and educational aspects of innovation diffusion to ensure effective adoption. Additionally, Kharabsheh et al.

(2024) examined the role of cloud-based data integration solutions in construction projects, utilizing IDT to assess the impact of these technologies on project collaboration and data sharing. Their research found that the characteristics of cloud solutions, such as accessibility and scalability, significantly influenced their adoption, thereby enhancing project performance. Collectively, these studies illustrate the vital role of Innovation Diffusion Theory in facilitating the adoption and effective implementation of data integration practices within the construction sector, ultimately contributing to improved project outcomes.

The innovation diffusion theory was used to explain the effect of data integration practices on performance of road construction projects. The adoption and utilization of data integration practices depends on relative advantage, compatibility, complexity, trialability, and observability. One critical aspect of this relationship is the concept of relative advantage, which refers to the perceived benefits that data integration brings compared to traditional methods. Niu (2020) observes that data integration offers a more holistic view of project data, enabling stakeholders to make more informed decisions. This comprehensive perspective can lead to improved project outcomes, such as better resource allocation and enhanced communication among team members. Additionally, data integration can be customized to meet the specific needs of various stakeholders, further reinforcing its relative advantage. This adaptability ensures that all parties involved can access the information most relevant to their roles, thereby increasing engagement and collaboration throughout the project lifecycle.

Furthermore, data integration plays a vital role in reducing the complexity associated with new technologies or practices. By presenting data in a more user-friendly format, it diminishes the perceived challenges of utilizing innovative solutions in road construction. When project teams can easily navigate and interpret integrated data, the adoption of new practices becomes more feasible and attractive (Uzumcu & Acilmis, 2024). This reduction in complexity enhances the overall user experience, encouraging stakeholders to embrace innovations more readily. Moreover, data integration facilitates trialability by allowing stakeholders to test innovations with real-world data before full implementation. This

aspect not only provides decision-makers with critical insights into the effectiveness of new methods but also fosters a culture of experimentation and continuous improvement within the organization, ultimately leading to better performance in road construction projects.

2.2.3 Theory of Constraints

Goldratt proposed the theory of constraints, which is based on management philosophy (1984). This theory posits that every manageable structure or organization is limited by a small number of constraints that inhibit its ability to achieve its goals. Goldratt argues that at any given time, at least one constraint will be the bottleneck that restricts overall performance (Al-Hussein et al., 2022). The TOC employs a focused approach to identify these constraints and reorganize the organization's resources and efforts around them. Marais (2023) indicates that by concentrating on the most limiting factor, organizations can streamline processes, eliminate inefficiencies, and ultimately enhance their operational efficiency (Raval, Kant & Shankar, 2020). This method not only helps in recognizing critical bottlenecks but also aids in aligning organizational resources to target these weaknesses effectively, ensuring a more robust path toward achieving strategic objectives.

A fundamental assumption of the theory of constraints is that organizational processes are inherently fragile (Kamada & Kojima, 2024). The theory emphasizes that the weakest link or most constrained part of an organization can significantly disrupt overall processes and adversely affects outcomes. This vulnerability highlights the importance of identifying and addressing constraints promptly. According to Mishra et al. (2020), failure to recognize these bottlenecks can lead to inefficiencies that ripple through the organization, ultimately impacting productivity and profitability. By focusing on the constraints, organizations can initiate a cycle of continuous improvement, where the identification of one constraint leads to its resolution, subsequently revealing new constraints to address. This iterative process encourages a culture of ongoing assessment and enhancement,

making TOC a powerful tool for organizations seeking to optimize their operations and adapt to changing market conditions.

The theory is based on idea that organizations can be assessed and managed by changes in three variables: throughput, operating cost, and inventory. The total amount of money spent by the system on purchased items it plans to sell is referred to as inventory (Iyanda & Samuel, 2024). All the capital used by the system to convert inventory into output is referred to as operational cost (Marais 2023). The rate at which the device produces revenue from sales is known as throughput. The essential conditions must be met before the target can be achieved. These usually involve things like protection, consistency, and legal obligations. The primary aim of most companies is to generate profit. Generating income, on the other hand, is a required condition for many organizations and non-profit companies to achieve their objectives. Understanding how to make proper financial decisions is a vital prerequisite, whether it is the target or a required condition (Mishra et al, 2020).

Additionally, the application of TOC in construction project cost management is further illustrated by Choudhury et al. (2022), who examined the integration of TOC with Lean Construction principles. Their research found that combining these methodologies allowed construction firms to streamline processes, reduce waste, and optimize resource utilization, thereby lowering project costs. The study emphasized that by continuously monitoring constraints throughout the project lifecycle, firms could adapt their strategies and mitigates potential cost overruns more effectively. Furthermore, the research by Kumar and Sahu (2023) explored how TOC can facilitate effective decision-making in resource allocation, which directly impacts project costs. By employing TOC, the study indicated that construction companies could enhance their responsiveness to changing project demands, resulting in improved cost management practices and overall project success. Together, these studies demonstrate the significant role of the Theory of Constraints in shaping effective cost management strategies within the construction industry.

In this study, the theory of constraints was used to determine the influence of cost management practices on performance of road construction projects. According to TOC, every manageable system operates under a limited number of constraints that hinder its ability to achieve objectives effectively. Within the context of road construction, these constraints may manifest in various forms, such as supply chain disruptions, unforeseen risks, labor strikes, and inefficiencies in project activities (Mabin & Cavana, 2024). Each of these factors can significantly escalate project costs, leading to budget overruns and delays. Identifying and understanding these constraints allows project managers to develop targeted strategies that mitigate their effects, ultimately enabling more accurate cost estimation and enhanced cost control throughout the project lifecycle.

The implementation of TOC principles enables project managers to focus their efforts on addressing the most pressing constraints, optimizing resource allocation and improving overall project performance. Through continuous monitoring and analysis of these constraints, project teams can implement proactive measures that not only minimize cost overruns but also enhance the efficiency of construction processes. Chaudhari, Dohale and Iqbal (2023) indicate that by prioritizing the resolution of key constraints, stakeholders can foster a culture of continuous improvement within the project, leading to better decision-making and increased accountability. Ultimately, the application of cost management practices informed by the Theory of Constraints supports the successful delivery of road construction projects, ensuring that they are completed on time and within budget while meeting quality standards.

2.2.4 General System Theory

General System Theory (GST), introduced by Hungarian biologist Ludwig von Bertalanffy in 1972, serves as a foundational framework for understanding complex systems across various disciplines, including sociology, biology, and management (Von Bertalanffy, 1972). From a sociological standpoint, GST takes a transdisciplinary approach to organizations, emphasizing the interconnectedness and interdependence of various elements within a system. The core components of a sociological system include

objects, attributes, internal relationships, and the environment. Objects represent the individual parts or elements within the system, while attributes refer to their specific properties or characteristics. Internal relationships are the interactions that occur among these objects, and the environment encompasses external factors that influence the system. This comprehensive framework enables researchers and practitioners to analyze systems holistically, taking into account the multifaceted interactions that can impact overall functionality and performance (Alliou & Mourdi, 2023).

General system theory is built upon several key assumptions that underscore its application across various domains. One primary assumption is that systems are comprised of interrelated components that function together to produce a coherent outcome (Rapp & Corral-Granados, 2024). This interconnectedness implies that a change in one part of the system will likely affect other parts, necessitating a holistic view when analyzing issues or implementing solutions. Another fundamental assumption is that systems operate within larger environments, which means external influences can significantly impact their behavior and performance. Additionally, GST posits that systems are dynamic; they evolve over time in response to internal changes and external pressures (Delcea & Cotfas, 2023). Such assumptions provide a robust foundation for analyzing complex phenomena, enabling practitioners to consider the implications of both internal relationships and external factors when developing strategies for effective management and problem-solving. This framework remains relevant as it facilitates a comprehensive understanding of the intricate dynamics that characterize modern organizations.

Criticism of General System Theory (GST) often centers around its perceived vagueness and lack of specificity, which can make it challenging to apply in practical contexts (Wang, Jing & Lin, 2023). Detractors argue that while the theory emphasizes the interconnectedness of components within a system, it may oversimplify complex relationships, leading to inadequate solutions for intricate problems (Chong, Isaacs & McKinley, 2023). Additionally, the broad nature of GST can result in a lack of focus on individual components, potentially ignoring the unique characteristics and behaviors of

specific elements within a system. Kruglanski, Kopetz and Kopetz (2023) indicate that critics also highlight that GST does not provide concrete methodologies for measuring system effectiveness or for implementing changes, making it difficult for practitioners to translate theoretical insights into actionable strategies. Despite these criticisms, GST remains relevant due to its foundational principles that promote holistic thinking, encouraging the consideration of relationships and interactions in complex systems across various disciplines, which aids in understanding multifaceted issues and designing comprehensive solutions.

General System Theory (GST) has been instrumental in shaping project planning practices within the construction industry by providing a holistic framework for understanding complex project dynamics. For example, in their study, Liu et al. (2020) applied GST to analyze the interdependencies between various project components, including resources, timelines, and stakeholder interactions. Their research highlighted that using a systems approach in project planning allows project managers to better identify potential risks and integrate various planning elements effectively. By considering the project as an interconnected system, managers can implement strategies that enhance communication and collaboration among stakeholders, ultimately improving overall project performance. This systems-oriented perspective enables the identification of feedback loops and the influence of external factors on project outcomes, leading to more informed decision-making and resource allocation.

Additionally, the application of General System Theory in construction project planning is further illustrated by the work of Ghaffarianhoseini et al. (2021), who examined the role of GST in the context of sustainable construction practices. Their study emphasized that integrating a systems approach into project planning facilitates the incorporation of sustainability principles throughout the project lifecycle. By viewing sustainability not as a standalone objective but as a component of the overall project system, project managers can ensure that environmental, social, and economic factors are balanced. The findings demonstrated that a comprehensive systems approach enhances the adaptability and resilience of construction projects to changing conditions, such as regulatory requirements

and stakeholder expectations. Collectively, these studies illustrate the value of General System Theory in promoting a holistic understanding of project planning, ultimately leading to improved project outcomes and sustainability.

The study used the general system theory to explain the influence of project planning practices on performance of road construction projects in Kenya. This theory posits that construction projects function as open systems, comprising interrelated components that interact dynamically with one another and with external factors. In the context of road construction, stakeholders—including project managers, contractors, engineers, suppliers, and the local community—must collaborate effectively to ensure successful project outcomes (Gong, Jiang & Jia, 2023). Poor performance often indicates a breakdown in communication and feedback mechanisms among these stakeholders, leading to misunderstandings, delays, and increased costs. A systems approach in project planning can facilitate better coordination and integration of stakeholder contributions, enhancing the overall effectiveness and efficiency of road construction projects.

Effective project planning plays a crucial role in establishing clear objectives, defining project scope, and identifying key stakeholders involved in the process. A well-structured planning phase ensures that all parties align on project goals and expectations, which is critical for minimizing conflicts and misunderstandings. During this stage, stakeholders are identified, and their roles and responsibilities are delineated, fostering a collaborative environment that encourages open communication (Kruglanski *et al.*, 2023). In addition, project objectives must be realistic and achievable, taking into account the unique challenges associated with road construction in Kenya. Identifying project scope is equally important, as it delineates the boundaries of the project and helps prevent scope creep. Employing general system theory in project planning practices fosters a more integrated and responsive approach, ultimately leading to improved performance and successful project delivery.

2.2.5 Theory of Change

The theory of change can be traced back to the influential work of Peter Drucker in his book titled “The Practice of Management.” This theory emphasizes the generation of knowledge regarding the effectiveness of programs and interventions. In the 1990s, Weiss (1998) highlighted that the theory of change offers a comprehensive framework that outlines the intermediate and early-term changes necessary to achieve long-term goals. By clearly mapping out the pathways to success, the theory allows stakeholders to visualize how various activities contribute to desired outcomes (Jankvist, Gregersen & Lauridsen, 2021). Furthermore, it provides a systematic model of how a project should function, enabling practitioners to identify assumptions and linkages within their strategies. This model can be continuously tested and refined through robust monitoring and evaluation processes, ensuring that the program remains aligned with its objectives and can adapt to changing circumstances.

Theory of Change is essentially a comprehensive description and illustration of how and why a desired change is expected to happen in a particular context (Waisbord, 2020). It is focused in particular on mapping out or “filling in” what has been described as the “missing middle” between what a program or change initiative does (its activities or interventions) and how these lead to desired goals being achieved. It does this by first identifying the desired long-term goals and then works back from these to identify all the conditions (outcomes) that must be in place (and how these related to one another causally) for the goals to occur. These are all mapped out in an Outcomes Framework (Majumder, Majumder & Biswas, 2022).

The theory of change posits that project monitoring can be effectively introduced at any level of intervention, even after activities have been identified and planned. This flexibility allows for continuous oversight and assessment across various notable areas of intervention, including strategy, policy, programs, events, or specific projects. By illustrating how a series of activities leads to a sequence of results, the theory of change highlights the pathway to achieving intended impacts. Additionally, this framework is

instrumental in identifying current needs and opportunities, as well as outlining actionable steps to transition towards desired outcomes. This process fosters the design of realistic goals and enhances accountability, providing a clear understanding of strategies for monitoring and evaluation initiatives. Ultimately, the theory of change promotes a structured approach to assessing program effectiveness and adjusting strategies as necessary (Fazil, Lee & Fadzline, 2021).

Monitoring is fundamentally focused on the regular assessment of changes occurring within the components of a project and its surrounding environment, which are viewed as outcomes resulting from the project's interventions (de Vries, & Rudiarto, 2023). This ongoing process is essential for understanding how various elements of a project interact and evolve over time. The theory of change serves as a model that elucidates the pathway through which an intervention leads to the intended or observed impacts. Often referred to as a results chain, program theory, program logic model, or attribution logic, the theory of change effectively illustrates a series of assumptions and links that outline the presumed relationships between activities and outcomes (Reinholz & Andrews, 2020). This framework holds significant importance for planning and coordination, as well as for conducting research and surveillance, ensuring that stakeholders remain aligned and informed throughout the project lifecycle.

The Theory of Change (ToC) has been widely utilized in studies examining project monitoring practices in construction projects, serving as a framework to articulate the pathway through which project interventions are expected to achieve their intended outcomes. For instance, Singh and Sadhu (2020)) applied ToC to assess the effectiveness of monitoring frameworks in large-scale infrastructure projects. Their research emphasized that clearly defining expected outcomes and the means to achieve them through a ToC lens improved the clarity and focus of monitoring activities. This approach enabled project managers to track progress against specific indicators and adjust strategies as needed, ultimately enhancing project performance. Similarly, Barasa et al. (2020) explored the use of ToC in monitoring public infrastructure projects in Kenya, finding that

it facilitated stakeholder engagement and fostered a shared understanding of project objectives, which contributed to more effective monitoring and evaluation processes.

In addition, the work of Alzahrani and Emsley (2020) demonstrated how ToC can be integrated into the project lifecycle to enhance monitoring practices in construction projects. Their study showed that by employing a ToC framework, project teams could identify assumptions and external factors that might impact project success. This proactive identification of risks allowed for better-informed decision-making and resource allocation during project execution. Moreover, Jha et al. (2021) highlighted the importance of ToC in establishing a clear monitoring and evaluation strategy that aligns with the project's goals. Their findings indicated that projects utilizing a ToC framework experienced improved adaptability and responsiveness to changing conditions, leading to better project outcomes. Collectively, these studies underscore the value of the Theory of Change in shaping effective project monitoring practices within the construction sector, fostering clearer communication, stakeholder alignment, and enhanced project performance.

The theory of change was used to explain the moderating effect of project monitoring on the relationship between project management information system practices and performance of construction projects. Within this framework, monitoring and evaluation play a critical role by providing vital information regarding the progress of a project, identifying potential risks, and highlighting weaknesses that require attention (Jankvist, Gregersen & Lauridsen, 2021). This continuous flow of information serves as a foundation for effective decision-making and project improvement strategies. By understanding the dynamics at play, project managers can strategically allocate resources to address identified challenges. The insights garnered from monitoring and evaluation processes allow teams to make informed adjustments, fostering a proactive approach that can significantly enhance overall project performance.

Through the implementation of targeted interventions, risks can be managed effectively, and challenges can be addressed in a timely manner. These interventions are instrumental

in ensuring that projects align with their set objectives, contributing to the sustainability of the overall initiative. By utilizing PMIS practices, project managers can enhance the likelihood of completing projects on schedule and within budget (Reinholz & Andrews, 2020). This alignment of s and resource allocation not only facilitates project success but also reinforces the importance of continuous assessment in driving positive outcomes. Ultimately, the integration of the theory of change within the context of PMIS practices emphasizes a structured approach to project management that promotes accountability and enhances project performance across the construction sector.

2.3 Conceptual Framework

A conceptual framework refers to the diagrammatical visualization of theoretical aspects of a particular research so as to show the existing relationship between variables (Waddell, 2020). It acts as a foundational tool that guides researchers in understanding, organizing, and presenting the connections between key elements of their study. By mapping out these relationships, a conceptual framework helps clarify the theoretical basis of the research, providing a clear structure that links abstract ideas to the research objectives and methodology. This visualization also helps in establishing the theoretical foundation of the study and aligning the research objectives with the proposed hypotheses (Babbie, 2021). It ensures that the study remains focused and that the variables are defined and connected in a meaningful way. In addition, a conceptual framework serves as a communication tool, enabling readers to quickly grasp the focus and scope of the study. It bridges the gap between theoretical concepts and practical research, ensuring that the investigation is both systematic and grounded in a strong theoretical foundation. This framework typically includes dependent and independent variables, as well as any moderating or mediating factors, to explain how one variable influence another.

This study's conceptual framework sought to demonstrate the relationship between PMIS practices, specifically resource management practices, data integration practices, cost management practices, and project planning practices, and the performance of road construction projects in Kenya. The choice of these independent variables is grounded in

prior empirical research. According to Varajão, Marques, and Trigo (2022), PMIS practices such as resource management, data integration, cost management, and project planning are essential for streamlining processes and ensuring project success. Similarly, Barang'a and Shale (2024) identified resource management, cost management, and data integration as critical PMIS practices that enhance performance and accountability in project delivery. In addition, Waithira and Muchelule (2024) also emphasized the importance of resource management, project planning, and cost management in shaping project outcomes. These studies provide strong support for the selection of the four PMIS practices as the study's independent variables. The conceptual framework is illustrated in Figure 2.1 below: Conceptual Framework of PMIS Practices and Performance of Road Construction Projects in Kenya.

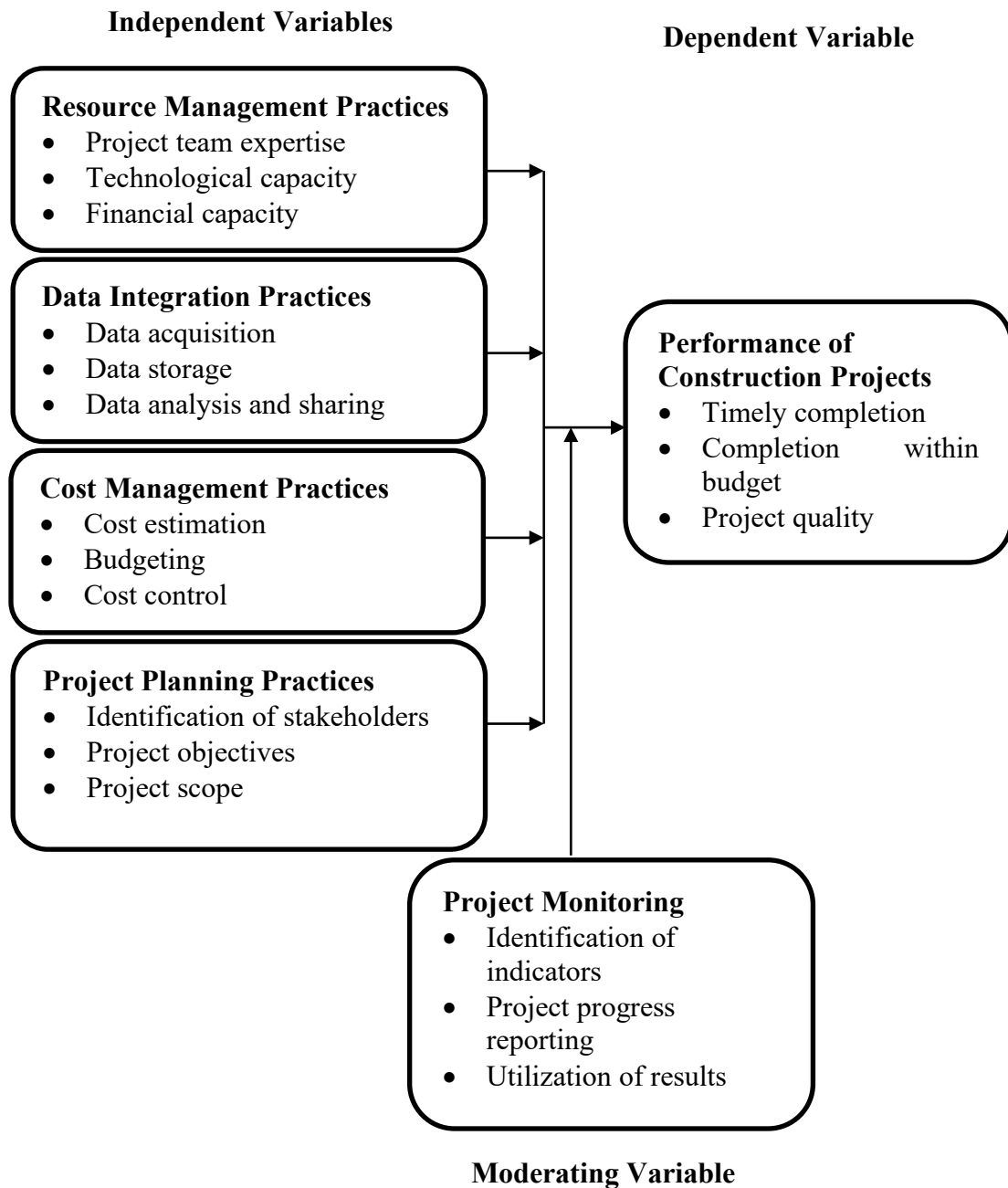


Figure 2.1: Conceptual Framework

Source: Author (2023)

2.3.1 Project Management Information System Practices

Project Management Information System (PMIS) practices refer to the systematic use of digital tools, processes, and techniques that support the planning, execution, monitoring, and evaluation of projects to achieve desired outcomes (Caniëls & Bakens, 2020). According to Varajão, Marques, and Trigo (2022), PMIS practices encompass resource management, data integration, cost management, and project planning, all of which help streamline workflows, enhance communication, and support decision-making in project environments. These practices are increasingly being adopted across construction projects in Kenya, where they play a vital role in ensuring efficiency, accountability, and timely delivery of road projects.

Despite the recognized benefits, critiques of PMIS tools remain limited, particularly regarding their constraints. Uwitonze (2024) emphasizes the positive impact of PMIS while underexploring challenges such as data overload, where project managers may be overwhelmed by excessive information, technological obsolescence that renders systems outdated within short cycles, and resistance to adoption by staff unfamiliar or uncomfortable with new technologies. Abbasbhai and Somabhai (2020) indicate that addressing these issues is important, as uncritical reliance on PMIS without acknowledging limitations may undermine project performance and lead to inefficiencies in resource allocation and stakeholder engagement.

Generally, while the use of PMIS practices demonstrates a sound understanding of modern project management and reflects moderate originality in integrating digital tools into construction management, there is still scope for deeper theoretical interrogation (Park, Lee & Kim, 2021). The incorporation of emerging trends in digital project management, such as artificial intelligence, predictive analytics, and cloud-based collaboration, would enrich the understanding of PMIS and enhance its relevance to evolving project contexts (Caniëls & Bakens, 2020). A more critical perspective that combines both strengths and weaknesses of PMIS can provide a balanced view and improve the theoretical grounding of studies in this domain.

2.3.2 Resource Management Practices

Resource management practices encompass a range of processes and strategies that organizations employ to oversee their resources with efficiency and effectiveness. These resources span human capital, financial assets, physical materials, and information, each playing a vital role in organizational and project success (van Besouw, 2021). Within the context of project management, where projects are temporary efforts with defined objectives, resource management is crucial for meeting goals on time and within budget. Effective resource management involves careful planning to identify necessary resources, followed by the strategic allocation of those resources in alignment with project timelines and tasks. This approach ensures that each project component has adequate support, leading to streamlined operations and minimizing the risk of bottlenecks.

Improved resource management in projects often yields broader organizational benefits, positively influencing team morale and engagement. When project managers allocate resources appropriately, team members have access to the tools, support, and materials they need to perform effectively, enhancing job satisfaction and overall productivity. Addressing potential shortages proactively reduces the likelihood of disruptions that can delay or jeopardize project outcomes (Ngereja & Hussein, 2021). Furthermore, resource management practices encourage a culture of accountability and adaptability, as teams become better prepared to handle unforeseen changes or demands. In this way, resource management serves as both a foundational component of successful project execution and a means to elevate the organization's operational resilience, promoting sustainable growth and continuous improvement. Resource management practices include project team expertise, technological capacity and financial capacity (Harsch & Festing, 2020).

Project team expertise encompasses the knowledge, skills, and experiences that individual team members bring to a project, playing a crucial role in achieving project goals. The effectiveness of a project often hinges on the collective expertise of its team and their ability to collaborate seamlessly (Sankaran, Vaagaasar & Bekker, 2020). Expertise management begins with identifying the specific skills and knowledge required for the

project, which allows for the strategic selection of team members whose abilities align with project demands. Once the team is assembled, each member's unique contributions become essential for tackling complex tasks, solving unexpected problems, and maintaining progress. Ensuring that team members have well-defined roles and understand the broader project objectives is key to aligning their expertise with the project's needs, leading to smoother coordination and greater accountability (Raja & Murali, 2020).

Supporting project team expertise is not only about having the right people but also about providing them with the resources, tools, and environments they need to succeed (Ngereja & Hussein, 2021). Team members must have access to ongoing training, relevant information, and open lines of communication to fully leverage their expertise. Project managers play a vital role in fostering an environment where team members can collaborate, share insights, and provide feedback, thereby enhancing collective knowledge and problem-solving capabilities. The alignment of team expertise with project objectives enhances productivity and encourages a proactive approach, where team members feel empowered to address challenges creatively and adapt to evolving project needs. Effective expertise management ultimately drives project success, creating a foundation for innovation and resilience that benefits the organization as a whole (Raja & Murali, 2020).

Technological capacity refers to an organization's ability to effectively use and leverage technology to achieve its goals and objectives (Adamides and Karacapilidis, 2020). It involves the development, adoption, and use of technology to support business processes and improve organizational performance. Project managers need to have access to technology tools and systems that can help them plan, execute, monitor, and control projects effectively (Kanamugire, 2022). The management of technological capacity in project management involves identifying the technology needs of the project, selecting appropriate technology solutions, and managing the implementation and ongoing use of technology throughout the project.

Technological capacity is essential for an organization's ability to leverage technology to reach its goals and improve overall performance (Adamides and Karacapilidis, 2020). This capacity encompasses developing, adopting, and utilizing technology that supports business operations, ensuring they are more efficient and productive. For project managers, technological capacity means access to advanced tools and systems that facilitate various phases of project management, from planning and execution to monitoring and control. Access to the right technology can streamline complex tasks, improve accuracy, and enhance decision-making by providing real-time data and insights. In today's rapidly changing business environment, a strong technological foundation not only supports day-to-day operations but also equips organizations to adapt and respond to market shifts and project-specific demands effectively (Kanamugire, 2022).

Managing technological capacity in projects requires a structured approach, beginning with a clear understanding of the project's specific technological needs. This involves evaluating the tools and solutions best suited for the project's goals and ensuring that these tools are aligned with the organization's broader technological strategy (Chen, 2022). Once suitable technologies are identified, it is essential to oversee their implementation, train team members on effective use, and address any technical issues that arise. Continuous evaluation and updates to technology also play a vital role, as the evolving nature of projects may require adjustments or upgrades to maintain effectiveness. With a proactive approach to technological capacity management, project managers can reduce risks, enhance team productivity, and ensure the project's goals are met on time and within budget, ultimately supporting sustained competitive advantage (Kanamugire, 2022).

Financial capacity is fundamental in project management, as it directly influences a project's success and sustainability (Makori & James, 2021). Adequate financial resources ensure that each phase of the project can progress without delays or compromises, from procurement and staffing to operational activities. Developing financial capacity involves a detailed assessment of the financial requirements needed to complete the project, taking into account all costs, from initial investment to contingency funds (Stella, 2023). This includes not only direct expenses but also indirect and unforeseen costs, which can impact

the project's financial health. Financial capacity also includes a project's ability to secure funding, whether through internal resources or external financing, which is essential in managing liquidity and maintaining cash flow throughout the project's lifecycle (Baraka & Shukla, 2021).

Effective financial capacity management requires ongoing budget oversight and control mechanisms to ensure spending aligns with the allocated resources (Nachinguru & Mwila, 2023). Establishing a comprehensive budget at the start is essential, but maintaining that budget demands continuous monitoring and control of project costs. Financial management tools and regular financial reporting help project managers identify potential cost overruns early, allowing for timely adjustments to prevent budget breaches. Furthermore, strong financial capacity management supports accountability and transparency, as stakeholders have a clear view of where funds are being allocated and utilized. This not only aids in building stakeholder trust but also enhances the likelihood of project success, as financial constraints are mitigated through informed decision-making (Makori & James, 2021; Baraka & Shukla, 2021).

2.3.3 Data Integration Practices

Data integration is essential in managing complex projects, as it brings together diverse data sources into a cohesive system, enabling more comprehensive analysis and informed decision-making. This process includes identifying relevant data sources, extracting pertinent data, transforming it to ensure consistency, and loading it into a centralized repository, often referred to as a data warehouse or data lake (Akselrod, Shpakov & Shpakova, 2022). This integrated repository offers project managers and stakeholders a unified view of all project data, which supports accurate monitoring and coordination across departments. Additionally, a well-integrated data system reduces redundancy and inconsistencies, fostering efficient data usage that aligns with project objectives. As a result, the practice of data integration is critical for organizations aiming to streamline information flows and maintain real-time visibility into project metrics (Alkhudary & Gardiner, 2024).

Structured data integration practices enhance the project's decision-making process by providing access to reliable, up-to-date information. Establishing data standards is a key component, as it ensures data consistency across all sources, which is vital for accurate analysis (Sbiti, Beddiar & Mazari, 2021). This standardization simplifies data consolidation and improves data quality, which directly impacts the validity of project evaluations and forecasts. Furthermore, implementing a robust data integration solution aligns data use with the organization's goals, aiding project managers in identifying trends and potential issues early (Akselrod, Shpakov & Shpakova, 2022). Having a unified data view allows for proactive adjustments, which supports better project performance, resource allocation, and overall project outcomes. Effective data integration is thus integral to achieving a responsive project management system that adapts to changing project requirements and stakeholder needs (Alkhudary & Gardiner, 2024). Data integration practices include data acquisition, data storage and data analysis and sharing.

Data acquisition encompasses the process of gathering data from multiple sources to support project objectives, involving careful identification of relevant data types, sources, and acquisition strategies (Bernasconi, Canakoglu & Ceri, 2021). This process starts with defining specific data requirements, ensuring alignment with the project's goals and needs. Petrasch and Petrasch (2022) indicate that identifying suitable data sources, whether internal databases, external datasets, or public repositories, is a critical step to ensure that the data is accurate, relevant, and accessible. Data acquisition also considers practical constraints such as time and budget, ensuring that the process remains both efficient and cost-effective (Yousif, Zakaria & Shamsuddin, 2021). Collecting data in a structured manner allows project teams to capture essential information that forms the basis for further analysis, increasing the data's overall quality and usability.

A structured approach to data acquisition can greatly enhance a project team's decision-making capacity, fostering an environment of informed and strategic planning. Once data is collected, effective management is crucial, encompassing data storage, security, and organization to enable easy retrieval and application in analysis (Zhu & Wu, 2022). Employing appropriate data analysis techniques allows project teams to interpret the data,

uncover trends, and develop actionable insights, directly supporting project execution and progress tracking. When data acquisition is carefully aligned with project objectives, it enables teams to respond proactively to emerging challenges, adjust strategies as necessary, and ultimately improve project outcomes through data-driven decisions (Vieira, Dias & Oliveira, 2020). Consequently, the acquisition of relevant and timely data is an essential component in achieving project success and in making informed, adaptive decisions throughout the project lifecycle.

Data storage is essential in project management for securely maintaining and managing all project-related data in a centralized system, ensuring it remains accessible and safeguarded from unauthorized access (Raghavan & Kee, 2020). The types of data stored include critical project documents such as schedules, budgets, progress updates, and other relevant records that are essential for project monitoring and reporting. A centralized storage location streamlines data management, providing team members and stakeholders with a single point of access to up-to-date information. This accessibility is crucial for maintaining transparency and supporting collaborative efforts throughout the project lifecycle. Properly structured data storage practices also help prevent data fragmentation, which can lead to inefficiencies and data discrepancies that hinder effective decision-making (Nwosu, 2024).

To ensure data integrity and accessibility, project data storage practices incorporate several essential components, including data organization, security, and backup protocols. A structured approach involves setting up access controls that define user permissions, limiting access to sensitive information to authorized individuals only (Carriço, Mendes & Brito, 2020). Additionally, data organization is key; information is categorized and stored systematically, making it easier to locate specific data quickly. Regular data backups provide an added layer of security, protecting against data loss due to unexpected incidents or technical failures. Implementing data retention policies is another critical aspect, as it ensures that data is stored only for as long as necessary and complies with legal and regulatory requirements, helping maintain storage efficiency and data privacy.

(Manda, 2022). These practices collectively support a secure, organized, and reliable data storage system that enhances project control and accountability.

Data storage plays a crucial role in project management as it facilitates the secure storage and efficient management of project-related information in a centralized location. This centralized system serves as a repository for various types of data, including project plans, schedules, budgets, progress reports, and other essential documents that are integral to the success of any project (Hindarto, 2023). A well-implemented data storage strategy ensures that all team members have easy access to the necessary information while safeguarding the data against unauthorized access and potential breaches. The organization of this data is paramount, as it not only enhances retrieval efficiency but also contributes to maintaining the accuracy and integrity of the information stored. Therefore, effective data storage is not merely about placing data in one location; it encompasses a comprehensive approach to managing the data lifecycle from collection to archiving.

Effective data storage practices demand a structured methodology to ensure optimal data management and security. This includes implementing a centralized data storage system that acts as a singular source of truth for all project-related information (Hassan, Ahmad & Salehuddin, 2020). Establishing data access controls is critical, allowing only authorized personnel to access sensitive data, thus maintaining confidentiality and compliance with relevant regulations. Additionally, organizing data in a structured manner facilitates easy navigation and retrieval, which is essential for timely decision-making and reporting. Regularly backing up data is another vital component, as it mitigates the risks associated with data loss due to system failures or cyber incidents. Implementing data retention policies further enhances data management by dictating how long certain types of data should be kept and when they should be archived or deleted, ensuring that the storage system remains efficient and compliant with legal standards (Hindarto, 2023). Together, these practices contribute to a robust data management framework that supports effective project execution and enhances overall project outcomes.

2.3.4 Cost Management Practices

Cost management is a comprehensive process that encompasses the planning, estimating, budgeting, tracking, and controlling of project costs, serving as a critical component of successful project management (Mishra et al. 2020). This process begins with cost estimating, where project teams predict the financial resources necessary to complete the project. Following estimation, budgeting allocates these costs over the project's timeline, ensuring that funds are available when needed. Tracking involves ongoing monitoring of expenditures to identify variances between actual and planned costs, allowing for timely interventions if discrepancies arise (Albtoush & Albtoush, 2020). Furthermore, effective cost management incorporates resource management to ensure optimal use of financial and physical resources, along with contract management to oversee agreements with vendors and suppliers. These elements collectively contribute to a structured approach that enhances the ability to maintain financial control throughout the project lifecycle.

Implementing robust cost management practices enables project teams to effectively manage costs, control spending, and ultimately ensure that projects are completed within the established budget (Abdul-Samad & Kulandaisamy, 2022). A structured approach to cost management not only facilitates real-time tracking and adjustments but also fosters a culture of accountability among team members, as they are aware of the financial implications of their decisions. Moreover, integrating risk management into cost management practices allows project teams to anticipate potential financial challenges and develop contingency plans to mitigate their impact (Obi, Gupta & Walton, 2021). This proactive stance enhances financial resilience and can prevent budget overruns that may jeopardize project success. As project teams refine their cost management strategies, they gain valuable insights into spending patterns and resource utilization, which can inform future project planning and improve overall efficiency in project execution. Ultimately, effective cost management is essential for delivering quality outcomes while maximizing resource efficiency and stakeholder satisfaction. Cost management practices include cost estimation, budgeting and cost control (Albtoush, Doh & Albtoush, 2020).

Cost estimation is an essential process in project management that involves predicting the financial resources required for a project or product. This process is inherently dynamic, necessitating regular updates and refinements as the project progresses and new information becomes available (Farouk & Rahman, 2023). Regularly revisiting cost estimates ensures that they reflect current conditions and realities, which is vital for maintaining accuracy and relevance throughout the project lifecycle. Understanding the specific project requirements is critical, as is gaining insight into the availability and costs of necessary resources such as materials, labor, and equipment (Fazil, Lee & Fadzline, 2021). This comprehensive understanding allows project teams to develop more precise cost predictions, providing a clearer picture of the financial landscape and enabling proactive management of budgetary constraints.

Implementing effective cost estimation practices is instrumental in developing accurate project budgets, ensuring efficient resource utilization, and minimizing the risk of cost overruns. Accurate cost estimates empower project teams to allocate financial resources judiciously, helping to avoid waste and inefficiencies that can arise from budget mismanagement (Chen, 2022). Additionally, a robust cost estimation framework supports informed decision-making by providing the necessary financial insights to assess project feasibility and prioritize activities effectively. When project teams have a reliable cost estimation process in place, they can better anticipate financial challenges and devise strategies to address them, ultimately leading to improved project outcomes (Yilmaz, Demirkesen & Li, 2024). Furthermore, accurate cost estimations foster greater accountability among team members, as they can align their efforts with the established financial framework, ensuring that each aspect of the project contributes to achieving the overall budgetary goals.

Budgeting serves as a fundamental process for creating a financial plan tailored to a project, organization, or individual, laying the groundwork for effective financial management. This process entails estimating anticipated income and expenses over a specific period and allocating resources accordingly to align with project objectives (Okereke, Mohammed & Eze, 2022). In the context of road projects, which often involve

substantial financial investment, accurate budgeting becomes even more critical. Cost overruns in these projects can lead to significant delays, resource wastage, and ultimately jeopardize project viability (Naeni & Salehipour, 2021). A well-structured budget helps ensure that financial resources are used efficiently, allowing project managers to maintain control over expenditures while also preparing for unforeseen circumstances that may require financial adjustments. As such, effective budgeting not only safeguards the project's financial health but also contributes to successful delivery within the planned timeline and scope (Farouk & Rahman, 2023).

Moreover, budgeting is a vital component of project management that empowers project managers to allocate resources effectively and make informed decisions about project priorities (Obi, Gupta & Walton, 2021). A comprehensive budget provides a clear framework for assessing the financial implications of various project activities, helping managers identify areas where resources can be optimized or reallocated as needed (Ojo, Ogunsina & Ogunsemi, 2022). It also facilitates prioritization by illuminating the relationship between financial resources and project deliverables, ensuring that critical tasks are adequately funded while minimizing waste. The ability to make data-driven decisions based on budgetary constraints enhances the overall management of road projects, allowing for better risk management and strategic planning (Egboga & Hauwa, 2022). Additionally, an accurate budget fosters accountability among team members, as it establishes clear financial expectations and enables performance monitoring throughout the project lifecycle. Ultimately, effective budgeting not only supports operational efficiency but also enhances stakeholder confidence in the project's success and sustainability.

Cost control in project management is a fundamental practice that focuses on monitoring and managing expenses to ensure alignment with the project's budget (Albtoush & Albtoush, 2020). This process involves regularly tracking expenditures, comparing them against the planned budget, and identifying any variances that may arise throughout the project lifecycle. Effective cost control helps project teams maintain financial discipline, enabling them to recognize potential overruns early and implement corrective measures

promptly (Farouk & Rahman, 2023). Furthermore, it fosters transparency and accountability among team members and stakeholders, as they can assess the financial health of the project in real time. Ultimately, adhering to cost control practices not only enhances the project's operational efficiency but also strengthens stakeholder confidence by demonstrating prudent financial management, which is critical for long-term project success (Liu & Cao, 2021).

Moreover, maintaining strict cost control contributes significantly to maximizing the value delivered by the project to the community while ensuring that it meets its intended goals and objectives (van Besouw, 2021). When project teams are diligent in monitoring costs and making informed financial decisions, they can allocate resources more effectively, ensuring that funds are utilized in the most impactful manner. This strategic allocation is vital for projects that serve community interests, as it helps ensure that necessary services or infrastructure are delivered without unnecessary financial strain. Abdul-Samad and Kulandaisamy (2022) indicate that effective cost control can lead to increased stakeholder satisfaction, as it demonstrates a commitment to delivering quality outcomes within budget constraints. By continuously assessing financial performance and adjusting plans accordingly, project managers can better align project execution with community needs and expectations, ultimately enhancing the project's overall impact and sustainability (Naugolnova, 2021).

2.3.5 Project Planning Practices

Project planning is a critical process in project management that involves developing a comprehensive roadmap that articulates the project's objectives, scope, schedule, budget, and resources. This phase is essential for establishing a clear vision for the project and ensuring that all stakeholders are aligned on the goals and expected outcomes (Majumder, Majumder & Biswas, 2022). Through careful planning, project managers can outline the specific steps necessary to achieve the project's goals, creating a structured approach that enhances efficiency and accountability. Effective project planning also allows teams to anticipate challenges and uncertainties, providing a framework for addressing potential

obstacles before they impact the project's progress (Yang, Yu & Zhu, 2020). By laying out the groundwork for resource allocation, scheduling, and task prioritization, project planning establishes the foundation for successful project execution.

Furthermore, comprehensive project planning encompasses various elements that contribute to the overall success of the initiative. Defining clear objectives ensures that all team members understand what they are working toward, while establishing a detailed project plan provides a sequential outline of activities and timelines that guide the project (Vujović, Denić & Radojkovic, 2020). Creating a project budget helps in allocating financial resources effectively, ensuring that funds are available when needed. Additionally, identifying potential project risks allows teams to develop strategies to mitigate these risks, enhancing resilience and adaptability (Nyandongo & Lubisi, 2021). Defining project milestones enables tracking progress and maintaining momentum, while assigning roles and responsibilities clarifies expectations for team members, fostering accountability. In addition, a well-developed communication plan ensures that information flows smoothly among stakeholders, facilitating collaboration and decision-making. Collectively, these components enable project teams to navigate the complexities of project execution, ultimately leading to the timely delivery of quality outcomes within budget constraints. Project planning practices identification of stakeholders, project objectives and project scope.

Stakeholders are a vital component of any project, encompassing individuals or groups who hold an interest in the project's outcome and possess the power to influence its success. Their involvement can significantly affect project dynamics, making it essential for project managers to identify all relevant stakeholders early in the project lifecycle (Tuyishime & Nyambane, 2021). This identification process requires a thorough understanding of the project's context and objectives, as well as the interests and expectations of various stakeholder groups. Engaging stakeholders effectively can lead to valuable insights, enhanced collaboration, and support, which are crucial for aligning project goals with stakeholder expectations. Additionally, recognizing potential stakeholders' varying levels of influence and interest allows project teams to prioritize

engagement efforts, ensuring that key stakeholders are kept informed and involved throughout the project's development (Irfan, Khan & Khan, 2021).

Engaging stakeholders actively in project management is paramount to minimizing risks and addressing issues that may arise during the project lifecycle. Involvement of stakeholders fosters a sense of ownership and accountability, encouraging them to contribute positively to the project's objectives (Gaur, 2022). Regular communication and collaboration with stakeholders help project managers identify concerns or objections early on, allowing for timely resolutions that can mitigate potential disruptions to the project. Furthermore, understanding the needs and expectations of stakeholders enables project teams to tailor their approaches, enhancing stakeholder satisfaction and reducing the likelihood of conflicts. This proactive stakeholder engagement not only supports project objectives but also cultivates a positive environment where stakeholder input is valued, ultimately leading to improved project outcomes (Zwikaël & Gilchrist, 2021). The interplay between stakeholder engagement and project success underscores the importance of integrating stakeholder management into the broader project management framework.

Project objectives play a crucial role in project management as they articulate specific, measurable, achievable, relevant, and time-bound (SMART) goals that the project aims to accomplish (Ammar, 2024). These objectives provide a clear focus and direction for the project team, serving as a guiding framework for decision-making throughout the project lifecycle. Well-defined objectives help the team prioritize tasks and allocate resources efficiently, ensuring that efforts are aligned with the desired outcomes. Moreover, clear objectives facilitate effective communication among team members and stakeholders, as they establish a common understanding of what success looks like (Gallego, Ortiz-Marcos & Ruiz, 2021). This clarity enables teams to maintain momentum and direction, ultimately leading to a more organized and effective project execution process.

Furthermore, having well-articulated project objectives is essential for evaluating project success and implementing necessary adjustments along the way. The ability to measure

progress against established objectives allows project teams to assess whether they are on track to meet their goals (Kosztván & Hegedűs, 2020). If discrepancies arise, the project team can identify the root causes of these issues and make informed adjustments to strategies, timelines, or resource allocation to steer the project back on course. This dynamic aspect of project objectives enhances the team's adaptability and responsiveness to changing circumstances, which is vital in today's fast-paced project environments (Zhang & Yuce, 2022). Additionally, project objectives serve as benchmarks for accountability, providing a basis for performance evaluations and ensuring that all team members remain aligned with the overarching project goals. In this way, well-defined project objectives not only guide day-to-day activities but also contribute to long-term project success and stakeholder satisfaction.

Project scope serves as a foundational element of project management, delineating the boundaries that encompass the project's goals, deliverables, tasks, timelines, resources, and budget. This comprehensive definition is essential in clarifying what is included in the project and what is explicitly excluded, thereby preventing scope creep—an uncontrolled expansion of project parameters that can lead to resource overuse and budget overruns (Mwanza, Namusonge & Makokha, 2020). A well-defined project scope not only guides the project team in their daily activities but also facilitates effective communication among stakeholders by establishing clear expectations. Understanding the project scope allows teams to focus their efforts on the tasks that matter most, thereby increasing efficiency and productivity. Moreover, it serves as a reference point for making informed decisions regarding resource allocation and project prioritization, ultimately contributing to the successful completion of the project.

Managing project scope is crucial for maintaining control over the project and ensuring adherence to the established budget and timelines. Any changes to the project scope must be handled with care to prevent disruptions that could affect the project's overall objectives (Yang et al., 2020). Effective scope management involves a structured change control process, which includes evaluating the impact of proposed changes on resources, timelines, and costs before implementation. Regular reviews of the project scope

throughout the project lifecycle enable teams to assess progress and make necessary adjustments in a timely manner. This proactive approach helps in identifying potential issues before they escalate, ensuring that the project remains aligned with its goals (Vujović et al., 2020). Additionally, consistent communication with stakeholders about the project scope fosters transparency and trust, as stakeholders are kept informed about any changes and their implications. Ultimately, diligent scope management not only safeguards the project's objectives but also enhances the overall project management process, leading to improved outcomes and stakeholder satisfaction.

2.3.6 Project Monitoring

Project monitoring is an essential component of effective project management, encompassing the systematic process of tracking and reviewing project progress to ensure alignment with established objectives (Amin, Scheepers & Malik, 2023). This involves continuously measuring actual performance against the project plan, which includes timelines, deliverables, and resource allocation. Identifying potential issues or risks early in the process allows project managers to take proactive measures, thereby minimizing disruptions that could hinder the project's success (Shema & Irechukwu, 2022). Furthermore, monitoring progress facilitates the timely adjustment of strategies and resources, ensuring that the project remains on course. This dynamic approach not only enhances operational efficiency but also fosters a culture of accountability within the project team. As project managers stay vigilant in overseeing progress, they can maintain momentum and address any deviations before they escalate into more significant problems.

Regular project monitoring and reporting serve as vital tools for stakeholder engagement and communication. Stakeholders rely on accurate and timely information to make informed decisions about the project's direction and progress (Lehtinen & Aaltonen, 2020). Effective reporting mechanisms provide insights into key performance indicators and overall project health, allowing stakeholders to assess whether the project is on track to meet its goals. This transparency strengthens trust and collaboration among all parties

involved, as stakeholders feel informed and valued in the decision-making process. Moreover, comprehensive monitoring can uncover trends or patterns that may impact future projects, thereby contributing to organizational learning and improvement (Okafor, 2021). In addition, diligent project monitoring not only safeguards the current project's success but also lays the groundwork for enhanced performance in future initiatives, making it a cornerstone of effective project management. Project monitoring encompasses identification of indicators, project progress reporting and utilization of results.

Indicators serve as critical measures in project management, enabling teams to track progress toward specific goals and objectives effectively. These indicators provide a framework for assessing whether a project is on course to meet its predefined objectives while also highlighting potential issues or risks that could jeopardize project success (Amin, Scheepers & Malik, 2023). Different types of indicators, such as quantitative metrics (budget variance, time spent on tasks) and qualitative assessments (stakeholder satisfaction), can be employed to provide a comprehensive view of the project's health. Establishing clear indicators allows project managers to make informed decisions based on real-time data, facilitating timely interventions when necessary (Kose, Bakici & Hazir, 2022). This systematic approach not only enhances accountability among team members but also promotes a culture of continuous improvement, as teams can learn from their performance relative to the established indicators.

Defining indicators involves setting specific targets that the project aims to achieve, which creates a clear benchmark for measuring success. Once indicators and targets are established, a robust monitoring and reporting system must be implemented to ensure that progress is tracked consistently (Mutua, Juma & Owuor, 2020). This system enables project managers to gather data, analyze trends, and generate reports that inform stakeholders about the project's status. Regular updates on indicators foster transparency and keep all stakeholders engaged, allowing them to participate actively in decision-making processes. Furthermore, the ability to identify deviations from expected progress in real-time empowers project teams to take corrective actions swiftly, ensuring that the project remains aligned with its objectives. Ultimately, well-defined indicators and a

comprehensive monitoring system are essential for maintaining focus and ensuring that projects deliver the intended results efficiently and effectively (Ribeiro & Ramos, 2022).

Project progress reporting plays a vital role in the successful management of any project, as it involves providing stakeholders with regular updates on the project's status. These updates typically cover essential aspects such as progress toward meeting project objectives, any issues or risks that have surfaced, and the measures being implemented to address these challenges (Kose, Bakici & Hazir, 2022). An effective reporting process helps maintain transparency and accountability among project teams and stakeholders, fostering trust and collaboration. It allows stakeholders to stay informed about the project's developments, understand the current state of affairs, and align their expectations accordingly. Additionally, clear and concise progress reports contribute to enhanced communication among team members, which can lead to a more cohesive working environment and improved problem-solving capabilities (Mbiru, Ayentimi & Wickham, 2023).

Engagement of stakeholders is paramount for ensuring the project's ongoing success, and effective progress reporting is instrumental in achieving this engagement. When stakeholders are kept up-to-date with relevant information, they are better positioned to make informed decisions and identify potential issues or risks early on (Alkhudary, & Gardiner, 2024). This proactive approach enables timely corrective actions that can mitigate risks and help maintain the project's trajectory toward its goals. Furthermore, a well-structured reporting framework can facilitate discussions and collaboration among stakeholders, allowing for shared insights and perspectives that can enhance project outcomes. Project managers should prioritize the development of informative and engaging reports that cater to the needs and interests of stakeholders, ensuring that all relevant information is presented clearly and effectively. This not only aids in keeping the project on track but also strengthens stakeholder relationships, which are crucial for long-term project success (Okello, 2021).

Utilization of results is a fundamental aspect of project management that emphasizes the importance of leveraging findings and outcomes to inform decision-making and enhance overall performance (Amin, Scheepers & Malik, 2023). This process involves systematically analyzing the data and insights derived from project activities and applying them to refine strategies, processes, and practices within the organization. When project results are effectively utilized, organizations can not only achieve their immediate objectives but also foster continuous improvement and innovation (Gutierrez-Gutierrez & Antony, 2020). This approach enables project teams to assess the effectiveness of their efforts, learn from successes and failures, and make informed adjustments that drive future initiatives. Additionally, the utilization of results creates a feedback loop that helps stakeholders understand the value of the project, reinforcing their support and engagement in ongoing and future projects.

Maximizing the impact of a project hinges on the ability to translate results into actionable insights that benefit stakeholders. Effective utilization of results involves several key steps, including disseminating findings to relevant parties, integrating insights into organizational practices, and fostering a culture of learning and adaptation (Okafor, 2021). When project managers prioritize these steps, they ensure that the knowledge gained from the project informs broader organizational strategies and initiatives. This process not only enhances organizational performance but also promotes transparency and accountability among stakeholders, who can see how project outcomes translate into tangible benefits (Kose, Bakici & Hazir, 2022). Furthermore, engaging stakeholders in discussions about the implications of project results can lead to new opportunities and collaborative efforts that extend the value created. Ultimately, the deliberate and strategic utilization of project results is essential for organizations seeking to optimize their impact and drive sustained value for all stakeholders involved.

2.3.7 Performance of Road Construction Projects in Kenya

Project performance is a key indicator of project success and is essential to ensure that the project delivers the intended benefits to the stakeholders (Dixit, 2020). It refers to the

ability of a project to achieve its goals and objectives within the specified constraints of time, budget, and scope. It is a measure of how effectively and efficiently a project is executed and delivered. The Project Performance Triangle illustrates the relationship between three primary constraints that impact project performance: time, cost, and scope (Ingle & Mahesh, 2022). These three constraints are interdependent, and any change in one will impact the other two. The triangle is often represented graphically with time, cost, and scope forming the three sides of the triangle, with quality at the center.

Time is a crucial element in project management that encompasses the duration and timeline required to complete a project. The significance of adhering to a specified timeframe cannot be overstated, as delays in project completion can have cascading effects on other critical constraints, particularly budget and quality (Rajabi, El-Sayegh & Romdhane, 2022). A well-defined timeline serves as a roadmap for project teams, enabling them to plan, allocate resources, and prioritize tasks effectively. Establishing clear deadlines encourages accountability and motivates team members to stay focused on their objectives. Moreover, the impact of time on stakeholder satisfaction should not be overlooked, as timely project delivery can enhance trust and strengthen relationships with clients and other stakeholders (Hindarto, 2023). Therefore, careful consideration of time management practices is essential to ensure that projects are executed efficiently and effectively.

Timely completion of projects is often regarded as a key determinant of project success, as it directly influences the overall project outcome. When projects are completed on schedule, it positively affects not only the budget but also the quality of deliverables and stakeholder satisfaction (Assaad, El-Adaway & Abotaleb, 2020). Conversely, delays can lead to increased costs, compromised quality, and heightened frustration among stakeholders, which may result in reputational damage for the organization. Effective time management practices, such as establishing milestones, conducting regular progress assessments, and implementing corrective measures when necessary, can significantly mitigate the risk of delays (Hijazi, 2021). Furthermore, incorporating agile methodologies and adaptive planning can enhance a project team's ability to respond to unforeseen

challenges while maintaining a focus on timely delivery (Hindarto, 2023). Ultimately, understanding the interplay between time and other project constraints is critical for achieving project objectives and maximizing value for all involved parties.

Completion within budget is a fundamental aspect of project management that reflects an organization's ability to execute a project without exceeding the allocated financial resources. Adhering to budget constraints is crucial for maintaining the integrity of project goals and ensuring overall project success (Alsaadi & Norhayatizakuan, 2021). When a project remains within budget, it not only facilitates the optimal use of financial resources but also positively influences other critical areas, such as quality and scope. Projects that encounter budget overruns often face pressure to cut corners or reduce the scope of work, which can lead to diminished quality and stakeholder dissatisfaction (Ammar, 2024). Consequently, effective budget management plays a vital role in ensuring that projects deliver their intended outcomes without compromising the standards expected by stakeholders.

Financial management is a key component of project completion within budget, as it involves careful planning, monitoring, and controlling of costs throughout the project lifecycle. Establishing a comprehensive budget at the project's outset allows project managers to allocate resources effectively, anticipate potential financial challenges, and develop contingency plans to address unforeseen expenses (Tayeh, Salem & Alaloul, 2020). Regular financial tracking and reporting are essential to ensure that the project stays on course, enabling teams to identify variances and implement corrective actions when necessary (Schön, 2023). Moreover, completing projects within budget enhances the return on investment for stakeholders, as it indicates efficient resource utilization and prudent financial oversight. This financial discipline not only bolsters stakeholder confidence but also positions the organization for future project opportunities by establishing a track record of successful budget management and delivery.

Project quality is an essential dimension of project management that reflects the extent to which a project meets its predefined objectives while satisfying stakeholder needs and

expectations (Heydari, Heravi & Karimi, 2024). The assessment of project quality is multifaceted, encompassing various criteria such as adherence to project specifications, stakeholder satisfaction, and the overall effectiveness of the project execution. A high-quality project not only fulfills the expected benefits but also is delivered within budget and on schedule, making it a cornerstone of project success (Manda, 2022). Effective quality management throughout the project lifecycle ensures that teams maintain a strong focus on delivering value, addressing any deficiencies in the planning or execution phases, and implementing corrective measures as needed. This comprehensive approach to quality contributes to building trust and confidence among stakeholders, ultimately leading to enhanced project outcomes and increased organizational credibility.

Quality assurance plays a pivotal role in maintaining project quality by systematically evaluating project deliverables to confirm their alignment with established requirements and quality standards (Dixit, 2020). This process involves a range of activities, including quality reviews, testing, and inspections, all designed to identify potential issues early in the project lifecycle. By implementing a robust quality assurance framework, project managers can detect deviations from quality benchmarks and take proactive steps to mitigate risks before they escalate (Schön, 2023). Furthermore, fostering a culture of quality within the project team encourages continuous improvement and innovation, as team members are motivated to seek out best practices and enhance processes (Ingle & Mahesh, 2022). Ultimately, a commitment to quality assurance not only safeguards project integrity but also ensures that the final deliverables meet or exceed stakeholder expectations, reinforcing the project's overall success and impact.

2.4 Empirical Literature Review

This section presents empirical literature on the effect of resource management practices, data integration practices, cost management practices and project planning practices on performance of construction projects.

2.4.1 Resource Management Practices

In India, Raja and Murali (2020) conducted a study examining resource management in construction projects, focusing on the challenges that arise during project implementation. The study adopted a systematic review of literature to explore how construction firms handle different categories of resources, with particular emphasis on labor. The findings revealed that resource management remains one of the most persistent problems faced daily in construction projects, especially with regard to effective labor management. In the case of gated community projects, which include the construction of residential buildings, labor was considered a critical resource influencing both cost and timelines. Shortages of skilled and unskilled labor resources were found to significantly contribute to delays and cost overruns. The study concluded that proper allocation and utilization of required resources is essential to ensuring projects are completed within scheduled timeframes and allocated budgets.

In Nigeria, Okolocha, Anugwu and Ukoh (2023) looked at the effect of project resource management on economic sustainability development in pharmaceutical firms located in Imo State. The study employed a survey research design, targeting a sample of 100 respondents from pharmaceutical firms in Imo State, Nigeria. Data were collected using a structured questionnaire designed to gather information on the relationship between project resource management and economic sustainability. The results indicated that project resource management has a significant and positive effect on economic sustainable development in pharmaceutical firms in Imo State, Nigeria. This finding suggests that effective management of project resources contributes to the economic sustainability of firms within the pharmaceutical industry. Based on these findings, the researchers recommended addressing the noticeable lack of knowledge regarding sustainability concepts among project managers. They emphasized the urgent need for project managers to acquire knowledge and skills related to sustainable project management to enhance economic sustainability practices in their firms.

In another study, Ajao, Ajayi and Ojo (2024) assessed the effect of resource management practices on the performance of construction firms in Southwest Nigeria. The study employed a descriptive research design and utilized a structured questionnaire that adhered to established guidelines for research instrument design. The target population consisted of construction firms operating in Southwest Nigeria, with the sample frame comprising managers, specifically site and project managers, who are responsible for managerial activities within their respective firms. The findings of the study revealed that there are both internal and external factors influencing resource management practices within construction firms in the study area. The regression analysis indicated that resource management practices had a generally positive significance on performance, with the exception of cost management, which exhibited a negative relationship. This negative finding suggested that the management of costs is inefficient, as project costs were often allocated to other resources rather than being directly spent on their intended purposes.

In Rwanda, Kanamugire (2022) studied the influence of project resource management on performance of construction project in Rwanda. The study was conducted as a case study of Nyamata Hostel Construction Project. The researcher used mixed method approach by incorporating both quantitative and qualitative methods. The target population included 85-project team comprising of Bakat Co Ltd with Nyamata hostel construction Project. The results indicated that project team incentives and financial resource planning had no significant effect on project performance of Nyamata Housing Project while Material resource planning has no significant effect on project performance of Nyamata Housing Project.

Baraka and Shukla (2021) conducted a research on resource management practices and construction projects performance in Rwanda. The target population was a total of 168 members that included 53 project managers, 110 project owners and 5 staff members at Land Survey Engineering Consultancy Limited (LSEC Ltd). The researcher utilized random sampling techniques for project managers and purposive sampling to select the project owners and staff member at LSEC Ltd. The findings showed that resources managements were highly related with the performance of construction projects in land

surveying and engineering consultancy limited. The results revealed that more use resource management facilitates the project performances easily and faster. It further indicated strong positive correlation of the resources managements and construction projects performance.

In a different study, Kabeza, Niyonkuru and Semakula (2024) examined the relationship between project resource management practices and project performance in Rwanda, specifically focusing on the Advancing Citizens Engagement project funded by Spark Microgrants in the Musanze sector. This study employed a mixed-methods approach. The analysis revealed a strong positive correlation between resource management practices and project performance, indicating that effective management of resources significantly contributes to the success of the project. Resource planning, particularly documentation and scope assessment, was identified as having a significant impact on project success. Furthermore, efficient resource allocation practices, aligned with the skills and availability of team members, contributed to improved cost control and operational efficiency. The study emphasized the need for implementing robust monitoring mechanisms for resource utilization to prevent over-allocation or underutilization.

In Somalia, Mohamed (2023) studied the effect of resource management on project execution, focusing specifically on the Karan Hospital project in Mogadishu, Somalia. A cross-sectional study design was employed to evaluate the contribution of resource management to project execution. The research utilized a descriptive design, incorporating both qualitative and quantitative data collection methods. Questionnaires and interview guides served as the primary tools for gathering data. The findings revealed that project managers played a crucial role in the planning stage, indicating that the budgeted funds were sufficient to complete the project. The budget for the project was properly determined by combining estimated costs of individual activities to establish an authorized cost baseline. The human resource department was significantly involved in both the planning and execution phases. Additionally, it was found that all necessary resources, including qualified personnel and infrastructure, were allocated for the project's execution.

In a different study, Yusuf (2022) studied the influence of resource management on the implementation of development projects in Mogadishu, Somalia. The study adopted a descriptive survey design targeting a population of 1,045 individuals, including project coordinators, technical advisors, staff, and beneficiaries of the Productive Sector Development Project. Data were collected using a structured questionnaire designed to gather insights on various dimensions of resource management. The results indicated that effective resource management significantly contributes to the implementation of development projects in Mogadishu, Somalia. Specifically, financial resource management, human resource management, time resource management, and material resource management were identified as significant predictors of project implementation. The study concluded that a comprehensive approach to resource management plays a crucial role in the success of development projects.

In Nairobi City County, Makori and James (2021) conducted a study on resource management practices and performance of commercial housing projects. The study made use of descriptive research design. It targeted a population of forty commercial housing projects within Nairobi City County, Kenya; completed between the years 2017 and 2020. The study found out that many commercial housing projects in Kenya are facing performance challenges in the sense that some projects remain stalled; others get completed late beyond the planned time, reduced scope while others collapse because of poor quality. The results indicated that human resource management, financial resource management, and material resource management were influencing performance of commercial housing projects.

Ntinyari and Nyang'au (2024) examined the effect of resource management practices on the performance of donor-funded health projects in Nairobi City County, Kenya. The study employed a descriptive research design and targeted project managers involved in health projects implemented by NGOs. Data were collected through questionnaires, with a pilot study conducted involving a portion of the sample size to test the instruments. The study revealed strong positive correlations between project performance and both resource allocation and task management. Regression analysis further supported these findings,

indicating significant positive coefficients for resource allocation and task management. These results suggested that improvements in resource allocation and task management practices positively influence the performance of donor-funded health projects. The study concluded that effective resource management practices significantly enhance project performance and recommended that project managers prioritize investments in these areas to optimize project outcomes.

Kurgat and Odhiambo (2023) looked at the effect of project resource management on the performance of large-scale water projects in the Rift Valley region of Kenya. The study was anchored by the resource-based view theory and adopted a descriptive research design. Data collection was conducted using a questionnaire to gather quantitative data. The results of the descriptive statistical analysis indicated that project resource management significantly affects the performance of large-scale water projects. Correlation analysis revealed a positive and significant relationship between project resource management and performance, suggesting that efficient and effective management of resources contributes to higher levels of project performance. Furthermore, the regression analysis showed a significant effect, confirming that project resource management directly influences the performance of large-scale water projects. The study concluded that optimized resource management can minimize cost overruns and streamline operations. It recommended prioritizing the allocation of critical resources to high-impact tasks as a strategy to enhance the performance of large-scale water projects.

Wafula and Mungai (2024) studied the effect of project resource management techniques on the sustainability of donor-funded internet connectivity projects in public schools located in Bungoma County, Kenya. A descriptive research design was adopted, targeting a total of 54 public schools in Bungoma County that are connected under the Education Broadband Connectivity Project. Data was collected using structured questionnaires. The study's findings indicated that project resource allocation has a significant impact on project performance. It was highlighted that effective resource allocation is essential for assigning the necessary resources to tasks throughout the project's lifecycle, thereby enhancing its overall performance. However, the research also identified a challenge faced

by project managers, who often lack the skills required for accurate resource estimation. This deficiency can hinder their ability to allocate the appropriate resources needed for successful project implementation. To address these issues, the study recommended that fund allocation should be based on actual budgetary requirements, with a clear and easily understood approval process.

Most existing studies on resource management practices have been conducted in contexts such as India (Raja & Murali, 2020), Nigeria (Okolocha et al., 2023; Ajao et al., 2024), Rwanda (Kanamugire, 2022; Kabeza et al., 2024), Somalia (Mohamed, 2023; Yusuf, 2022), and in selected Kenyan sectors like housing (Makori & James, 2021), health (Ntinyari & Nyang'au, 2024), water (Kurgat & Odhiambo, 2023), and donor-funded ICT projects (Wafula & Mungai, 2024). While these studies confirm that resource management enhances project outcomes, little attention has been paid to road construction projects in Kenya, despite their economic importance, creating a contextual gap. Methodologically, many employed literature reviews, descriptive designs, or single-case surveys, often overlooking the integration of PMIS-based practices, limiting generalizability. Conceptually, prior studies focused mainly on labor, finance, and materials but neglected the role of PMIS tools in digital scheduling, allocation, and reporting. This study therefore addresses contextual, methodological, and conceptual gaps by examining PMIS-based resource management practices and their influence on performance of road construction projects in Kenya.

2.4.2 Data Integration Practices

Akselrod, Shpakov and Shpakova (2022) conducted a study on integration of data flows of the construction project life cycle to create a digital enterprise based on building information modeling. The study used a systematic review of literature. The results indicated that the main advantage of the integration of data flows is the possibility of multiple reuse of information by all participants in the development and implementation of an investment and construction project without changes and distortions of data about the construction object. This leads to a reduction in lost working time, a decrease in the

payroll due to a decrease in labor costs for information processing, savings due to a decrease in inventories, a reduction in construction time and a decrease in work in progress.

In the United States, Demirkesen and Bayhan (2020) conducted an extensive study examining the impact of integrating data management on the performance of construction project management. To gather relevant insights, the researchers designed a comprehensive questionnaire and administered it to construction professionals, collecting data from a total of 121 diverse projects. The analysis was performed using structural equation modeling, a robust statistical technique that allowed for the evaluation of complex relationships between variables. The findings revealed that the integration of data management significantly enhances project management performance, highlighting the importance of effective data practices in achieving project success. Consequently, the study underscores that the construction industry remains in urgent need of well-defined practices and strategies to optimize data management and improve overall project outcomes.

In a different study, Okwori, Viklander and Hedström (2024) explored the transformative impact of integrating artificial intelligence (AI) and real-time data technologies on traditional data engineering practices. The research employs a comprehensive analytical approach, drawing on real-world case studies and empirical data to assess the impact of AI and real-time data integration on data engineering. Through this analysis, the study evaluates how these technologies streamline data flows, improve data quality, and reduce processing times. The findings of the study reveal that the adoption of AI and real-time integration technologies significantly enhances the efficiency of data flows and overall data quality. These technologies are shown to accelerate processing times, enabling organizations to respond more rapidly to business needs. However, the research also identifies key challenges, including compatibility issues with existing systems and security concerns that arise from integrating new technologies.

Yousif, Zakaria and Shamsuddin (2021) conducted a study on the review of big data integration in construction industry digitalization in Malaysia. This research presented a comprehensive study of the literature investigating the potential application of Big Data (BD) integration in the construction industry. The results showed that the adoption of such technologies in this industry remains at a nascent stage and lags broad uptake of these technologies in other fields. The Construction Industry is driving to boost its productivity through the implementation of data technologies. The study reveals that the importance of construction data integration and up-to-date monitoring of the well-integrated data in the construction process of projects is essential.

Afshari, Mehran and Tavakolian (2022) conducted a study on the impact of integration management on Mashhad construction projects management performance. An online questionnaire was designed and administered to 121 construction professionals in Mashhad construction firms based on the proposed framework. Face-to-face interviews were conducted with 22 professionals to increase the response rate. The findings revealed that integration management has a considerable impact on project management performance. Hence, this study demonstrates the core component of integration management with its construction specific components and clearly visualizes the strong tie between integration and performance. With respect to the strong influence of integration management on the project management performance, it is essential that project managers effectively coordinate the processes and relevant parties.

In Iraq, Al Mhdawi (2020) conducted a significant study focused on the impact of data integration management on the performance of construction project management within an oil refining company. The statistical population for this study comprised all employees of the Oil Refinery Company, totaling 4,652 individuals. To gather comprehensive data, the research utilized two specially designed risk management project questionnaires, which included four dimensions and a total of 30 questions. Through careful analysis of the collected responses, the findings indicated that data integration management plays a crucial role in enhancing the performance of construction projects in the oil refining sector. This research highlights the importance of implementing effective data integration

practices to improve project outcomes and efficiency within the construction industry in Iraq, particularly in complex environments like oil refining.

Sharma and Gupta (2021) examined the impact of data integration practices on the performance of construction projects in India, with a particular focus on project delivery time and cost efficiency. The study utilized a mixed-methods approach, combining quantitative surveys and qualitative interviews from project managers, contractors, and other key stakeholders involved in construction across various regions of India. This comprehensive methodology allowed the researchers to capture diverse perspectives on data integration practices. The findings revealed that effective data integration significantly reduced project delays and cost overruns, leading to improved project outcomes overall. Specifically, projects that implemented integrated data management systems reported a remarkable 25% increase in on-time delivery and a 30% reduction in unexpected costs. These results highlight the critical importance of data integration in enhancing performance and operational efficiency within the Indian construction sector, suggesting that organizations adopting these practices can achieve significant competitive advantages.

Nguyen and Tran (2022) investigated the relationship between data integration practices and the efficiency of construction project management in Vietnam. The researchers employed a quantitative research design, utilizing structured questionnaires distributed to 150 project stakeholders, including contractors, engineers, and project managers from various construction firms. This approach enabled a comprehensive analysis of the current state of data integration in the industry. The results demonstrated a strong positive correlation between robust data integration practices and enhanced project management efficiency, particularly in terms of time savings and improved collaboration among stakeholders. Specifically, the study found that companies implementing advanced data integration reported an impressive 40% improvement in project management efficiency compared to those relying on traditional methods. These findings underscore the necessity of integrating data practices in construction management to foster better coordination, communication, and overall project success in the competitive Vietnamese market.

In Zambia, Mumba and Soko (2023) conducted an assessment of how data integration practices influence the performance of construction projects, with a particular focus on quality and stakeholder satisfaction. The researchers adopted a qualitative research methodology, engaging in in-depth interviews with 30 construction professionals, including engineers, project managers, and quality assurance specialists. The findings revealed that effective data integration significantly enhanced quality control measures and led to higher rates of stakeholder satisfaction. Participants highlighted that projects employing integrated data systems experienced a notable reduction in defects, which positively impacted overall project quality. Additionally, many professionals noted improvements in communication among stakeholders, contributing to a more collaborative working environment. This research underscores the critical role that data integration plays in enhancing project quality and strengthening relationships with stakeholders, suggesting that organizations prioritizing these practices can achieve better project outcomes and foster positive stakeholder engagement.

In Tanzania, Kibasa and Nduku (2024) evaluated the effects of data integration practices on the performance of construction projects, focusing specifically on resource allocation and project sustainability. Using a survey method, the researchers collected data from 100 construction firms operating within the country. The analysis revealed that projects employing effective data integration practices reported significantly improved outcomes in terms of resource allocation and sustainability metrics. Many respondents indicated that integrated data systems facilitated more efficient resource management, which not only reduced waste but also contributed to lower environmental impact. The findings emphasized the importance of data integration in achieving sustainable construction practices and highlighted how better resource allocation can enhance project longevity and minimize adverse effects on the environment. This study illustrates the potential of data integration as a strategic tool for enhancing both the efficiency and sustainability of construction projects in Tanzania.

In Kenya, Ochieng and Mutiso (2023) investigated the impact of data integration practices on the performance of construction projects, emphasizing project cost management and

delivery timelines. The study utilized a quantitative research design, gathering data through questionnaires from 200 professionals in the construction industry, including project managers, quantity surveyors, and site engineers. The findings indicated that data integration practices had a significant positive effect on managing project costs and ensuring timely delivery. Respondents noted that effective data management not only streamlined operations but also facilitated better forecasting and planning, leading to more accurate budget estimates. Moreover, projects that successfully integrated data management practices experienced improvements in delivery timelines. These results highlight the critical role of data integration in achieving successful construction project outcomes in Kenya, suggesting that embracing modern data practices can lead to substantial enhancements in both efficiency and effectiveness within the industry.

Most of the reviewed studies on data integration practices have been conducted in countries such as India (Sharma & Gupta, 2021), Vietnam (Nguyen & Tran, 2022), Zambia (Mumba & Soko, 2023), Tanzania (Kibasa & Nduku, 2024), and the United States (Demirkesen & Bayhan, 2020), while in Kenya, existing research (Ochieng & Mutiso, 2023) has largely examined general construction projects with emphasis on cost management and delivery timelines, without focusing on road construction projects, despite road infrastructure accounting for over 80% of passenger and cargo transport in the country. Methodologically, while previous studies adopted approaches such as literature reviews, mixed-methods, and cross-sectional surveys, many relied on single-method strategies with limited generalizability, leaving a gap that this study addresses through stratified sampling to capture diverse road projects under KeNHA, KURA, and KeRRA. Conceptually, most prior studies assessed data integration in relation to efficiency, cost, and sustainability, yet few explicitly linked it to PMIS frameworks or critiqued limitations such as compatibility and security, creating a gap this study fills by situating data integration within PMIS practices and testing its influence on road construction project performance in Kenya.

2.4.3 Cost Management Practices

In Malaysia, Albtcoush, Doh, and Albtcoush (2020) conducted a comprehensive study on the significance of cost management in construction projects. Employing a qualitative research approach, the researchers gathered data through structured questionnaires distributed to relevant stakeholders in the construction industry. The results underscored that effective cost management is a crucial stage in the construction project life cycle, emphasizing that projects must implement cost management practices from the initial planning stages to ensure successful completion within the specified budget, timeline, and quality standards. The study highlighted the importance of continuous monitoring of costs, which involves systematically tracking expenditures throughout the project's duration. This ongoing oversight enables project managers to identify any deviations from the budget and make timely adjustments as necessary, ultimately helping to maintain financial control and enhance project performance.

In Malaysia, Fazil, Lee, and Fadzline (2021) conducted an insightful study focusing on the performance of cost estimation in construction projects. The research identified a total of 238 construction cost estimation papers published across 23 different journals, providing a comprehensive overview of the existing literature in this field. Out of these, only 33 papers specifically addressed the factors that influence the performance of cost estimation processes. The study categorized these influencing factors into several thematic clusters, with the majority relating to control themes. The findings revealed that key cost estimation factors encompass input control, behavior control, output control, project complexity, task characteristics, and technology characteristics. This categorization underscores the multifaceted nature of cost estimation performance and highlights the importance of various control mechanisms in enhancing the accuracy and reliability of cost estimates in construction projects.

In Abuja, Nigeria, Egboga and Hauwa (2022) conducted a thorough examination of the effect of cost estimation on project performance within construction firms. To achieve this, the researchers adopted a descriptive research design and utilized a structured

questionnaire as the primary instrument for data collection. The purposive sampling technique was employed to ensure that the participants selected were relevant to the study. The findings revealed that both bottom-up estimation and parametric cost estimating were positively and significantly influenced by factors such as project scope/specifications, time/schedule, and overall cost. This highlights the critical need for project managers to understand and consider this relationship. Consequently, the study recommends that project managers focus on developing cost estimates and schedules using modern project management tools to enhance accuracy and ensure successful project outcomes.

In Nigeria, Okereke, Mohammed and Eze (2022) conducted a research on the role of construction cost management practices on construction organizations' strategic performance. This study adopted a well-structured questionnaire administered to construction professionals via electronic means and using snowball sampling technique in the six states of the south-south geopolitical zone of Nigeria. It was found that major factors influencing construction cost management are; experience and competence of the project managers, weak management support and control, poor project communications, external economic environment, and lack of use of project management tools (technology). Also, effective cost management was found to play a critical role in the strategic performance of construction organizations; with most benefits being in the areas of waste and expenses reduction, improves operational efficiency need, helps to predict future expenses, ensures procurement effectiveness, and improve profit maximization.

Similarly, Ahmodu, Ajao and Shittu (2023) examined the effect of cost management practice techniques on the performance of fast-moving consumer goods (FMCG) companies in Nigeria. The research employed an ex-post-facto design, targeting a population of 35 listed FMCG companies in Nigeria. Quantitative data were collected from the audited financial reports of selected companies for a period of twelve years, from 2009 to 2020. The findings revealed that budgetary control was positively related to FMCG performance, but the relationship was statistically insignificant. The study also indicated that budgetary control and standard costing techniques were negatively correlated, whereas activity-based costing and life-cycle costing were positively

correlated. Ultimately, only the standard costing hypothesis was accepted, while the others were rejected. The study concluded that effective costing techniques are crucial for identifying, measuring, and quantifying cost management practices that impact FMCG firm performance.

Okereke, Mohammed and Eze (2022) assessed the role of cost management practices on the strategic performance of construction firms in Nigeria. The research utilized a well-structured questionnaire administered to construction professionals through electronic means, employing a snowball sampling technique across six states in the South-South geopolitical zone of Nigeria. The study identified several major factors influencing construction cost management, including the experience and competence of project managers, weak management support and control, poor project communications, external economic conditions, and a lack of project management tools (technology). It was also found that effective cost management significantly contributes to the strategic performance of construction organizations, providing benefits such as waste and expense reduction, improved operational efficiency, better expense prediction, enhanced procurement effectiveness, and increased profit maximization. The study concluded with a recommendation for project managers to continuously upgrade their skills in cost management to enhance the strategic competitive position of their firms.

In Ghana, Nwankwo (2023) conducted an insightful examination of the influence of cost management on the project success rate within Nigeria's oil and gas industry. The study utilized a descriptive research design and employed a purposive sampling technique to gather information from a sample of 292 employees through a structured questionnaire. The findings revealed that key factors, including labor, materials, equipment, and financial costs, significantly impact the success rate of projects in this sector. Furthermore, the research highlighted that effective cost management plays a crucial role in ensuring timely delivery of oil and gas projects in Nigeria. It emphasized that the success of project delivery is closely linked to the financial capability of clients, as adequate funding is essential for managing project costs and achieving successful outcomes.

In Ethiopia, Yismalet and Alemu (2022) conducted a study on improving project cost management practice and profitability of domestic contractors. The study approach involves both literature search and the use of structured and unstructured questionnaires. The results revealed that majority of the contractors use the cost controlling system for generating information regarding profitability and efficiency of resources' performance, even though, an efficient cost controlling system is capable to provide early warning of uneconomical operations and identifying and tracking the causes of the observed inefficiency by generating feedback to the estimation process. Even though, majority the contractors prepare budget, a small proportion of them use the budget for facilitating the cost controlling process.

Among Sudanese leather companies, Abdelraheem (2023) conducted a study aimed to determine the impact of strategic cost management (SCM) on total quality management (TQM) principles. The researcher conducted a literature review to identify knowledge gaps and formulate hypotheses, employing a descriptive and analytical approach. Data were collected through a questionnaire distributed to accountants, administrators, and industrial engineers at the Sudanese Leather Company. The analysis involved exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to categorize questionnaire statements into variables. The study concluded that strategic cost management (SCM) positively impacts customer focus (CF) in Sudanese leather companies. However, it found no significant effect of SCM on employee participation (EP) and continuous improvement (CI) within the same companies.

In Kenya, Baariu and Kamaara (2024) examined the influence of project cost management practices on the performance of sewerage management projects funded by the National Government in Nairobi City County, Kenya. This research employed a descriptive research design and was guided by the Theory of Constraints and The Control Theory. The study targeted a total of 167 employees involved in the sewerage management projects, including 64 government representatives and 39 local authorities, resulting in 270 respondents from 18 projects. A census approach was used due to the small population, and data were collected through questionnaires. The study concluded that both

cost budgeting and cost control have significant effects on the performance of sewerage management projects in Nairobi City County, Kenya.

Similarly, Githinji and Mungai (2024) studied the effect of project cost management on the sustainability of the Inua Jamii cash transfer community development programs in Kiambu County. The study utilized a descriptive research design and focused on the four Inua Jamii Cash Programs in Kiambu County. Data were collected using questionnaires. The findings revealed a strong significant relationship between cost estimation and program sustainability, as well as a strong significant relationship between cost budgeting and program sustainability. Based on these results, the study recommended that program managers adopt appropriate cost estimation methods, implement best practices for monitoring the Inua Jamii cash programs, and utilize innovative techniques to accurately control project costs to enhance program sustainability.

In addition, Gitonga (2022) investigated the relationship between project cost management and the performance of urban road projects in Kenya, particularly focusing on issues such as delays, high costs, and low quality that have been prevalent in these projects. The study employed a descriptive survey research design targeting a population of 408 registered construction professionals involved in projects under the Kenya Urban Roads Authority. A sample size of 202 was selected for the study. Primary data were collected through the distribution of questionnaires to gather insights from the professionals regarding project cost management practices. The findings indicated that project cost management has a positive and statistically significant impact on the performance of urban road projects in Kenya. The study concluded that effective project cost management is crucial for enhancing the performance of these projects.

Nzivo and Mungai (2024) looked at the influence of cost management on the performance of road projects in Machakos and Makueni counties in Kenya. Specifically, the study sought to establish how resource allocation and cost control affect the performance of these road projects. An explanatory research design was employed, focusing on a target population of 42 road projects completed within the last five years in Machakos and

Makueni counties. A census of all respondents was conducted due to the relatively small population size. Primary data were collected using a structured questionnaire. The study concluded that both resource allocation and cost control have a positive and significant impact on the performance of road projects in Machakos and Makueni counties. Based on these findings, the study recommended that the National Construction Authority, the National Environment Management Authority (NEMA), and the Engineers Board of Kenya should develop policies to ensure the quality implementation of projects that align with road standards, cost requirements, and environmental conservation efforts.

Ogega and Pedo (2023) examined the effect of cost management on the performance of construction projects in public hospitals in Nairobi County, Kenya. Specifically, it sought to establish the effects of cost planning, cost monitoring, and cost control on the performance of these projects, measured through adherence to budget, quality, and completion time. A descriptive research design was employed, utilizing a questionnaire for data collection. The target population consisted of 200 technical personnel involved in Engineering Procurement and Construction (EPC) projects across 57 healthcare facilities managed by the Nairobi City County Government (NCCG). The findings revealed that cost planning positively influences the performance of construction projects. Furthermore, there was a positive and significant relationship between cost control and the performance of construction projects. Results were presented in the form of tables and figures, highlighting the impact of effective cost management practices on project outcomes.

Kimotho, Nyang'au and Muchelule (2024) examined the effect of quality cost management on the performance of sports stadia construction projects in Kenya. Guided by the total quality management theory, the study targeted 17 sports stadia projects across Kenya as the unit of analysis. A census was conducted involving 255 respondents who were directly involved in these projects. Primary data was collected through a structured questionnaire. The study analyzed the relationship between quality cost management and the performance of sports stadia construction projects. The study found a significant but weak correlation between quality cost management and the performance of sports stadia construction projects. It was determined that quality cost management explained 8.4% of

the variation in performance outcomes. Based on these findings, the study recommends implementing thorough appraisal activities to identify quality-related failures and taking appropriate action.

Although studies in Malaysia (Albtoush et al., 2020; Fazil et al., 2021), Nigeria (Egboga & Hauwa, 2022; Okereke et al., 2022), Ghana (Nwankwo, 2023), Ethiopia (Yismalet & Alemu, 2022), and Sudan (Abdelraheem, 2023) have examined cost management across diverse construction and industrial settings, and Kenyan studies (e.g., Gitonga, 2022; Nzivo & Mungai, 2024; Ogega & Pedo, 2023) have explored cost planning, budgeting, and cost control, there remains a contextual gap in understanding how PMIS-enabled cost management practices influence performance in Kenyan road construction projects that face persistent challenges of budget overruns, delays, and accountability concerns. Methodologically, many of the reviewed studies relied on single-method approaches such as descriptive surveys, purposive sampling, or ex-post-facto designs, often within localized project contexts, limiting triangulation, generalizability, and representation across diverse agencies like KeNHA, KURA, and KeRRA. Conceptually, most works address cost management in traditional terms, planning, estimation, and control, without embedding these within the Project Management Information Systems (PMIS) framework or interrogating how digital tools enhance cost monitoring, integration, and reporting. This leaves a significant gap that this study seeks to fill by examining the influence of PMIS-enabled cost management practices on the performance of road construction projects in Kenya.

2.4.4 Project Planning Practices

In India, Majumder, Majumder, and Biswas (2022) conducted a thorough study to assess the impact of effective construction planning on project performance improvement. Utilizing a descriptive research design, the researchers gathered and analyzed data to understand the dynamics at play in the construction sector. The findings revealed that the organizational characteristics of construction firms, alongside the project environment, significantly influence planning and scheduling efforts. The study emphasized that firms

need to be structured appropriately to maintain a relevant environmental context during project planning. Additionally, the expansion of the construction sector is closely tied to the growth of the corporate sector and infrastructure development, which can influence project outcomes directly or indirectly. These insights underscore the critical need for effective planning strategies that align with both organizational and environmental factors to enhance overall project performance in construction.

In Rwanda, Tuyishime and Nyambane (2021) conducted a comprehensive study to examine the relationship between planning and project performance in public institutions, specifically focusing on the Rwanda Utilities Regulatory Authority. The researchers employed a causal research design to investigate this relationship, targeting a population of 145 respondents associated with the institution. To gather data, they utilized a structured questionnaire, ensuring a systematic approach to data collection. The findings of the study revealed that effective project planning practices significantly influence project performance. Key aspects of planning, such as setting clear objectives, defining targets, establishing key performance indicators, coordinating activities, and mobilizing necessary resources, were found to have a substantial impact on enhancing the overall performance of projects within the public sector. This study underscores the importance of strategic planning in achieving successful project outcomes.

Wangai and Musembi (2023) conducted an insightful study on the relationship between project planning practices and the performance of construction projects in Nairobi City County, Kenya. The target population included 125 construction projects within the region, focusing on the management practices employed by project teams. To gather data, the researchers utilized semi-structured questionnaires distributed to 125 project managers, who served as the respondents for the study. The findings revealed that a significant majority of the firms recognized the importance of human resource management within their project planning practices. Notably, most firms provided training for their project team members, enhancing their skills and competencies. Furthermore, the study found that projects were completed with relative ease, indicating effective planning, and the budgeted funds were deemed sufficient for project completion,

highlighting the positive impact of structured project planning on performance outcomes in the construction sector.

Mwanza, Namusonge, and Makokha (2020) conducted a comprehensive study to assess the influence of project planning practices on the performance of construction projects in Kenya. The research utilized a mixed-methods design, incorporating descriptive surveys, a census approach, and correlation analysis. The target population consisted of 1,761 respondents, while a sample size of 313 was achieved, which included 160 managers from Early Childhood Development Education, 11 managers from county polytechnics, 133 stall managers, and 9 managers of county modern markets. The findings revealed a negative significant influence of project planning practices on the performance of construction projects. Despite this, the study also highlighted that effective planning provides crucial direction for activities, ensuring they are executed on time and minimizing the likelihood of mistakes, thus underscoring the importance of addressing planning deficiencies to enhance project outcomes in the construction sector.

Kabiti and Kikwatha (2022) evaluated how project planning procedures affect the effectiveness of road construction projects in Meru County. Specifically, it sought to determine the effects of project communication planning, schedule planning, and project scope planning on the performance of road construction projects in the region. The study employed a descriptive research design, targeting 203 road construction officials in Meru County. Data collection tools included a questionnaire and an interview schedule to gather primary data. The study found a significant effect of project resource, schedule, communication, and scope planning on the performance of road construction projects managed by KeRRA in Meru County. The research emphasized the importance of arranging project activities systematically for smooth execution and defining specific tasks clearly.

Oduor and Gatobu (2024) looked at the influence of project planning practices on the performance of urban housing projects in Kenya. Specifically, it sought to assess the influence of project design and risk management on the performance of these housing

projects. The study adopted a descriptive research design, targeting a population of 140 individuals, including engineers, supervisors, and contractors involved in the implementation of infrastructure projects by the Housing Finance Company of Kenya. A census was conducted due to the small population size, with primary data collected through self-administered structured questionnaires. The study findings revealed that effective project design and risk management significantly influence the performance of urban housing projects in Kenya. Regression analysis indicated positive and statistically significant coefficients for project design and risk management in relation to overall project performance. These results highlight the critical role of comprehensive project planning practices in enhancing project outcomes and aligning project objectives with organizational goals and strategies.

In another study, Opiyo and Muchelule (2024) looked at the impact of project planning practices on the performance of Public-Private Partnership (PPP) projects in the Kenyan energy sector. The research employed a descriptive research methodology to examine the influence of project planning practices on PPP project performance in Kenya's energy sector. The study focused on seven major energy projects and utilized a census approach, administering questionnaires to 120 respondents. The study established that the joint variables accounted for 54.2% of the variation in project performance within the energy sector, demonstrating a strong correlation between these variables and project performance. Specifically, project risk planning and project cost planning positively and significantly influenced the performance of PPP projects in the Kenyan energy sector.

Owuor, Kwakha and Ongaro (2022) looked at the influence of project planning on the performance of universal service projects in selected areas of Kenya. The study utilized a mixed-methods approach, employing both quantitative and qualitative research techniques. The target population consisted of 443 respondents, with a sample size of 209 selected through stratified random sampling, simple random sampling, and purposive sampling techniques. Data collection was conducted using both questionnaires and interview schedules. The study found that governance project planning activities associated with the Universal Service Fund (USF) positively influenced project success.

It concluded that effective project planning is crucial for the success of USF projects. The study recommended that the reporting structure implemented by the Universal Service Fund should facilitate timely actions during the planning phases to enhance project outcomes.

Kitungo and Musembi (2024) examined the influence of project planning practices on the performance of Kenya Rural Roads Authority (KeRRA) projects in Machakos County. The study aimed to assess how specific aspects of project planning, such as project scope planning and project schedule planning, affect the overall performance of these projects. The study employed both descriptive and inferential statistical analyses to evaluate the data. It focused on establishing the relationships between project planning practices and project performance within the context of KeRRA projects in Machakos County. The study found that project scope planning and project schedule planning significantly influenced the performance of Kenya Rural Roads Authority (KeRRA) projects in Machakos County. Specifically, it was revealed that effective project scope planning—encompassing the identification of project deliverables, resources, and timelines—was crucial for ensuring that projects were completed within the established goals and requirements. Additionally, thorough project schedule planning, which involves detailed planning of timelines and milestones, was shown to enhance the likelihood of meeting project deadlines and ensuring efficient resource allocation.

Jepkorir and Pedo (2023) examined project planning and implementation of information communication technology (ICT) projects in Kakamega County, Kenya. The study adopted a descriptive research design and targeted a population of 110 project managers, supervisors, and engineers involved in the implementation of ICT projects in Kakamega County. Primary data was collected through a questionnaire that consisted of both structured and open-ended questions to capture qualitative and quantitative data. The study found that all independent variables had strong positive correlations with the dependent variable, indicating that effective project planning and implementation are closely linked. The multiple regression model demonstrated a fairly strong relationship with the data associated with the variables, confirming its predictive capability. A

statistically significant relationship was established between the independent variables, project resource planning and degree of participation in planning, and the implementation of ICT projects. Notably, the degree of participation in planning emerged as the strongest determinant of successful implementation, followed by project resource planning.

Most existing studies across India, Rwanda, and several African countries, including Kenya, demonstrate that project planning practices—such as scope, schedule, resource, communication, and risk planning—significantly influence project performance in construction and other sectors. However, a contextual gap exists because while studies in Kenya (e.g., Kabiti & Kikwatha, 2022; Kitungo & Musembi, 2024; Oduor & Gatobu, 2024) have examined planning practices in road construction, housing, and energy projects, none have explicitly explored how PMIS-facilitated planning practices shape the performance of road construction projects, despite their scale, complexity, and persistent challenges with delays and cost overruns. A methodological gap is evident as most prior studies relied heavily on descriptive or mixed-method designs with questionnaires and interviews, often confined to localized samples, limiting triangulation, robustness, and generalizability across agencies like KeNHA, KURA, and KeRRA that oversee diverse road projects nationwide. Conceptually, while the reviewed studies emphasize traditional planning dimensions (scope, schedule, cost, communication, and risk), they rarely interrogate these within the digital context of PMIS integration—how real-time data, automated scheduling, and collaborative platforms improve planning precision, coordination, and performance. This leaves a gap that the present study seeks to address by examining the influence of PMIS-facilitated project planning practices on the performance of road construction projects in Kenya.

2.4.5 Project Monitoring

In Australia, Amin, Scheepers and Malik (2023) examined the role of project monitoring and evaluation (M&E) in the relationships among stakeholders involved in international development (ID) projects. The study employed a qualitative approach, collecting in-depth interview data from various ID project stakeholders, including project donors,

implementing partners, and members of steering committees. The findings reveal that project M&E activities serve multiple purposes, including the collection of data related to inputs, outputs, outcomes, and overall project impact. This data is shared with stakeholders to facilitate evidence-based decision-making, which enhances the project's impact on the community. Furthermore, the study indicates that M&E activities help strengthen stakeholder relationships by involving diverse stakeholders at various stages of ID projects, enabling them to identify community needs and showcase the positive effects on the community. However, agency issues such as goal incongruence, information asymmetry, and risk-sharing pose challenges to stakeholder relationships.

In Pakistan, Amin (2024) examined the influence of monitoring and evaluation (M&E) on the impact of international development (ID) projects. Grounded in agency theory, the study employed empirical research methods to investigate the relationship between M&E practices and project impact. The research specifically analyzed the individual effects of project monitoring and project evaluation on the success of international development projects. The findings of the study revealed critical insights into the roles of monitoring and evaluation in enhancing project impact. Specifically, it was determined that resolving goal incongruence—where stakeholders have differing objectives—was effectively achieved through both project monitoring and evaluation activities. This resolution plays a crucial role in improving the overall impact of ID projects. Additionally, the study found that information asymmetry, where stakeholders lack the same level of information, was primarily addressed through project monitoring rather than evaluation.

In Rwanda, Shema and Irechukwu (2022) conducted a comprehensive study focusing on monitoring and evaluation practices and their influence on the performance of construction projects. The researchers employed a descriptive research design that incorporated both qualitative and quantitative research approaches to gather in-depth insights. The target population consisted of 153 individuals involved in various aspects of construction projects, from which a sample size of 111 respondents was carefully selected using stratified random sampling techniques. The findings of the study revealed that effective monitoring and evaluation practices significantly impacted the successful

completion of construction projects, ensuring that they were finished within the estimated cost and timeframes. Additionally, the results highlighted that beneficiaries expressed a high level of satisfaction with the outcomes, indicating the critical role of monitoring and evaluation in enhancing project performance and stakeholder contentment.

Mtaki (2024) investigated the influence of project monitoring on the implementation of classroom construction projects funded under COVID-19 initiatives in the Ludewa district of the Njombe region. The study employed a descriptive research design and utilized a mixed-method approach to comprehensively address the research objectives. Qualitative data were gathered through interviews with sixteen Key Informants (KIs) who were directly and indirectly involved in the program. The findings of the study revealed that stakeholders with project monitoring competence significantly contribute to the adherence to required principles in project implementation. Additionally, an alternative in-house-based project monitoring approach was identified as having a substantial positive impact on the performance of development projects, particularly those focused on classroom construction, with effects observed at a 1% significance level. This study addresses a notable knowledge gap in the existing literature by underscoring the critical role of project monitoring in ensuring the success of development projects.

Byaruhanga, Muzaale and Jarbandhan (2020) conducted a research on contractor monitoring and performance of road infrastructure projects in Uganda. Purposive sampling was employed in selecting the procurement professionals, engineers and simple random sampling was adopted in selecting private consultants, members of parliament and respondents from the civil society organizations. Data for this study were collected using a closed ended questionnaire and interviews. The findings revealed that there is a positive significant relationship between contractor monitoring and performance of road infrastructure projects. This indicated that staff designated to monitor contractors lack adequate supervisory skills. The study noted that contract monitoring is essential for achieving the most profitable benefits from supplier relationships and to optimize total costs of the procurement function.

Turyasingura (2022) looked at the effect of project monitoring and evaluation (M&E) on the implementation of funded potato projects in the Kabale District. This study adopted a descriptive survey design, focusing on potato farmers as the unit of analysis. Data was collected through a questionnaire survey administered to a sample of 196 potato farmers. Structural equation modeling (SEM) was employed to test the study's hypotheses regarding the relationships between project M&E and project sustainability. The results revealed a significant positive relationship between project monitoring and evaluation and the sustainability of funded potato projects. This indicates that effective M&E practices contribute positively to the successful implementation and longevity of these projects. The study concludes that project monitoring and evaluation should be participatory, engaging project beneficiaries in the M&E process.

Similarly, Gathenge (2020) conducted an in-depth study to examine the effect of project monitoring and evaluation (M&E) on the performance of road infrastructure projects constructed by local firms in Kenya. This research was specifically carried out in the Lake Basin Region, focusing on a total of 41 road projects. The study's findings revealed that effective project monitoring and evaluation has a significant positive impact on the performance of these road projects. Key elements identified as crucial for successful outcomes included the regular conduct of management and evaluation activities, the allocation of sufficient financial resources for M&E tasks, and the employment of skilled staff with the necessary expertise. These factors collectively contribute to enhancing the overall performance of road infrastructure projects, underscoring the importance of robust monitoring and evaluation practices in achieving project success in the region.

Moreover, Musyimi and Ondara (2022) assessed the effects of technical expertise, cost implications, stakeholder involvement, and the existence of policy frameworks on the performance of projects financed by the County Government of Uasin Gishu. The researcher employed a descriptive research approach, targeting a population of 41 county officials drawn from various departments, including stakeholders. A simple random selection method was used to pick the sample units. Data was primarily collected using a structured self-administered questionnaire. The study found that the level of expertise

among project M&E staff in the County was moderate, while the costs associated with project M&E were rated as very high. Stakeholder involvement in project M&E activities was reported to be very high. It was established that technical expertise in collaborative M&E practices affected project performance to a moderate extent, as did policy frameworks. Inadequate funding for collaborative M&E and M&E budgets as a percentage of development expenditures negatively impacted project performance.

In addition, Wanjohi and Musembi (2024) investigated the influence of monitoring and evaluation (M&E) practices on the performance of road infrastructural projects in Kiambu County, Kenya. The research employed a descriptive research design, focusing on road construction projects in Kenya. Data collection involved semi-structured questionnaires administered using a drop-and-pick-up method. Qualitative data were analyzed using content analysis, while quantitative data were analyzed using descriptive statistics, including frequency, percentages, means, and graphical representations. The study found that stakeholder participation has a positive and significant effect on the performance of road infrastructural projects in Kiambu County. Additionally, project M&E reporting also demonstrated a positive and significant effect on project performance. The findings emphasize the importance of involving stakeholders in the M&E process to enhance project outcomes.

Tangala and Senelwa (2023) studied the influence of the project monitoring process on the implementation of aviation infrastructure construction projects in Kenya. The target population comprised 305 individuals involved in implementing aviation infrastructure projects in Kenya, including consultants, contractors, and project team members. A sample size of 173 was determined using Slovin's formula. Primary data were collected through a questionnaire that included both structured and open-ended questions, allowing for qualitative and quantitative data gathering. The study found a strong positive correlation between the four independent variables (monitoring planning, tools, techniques, and stakeholder participation) and the dependent variable (project implementation). The multiple regression model indicated a fairly strong relationship, suggesting a good predictive model. Monitoring planning emerged as the strongest

determinant of project implementation, followed by monitoring techniques, stakeholder participation, and monitoring tools.

Existing studies on project monitoring reveal that effective monitoring and evaluation (M&E) practices significantly enhance project performance across sectors and countries, including road construction, education, agriculture, and aviation infrastructure. Research in Kenya (e.g., Gathenge, 2020; Wanjohi & Musembi, 2024; Tangala & Senelwa, 2023) demonstrates that regular monitoring, stakeholder participation, skilled M&E personnel, and adequate resourcing positively affect project outcomes. Contextually, however, there is a gap in understanding how project monitoring interacts with PMIS-enabled practices specifically in road construction projects, despite evidence of PMIS improving data collection, reporting, and coordination. Methodologically, prior studies have largely employed descriptive designs, semi-structured questionnaires, and small or localized samples, limiting the generalizability of findings and the ability to test moderating effects rigorously. Conceptually, while monitoring has been linked to project performance, there is limited exploration of its moderating role between PMIS adoption and project outcomes, leaving a gap in understanding how monitoring amplifies or constrains the effectiveness of information systems in enhancing road construction performance in Kenya.

2.5 Critique of Existing Literature

Numerous studies have explored the impact of project management information system (PMIS) practices on the performance of road construction projects across various regions globally. For example, Gutierrez-Gutierrez and Antony (2020) investigated the success model of PMIS in the construction industry in China, finding that PMIS significantly influenced construction management processes. Their research highlighted how PMIS tools streamlined the management of resources, schedules, and risks in construction projects. However, the study was limited to the Chinese construction sector, and its findings were primarily focused on the overall management processes rather than the direct impact of PMIS on project performance outcomes, such as cost, time, and quality.

This limitation makes it difficult to generalize the results to other countries with different socio-economic, technological, and regulatory environments, such as Kenya. Thus, while the study provided useful insights into the broader role of PMIS, it left gaps in understanding how PMIS specifically affects the performance of road construction projects.

Similarly, Adamides and Karacapilidis (2020) conducted a study in India, examining how PMIS practices, such as quality performance management systems, quality performance tracking systems, and the quality cost matrix, influenced the performance of construction projects. Their research demonstrated a significant positive effect of PMIS on the quality, schedule, and cost aspects of project performance. However, this study, conducted in the context of India's distinct business environment, information and communication technology (ICT) infrastructure, and legal framework, is not directly applicable to Kenya's road construction sector. The differences in regulatory policies, technological readiness, and project management practices between the two countries present a significant limitation in applying the findings to the Kenyan context. Therefore, the existing literature on PMIS in road construction projects lacks comprehensive studies that address these contextual differences, highlighting the need for more research focused on Kenya's unique road construction environment.

In the United Arab Emirates, Al Khoori and Hamid (2022) explored the influence of project management information systems (PMIS) on project performance, particularly focusing on building projects. Their study found that aspects such as quality, information output, and user influence of PMIS significantly impacted project performance. While this study provided valuable insights into how PMIS can affect performance, it was conducted within the context of the UAE's building construction sector, which differs significantly from the road construction industry. The building sector involves different types of technical and logistical challenges compared to road construction projects, such as the scale of infrastructure, regulatory concerns, and environmental considerations. As such, the findings cannot be directly applied to road construction projects in Kenya, which

operate under different conditions in terms of project scope, technology adoption, and regulatory frameworks.

Similarly, in South Africa, Nyandongo and Lubisi (2021) assessed the use of PMIS and its impact on project outcomes, concluding that PMIS had a significant effect on project performance. Additionally, van Besouw (2021) conducted research in South Africa and Zimbabwe on smart PMIS for engineering projects, with findings indicating that PMIS plays a crucial role in improving performance. Despite their significance, both studies were conducted in South Africa, and their findings are limited by the specific project environments and challenges faced in those countries. The differences in project types, technological infrastructure, and socio-political contexts in Kenya mean that these findings cannot be generalized to the Kenyan road construction sector. There is a need for further research that focuses specifically on Kenya's road construction industry to understand how PMIS practices influence project performance in that unique context.

In Tanzania, Kilinga, Singh, and Ahmad (2024) examined the effect of project management information systems (PMIS) on project success within World Vision and found that PMIS played a positive role in enhancing project success. While the findings are valuable, it is important to note that this study was focused on projects within an international non-governmental organization (NGO) context, which often has different resource requirements, stakeholder management practices, and project goals compared to road construction projects in Kenya. NGOs typically prioritize community-focused initiatives with specific development objectives, such as health, education, and infrastructure, which may not align directly with the technical and logistical demands of large-scale road construction projects. This difference in project nature and scope limits the applicability of these findings to the road construction sector in Kenya.

Similarly, in Nairobi County, Sila and Gakobo (2021) explored the effect of PMIS on project performance in the construction industry, focusing on building projects. Their study found that PMIS utilization significantly contributed to improved project performance, specifically in adhering to time, budget, and quality specifications while

meeting project objectives. However, like the study in Tanzania, this research was confined to the building construction sector, which faces distinct challenges from road construction projects. Road projects typically involve different environmental, regulatory, and technical considerations, such as land acquisition, environmental impact assessments, and road safety measures, which are not as prevalent in building construction. As a result, the findings of Sila and Gakobo (2021) cannot be directly applied to road construction projects in Kenya, highlighting the need for further research that specifically addresses the unique characteristics and challenges of the road construction sector in the country.

Njeru and Kirui (2022) studied the relationship between project management information system (PMIS) user knowledge and the performance of construction projects in South Rift and found that user knowledge of PMIS significantly influenced project performance. While the study contributes valuable insights into how PMIS knowledge can affect project success, it is important to recognize that the context of South Rift differs significantly from road construction projects in Nairobi City County. Road construction projects often involve different logistical challenges, such as traffic management, land acquisition, and environmental impact assessments, which are less pronounced in typical construction projects. Moreover, Nairobi's urban setting presents unique demands on road infrastructure projects, such as high population density and complex stakeholder interests, which may not have been captured in the South Rift study. Therefore, while the findings of Njeru and Kirui (2022) are useful, they may not be fully applicable to the road construction projects in Nairobi City County.

In a similar vein, Kamau and Pedo (2021) examined the influence of PMIS on project performance within commercial banks in Nairobi, highlighting that the expertise of the project team, end-user involvement, project risk management, and monitoring and evaluation positively influenced the success of digitalization projects in Kenyan banks. However, this study was focused on the banking sector, which has fundamentally different objectives and challenges from the road construction industry. The nature of projects in commercial banks typically involves digital systems and financial services, while road construction projects are characterized by physical infrastructure development, land

management, and regulatory compliance. The skill sets, resources, and strategies needed to successfully manage these two types of projects are distinct. Therefore, while Kamau and Pedro's findings are valuable within the context of banking projects, they may not be directly applicable to road construction projects in Kenya, suggesting the need for research focused specifically on road construction contexts.

In addition, Simiyu and Kirinyet (2024) examined the influence of project management information systems (PMIS) on the performance of monitoring and evaluation systems in state-owned enterprises. Their study found that effective PMIS utilization enhanced project monitoring, improved data accuracy, and facilitated evidence-based decision-making. However, the study was confined to state-owned enterprises, which operate under structured governance and standardized reporting frameworks. Road construction projects, by contrast, often face more complex operational environments, regulatory requirements, and technical challenges, suggesting that the findings from state-owned enterprises may not be fully generalizable to the road construction sector in Kenya.

Further, Waithira and Muchelule (2024) investigated PMIS use in refugee humanitarian projects in Nairobi City County, highlighting improvements in coordination, resource tracking, and timely reporting of project outcomes. While the study demonstrates the benefits of PMIS in improving operational efficiency and stakeholder management, its focus on humanitarian projects limits its contextual applicability. Humanitarian projects typically have different objectives, timelines, and funding structures compared to road construction projects, which require long-term planning, technical design considerations, and adherence to road safety and environmental standards. This difference underscores the need for research that specifically addresses PMIS application in the road construction sector.

Moreover, Barang'a and Shale (2024) explored PMIS practices in World Bank-funded projects in Nairobi, demonstrating positive effects on project planning, execution, and overall performance. Despite these contributions, the study does not consider sector-specific challenges or the potential moderating role of monitoring and evaluation in PMIS

implementation. Road construction projects involve unique performance drivers, such as contractor coordination, resource allocation, and environmental compliance, which may interact with PMIS practices differently than in donor-funded or general projects. Consequently, there is a conceptual gap in understanding how PMIS can be optimized to enhance road construction project performance in Kenya.

2.6 Summary of the Literature Reviewed

The theoretical framework of this study is grounded in five key theories: the Resource-Based View (RBV), Innovation Diffusion Theory (IDT), Theory of Constraints (TOC), General System Theory (GST), and the Theory of Change (ToC). The RBV emphasizes leveraging unique organizational resources and capabilities to achieve a competitive advantage, particularly in resource management practices for road construction. Innovation Diffusion Theory explains the adoption of data integration practices based on perceived benefits, compatibility, and user-friendliness, highlighting how these practices improve decision-making and collaboration in construction projects. TOC focuses on identifying and addressing constraints that hinder project goals, emphasizing cost management and resource optimization to enhance performance. GST provides a holistic approach to project planning, emphasizing interconnectedness among stakeholders and elements in construction projects, fostering better coordination and communication for improved outcomes.

The Theory of Change serves as a moderating framework that connects project monitoring efforts with measurable performance improvements, offering a structured approach to understanding how interventions lead to desired outcomes. It emphasizes the importance of mapping intermediate outcomes, identifying key milestones, and refining strategies through continuous monitoring and evaluation. This framework provides a roadmap for linking inputs and activities to long-term goals while addressing potential barriers. By integrating the Theory of Change, the study underscores critical aspects such as efficient resource allocation, fostering stakeholder collaboration, encouraging innovation adoption, and promoting continuous assessment to drive impactful results. This comprehensive

theoretical perspective highlights the multifaceted approaches required to overcome challenges, optimize processes, and enhance the performance of road construction projects, ensuring timely and cost-effective delivery aligned with strategic objectives.

The conceptual framework provides a diagrammatic representation of the theoretical underpinnings of research, demonstrating relationships between variables. In this study, it illustrates how project management information system (PMIS) practices—such as resource management, data integration, cost management, and project planning—impact the performance of road construction projects in Kenya. Resource management practices involve efficiently allocating human, financial, and material resources to achieve project goals. Data integration practices focus on consolidating diverse data sources for improved decision-making and project outcomes. Cost management ensures financial control through budgeting and tracking, crucial for minimizing overruns in road projects. Project planning establishes a roadmap for project execution, enhancing stakeholder alignment and scope definition. In addition, effective project monitoring tracks progress and adjust strategies to maintain alignment with objectives, contributing to project success within constraints of time, cost, and scope.

The empirical literature shows that resource management practices such as project team expertise, technological capacity and financial capacity, influence the performance of projects. The empirical literature also showed that data integration practices like data acquisition, data storage and data analysis and sharing influence the performance of projects. Further, the empirical literature also shows that cost management practices including cost estimation, budgeting and cost control, influence the performance of projects. In addition, the empirical literature also indicates that project planning practices, such as identification of stakeholders, project objectives and project scope, influence the performance of projects. Moreover, the literature shows that project monitoring had an influence on influence the performance of projects, but none of the studies showed its moderating effect on the relationship between PMIS practices and performance of projects.

2.7 Research Gaps

Although numerous research studies have been conducted on project management information system (PMIS) practices and their influence on project performance, these studies are often limited to specific countries, regions, or organizational contexts. For instance, Gutierrez-Gutierrez and Antony (2020) explored PMIS success models in construction projects in China, while Al Khoori and Hamid (2022) examined the influence of PMIS on project performance in the United Arab Emirates. Similarly, Nyandongo and Lubisi (2021) assessed the impact of PMIS on project outcomes in South Africa, and Kilinga, Singh, and Ahmad (2024) investigated PMIS effects on project success within World Vision in Tanzania. These studies offer valuable insights but lack universal applicability due to variations in legal and institutional frameworks, levels of technological advancement, and socio-economic conditions across countries, making it difficult to generalize findings beyond the studied contexts.

In addition, while existing research highlights the relevance of PMIS in improving project outcomes, there is a notable gap in studies focusing on specific sectors or project types within underrepresented regions, such as Kenya. The unique challenges faced by road construction projects, including issues of resource allocation, cost management, and project planning, are rarely examined in-depth through the lens of PMIS practices. Furthermore, the dynamic nature of Kenya's infrastructure development landscape, shaped by rapid urbanization, evolving regulatory frameworks, and increasing integration of digital technologies, underscores the need for localized studies. By addressing these gaps, future research can provide context-specific insights into how PMIS practices can enhance project performance in road construction projects, ultimately contributing to more effective project management strategies tailored to Kenya's unique environment.

In Kenya, several studies have examined the influence of project management information systems (PMIS) on project performance across various sectors. For example, Sila and Gakobo (2021) studied PMIS in construction projects in Nairobi County, Njeru and Kirui (2022) investigated PMIS user knowledge in South Rift construction projects, and Kamau

and Pedo (2021) focused on PMIS in commercial banks. While these studies provide useful insights, they primarily address construction and banking sectors, neglecting the unique dynamics of road construction projects. Similarly, Simiyu and Kirinyet (2024) found that PMIS enhanced monitoring and evaluation in state-owned enterprises, but these findings may not generalize to road projects, which face complex operational, regulatory, and technical challenges. Waithira and Muchelule (2024) demonstrated PMIS benefits in refugee humanitarian projects, improving coordination and reporting, yet the differing objectives, timelines, and funding structures limit applicability to road construction. Additionally, Barang'a and Shale (2024) showed positive effects of PMIS on World Bank-funded projects, but their study overlooked sector-specific challenges and the moderating role of monitoring and evaluation in road projects. Consequently, there is a clear conceptual gap in understanding how specific PMIS practices, such as resource management, data integration, cost management, and project planning, can be optimized to enhance the performance of road construction projects in Kenya.

The gap in the existing literature lies in the lack of research on the application and impact of PMIS in road construction projects within Kenya, a sector with distinct challenges such as large-scale resource management, intricate project planning, and cost control mechanisms. To address this gap, the researcher aims to investigate the influence of PMIS practices—specifically resource management practices, data integration practices, cost management practices, and project planning practices—on the performance of Public Referral Hospitals in Kenya. This research will not only contribute to the body of knowledge on PMIS but also offer practical insights for improving the management and execution of road construction projects, as well as other large-scale infrastructure projects within the healthcare sector. The findings could inform policy and project management strategies to enhance efficiency, reduce costs, and improve project outcomes in Kenya's public infrastructure projects.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

Research methodology is the process of adhering to procedures, strategies as well as steps in collecting as well as analyzing collected data to answer specified research questions (Bell, 2022). The chapter mainly comprises of research design, study population, sampling frame, sample size as well as sampling method, data collection instruments, data collection process, reliability as well as validity, data collection procedure and data analysis as well as presentation.

3.2 Research Philosophy

Research philosophy refers to the foundational beliefs and assumptions that shape a researcher's approach to inquiry, influencing how they design studies, collect data, and interpret results (Bryman, 2022). It encompasses key elements such as epistemology, which explores the nature of knowledge; ontology, which examines the nature of reality; and ethics, which addresses the values that guide research practices. The four primary research philosophies, positivism, interpretivism, critical realism, and pragmatism, each offer distinct perspectives on how knowledge is constructed and understood (Creswell & Clark, 2021). Positivism asserts that knowledge is grounded in observable and measurable phenomena, favoring quantitative methods and objective analysis to derive generalizable conclusions. In contrast, interpretivism emphasizes the importance of understanding subjective human experiences and meanings, relying on qualitative methods to capture the rich contexts of social phenomena.

Critical realism serves as a middle ground, acknowledging that while reality exists independently, our understanding of it is influenced by social contexts and individual perceptions (Greene & Dreyer, 2021). Researchers using this approach seek to uncover underlying mechanisms and structures that shape observable outcomes, often integrating

both quantitative and qualitative data. Pragmatism, on the other hand, focuses on practical implications and the utility of research findings, allowing researchers the flexibility to utilize mixed methods tailored to specific research questions. Hair, Page and Brunsveld (2020) indicate that by adopting a pragmatic approach, researchers prioritize actionable insights over rigid adherence to any single methodological framework. Collectively, these research philosophies provide a framework for understanding how different epistemological and ontological assumptions influence research design and practice.

This study adopted a positivist research philosophy. Positivism research philosophy can be used to explain the existing relationship or realities between elements under investigation, and thus can be used to make predictions. In addition, positivism research approach is used to determine the realistic occurrence of events in a particular social construct through application of scientific approaches (Saunders, Lewis & Thornhill, 2023). According to Latwal (2020), the positivist research philosophy is a philosophical approach of identifying and recognizing items or elements in a particular social construct that have scientific proof and are based on logical as well as factual proof. Positivism tends to have a strong belief that development of research hypothesis based on theoretical aspects can be tested through observing social realities, and as such, positivism is a scientific technique (Hair, Page & Brunsveld, 2020). This philosophy was preferred over interpretivism or critical approaches because the study seeks objective measurement of relationships and generalizable findings rather than subjective interpretations. Additionally, positivism allows for the use of statistical tools to test hypotheses, which aligns with the quantitative nature of this research. Positivism research approach adopts a quantitative research approach and hence was used in this study to examine influence of project management information system practices on the performance of roads construction projects in Kenya.

3.3 Research Design

The study adopted both cross-sectional survey design and explanatory research design. The use of both cross-sectional survey design and explanatory research design allows for the collection of data at a single point in time to assess current PMIS practices, while also explaining the causal relationships between these practices and project performance. A cross-sectional survey design is a research approach that involves collecting data from a diverse group of individuals at a single point in time to assess a particular phenomenon or relationship (Hall,2020). In the context of a study examining the influence of project management information system (PMIS) practices on the performance of roads construction projects in Kenya, this design enables researchers to gather insights from various stakeholders, including project managers, engineers, and contractors, simultaneously. Capturing the current state of PMIS practices and their perceived impact on project performance, along with the moderating effect of project monitoring, allows for the identification of patterns and correlations within the data. This design proves particularly effective for establishing a snapshot of practices and outcomes in the construction industry, providing valuable information that can inform policy and improve project management strategies in Kenya's road construction sector.

An explanatory research design was used given that the research aims at determining the extent and nature of cause-and-effect relationship between the independent variables and the dependent variable. The goal of explanatory research is to discover connections as well as causal links between various variables. An explanatory study may also be conducted to investigate the impact of certain modifications on current norms and various processes (Mukherjee, 2020). The goal of explanatory design is to examine a specific scenario and explain the patterns of connection between variables. Explanatory research design was appropriate for a study as it seeks to establish causal relationships between variables. This design enables the investigation of how PMIS practices directly affect project performance while accounting for the moderating effect of project monitoring. By employing this approach, researchers can uncover underlying mechanisms and dynamics that contribute to project outcomes, providing a deeper understanding of the interaction

between PMIS and project performance. Additionally, explanatory research allows for the collection of both qualitative and quantitative data, enhancing the robustness of findings and supporting actionable recommendations for stakeholders in the construction sector.

Various studies on PMIS AND project performance have used both cross-sectional survey design and an explanatory research design. For instance, Simiyu and Kirinyet (2024) conducted a study on the relationship between PMIS and the performance of Monitoring and Evaluation (M&E) systems in state-owned enterprises in Kenya. They employed both a cross-sectional survey design and an explanatory research design to analyze how PMIS practices influence performance outcomes. Similarly, Waithira and Muchelule (2024) and Barang'a and Shale (2024) utilized both cross-sectional survey and explanatory designs to examine PMIS practices, enabling them to measure relationships between system usage and project performance while explaining the underlying causal mechanisms. This study used both cross-sectional survey design and explanatory research design to investigate the influence of project management information system practices on the performance of roads construction projects in Kenya.

3.4 Target Population

A population is a well-defined or set of people, services, elements, events, group of things or households that are being investigated (Waddell, 2020). The unit of analysis in this study was 68 road construction projects by KeNHA, 90 projects by KURA and 104 projects by KeRRA in Kenya for the financial year 2019/2020, 2020/2021 and 2021/2022 (Kenya Roads Board, 2023). The unit of observation was contractors, resident engineers, quantity surveyors as well as KURA officials and KeNHA officials working in the headquarters. Participants were selected based on their professional position, knowledge, and experience in road construction projects. This criterion ensured that only individuals with relevant expertise and direct involvement in project planning, implementation, and monitoring could provide informed insights on PMIS practices and their impact on project performance. The target population for the study consists of 262 contractors, 262 resident

engineers, 262 quantity surveyors, 54 KURA officials, 45 KeNHA officials, and 42 KeRRA officials working in the headquarters, totalling 927 individuals.

Table 3.1: Target Population

Category	Target Population
Contractors	262
Resident Engineers	262
Quantity Surveyors	262
KURA Officials in the headquarters	54
KeNHA Officials in the headquarters	45
KeRRA Officials in the headquarters	42
Total	927

Source: Kenya Roads Board (2023)

3.5 Sampling Frame

A sampling frame serves as a critical component in the research process, functioning as a comprehensive list of items or individuals that constitute the population from which a sample is drawn. This frame can encompass various entities, such as individuals, organizations, institutions, or households, depending on the nature of the study (Kothari, 2023). The importance of a well-defined sampling frame cannot be overstated, as it ensures that every member of the population is identifiable and has an equal chance of being selected for inclusion in the study. This equal opportunity for selection is essential to minimize bias and enhance the representativeness of the sample, thereby strengthening the validity of the research findings (Babbie, 2021). Additionally, a robust sampling frame aids in the efficient allocation of resources during the data collection process, as researchers can target their efforts more effectively when they have a clear understanding of the population. In sum, a sampling frame is foundational to achieving accurate and reliable research outcomes. The sampling frame of this study was 262 contractors, 262 resident engineers, 262 quantity surveyors, 54 KURA officials, 45 KeNHA officials, and 42 KeRRA officials working in the headquarters.

3.6 Sample Size and Sampling Technique

A sample size refers to the number of individuals included in a research study to represent a population. Sample size determination refers to the act of choosing the number of observations or replicates to include in a statistical sample (Creswell & Creswell, 2021).

3.6.1 Sample Size

Sample size refers to the number of participants or observations included in a study, which is crucial for ensuring the validity and reliability of research findings (Waddell, 2020). A well-determined sample size helps minimize sampling error, enhances the representativeness of the sample, and allows for more accurate generalizations about the population. Adequate sample size is essential for achieving statistical power, which increases the likelihood of detecting significant effects or relationships within the data. Punch (2020) indicates that the right sample size contributes to the overall credibility and robustness of the research outcomes. Slovin's formula was used in the determination of the sample size in this study. This formula was preferred because it puts into consideration the target population.

$$n = \frac{N}{1 + NE^2}$$

Where; n = Number of samples; N = Total population and e = Error tolerance (0.05)

$$n = \frac{927}{1 + (927 * 0.05^2)} = 279$$

Table 3.2: Sample Size

Category	Target Population	Sample Size
Contractors	262	79
Resident Engineers	262	79
Quantity Surveyors	262	79
KURA Officials in the headquarters	54	16
KeNHA Officials in the headquarters	45	14
KeRRA Officials in the headquarters	42	12
Total	927	279

3.6.2 Sampling Technique

The study made use of stratified random sampling in the selection of sample size from the target population. Stratified random sampling is a probability sampling that involves the categorization of the target population into strata, which are smaller groups. Stratification or categorization of data is normally done based on the shared characteristics or attributes of members of a population (Hall, 2020). The stratification of a sample size helps in ensuring that the sample size reflects the population being studied. The stratified random sampling technique was used in this study because it minimizes selection bias. The strata in this study were contractors, civil engineers and quantity surveyors. This sampling technique was used because it minimizes selection bias and the stratification of a sample size helps in ensuring that the sample size reflects the study population.

The study used proportionate stratification, where the sample size of each of the stratum is expected to be proportional to the population size of that specific stratum. The sample size in each stratum was therefore calculated using the formula below.

$$n_h = \frac{N_h}{N} * n$$

Where:

n_h is the sample size for stratum h ,

N_h is the population size for stratum h ,

N is total population size,

n is total sample size.

3.7 Data Collection Instruments

The study used both primary and secondary data. Secondary data is the data that has been already collected by and readily available from other sources (Hair, Page & Brunsveld, 2020). Such data is cheaper and more quickly obtainable than the primary data and also may be available when primary data cannot be obtained at all. Secondary data on timely completion of projects and completion within budget was obtained from the websites of Kenya Urban Roads Authority and Kenya National Highways Authority using a data extraction checklist.

Primary data is data collected from first-hand sources, using methods such as interviews, questionnaires, focused group discussions, and observations (Kothari, 2023). In this study, primary data was collected using a structured questionnaire comprising closed-ended questions. Structured questions are planned and created in advance, meaning all respondents are asked the same questions in the same order (Waddell, 2020). The independent variables, resource management practices, data integration practices, cost management practices, and project planning practices, were measured using a five-point Likert scale, where respondents indicated their level of agreement with statements related to each practice. The moderating variable, project monitoring, was also measured using a five-point Likert scale assessing how monitoring activities influence project execution. The dependent variable, performance of road construction projects, was measured using a five-point Likert scale capturing respondents' perceptions of project outcomes, including timeliness, budget adherence, and quality standards. Nominal scales were used to collect demographic information, such as respondents' professional role, experience, and affiliation (Hall, 2020). Questionnaires were chosen because they are easy to administer, cost-effective, and allow large amounts of information to be collected from a wide population (Creswell & Clark, 2021).

The questionnaire comprised of six sections. The first section collected data on the general information of the respondents. The second, third, fourth and fifth sections collected data on the independent variables which included resource management practices, data integration practices, cost management practices and project planning practices. The sixth section covered the section on the moderating variable, which is project monitoring. The seventh section covered questions on the dependent variable, which was performance of construction projects.

3.8 Pilot Test

A pilot study was conducted in an effort to identify and rephrase any ambiguous, misinterpreted or misunderstood questions. Pilot test was carried out so as to ensure the reliability and validity and reliability of the research instrument. The pilot test also facilitated the removal of typographical errors and determination of whether the questions asked are relevant and appropriate. The pilot study was conducted among road construction projects in Kiambu County due to its proximity and similarity in characteristics to those of Kenya. According to Kothari (2023), the sample size for a pilot study should be 10 percent of the sample size. The pilot group comprised of 10 percent of the sample size (28).

3.8.1 Validity of the Research Instruments

According to Kothari (2023), validity is the extent to which results acquired from the process of analysis of the data actually embodies the phenomenon under study. There are three types of validity: face validity, content validity, and construct validity. Face validity referred to the extent to which a research instrument appeared to measure what it was intended to measure, based on subjective judgment (Babbie, 2021). This type of validity assessed whether the items on a survey or questionnaire seemed relevant and appropriate for the study objectives at first glance. To enhance face validity, the researcher conducted a pilot test, which involved administering the instrument to a small group of respondents similar to the target population. Feedback from these respondents highlighted any unclear

or ambiguous questions, allowing the researcher to make necessary revisions. This iterative process ensured that the instrument was not only comprehensible but also aligned with the research focus. As a result, the improved face validity increased the likelihood that respondents understood the questions correctly, thereby yielding more accurate data that accurately reflected the constructs under investigation.

Content validity, on the other hand, assessed whether the research instrument comprehensively covered the construct it aimed to measure. This involved examining the relevance and representativeness of the items in relation to the entire content domain (Creswell & Clark, 2021). To enhance content validity, the researcher actively sought input from subject matter experts and supervisors, who provided valuable insights into the appropriateness and completeness of the questions. These experts reviewed the instrument to ensure that all relevant aspects of the research topic were adequately represented and that no significant content areas were overlooked. By developing research instruments that closely aligned with the study's objectives and incorporating expert feedback, the researchers were able to strengthen both face validity and content validity. This dual approach ultimately contributed to more reliable and valid research outcomes, enhancing the overall credibility of the study and ensuring that the findings could be effectively utilized for practical applications.

According to Hall (2020), construct validity assesses the accuracy with which a set of questions measures the presence of a particular construct. It is crucial for ensuring that the research instrument effectively captures the intended variables. In this study, confirmatory factor analysis (CFA) was employed to rigorously test the construct validity of the study variables. CFA evaluates how well a measure represents a specific construct and verifies whether the data supports the hypothesized relationships between the variables. For the items to demonstrate construct validity, they must explain a variance of 0.5 or higher towards the construct, indicating a strong association. Additionally, the Average Variance Extracted (AVE) for each construct should exceed 0.4, as this threshold signifies that the construct explains a substantial portion of the variance in the observed variables. By utilizing these statistical measures, the researcher aimed to ensure that the instrument not

only aligned with the theoretical framework but also provided reliable and valid results essential for the integrity of the study.

3.8.2 Reliability of the Research Instruments

Reliability refers to the extent to which a data collection instrument, such as a questionnaire, consistently yields the same results when administered multiple times under similar conditions. High reliability indicates that the instrument provides stable and consistent measurements, enhancing the credibility of the research findings (Bell, 2022). In the context of this study, ensuring the reliability of the data collection tool was essential, as it directly impacts the validity of the conclusions drawn from the data. The reliability of the data collection instrument was assessed through statistical measures that reflect how consistently the instrument performs, contributing to the overall robustness of the study's methodology.

To quantify the reliability of the instrument used in the study, the researcher employed Cronbach's alpha coefficient, a commonly used measure of internal consistency that assesses the degree to which items in a questionnaire are related as a group. Cronbach's alpha ranges from 0 to 1, with higher values indicating a greater level of reliability (Bryman, 2022). Specifically, Greene and Dreyer (2021) indicate that an alpha coefficient greater than 0.7 is deemed acceptable, signifying that the items are sufficiently correlated and measure the same underlying construct. Conversely, an alpha coefficient below 0.7 raises concerns about the reliability of the instrument. By conducting this analysis, the researcher aimed to validate that the questionnaire used in the study was both reliable and effective in capturing the constructs of interest, thereby ensuring the integrity of the research findings.

3.9 Data Collection Procedure

Before going to the field, a letter of data collection was obtained from the department of entrepreneurship, technology, leadership and management in Jomo Kenyatta University of Agriculture and Technology (JKUAT). Thereafter, a research permit was obtained from the National Commission for Science, Technology and Innovation (NACOSTI). This was followed by requesting for permission to collect data from the management of KeNHA, KURA and KeRRA. The study made use of drop -off and pick- up later method. The respondents were given two weeks after which the research instruments (questionnaires) were collected. The drop -off and pick -up later method was the most appropriate due to the low availability of the study's participants. The respondents were required to complete the questionnaire as honestly and as completely as possible. The respondents were assured that strict confidentiality was maintained in dealing with their identities.

3.10 Data Analysis and Presentation

The questionnaire generated both quantitative and qualitative data. Thematic analysis was used to analyze qualitative data from the open-ended questions. Thematic analysis is one of the most common forms of analysis in qualitative research. The goal of a thematic analysis is to identify themes and patterns in the data that are important or interesting, and use these themes to address the research or say something about an issue (Bryman, 2022). This is much more than simply summarizing the data; a good thematic analysis interprets and makes sense of it. It emphasizes pinpointing, examining, and recording patterns (or "themes") within data. Themes are patterns across data sets that are important to the description of a phenomenon and are associated with a specific research question. The themes become the categories for analysis (Waddell, 2020). The results from the qualitative data analysis were presented in a narrative form. In addition, qualitative results were used to improve the credibility of the quantitative results, and provide explanations for the findings of the quantitative analysis.

Descriptive and inferential statistics were used in analyzing quantitative data with the help of the Statistical Package for Social Sciences (SPSS version 28) statistical software. Descriptive statistics were used to analyze the preliminary information of the respondents, and in describing the responses of the respondents in relation to the indicators of the independent and dependent variables. In the analysis of nominal data (demographic information), the study used descriptive statistics such as frequencies and percentages, but in the analysis of ordinal data (Likert scale questions) the study used frequency distribution, percentages, mean, and standard deviation. The results were presented in tables and figures such as pie charts and bar charts.

Inferential statistics included Pearson correlation coefficient and multiple linear regression analysis. The study used a composite index for each variable in the inferential statistics. This is because the composite index is in continuous form as required in Pearson correlation and linear regression analysis. Multiple regression analysis is carried out on data with two or more explanatory variables. Linear regression analysis makes use of the ordinary least square method, particularly when the dependent variable is in numerical form (continuous). The multiple regression model was as follows:

3.10.1 Model Specification

The study adopted an Ordinary least squares (OLS) regression. As a statistical technique of analysis, OLS regression estimates the association between one or more independent study variables and dependent variable; the technique estimates the association by reducing the sum of squares in the variation between the predicted and observed values of dependent variable organized as a straight line (Bell, 2022). In this study, OLS regression was explained in bivariate model setting, that is, model where dependent study variable (Y) is predicted by a single independent study variable (X). The study employed a univariate regression model to examine the influence of each independent variable on the performance of road construction projects. Specifically, the independent variables included: resource management practices, data integration practices, cost management practices, and project planning practices. The univariate regression model was as follows;

$$Y = \beta_0 + \beta_1 X_1 + \varepsilon$$

Whereby;

Y = Performance of roads construction projects;

β_0 = Constant;

β_1 = Coefficients of determination;

X_1 = Independent Variable;

ε = Error term

Multivariate regression is a statistical technique used to examine the relationship between two or more independent variables and two or more dependent variables simultaneously (Bryman, 2022). It allows researchers to determine how multiple predictors collectively and individually influence multiple outcomes, while controlling for interrelationships among the variables. Since the independent variables in this study are four, the multivariate regression model was as follows;

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$$

Whereby;

Y = Performance of roads construction projects;

β_0 = Constant;

$\beta_1 - \beta_4$ = Coefficients of determination;

X_1 = Resource management practices;

X_2 = Data integration practise;

X_3 = Cost management practices;

X_4 = Project planning practices; and

ε = Error term

3.10.2 Moderation analysis

Stepwise regression analysis was used in the research to determine how project monitoring (z) moderates the relationship between the independent variables and the dependent variable. The statistical model that was utilized for the analysis was as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_z X + \beta_{1z} X_1 Z + \beta_{2z} X_2 Z + \beta_{3z} X_3 Z + \beta_{4z} X_4 Z + \varepsilon$$

Where:

Y = Performance of roads construction projects;

B₀ = Constant;

β₁- β₄ =Coefficients of determination;

X₁ = Resource management practices;

X₂ = Data integration practise;

X₃ = Cost management practices;

X₄ = Project planning practices; and

Z = Hypothesized moderator (project monitoring); β_z = Coefficient of X_i*Z the interaction term between project monitoring and each of the predictor variables for i=1, 2, 3, 4; and ε = Error term

3.10.3 Diagnostic Tests

Diagnostic tests were carried out to test the five key assumptions, which include linear relationship, multivariate normality, no or little multicollinearity, no auto-correlation, and homoscedasticity. Multicollinearity in regression is a condition that occurs when some predictor variables in the model are correlated with other predictor variables. One variable can be predicted from the other with some degree of accuracy (Bryman, 2022). In perfect multicollinearity, the predictor is singular and cannot be inverted. Multicollinearity was tested in this study using tolerance and the Variance Inflation Factor (VIF). Tolerance measures the influence of one independent variable on all other independent variables;

and is calculated with an initial linear regression analysis. A VIF of more than 10 indicates that there is multicollinearity in the data set.

Linear regression needs the relationship between the independent and dependent variables to be linear. It is also important to check for outliers since linear regression is sensitive to outlier effects (Bryman, 2022). The linearity assumption was tested with scatter plots. A scatter plot is drawn using residuals and y-values. Y-values are taken on the vertical y-axis, and standardized residuals are then plotted on the horizontal x-axis. If the scatter plot follows a linear pattern (not a curvilinear pattern), then the linearity assumption is met.

A linear regression analysis requires that there is little or no autocorrelation in the data. Autocorrelation occurs when the residuals are not independent from each other. In other words, when the value of $y(x+1)$ is not independent from the value of $y(x)$ (Bryman, 2022). While a scatterplot allows checking for autocorrelations, one can test the linear regression model for autocorrelation with the Durbin-Watson test. The Durbin-Watson's test statistic tests the null hypothesis that the residuals are not linearly auto-correlated. While d can assume values between 0 and 4, values around 2 indicate no autocorrelation. As a rule of thumb, values of $1.5 < d < 2.5$ show that there is no auto-correlation in the data. However, the Durbin-Watson test only analyzes linear autocorrelation and only between direct neighbors, which are first order effects.

In linear regression analysis, having data that shows heteroscedasticity can ruin the results (at the very least it will give biased coefficients) (Hall, 2020). The study used the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity. Heteroscedasticity exists if the variance of the error term varies across observations. According to the null hypothesis, a constant variance exists while the alternative hypothesis purports that heteroscedasticity does exist. The violation of homoscedasticity causes an increase as heteroscedasticity increases.

To fulfill the requirement of normal distribution, the Shapiro Wilk test was used to investigate whether the variables are normally distributed or not (Creswell & Clark, 2021). The null-hypothesis of this test is that the population is normally distributed; thus, if the

p-value is less than the chosen alpha level, then the null hypothesis is rejected and there is evidence that the data tested is not from a normally distributed population; in other words, the data is not normal.

3.11 Operationalization of Variables

The study seeks to examine the influence of project management information system practices on the performance of roads construction projects in Kenya and the moderating effect of project monitoring. Table 3.3 outlined general variables, specific variable types, variable indicators, measurement of variables and supporting literature.

Table 3.3: Operationalization of Research Study Variables

General Variable	Specific Variable Type	Variable Indicators	Measurement of the variables	Supporting Literature
Dependent Variable	Performance of Construction Projects	● Timely completion ● Completion within budget ● Project quality	Ordinal scale (Likert Scale)	Dixit (2020); Ingle and Mahesh (2022); Hijazi (2021)
Independent Variables	Resource Management Practices	● Project team expertise ● Technological capacity ● Financial capacity	Ordinal scale (Likert Scale)	Raja and Murali (2020); Okolocha et al. (2023); Ajao et al. (2024)
Independent Variables	Data Integration Practices	● Data acquisition ● Data storage ● Data analysis and sharing	Ordinal scale (Likert Scale)	Akselrod et al. (2022); Demirkesen and Bayhan (2020)
Independent Variables	Cost Management Practices	● Cost estimation ● Budgeting ● Cost control	Ordinal scale (Likert Scale)	Albtoush et al. (2020); Fazil et al. (2021)
Independent Variables	Project Planning Practices	● Identification of stakeholders ● Project objectives ● Project scope	Ordinal scale (Likert Scale)	Majumder et al. (2022); Wangai and Musembi (2023)
Moderating variable	Project Monitoring	● Identification of indicators ● Project progress reporting ● Utilization of results	Ordinal scale (Likert Scale)	Amin et al. (2023); Amin (2024)

3.12 Ethical Considerations

Approvals and research permits were obtained from Jomo Kenyatta University of Agriculture and Technology and the National Commission for Science, Technology and Innovation, and formal permissions were sought from the management of the Kenya National Highways Authority, Kenya Urban Roads Authority, and Kenya Rural Roads Authority to ensure compliance with institutional and national ethical requirements. Participation in the study was entirely voluntary, and respondents were informed of their right to withdraw from the study at any stage without any negative consequences. Informed consent was obtained from all participants before administering the questionnaires, ensuring that respondents understood the purpose of the study, the procedures involved, and how the data would be used. Confidentiality and anonymity of respondents were strictly maintained, with no personal identifiers linked to the data collected. The collected data was used solely for academic purposes, and findings were reported in aggregate form to prevent the disclosure of individual responses. Furthermore, respondents were assured that their answers would be treated with the highest level of privacy and that all ethical standards in data handling, storage, and reporting were fully observed throughout the research process.

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSIONS

4.1 Introduction

This section presents descriptive data analysis as per the objectives of the study. The general objective of the research was to investigate the influence of project management information system practices on the performance of road construction projects in Kenya. The section begins with questionnaire's response rate, followed by general information and descriptive analysis on resource management practices, data integration practices, cost management practices and project planning practices, project monitoring and performance of road construction projects in Kenya. The findings were presented in Figures and Tables.

4.2 Data Preparation and Screening

The first phase of analyzing the survey data involved examining response rates, response distribution, and the presence of missing values. This process was vital for determining the robustness and representativeness of the collected data. A high response rate, defined as the proportion of completed surveys relative to the total number distributed, was necessary to ensure that the findings could be accurately generalized to the larger population. Furthermore, analyzing the distribution of responses allowed for the identification of potential biases or trends within the data, which could affect the overall validity of the results. Addressing missing values—instances where participants did not answer specific questions—was also critical to avoid skewed outcomes and maintain the integrity of the analysis. This screening process played an essential role in confirming the quality and reliability of the survey findings, thereby supporting the credibility of the research.

4.2.1 Questionnaires' Response Rate

A high response rate is often indicative of the reliability and generalizability of the study's findings, as it suggests that a substantial portion of the target population participated, thereby reducing potential bias and enhancing the representativeness of the data collected (Hair et al., 2020). The study targeted a total of 279 respondents, comprising 79 contractors, 79 resident engineers, 79 quantity surveyors, 16 KURA officials, 14 KeNHA officials, and 12 KeRRA officials. Table 4.1 shows the response rate by category of respondents.

Table 4.1: Questionnaires' Response Rate

Category	Sample Size	Returned	Unusable	Usable	Response Rate (%)
Contractors	79	72	2	70	88.61
Resident Engineers	79	73	1	72	91.14
Quantity Surveyors	79	72	1	71	89.87
KURA Officials (HQ)	16	15	1	14	87.50
KeNHA Officials (HQ)	14	12	0	12	85.71
KeRRA Officials (HQ)	12	11	0	11	91.67
Total	279	255	5	250	89.61

Source: Research Data (2024)

From the table, out of the 279 questionnaires distributed, 255 were returned, reflecting an overall return rate of 91.40%. Among these, 5 questionnaires (1.79%) were deemed unusable due to incomplete responses or failure to meet the study's criteria, resulting in 250 usable responses (89.61%). The response rates varied slightly across respondent categories: Resident Engineers and KeRRA officials had the highest usable response rates at 91.14% and 91.67%, respectively, while KeNHA officials recorded the lowest at 85.71%. Contractors, Quantity Surveyors, and KURA officials had usable response rates ranging between 87.50% and 89.87%. According to Babbie (2021), a response rate above 70% is considered excellent for survey research. Therefore, the overall response rate of

89.61% in this study is very high, indicating strong participation and providing a reliable and representative dataset for subsequent analysis and conclusions.

4.2.2 Missing Values

In surveys, questionnaires, and other data collection methods, missing values can occur for various reasons, such as non-response to specific questions, data entry errors, or participants choosing not to answer certain items (Bryman, 2022). The data underwent screening for potential issues related to missing data, following the guidelines outlined by Babbie (2021). Upon receiving each completed questionnaire, they were sequentially numbered to track and verify completion. Questionnaires that were found to be incomplete or had substantial missing data were excluded from the analysis. The presence of missing values can significantly impact the analysis and interpretation of data. They can lead to biased results, reduced statistical power, and complications in data modeling if not appropriately handled. Properly addressing missing values is crucial for ensuring the integrity and validity of the research findings, allowing for more accurate conclusions and interpretations.

4.3 Reliability Results

Reliability is to the degree to which a data gathering tool, such as a questionnaire, consistently produces data or findings over time. If a measure continuously produces same outcome, it is considered to be highly reliable (Hall, 2020). The Cronbach's alpha coefficient, which runs from 0 to 1, will be used to assess reliability of data, which is a measure of average correlation and internal consistency between assertions assessing a construct. Internal consistency, which is, how closely connected a group of things are, is measured by Cronbach's alpha. It is regarded as a scale of dependability indicator (Bell, 2022). Higher values of alpha coefficient indicate that the items used to measure the idea of interest are consistent. Cronbach's alpha (α) values which are more than 0.7 are regarded as acceptable. The results were as presented in Table 4.2.

Table 4.2: Reliability Results

Variables	Indicators	Cronbach's Alpha	No. of Items
Resource Management Practices	Project team expertise	0.824	3
	Technological capacity	0.801	3
	Financial capacity	0.745	3
	Average	0.790	9
Data Integration Practices	Data acquisition	0.845	3
	Data storage	0.820	3
	Knowledge Management	0.876	3
	Average	0.847	9
Cost Management Practices	Cost estimation	0.710	3
	Budgeting	0.858	3
	Cost control	0.749	3
	Average	0.772	9
Project Planning Practices	Scope development	0.759	3
	Work breakdown structures	0.795	3
	Schedule development	0.756	3
	Average	0.770	9
Project Monitoring	Identification of indicators	0.970	3
	Project progress reporting	0.911	3
	Utilization of results	0.829	3
	Average	0.903	9
Performance of Road Construction Projects	Timely Completion	0.854	4
	Completion within Budget	0.888	4
	Project quality	0.722	4
	Average	0.821	12

Source: Pilot Data (2024)

From the results, as shown in Table 4.4, the resource management practices had a Cronbach's alpha coefficient of 0.790, data integration practices had a Cronbach's alpha coefficient of 0.847, the cost management practices had a Cronbach's alpha coefficient of 0.772, project planning practices had a Cronbach's alpha coefficient of 0.770, project monitoring had a Cronbach's alpha coefficient of 0.903, and performance of road construction projects had a Cronbach's alpha coefficient of 0.821. This implies that resource management practices, data integration practices, cost management practices, project planning practices, project monitoring and performance of road construction projects were reliable.

4.4 General Information

The general information of the respondents comprised of highest level of education, duration their organizations had been operating and the duration of time they had been working in their organizations.

4.4.1 Highest Level of Education

The respondents were asked to indicate their highest level of education. The results were as shown in Figure 4.1.

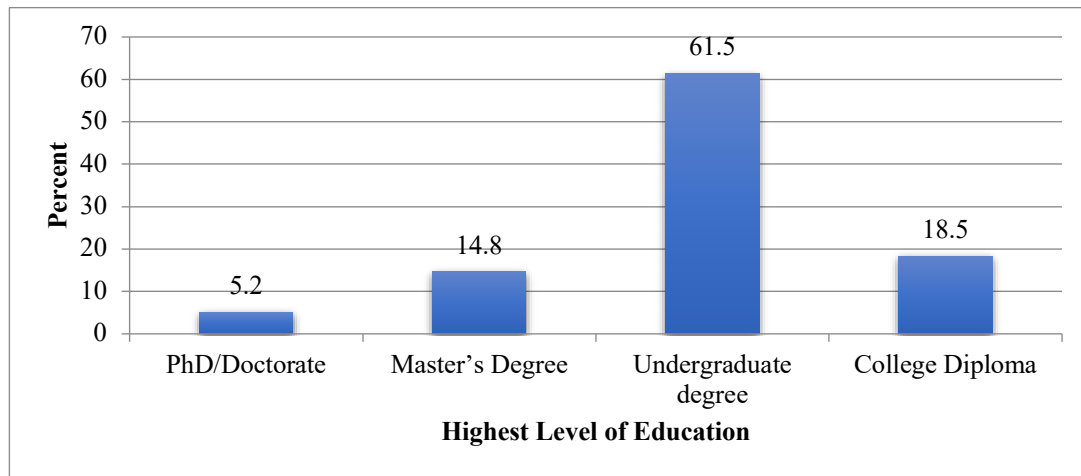


Figure 4.1: Highest Level of Education

Source: Research Data (2024)

From the results, the majority of respondents held an undergraduate degree (61.5%), followed by college diplomas (18.5%), master's degrees (14.8%), and PhD/doctorate qualifications (5.2%). Education level was assessed in this study to determine whether respondents possessed the necessary knowledge and skills to effectively understand and utilize Project Management Information System (PMIS) practices, which are critical for planning, monitoring, and evaluating road construction projects. The findings indicate that over 80% of respondents have at least a college diploma, suggesting that most personnel in the Kenyan road construction industry are relatively well-educated. This level of

education is likely to enhance their ability to adopt and implement PMIS practices efficiently, thereby supporting improved project monitoring, reporting, and overall performance. Comparatively, Waithira (2023) found that higher education levels among project personnel positively influence the adoption of digital project management tools, reinforcing the conclusion that education facilitates better comprehension and use of information systems in construction projects.

4.4.2 Duration the Organizations have been Operational

The respondents were asked to indicate the duration of time their organizations had been operational. The results were as shown in Figure 4.2.

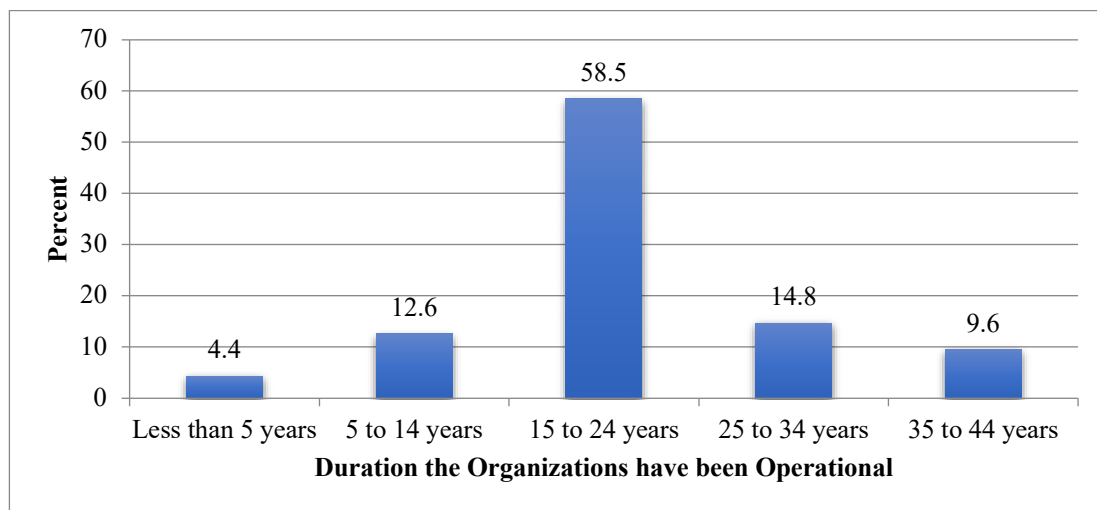


Figure 4.2: Duration the Organizations have been Operational

Source: Research Data (2024)

From the results, 58.5% of the respondents indicated that their organizations had been in operation for 15 to 24 years, 14.8% reported between 25 and 34 years, 12.6% indicated 5 to 14 years, 9.6% reported 35 to 44 years, and 4.4% had been in operation for less than 5 years. Information on the length of organizational operation was collected to assess the experience and stability of organizations in implementing Project Management Information System (PMIS) practices, which are critical for planning, monitoring, and

evaluating road construction projects. The findings suggest that a majority of organizations have been in operation for 15 to 24 years. Organizations with longer operational histories are likely to have established systems, procedures, and institutional knowledge that support structured project management, consistent data collection, and informed decision-making. Conversely, organizations operating for less than 5 years may face challenges in PMIS adoption due to limited experience, weaker institutional frameworks, or lack of familiarity with structured project management systems. Comparing these results with prior studies, Simiyu and Kirinyet (2024) found that organizations with longer operational histories tend to adopt digital management tools more efficiently, as they have more robust processes and personnel capable of handling technology-based project management systems.

4.4.3 Duration of Working in the Organization

The respondents were requested to indicate the duration of time they had been working in the organization. The results were as shown in Figure 4.3.

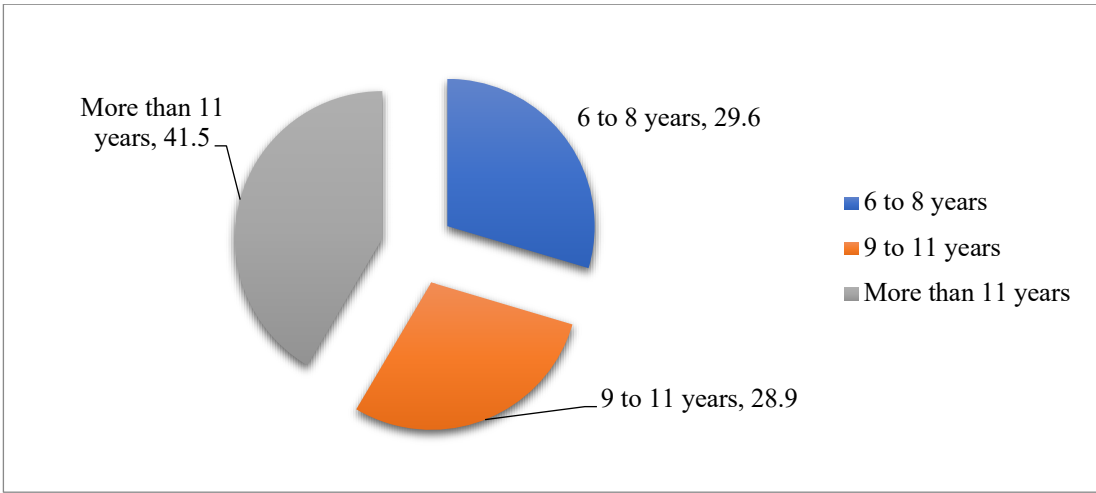


Figure 4.3: Duration of Working in the Organization

Source: Research Data (2024)

From the results, 41.5% of respondents had been working in their organizations for more than 11 years, while 29.6% had been employed for 6 to 8 years, and 28.9% for 9 to 11 years. Data on employee tenure was collected to assess the level of organizational experience and stability within the workforce, which is critical for the effective adoption and utilization of Project Management Information System (PMIS) practices in road construction projects. The high proportion of employees with more than 11 years of experience suggests low workforce turnover, implying that most personnel have accumulated significant organizational knowledge and familiarity with project management processes. Such experienced employees are more likely to understand, adopt, and effectively implement PMIS practices, thereby contributing to improved monitoring, evaluation, and overall project performance. Comparatively, studies by Waithira (2023) and Mugo and Kihoro (2022) indicate that longer employee tenure enhances the successful adoption of digital management systems because experienced staff can navigate complex processes, ensure data accuracy, and support continuity in project management practices. Conversely, lower tenure employees may require additional training to effectively use PMIS tools.

4.5 Descriptive Statistics

This section covers descriptive statistics on resource management practices, data integration practices, cost management practices, project planning practices and the performance of road construction projects in Kenya. In addition, the section covers the moderating role of project monitoring on the relationship between project management information system practices and performance of road construction projects in Kenya. Closed ended questions and items that were rated on a 5-point Likert scale yielded quantitative results, where 1 denotes strongly disagree, 2 denotes disagree, 3 denotes moderately agree, 4 denotes agree and 5 denotes strongly agree. Mean scores were categorized into ranges to interpret respondents' overall agreement, with 1.00–1.49 as Strongly Disagree, 1.50–2.49 as Disagree, 2.50–3.49 as Neutral, 3.50–4.49 as Agree, and 4.50–5.00 as Strongly Agree. According to Smith (2020), a standard deviation that is

below 0.8 is considered low, 0.8 to 1.2 is considered moderate and above 1.2 is considered high standard deviation.

4.5.1 Resource Management Practices

The respondents were asked to indicate their level of agreement with various statements on resource management practices in road construction projects. The results were as presented in Table 4.3.

Table 4.3: Resource Management Practices

	1(%)	2(%)	3(%)	4(%)	5(%)	Mean	Std. Deviation
The project team members were skilled in their respective roles and responsibilities	0.0	20.0	20.7	44.4	14.8	3.540	.975
The project team has the necessary knowledge and skills to deliver the project successfully.	0.0	0.0	28.1	43.0	28.9	4.007	.758
The project team members effectively applied their expertise to overcome any challenges.	0.0	27.4	0.0	35.6	37.0	3.822	1.102
The project team utilizes technology to enhance collaboration and communication	0.0	0.0	21.5	56.3	22.2	4.007	.663
The project team had the necessary technological expertise to execute the project successfully	0.0	0.0	6.7	71.1	22.2	4.155	.516
The project team demonstrated deep understanding for the technological requirements of the project	0.0	0.0	20.7	57.0	22.2	4.014	.657
Road projects are adequately funded to achieve its objectives	31.1	39.3	8.1	17.8	3.7	2.237	1.179
The project's financial management was transparent and accountable	36.3	33.3	3.0	23.0	4.4	2.259	1.186
The project team effectively managed financial resources to achieve its objectives	40.0	28.1	2.2	23.7	5.9	2.274	1.157

Source: Research Data (2024)

From the results, Table 4.3, the respondents agreed with a mean of 4.155 (Std. Deviation = 0.516) that the project team had the necessary technological expertise to execute the project successfully. They also agreed with a mean of 4.014 (Std. Deviation = 0.657) that the project team demonstrated a deep understanding of the technological requirements of the project. In addition, the respondents agreed with a mean of 4.007 (Std. Deviation = 0.663) that the project team utilizes technology to enhance collaboration and communication. These findings agree with Raja and Murali (2020) findings that firms have been adopting technology to improve communication between project team members. Further, the respondents agreed with a mean of 4.007 (Std. Deviation = 0.758) that the project team has the necessary knowledge and skills to deliver the project successfully. This suggests a relatively high level of agreement among respondents regarding the team's overall competency to successfully execute the project.

Moreover, the respondents agreed with a mean of 3.822 (Std. Deviation = 1.102) that the project team members effectively applied their expertise to overcome any challenges. The respondents also agreed with a mean of 3.540 (Std. Deviation = 0.975) that the project team members were skilled in their respective roles and responsibilities. These findings concur with Okolocha, Anugwu and Ukoh (2023) observation that project team members are trained to ensure that they have necessary skills in their duties. However, the respondents disagreed with a mean of 2.274 (Std. Deviation = 1.157) that the project team effectively managed financial resources to achieve its objectives. They also disagreed with a mean of 2.237 (Std. Deviation = 1.179) that road projects are adequately funded to achieve its objectives. These findings concur with Ajao, Ajayi and Ojo (2024) findings that road projects most of the times experience inadequate funding. Further, the respondents disagreed with a mean of 2.259 (Std. Deviation = 1.186) that the project's financial management was transparent and accountable. The standard deviations for all the statements ranged from 0.516 to 1.186, which indicates concurrence around the means.

The respondents were requested to indicate any other issues regarding resource management practices in road construction projects. From the findings, they indicated that efficient allocation of resources, including labor, equipment, and materials, is critical.

Ensuring that the right resources are available at the right time and in the right quantities can prevent delays, reduce costs, and enhance project performance. In addition, the respondents indicated that sustainable resource management is increasingly important in road construction. This includes using environmentally friendly materials, minimizing waste, and incorporating eco-friendly construction practices. Sustainable road construction not only reduces the environmental impact but can also lead to cost savings over the long term.

The respondents indicated that embracing technological advancements and innovative construction methods can improve resource management. For example, the use of Building Information Modeling (BIM), advanced construction equipment, and data analytics can enhance project efficiency, reduce resource consumption, and improve project outcomes. Also, the respondents indicated that ensuring the quality of construction materials and workmanship is integral to resource management. Substandard materials or work can lead to the need for rework, increased resource consumption, and project delays. Effective quality control practices can save resources in the long run.

4.5.2 Data Integration Practices

The respondents were asked to indicate their level of agreement with various statements on data integration practices in road construction projects. The results were as presented in Table 4.4.

Table 4.4: Data Integration Practices

	1(%)	2(%)	3(%)	4(%)	5(%)	Mean	Std. Deviation
Our project team effectively identified the data requirements for the project	0.0	0.0	20.7	34.8	44.4	4.2370	.774
The use of PMIS successfully helps in collecting and recording accurate data	0.0	0.0	14.1	34.1	51.9	4.377	.721
Our projects use appropriate techniques to ensure data quality	0.0	0.0	27.4	50.4	22.2	3.948	.705
Our project team effectively managed data storage throughout the project	0.0	0.0	27.4	28.1	44.4	4.170	.833
Our project team utilizes appropriate technologies and systems for data storage	0.0	0.0	20.7	64.4	14.8	3.940	.595
Our projects utilize appropriate backup and recovery strategies to protect stored data.	0.0	0.0	27.4	57.8	14.8	3.874	.639
Road projects have a culture that encourages knowledge sharing and collaboration.	42.2	16.3	11.9	23.7	5.9	2.348	1.183
Our organization has a dedicated team responsible for managing knowledge management initiatives.	0.0	0.0	20.7	42.2	37.0	4.163	.745
Knowledge management practices in our organization are effective in capturing and sharing valuable knowledge	0.0	0.0	28.1	49.6	22.2	3.940	.709

Source: Research Data (2024)

From the results, the respondents agreed with a mean of 4.377 (Std. Deviation = 0.721) that the use of Project Management Information System (PMIS) successfully helps in collecting and recording accurate data. They also agreed with a mean of 4.237 (Std. Deviation = 0.774) that their project teams effectively identified the data requirements for the project. These findings concur with Akselrod, Shpakov and Shpakova (2022) findings that effective data integration practices require a structured approach that involves

identifying data sources, defining data requirements and establishing data standards. They further agreed with a mean of 4.170 (Std. Deviation = 0.833) that their project teams effectively managed data storage throughout the project.

In addition, the respondents agreed with a mean of 4.163 (Std. Deviation = 0.745) that their organizations had a dedicated team responsible for managing knowledge management initiatives. Further, the respondents agreed with a mean of 3.948 (Std. Deviation = 0.705) that their projects use appropriate techniques to ensure data quality. These findings concur with Demirkesen and Bayhan (2020) findings that data integration enables project teams to access and analyse data from various sources to inform decision-making and improve project outcomes. In addition, the respondents agreed with a mean of 3.940 (Std. Deviation = 0.709) that knowledge management practices in our organization are effective in capturing and sharing valuable knowledge.

Moreover, the respondents agreed with a mean of 3.940 (Std. Deviation = 0.595) that their project teams utilize appropriate technologies and systems for data storage. These findings are in line with Okwori, Viklander and Hedström (2024) findings that data storage practices in project management require a structured approach that involves using a centralized data storage system. The respondents agreed with a mean of 3.874 (Std. Deviation = 0.639) that their projects utilize appropriate backup and recovery strategies to protect stored data. However, with a mean of 2.348 (Std. Deviation = 1.183) the respondents disagreed with the statement indicating that road projects have a culture that encourages knowledge sharing and collaboration. The standard deviations for all the statements ranged from 0.595 to 1.183, which indicates concurrence around the means.

The respondents were requested to indicate other issues regarding data integration practices in road construction projects. The respondents indicated that ensuring that data from various sources and stakeholders adhere to consistent standards is crucial. In road construction, data may come from diverse systems, equipment, and software. Standardization helps facilitate data integration and interoperability. The respondents also indicated that the ability to collect and integrate real-time data is becoming increasingly

important. Technologies like IoT (Internet of Things) sensors and telematics provide real-time information on equipment performance, construction progress, and environmental conditions. Integrating real-time data enables more agile decision-making and better project management.

Further, the respondents indicated that Geographic Information Systems (GIS) play a vital role in road construction projects. Integrating GIS data allows for spatial analysis, site selection, route planning, and environmental impact assessments. Seamless integration of GIS data with project management systems can enhance project efficiency. The respondents further indicated that many construction projects are leveraging cloud-based solutions for data integration. Cloud platforms provide scalable, flexible, and accessible environments for storing, processing, and sharing project data, promoting collaboration among project stakeholders.

4.5.3 Cost Management Practices

The respondents were asked to indicate their level of agreement with various statements on cost management practices in road construction projects. The results were as presented in Table 4.5.

Table 4.5: Cost Management Practices

	1(%)	2(%)	3(%)	4(%)	5(%)	Mean	Std. Deviation
Our project team utilizes appropriate methods and tools for cost estimation.	0.0	5.2	15.6	40.0	39.3	4.133	.862
Our project team ensures that cost estimates were aligned with project objectives	0.0	3.0	20.7	49.6	26.7	4.000	.772
Our project team utilizes cost estimates to inform decision-making throughout the project.	0.0	7.4	26.7	28.9	37.0	3.955	.968
Our project team utilizes the project budget to inform decision-making throughout the project.	0.0	0.0	26.7	43.7	29.6	4.029	.752
Our project team effectively monitor and track project expenditures against the budget.	40.7	25.9	3.7	20.0	9.6	2.318	1.122
The project team makes adjustments to the project budget as needed to ensure project success.	0.0	12.6	20.7	44.4	22.2	3.763	.940
Road projects make use of cost control	0.0	17.0	26.7	41.5	14.8	3.540	.944
Our project team effectively communicates cost control measures to stakeholders.	2.2	6.7	15.6	48.9	26.7	3.911	.942
Cost control involves monitoring and managing project expenditures	0.0	7.4	8.1	43.0	41.5	4.185	.874

Source: Research Data (2024)

From the results as shown in Table 4.5, the respondents agreed with a mean of 4.185 (Std. Deviation = 0.874) that cost control involves monitoring and managing project expenditures. They also agreed with a mean of 4.133 (Std. Deviation = 0.862) that their project teams utilize appropriate methods and tools for cost estimation. The respondents further agreed with a mean of 4.029 (Std. Deviation = 0.752) that their project teams utilize the project budget to inform decision-making throughout the project. The respondents

agreed with a mean of 4.000 (Std. Deviation = 0.772) that their project teams ensure that cost estimates were aligned with project objectives. These findings agree with Egboga and Hauwa (2022) findings that budgeting is a critical aspect of road projects as they require significant investment, and cost overruns can be detrimental to the project's success. In addition, the respondents agreed with a mean of 3.955 (Std. Deviation = 0.968) that our project team utilizes cost estimates to inform decision-making throughout the project.

Further, the respondents agreed with a mean of 3.911 (Std. Deviation = 0.942) that their project teams effectively communicate cost control measures to stakeholders. These findings agree with van Besouw (2021) findings that by monitoring costs and taking corrective actions when necessary, project teams can ensure that the project stays within budget and is completed on time. Also, the respondents agreed with a mean of 3.763 (Std. Deviation = 0.940) that the project team makes adjustments to the project budget as needed to ensure project success. Moreover, the respondents agreed with a mean of 3.540 (Std. Deviation = 0.944) that road projects make use of cost control. These findings are in concurrence with Nwankwo (2023) findings that effective cost control is essential to the success of a project. However, the respondents disagreed with a mean of 2.318 (Std. Deviation = 1.122) with the statement indicating that their project team effectively monitors and tracks project expenditures against the budget. The standard deviations for all the statements ranged from 0.752 to 1.122, which indicates concurrence around the means.

The respondents were asked to indicate other issues regarding cost management practices in road construction projects. From the findings, the respondents indicated that one of the major challenges in road construction projects is often inaccurate initial cost estimations. This can result from incomplete project scope definition, insufficient data, or overly optimistic assumptions. It's crucial to develop realistic and comprehensive cost estimates at the project's outset to avoid budget overruns later. They also indicated that changes to project scope, design, or specifications during construction can lead to additional costs. Properly managing change orders and assessing their impact on the budget is essential.

Effective change order management helps control costs and ensures that all changes are properly documented.

The respondents also indicated that regular monitoring and reporting of project costs are essential. Without accurate and timely information on project expenditures, it becomes challenging to identify and address cost overruns in a timely manner. Implementing a robust cost tracking and reporting system is vital. Also, the respondents indicated that efficient resource allocation is crucial for managing costs. This includes optimizing labor, equipment, and materials usage to avoid wastage and reduce expenses. Proper scheduling and resource planning are key to achieving this. Further, having a contingency budget in place for unexpected events and issues is a prudent cost management practice. A well-planned contingency can help cover unforeseen costs without affecting the project's overall budget.

4.5.4 Project Planning Practices

The respondents were asked to indicate their level of agreement with various statements on project planning practices in road construction projects. The results were as presented in Table 4.6.

Table 4.6: Project Planning Practices

	1(%)	2(%)	3(%)	4(%)	5(%)	Mean	Std. Deviation
The project scope is flexible enough to accommodate changes as the project progressed.	5.2	0.0	32.6	37.8	24.4	3.763	.994
The project team has a clear understanding of the project scope and objectives.	7.4	13.3	28.1	36.3	14.8	3.377	1.118
Changes to the project scope were well-documented and managed effectively	0.0	6.7	34.1	29.6	29.6	3.822	.937
The use of a work breakdown structure helped to define the project's scope clearly.	7.4	13.3	28.1	36.3	14.8	3.377	1.118
The work breakdown structure provided an effective framework for tracking progress.	7.4	13.3	27.4	29.6	22.2	3.459	1.189
The work breakdown structure enabled the project team to identify dependencies and ensure timely completion of tasks.	0.0	13.3	27.4	29.6	29.6	3.755	1.025
The project schedule is communicated clearly to all team members.	7.4	20.0	20.7	29.6	22.2	3.392	1.140
The project schedule is aligned with the project objectives and milestones	14.8	20.0	20.7	22.2	22.2	3.1704	1.174
The project schedule is effectively used to monitor progress and identify potential issues.	13.3	6.7	20.7	29.6	29.6	3.555	1.136

Source: Research Data (2024)

The respondents agreed with a mean of 3.822 (Std. Deviation = 0.937) that changes to the project scope were well-documented and managed effectively. The respondents also agreed with a mean of 3.763 (Std. Deviation = 0.994) that the project scope is flexible enough to accommodate changes as the project progressed. These findings agree with Mwanza, Namusonge and Makokha (2020) findings that the project scope should be reviewed regularly throughout the project to ensure that the project team is staying on

track and that any necessary adjustments are made in a timely manner. They further agreed with a mean of 3.755 (Std. Deviation = 1.025) that the work breakdown structure enabled the project team to identify dependencies and ensure timely completion of tasks. These findings are in line with Nyandongo and Lubisi (2021) argument that work breakdown structure enabled the project team to identify dependencies. The respondents agreed with a mean of 3.555 (Std. Deviation = 1.136) that the project schedule is effectively used to monitor progress and identify potential issues.

With a mean of 3.459 (Std. Deviation = 1.189), the respondents were neutral with the statement indicating that the work breakdown structure provided an effective framework for tracking progress. With a mean of 3.392 (Std. Deviation = 1.140), the respondents were neutral with the statement indicating that the project schedule is communicated clearly to all team members. Moreover, the respondents were neutral with the statement indicating that the project teams have a clear understanding of the project scope and objectives as shown by a mean of 3.377 (Std. Deviation = 1.118). In addition, the respondents were neutral with the statement indicating that the use of a work breakdown structure helped to define the project's scope clearly as shown by a mean of 3.377 (Std. Deviation = 1.118). With a mean of 3.1704 (Std. Deviation = 1.174) the respondents were neutral with the statement indicating that the project schedule is aligned with the project objectives and milestones. The standard deviations for all the statements ranged from 0.994 to 1.189, which indicates concurrence around the means.

The respondents were asked to indicate other issues regarding project planning practices in road construction projects. From the findings, they indicated that conducting a thorough environmental impact assessment (EIA) is a crucial part of project planning. Road constructions have significant environmental consequences, such as habitat disruption and water pollution. Identifying and mitigating these impacts, as well as ensuring compliance with environmental regulations, should be integrated into the planning process. The respondents also indicated that involving local communities and relevant stakeholders from the planning stage is important. Identifying and addressing their concerns and needs, as well as seeking their input on project design and implementation, can help build support

and minimize conflicts throughout the project's life cycle. The respondents further indicated that compliance with permits and regulatory requirements is a critical aspect of project planning. This includes securing necessary permits for construction, land use, and environmental protection, and ensuring that the project adheres to all relevant laws and regulations.

4.5.5 Project Monitoring

The respondents were asked to indicate their level of agreement with various statements on project monitoring in road construction projects. The results were as presented in Table 4.7.

Table 4.7: Project Monitoring

	1(%)	2(%)	3(%)	4(%)	5(%)	Mean	Std. Deviation
Indicators of project monitoring are specific and measurable	0.0	0.0	34.1	51.1	14.8	3.807	.674
Indicators provide information on the progress or success of a project.	0.0	0.0	27.4	50.4	22.2	3.948	.705
Our project team effectively identifies relevant indicators to measure project progress.	0.0	0.0	27.4	50.4	22.2	3.948	.705
The use of technology helps in generating project progress reports	0.0	0.0	20.0	72.6	7.4	3.874	.510
Our project team effectively communicates any issues or challenges related to project progress	22.2	45.2	8.9	19.3	4.4	2.385	1.158
Stakeholders are given opportunities to provide feedback on project progress reports.	0.0	0.0	20.0	57.8	22.2	4.022	.651
Our project team utilizes project results to inform decision-making	0.0	7.4	20.0	35.6	37.0	4.022	.934
Our project team ensures that project results were aligned with project objectives and goals.	7.4	7.4	13.3	34.8	37.0	3.866	1.108

	1(%)	2(%)	3(%)	4(%)	5(%)	Mean	Std. Deviation
Our project team ensures that project results were communicated to stakeholders in a clear and understandable manner.	7.4	22.2	20.0	28.1	22.2	3.355	1.154

Source: Research Data (2024)

The respondents agreed with a mean of 4.022 (Std. Deviation = 0.651) that stakeholders are given opportunities to provide feedback on project progress reports. These findings concur with Tuyishime and Nyambane (2021) findings that engaging stakeholders in project management are essential to ensure the project's success and to minimize risks and issues during the project lifecycle. The respondents also agreed with a mean of 4.022 (Std. Deviation = 0.934) that their project teams utilize project results to inform decision-making. In addition, the respondents agreed with a mean of 3.948 (Std. Deviation = 0.705) that their project teams effectively identify relevant indicators to measure project progress. Further, the respondents agreed with a mean of 3.948 (Std. Deviation = 0.705) that indicators provide information on the progress or success of a project. The findings agree with Majumder et al. (2022) findings that indicators generated play a key role in showing the progress or success of a project.

With a mean of 3.874 (Std. Deviation = 0.510) the respondents agreed that the use of technology helps in generating project progress reports. The respondents further agreed with a mean of 3.807 (Std. Deviation = 0.674) that indicators of project monitoring are specific and measurable. The respondents also agreed with a mean of 3.866 (Std. Deviation = 1.208) that their project teams ensure that project results were aligned with project objectives and goals. These findings concur with Wangai and Musembi (2023) findings that project teams ensure that project results were aligned with project objectives and goals. With a mean of 3.355 (Std. Deviation = 1.254) the respondents were neutral on the statement indicating that project teams ensure that project results were communicated to stakeholders in a clear and understandable manner. However, respondents disagreed with a mean of 2.385 (Std. Deviation = 1.158) that their project teams effectively

communicate any issues or challenges related to project progress. The standard deviations for all the statements ranged from 0.510 to 1.158, which indicates concurrence around the means.

The respondents were asked to indicate other issues regarding project monitoring in road construction projects. From the findings, the respondents indicated that while respondents generally agreed that indicators of project monitoring are specific and measurable, it would be beneficial to delve deeper into the specific indicators being used. The respondents also indicated that a disagreement among respondents regarding the effective communication of issues or challenges related to project progress. This raises questions about the communication channels in place and whether there are barriers to transparently sharing challenges. Exploring the reasons behind this perception could provide valuable insights into communication dynamics within the project team.

In addition, while stakeholders are given opportunities to provide feedback on project progress reports, the level of satisfaction with this engagement could be explored further. Understanding the nature of stakeholder feedback, the responsiveness of the project team to feedback, and any challenges in incorporating stakeholder input into decision-making would provide a more comprehensive view. While respondents generally indicated satisfaction among beneficiaries and financiers, exploring the specific aspects that contribute to or detract from satisfaction could provide actionable insights. For example, understanding the criteria used by beneficiaries and financiers to assess satisfaction and any identified areas for improvement could guide future project planning.

4.5.6 Performance of Road Construction Projects

The respondents were asked to indicate their level of agreement with various statements on performance of road construction projects in Kenya. The results were as presented in Table 4.8.

Table 4.8: Performance of Road Construction Projects

	1(%)	2(%)	3(%)	4(%)	5(%)	Mean	Std. Deviation
Projects in our organization are completed within schedule	37.8	28.1	8.9	6.7	18.5	2.400	1.102
Some projects in our organization take longer period to be completed than required	7.4	20.0	20.7	29.6	22.2	3.392	1.140
Some projects in our organization take shorter period to be completed	5.2	5.2	19.3	22.2	48.1	4.029	1.165
I am satisfied with the time taken to complete projects	13.3	6.7	20.7	29.6	29.6	3.5556	1.136
Projects in our organization are completed within the set budget	0.0	7.4	26.7	51.1	14.8	3.733	.802
Some projects incur cost overrun	0.0	2.2	22.2	34.8	40.7	4.140	.839
Some projects in our organization have been left incomplete due to insufficient budget	0.0	14.1	27.4	36.3	22.2	3.666	.977
Our organization has put proper strategies to ensure projects are completed within the set budget	0.0	14.8	26.7	51.1	7.4	3.511	.836
The beneficiaries are satisfied with the road projects	0.0	0.0	34.1	43.7	22.2	3.881	.743
The financiers are satisfied with the quality of the roads projects	0.0	6.7	48.9	29.6	14.8	3.525	.827
The project was completed to a high standard of quality	0.0	0.0	20.7	57.0	22.2	4.014	.657
The project met all of the specified requirements and objectives	0.0	42.2	28.1	7.4	22.2	2.192	.873

Source: Research Data (2024)

The respondents agreed with a mean of 4.140 (Std. Deviation = 0.839) that some projects in their organization incur cost overrun. In addition, the respondents agreed with a mean of 4.029 (Std. Deviation = 1.165) that some projects in their organization take a shorter period to be completed. Further, the respondents agreed with a mean of 4.014 (Std. Deviation = 0.657) that the project was completed to a high standard of quality. Also, the respondents agreed with a mean of 3.881 (Std. Deviation = 0.743) that the beneficiaries

are satisfied with the road projects. The respondents disagreed with a mean of 2.192 (Std. Deviation = 0.873) that the project met all of the specified requirements and objectives. These findings agree with Kisavi (2020) observation that most of the projects do not meet their set objectives. The respondents also agreed with a mean of 3.733 (Std. Deviation = 0.802) that projects in their organization are completed within the set budget. The respondents agreed with a mean of 3.666 (Std. Deviation = 0.977) that some projects in their organization have been left incomplete due to insufficient budget.

Further, the respondents agreed with a mean of 3.5556 (Std. Deviation = 1.136) that they are satisfied with the time taken to complete projects. In addition, the respondents agreed with a mean of 3.525 (Std. Deviation = 0.827) that the financiers are satisfied with the quality of the road projects. Also, the respondents agreed with a mean of 3.511 (Std. Deviation = 0.836) that their organization has put proper strategies to ensure projects are completed within the set budget. However, with a mean of 3.392 (Std. Deviation = 1.140) the respondents were neutral with the statement indicating that some projects in their organization take a longer period to be completed than required. The respondents disagreed with a mean of 2.400 (Std. Deviation = 1.102) with the statement indicating that projects in their organization are completed within the schedule. These findings agree with Ochieng and Ochieng (2021) findings that cost overruns and delays were common in road construction projects in Kenya, with an average cost overrun of 45% and an average delay of 21 months. The standard deviations for all the statements ranged from 0.743 to 1.165, which indicates concurrence around the means.

The secondary data for the road projects was obtained from the annual reports of KURA, KeNHA, and KeRRA. Table 4.9 presents the estimated budgets, completion budgets, cost overruns, estimated timeframes, completion times, and time overruns for projects implemented by each organization.

Table 4.9: Time Overrun and Cost Overrun on Road Construction Projects

Organization	KURA	KeNHA	KeRRA
Average Estimated Budget (KES)	45,000,000	500,000,000	14,000,000
Average Completion Budget (KES)	63,750,000	725,000,000	18,900,000
Average Cost Overrun (%)	41.67	45	35
Average Estimated Time (Months)	36	48	24
Average Completion Time (Months)	52	70	34
Average Time Overrun (%)	44.44	45.83	41.67

Source: Research Data (2024)

As indicated in Table 4.9, the results show that that road projects under the three organizations experienced significant cost and time overruns. On average, KURA projects, with an estimated budget of KES 45 million, had a completion budget of KES 63.75 million, reflecting a cost overrun of 41.67%. The projects were initially planned to take 36 months but were completed in 52 months, resulting in a time overrun of 44.44%. Similarly, KeNHA projects, which have larger budgets averaging KES 500 million, recorded a cost overrun of 45% and a time overrun of 45.83%, indicating that even well-funded projects are prone to budget and schedule deviations. KeRRA projects, with smaller budgets averaging KES 14 million, showed a slightly lower cost overrun of 35% but still experienced a time overrun of 41.67%, highlighting challenges in project execution across all organizations regardless of project size. These findings imply that cost and time management remain major challenges in road construction projects in Kenya. The overruns suggest potential issues such as delays in funding, resource constraints, technical challenges, and project management inefficiencies. Additionally, the data indicates that larger-budget projects (KeNHA) tend to have higher absolute overruns, which could have a greater impact on the overall road infrastructure program. Overall, the results underscore the need for improved planning, monitoring, and control mechanisms to ensure that projects are delivered within budget and on schedule.

4.6 Factor Analysis

To evaluate construct validity, the research items were analyzed using principal components extraction along with varimax rotation. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was employed to assess the strength of the observed correlation coefficients compared to the partial correlation coefficients. It is important to note that KMO values below 0.5 indicate that factor analysis cannot be performed effectively. The factor loadings for various aspects, including resource management practices, data integration practices, cost management practices, project planning practices, project monitoring, and the performance of road construction projects, are detailed below:

4.6.1 Resource Management Practices

Table 4.10 presents the results of the factor analysis conducted to evaluate resource management practices within the context of road construction projects. This analysis aims to determine the underlying factors that contribute to effective resource management by examining various indicators related to team skills, technological expertise, and financial management practices.

Table 4.10: Factor Analysis for Resource Management Practices

	Component 1
The project team members were skilled in their respective roles and responsibilities	.975
The project team has the necessary knowledge and skills to deliver the project successfully.	.958
The project team members effectively applied their expertise to overcome any challenges.	.965
The project team utilizes technology to enhance collaboration and communication	.963
The project team had the necessary technological expertise to execute the project successfully	.976
The project team demonstrated deep understanding for the technological requirements of the project	.957
Road projects are adequately funded to achieve its objectives	.979
The project's financial management was transparent and accountable	.986
The project team effectively managed financial resources to achieve its objectives	.958
Rotation Sums of Squared Loadings	
Total	8.629
% of Variance	95.87%
Cumulative %	95.87%
KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.926
Bartlett's Test of Sphericity	Approx. Chi-Square
	df
	Sig.
	511.647
	36
	.000
Extraction Method: Principal Component Analysis.	
a. 1 components extracted.	

Source: Research Data (2024)

The results from Table 4.10 indicate a strong correlation among the items related to resource management practices, with factor loadings ranging from .975 to .986. These high values suggest that the project team members possess the necessary skills and expertise essential for project success. Notably, the indicator regarding financial management, with a loading of .986, highlights the critical role of transparency and accountability in managing resources effectively. The Kaiser-Meyer-Olkin (KMO) value

of .926 demonstrates an excellent level of sampling adequacy, suggesting that the data collected is suitable for factor analysis. Additionally, Bartlett's Test of Sphericity yielded a significant result ($p < .001$), confirming that the correlations among the variables are sufficient to justify the factor analysis. The extraction of a single component that accounts for 95.87% of the variance indicates that these resource management practices collectively influence project performance, emphasizing the importance of skilled team members, effective use of technology, and sound financial practices in achieving project objectives.

4.6.2 Data Integration Practices

Table 4.11 displays the results of the factor analysis conducted to assess data integration practices in road construction projects. This analysis focuses on the indicators related to data requirements, management systems, and knowledge-sharing culture, aiming to identify the underlying factors that contribute to effective data integration within project teams.

Table 4.11: Factor Analysis for Data Integration Practices

	Component 1
Our project team effectively identified the data requirements for the project	.974
The use of PMIS successfully helps in collecting and recording accurate data	.921
Our projects use appropriate techniques to ensure data quality	.955
Our project team effectively managed data storage throughout the project	.933
Our project team utilizes appropriate technologies and systems for data storage	.956
Our projects utilize appropriate backup and recovery strategies to protect stored data.	.939
Road projects have a culture that encourages knowledge sharing and collaboration.	.983
Our organization has a dedicated team responsible for managing knowledge management initiatives.	.945
Knowledge management practices in our organization are effective in capturing and sharing valuable knowledge	.928
Rotation Sums of Squared Loadings	
Total	8.599
% of Variance	95.55%
Cumulative %	95.55%
KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.912
Bartlett's Test of Sphericity	Approx. Chi-Square 473.182
	df 36
	Sig. .000
Extraction Method: Principal Component Analysis.	
a. 1 components extracted.	

Source: Research Data (2024)

The results presented in Table 4.11 indicate a high level of correlation among the various indicators associated with data integration practices, with factor loadings ranging from .921 to .983. The indicator with the highest loading, related to fostering a culture of knowledge sharing and collaboration, suggests that organizational support for such practices is critical for project success. The loading of .974 for the item concerning the identification of data requirements further underscores the importance of accurately

determining what data is needed for effective project management. The KMO value of .912 signifies a high degree of sampling adequacy, which supports the validity of conducting factor analysis on this data. Moreover, Bartlett's Test of Sphericity yielded a significant result ($p < .001$), indicating that the correlations among the variables are strong enough to justify the factor analysis. The extraction of a single component that explains 95.55% of the variance highlights the centrality of effective data integration practices in enhancing project performance, showcasing the importance of technological systems and knowledge management initiatives in supporting successful project outcomes.

4.6.3 Cost Management Practices

Table 4.12 presents the findings from the factor analysis conducted on cost management practices within road construction projects. This analysis aims to identify the key components that influence effective cost management, focusing on various indicators such as cost estimation methods, budget alignment, and cost control measures.

Table 4.12: Factor Analysis for Cost Management Practices

	Component 1
Our project team utilizes appropriate methods and tools for cost estimation.	.962
Our project team ensures that cost estimates were aligned with project objectives	.972
Our project team utilizes cost estimates to inform decision-making throughout the project.	.968
Our project team utilizes the project budget to inform decision-making throughout the project.	.952
Our project team effectively monitor and track project expenditures against the budget.	.922
The project team makes adjustments to the project budget as needed to ensure project success.	.940
Road projects make use of cost control	.944
Our project team effectively communicates cost control measures to stakeholders.	.942
Cost control involves monitoring and managing project expenditures	.974
Rotation Sums of Squared Loadings	
Total	8.811
% of Variance	97.92%
Cumulative %	97.92%
KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.895
Bartlett's Test of Sphericity	Approx. Chi-Square
	df
	Sig.

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Source: Research Data (2024)

The factor analysis results reveal strong correlations among the assessed indicators of cost management practices, with factor loadings ranging from .922 to .974. The highest loading, .974, corresponds to the item indicating that cost control involves actively monitoring and managing project expenditures, emphasizing its critical role in successful project management. Additionally, the project team's ability to ensure that cost estimates align with project objectives (.972) highlights the importance of integrating cost considerations into overall project planning and execution. The KMO value of .895

indicates good sampling adequacy, supporting the appropriateness of the factor analysis. Bartlett's Test of Sphericity yielded a significant result ($p < .001$), confirming that the variables are sufficiently correlated to warrant factor analysis. The extraction of a single component that accounts for 97.92% of the variance demonstrates the central importance of cohesive cost management practices in achieving project objectives, thereby underscoring the necessity for systematic approaches to cost estimation, tracking, and control within road construction projects.

4.6.4 Project Planning Practices

Table 4.13 displays the results of the factor analysis conducted on project planning practices within road construction projects. This analysis aims to elucidate the key elements that contribute to effective project planning, focusing on various indicators such as scope flexibility, work breakdown structure, and project scheduling.

Table 4.13: Factor Analysis for Project Planning Practices

	Component 1
The project scope is flexible enough to accommodate changes as the project progressed.	.994
The project team has a clear understanding of the project scope and objectives.	.918
Changes to the project scope were well-documented and managed effectively	.937
The use of a work breakdown structure helped to define the project's scope clearly.	.918
The work breakdown structure provided an effective framework for tracking progress.	.989
The work breakdown structure enabled the project team to identify dependencies and ensure timely completion of tasks.	.925
The project schedule is communicated clearly to all team members.	.914
The project schedule is aligned with the project objectives and milestones	.974
The project schedule is effectively used to monitor progress and identify potential issues.	.936
Rotation Sums of Squared Loadings	
Total	8.752
% of Variance	97.25%
Cumulative %	97.25%
KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.889
Bartlett's Test of Sphericity	Approx. Chi-Square
	df
	Sig.
	543.672
	36
	.000
Extraction Method: Principal Component Analysis.	
a. 1 components extracted.	

Source: Research Data (2024)

The factor analysis results indicate a strong correlation among the examined indicators of project planning practices, with factor loadings ranging from .914 to .994. The item with the highest loading, .994, pertains to the flexibility of the project scope to accommodate changes, highlighting the essential adaptability required in project management. Furthermore, the significant loading of .974 for the alignment of the project schedule with objectives and milestones underscores the importance of having a clear and structured

planning framework. The KMO value of .889 signifies good sampling adequacy, which supports the validity of conducting factor analysis. Bartlett's Test of Sphericity yielded a significant result ($p < .001$), indicating that the variables are adequately correlated for analysis. The extraction of a single component accounting for 97.25% of the variance emphasizes the vital role of cohesive project planning practices in enhancing project execution and success, demonstrating that clear documentation, effective communication, and adaptability are critical for addressing challenges during the project lifecycle.

4.6.5 Project Monitoring

Table 4.14 presents the findings from the factor analysis conducted on project monitoring practices within the context of road construction projects. This analysis aims to identify the key indicators that influence effective project monitoring, encompassing aspects such as the specificity of indicators, the role of technology, and stakeholder communication.

Table 4.14: Factor Analysis for Project Monitoring

	Component 1
Indicators of project monitoring are specific and measurable	.974
Indicators provide information on the progress or success of a project.	.925
Our project team effectively identifies relevant indicators to measure project progress.	.975
The use of technology helps in generating project progress reports	.951
Our project team effectively communicates any issues or challenges related to project progress	.958
Stakeholders are given opportunities to provide feedback on project progress reports.	.951
Our project team utilizes project results to inform decision-making	.934
Our project team ensures that project results were aligned with project objectives and goals.	.938
Our project team ensures that project results were communicated to stakeholders in a clear and understandable manner.	.954
Rotation Sums of Squared Loadings	
Total	8.739
% of Variance	97.22%
Cumulative %	97.22%
KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.892
Bartlett's Test of Sphericity	Approx. Chi-Square
	df
	Sig.
	520.845
	36
	.000
Extraction Method: Principal Component Analysis.	
a. 1 components extracted.	

Source: Research Data (2024)

The factor analysis results reveal a strong correlation among the indicators of project monitoring, with factor loadings ranging from .925 to .975. The highest loading, .975, corresponds to the project team's ability to effectively identify relevant indicators for measuring progress, underscoring the importance of precise and targeted monitoring in project management. Additionally, the item indicating that project monitoring indicators are specific and measurable received a loading of .974, further emphasizing the need for clear metrics in evaluating project success.

The KMO value of .892 indicates good sampling adequacy, which supports the reliability of the factor analysis. Bartlett's Test of Sphericity produced a significant result ($p < .001$), confirming that the variables are correlated and suitable for analysis. The extraction of a single component accounting for 97.22% of the variance highlights the cohesive nature of effective project monitoring practices. This suggests that well-defined indicators, timely communication of challenges, stakeholder engagement, and the use of technology for reporting are all critical factors that enhance decision-making and contribute to the overall success of road construction projects. The findings underscore the importance of integrating these practices to ensure that project results align with established objectives and goals.

4.6.6 Performance of Road Construction Projects in Kenya

Table 4.15 displays the results from the factor analysis performed on the performance of road construction projects, focusing on key indicators that assess project outcomes in terms of scheduling, budgeting, and quality standards.

Table 4.15: Factor Analysis for Performance of Road Construction Projects

	Component 1
Projects in our organization are completed within schedule	.922
Some projects in our organization take longer period to be completed than required	.940
Some projects in our organization take shorter period to be completed	.965
I am satisfied with the time taken to complete projects	.936
Projects in our organization are completed within the set budget	.922
Some projects incur cost overrun	.939
Some projects in our organization have been left incomplete due to insufficient budget	.977
Our organization has put proper strategies to ensure projects are completed within the set budget	.936
The beneficiaries are satisfied with the road projects	.943
The financiers are satisfied with the quality of the roads projects	.927
The project was completed to a high standard of quality	.957
The project met all of the specified requirements and objectives	.973
Rotation Sums of Squared Loadings	
Total	10.463
% of Variance	95.93%
Cumulative %	95.93%
KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.871
Bartlett's Test of Sphericity	Approx. Chi-Square
	df
	Sig.

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Source: Research Data (2024)

The factor analysis for the performance of road construction projects demonstrates a high level of correlation among the various performance indicators, with factor loadings ranging from .922 to .977. The highest loading of .977 relates to the item indicating that some projects have been left incomplete due to insufficient budget, highlighting the critical impact of financial constraints on project completion. Additionally, the items concerning satisfaction with project timelines and budgets show strong loadings of .936 and .922, respectively, indicating that both time and budget adherence are significant factors influencing overall project satisfaction.

The KMO value of .871 indicates good sampling adequacy, affirming the suitability of the data for factor analysis. Bartlett's Test of Sphericity produced a significant result ($p < .001$), confirming the correlation among the variables. The extraction of a single component that accounts for 95.93% of the variance suggests that these performance indicators collectively measure a cohesive construct of project performance. Overall, the findings underscore the importance of completing projects on schedule and within budget while maintaining high-quality standards. The satisfaction of beneficiaries and financiers with project outcomes reflects the effectiveness of management strategies employed. These insights can guide organizations in refining their project management practices to enhance the performance of road construction projects, ensuring they meet both financial and quality expectations.

4.7 Diagnostic Tests

Diagnostic tests in the context of regression assumptions refer to statistical techniques used to assess the validity of key assumptions underlying regression analysis. These tests aim to evaluate whether the data meets the necessary criteria for valid inference and interpretation. By conducting diagnostic tests, a researcher can identify potential violations of these assumptions, which may lead to biased parameter estimates and inaccurate inferences.

4.7.1 Heteroskedasticity Test

Heteroscedasticity Test, such as the Breusch-Pagan test, is a diagnostic test used in regression analysis to assess whether the variance of the residuals (errors) in a regression model is constant across all levels of the independent variables. The presence of heteroscedasticity violates the assumption of homoscedasticity, which assumes that the variance of the residuals is consistent. The null hypothesis for the Breusch-Pagan test is that there is homoscedasticity in the residuals, meaning that the variance of the errors is constant across all levels of the independent variables. The results were as presented in Table 4.16.

Table 4.16: Breusch-Pagan test for Heteroscedasticity

Ho: Constant variance	
Variables: Fitted with values of Performance of Road Construction Projects	
Chi2 (1)	0.871
Prob>chi2	0.350

Source: Research Data (2024)

The results of the Breusch-Pagan test for Heteroscedasticity indicate that the test statistic (Chi2) is 0.871 with 1 degree of freedom. The p-value associated with this test statistic is 0.350. With a p-value of 0.350, which is greater than the typical significance level of 0.05, we fail to reject the null hypothesis (Ho) that there is constant variance in the residuals. This suggests that there is no significant evidence of heteroscedasticity in the regression model. Therefore, the assumption of constant variance of the errors across all levels of the independent variable (performance of road construction projects) holds, indicating that the model meets the homoscedasticity assumption.

4.7.2 Test for Normality

A normality test, such as the Shapiro-Wilk test, is a statistical method used to assess whether a given sample of data follows a normal distribution. It evaluates the null hypothesis that the data are drawn from a population with a normal distribution. Many statistical techniques, including regression analysis, assume that the data are normally distributed, and violations of this assumption can lead to incorrect conclusions. The null hypothesis for the Shapiro-Wilk test is that the data are drawn from a population with a normal distribution. The results were as shown in Table 4.17.

Table 4.17: Test for Normality of Data

	Shapiro-Wilk		
	Statistic	df	Sig.
Resource Management Practices	.990	250	.186
Data Integration Practices	.976	250	.084
Cost Management Practices	.978	250	.098
Project Planning Practices	.984	250	.131
Performance of Road Construction Projects	.988	250	.155
Project Monitoring	.980	250	.107

a. Lilliefors Significance Correction

Source: Research Data (2024)

In this study, for resource management practices, data integration practices, cost management practices, project planning practices, performance of road construction projects, and project monitoring, the p-values are 0.186, 0.084, 0.098, 0.131, 0.155, and 0.107, respectively. Since all p-values are greater than the typical significance level of 0.05, there is insufficient evidence to reject the null hypothesis of normality for any of the variables. This suggests that the data for each variable are normally distributed, supporting the assumption required for many statistical analyses.

4.7.3 Autocorrelation Test

Autocorrelation Test, often assessed using the Durbin-Watson statistic, is a diagnostic tool used to detect the presence of autocorrelation in regression analysis residuals. Autocorrelation violates the assumption of independence of residuals in regression analysis, leading to biased coefficient estimates and inflated standard errors. Detecting autocorrelation is crucial for ensuring the reliability of regression results and making accurate inferences. The rule of thumb for the Durbin-Watson statistic is typically considered to be between 1.5 and 2.5. If the Durbin-Watson statistic falls within this range, it suggests that there is no significant autocorrelation present in the residuals. The results were as shown in Table 4.18.

Table 4.18: Autocorrelation Test

Model	Durbin-Watson
1	1.669

Source: Research Data (2024)

As shown in Table 4.18, the results of the autocorrelation test, indicated by the Durbin-Watson statistic, show a value of 1.669 for the model. The Durbin-Watson statistic falls below the ideal range of 1.5 to 2.5, suggesting a potential presence of positive autocorrelation in the residuals.

4.7.4 Multicollinearity Test

Multicollinearity Test is a diagnostic tool used to assess the extent of multicollinearity among independent variables in a regression model. Multicollinearity occurs when two or more independent variables in the regression model are highly correlated with each other, leading to inflated standard errors, unstable coefficient estimates, and difficulties in interpreting the effects of individual predictors. A commonly used rule of thumb is that VIF values should ideally be less than 10. VIF values greater than 10 indicate a problematic level of multicollinearity, although the severity of multicollinearity can vary depending on the context of the analysis and the specific research objectives. Values significantly exceeding 10 may require corrective actions to mitigate the effects of multicollinearity and improve the reliability of the regression model. The results were as presented in Table 4.19.

Table 4.19: Collinearity Statistics

	Tolerance	VIF
Resource Management Practices	.441	2.270
Data Integration Practices	.377	2.650
Cost Management Practices	.456	2.192
Project Planning Practices	.509	1.965

a. Dependent Variable: Performance of Road Construction Projects

Source: Research Data (2024)

As shown in Table 4.19, the VIF for resource management practices was 2.270, the VIF for data integration practices was 2.650, the VIF for cost management practices was 2.192, and the VIF for project planning practices is 1.965. Therefore, there is no evidence of problematic multicollinearity in the regression model. The VIF values for all independent variables are below the threshold of 10, indicating that the regression coefficients are likely to be reliable and the model can be interpreted with confidence.

4.7.5 Linearity Test

One of the assumptions in regression analysis is that the predictor (independent) variables and response (dependent) variable relationships are linear. A linear relationship tends to exist when the values of the independent variable (X) and the values of the dependent variable (Y) are apparently in a straight line when plotted on a graph. The line could be either in a negative or positive slope.

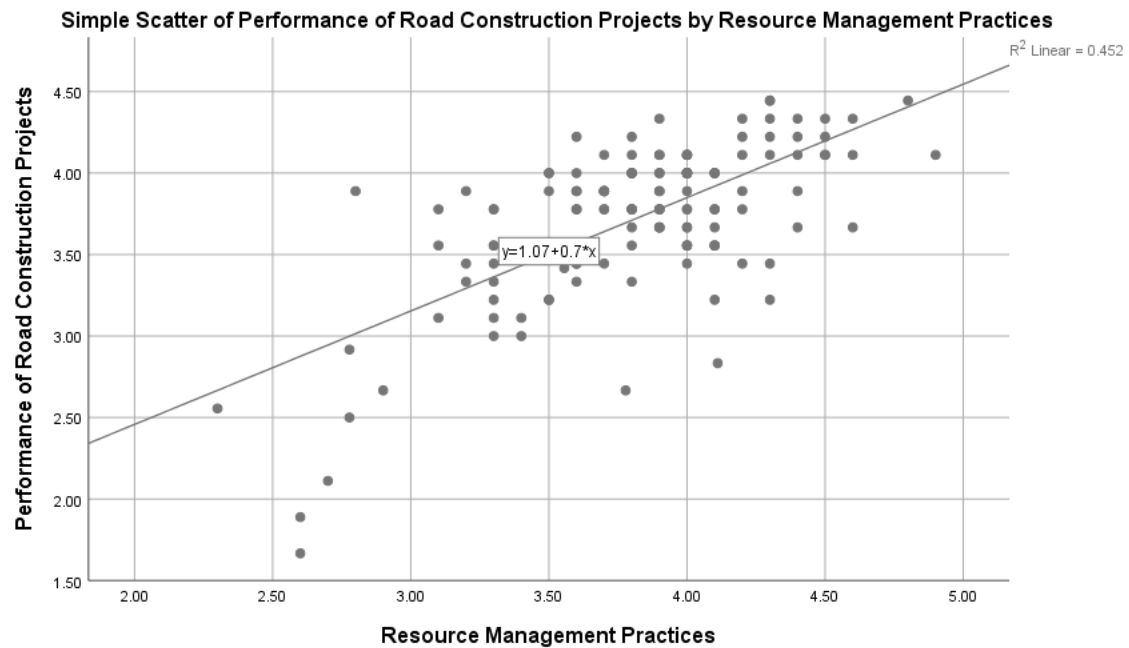


Figure 4.4: Scatterplot for the Records Management Practices and Performance of Road Construction Projects

Source: Research Data (2024)

As illustrated in Figure 4.4, the records management practices has a positive linear relationship with performance of road construction projects in Kenya. The findings imply that an improvement in the records management practices would lead to an improvement in the performance of road construction projects in Kenya. The results further indicate that the records management practices could explain 45.2% of the performance of road construction projects in Kenya. This means that having a records management practices is positively associated with performance of road construction projects in Kenya.

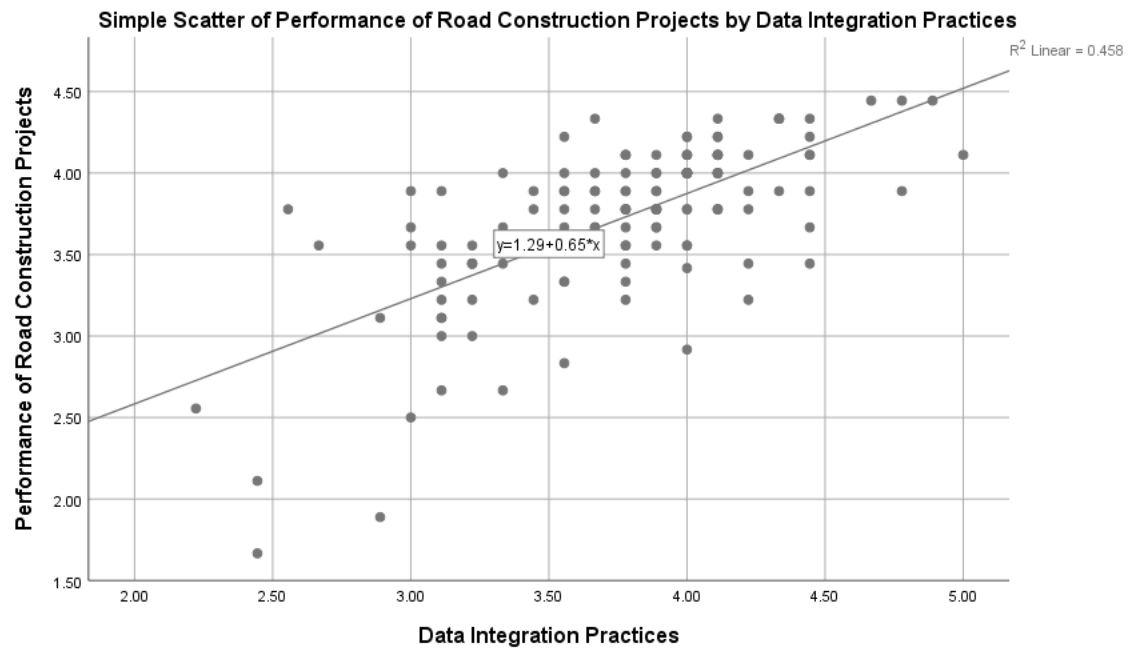


Figure 4.5: Scatterplot for the Data Integration Practices and Performance of Road Construction Projects

Source: Research Data (2024)

The results, as presented in Figure 4.5, show that the data integration practices has a positive linear relationship with performance of road construction projects in Kenya. The findings imply that an improvement in the data integration practices would lead to an improvement in the performance of road construction projects in Kenya. The results further indicate that the data integration practices could explain 45.8% of performance of road construction projects in Kenya. This is an indication that the data integration practices positively associates with performance of road construction projects in Kenya.

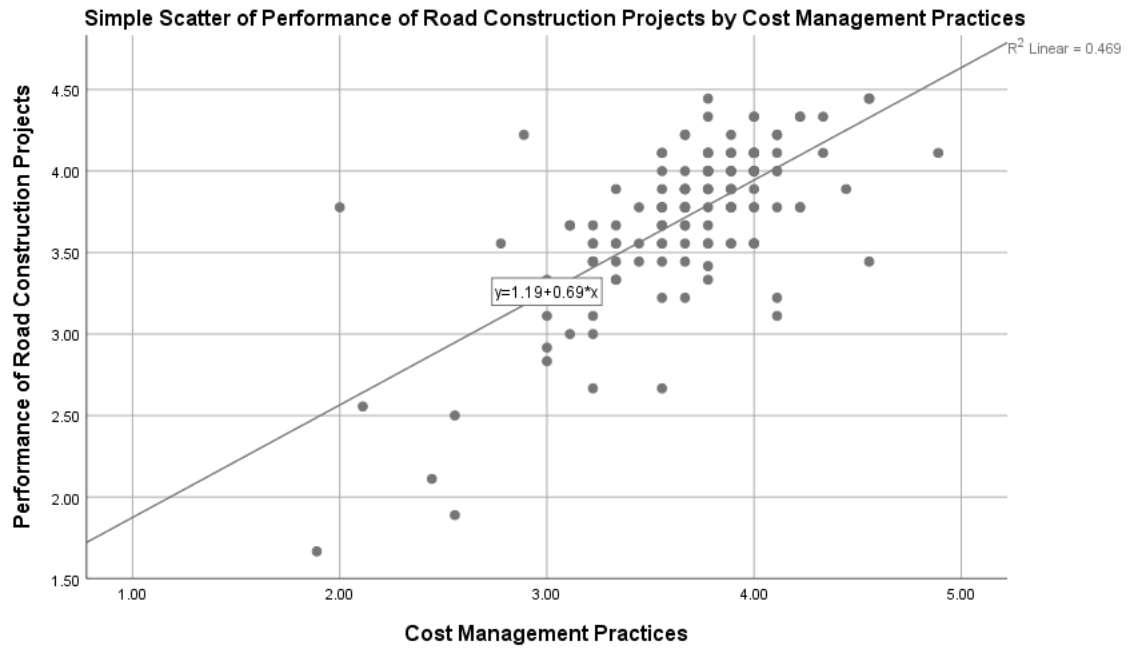


Figure 4.6: Scatterplot for the Cost Management Practices and Performance of Road Construction Projects

Source: Research Data (2024)

The results presented in Figure 4.6 indicate that cost management practices have a positive linear relationship with performance of road construction projects in Kenya. The findings imply that the use of the cost management practices would lead to an increase in organizational performance. The results further indicate that the talent management capability could explain 46.9% of performance of road construction projects in Kenya. This implies that cost management practices have a positive association with performance of road construction projects in Kenya.

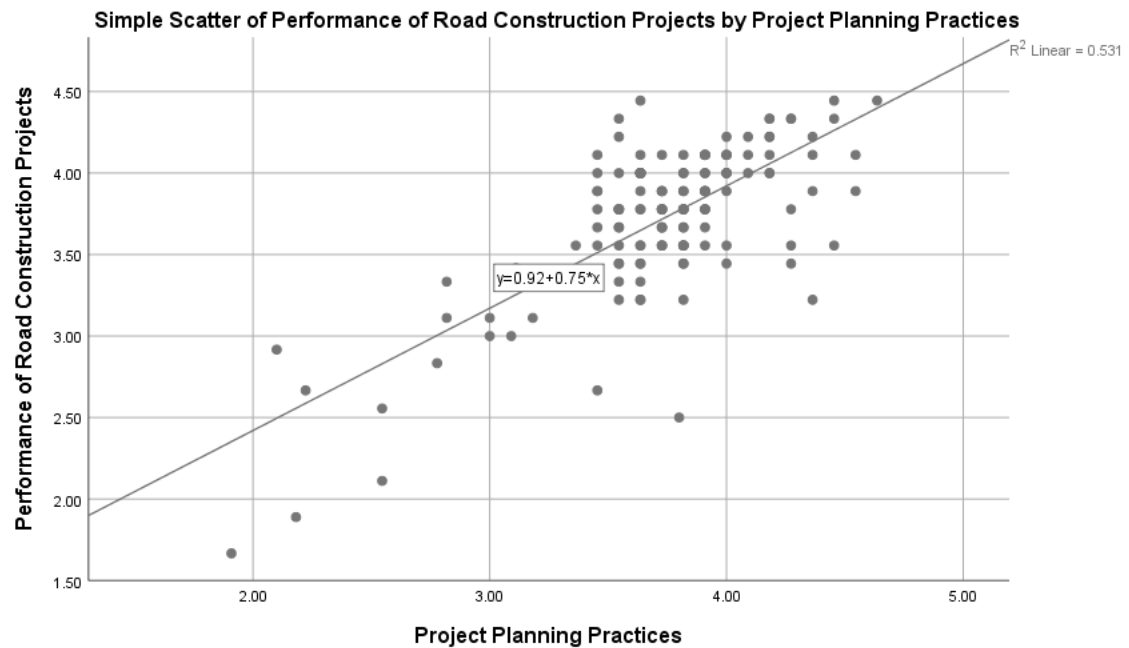


Figure 4.7: Scatterplot for Project Planning Practices and Performance of Road Construction Projects

Source: Research Data (2024)

According to the results presented in Figure 4.7, project planning practices has a positive linear relationship with performance of road construction projects in Kenya. The findings imply that an improvement in project planning practices would lead to an improvement in the performance of road construction projects in Kenya. The results further indicate that project planning practices could explain 53.1% of performance of road construction projects in Kenya. This means that project planning practices positively associates with performance of road construction projects in Kenya.

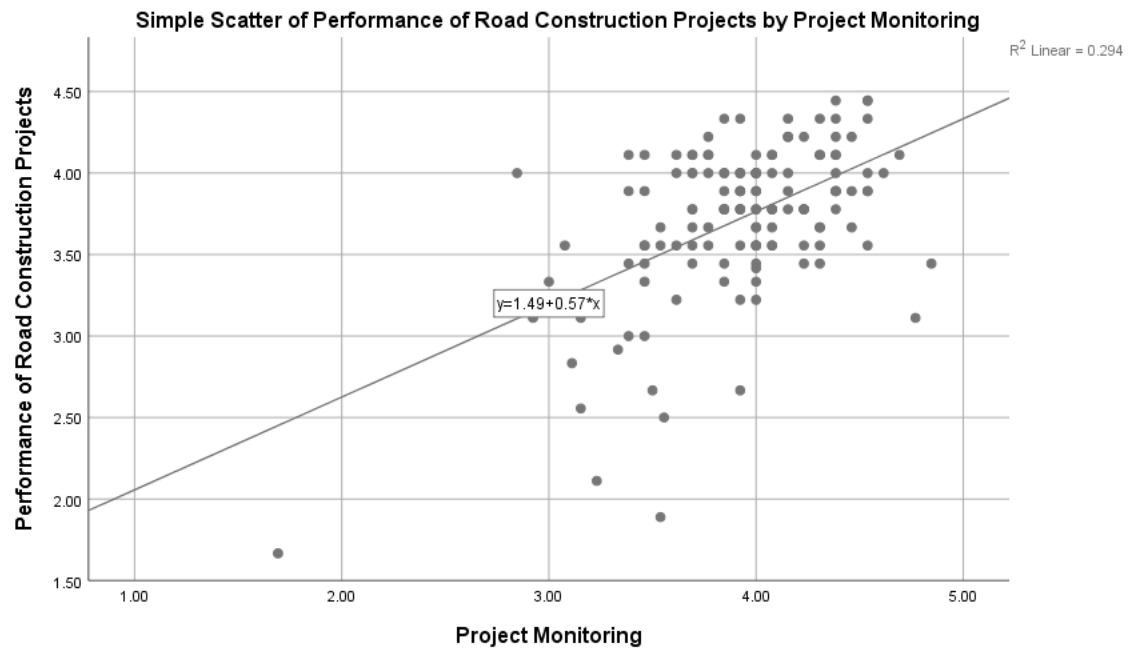


Figure 4.8: Scatterplot for Project Monitoring and Performance of Road Construction Projects

Source: Research Data (2024)

As illustrated in Figure 4.8, the project monitoring has a positive linear relationship with performance of road construction projects in Kenya. The findings imply that an improvement in the project monitoring would lead to an improvement in the performance of road construction projects in Kenya. The results further indicate that the project monitoring could explain 29.4% of the performance of road construction projects in Kenya. This means that project monitoring is positively associated with performance of road construction projects in Kenya.

4.8 Correlation Analysis

Correlation analysis is a statistical technique used to quantify the strength and direction of the relationship between two or more variables. It assesses how changes in one variable

are associated with changes in another variable. The correlation coefficient, typically denoted as "r," ranges from -1 to +1, where -1 indicates a perfect negative correlation, +1 indicates a perfect positive correlation, and 0 indicates no correlation. Positive correlations imply that as one variable increases, the other variable also tends to increase, while negative correlations suggest that as one variable increases, the other variable tends to decrease. Correlation analysis provides valuable insights into the nature and degree of association between variables, facilitating the identification of patterns, trends, and potential relationships in datasets. In this study, correlation results were as shown in Table 4.20.

Table 4.20: Correlation Analysis Results

		Performance of Road Construction Projects	Resource Management Practices	Data Integration Practices	Cost Management Practices	Project Planning Practices	Project Monitoring
Performance of Road Construction Projects	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	250					
Resource Management Practices	Pearson Correlation	.680**	1				
	Sig. (2-tailed)	0.000					
	N	250	250				
Data Integration Practices	Pearson Correlation	.690**	212	1			
	Sig. (2-tailed)	0.000	0.065				
	N	250	250	250			
Cost Management Practices	Pearson Correlation	.670**	206	195	1		
	Sig. (2-tailed)	0.000	0.076	0.89			
	N	250	250	250	250		
Project Planning Practices	Pearson Correlation	.726**	172	165	143	1	
	Sig. (2-tailed)	0.000	0.980	0.108	0.119		
	N	250	250	250	250	250	
Project Monitoring	Pearson Correlation	.521**	132	123	118	108	1
	Sig. (2-tailed)	0.000	0.143	0.152	0.173	0.192	
	N	250	250	250	250	250	250

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

Source: Research Data (2024)

As shown in Table 4.20, there is a significant positive correlation between resource management practices and the performance of road construction projects ($r = 0.680$, p -value=0.000). This indicates that higher levels of effective resource management are

associated with better performance in road construction projects. The findings agree with Kanamugire (2022) findings that project resource management has a significant influence on performance of construction project in Rwanda. The findings are also in concurrence with Raja and Murali (2020) findings that resource management on performance of construction projects in India.

Similarly, there is a significant positive correlation between data integration practices and the performance of road construction projects ($r = 0.690$, $p\text{-value}=0.000$). This suggests that improved data integration practices contribute to better outcomes in road construction projects. The findings are in line with Akselrod et al. (2022) observation that integration of data flows has an effect on performance of the construction projects. Also, the findings collaborate with Demirkesen and Bayhan (2020) argument that integration of data management has an influence on construction project management performance.

Further, there is a significant positive correlation between cost management practices and the performance of road construction projects ($r = 0.670$, $p\text{-value}=0.000$). This implies that effective cost management is linked to enhanced performance in road construction projects. The findings are in line with Fazil et al. (2021) finding that cost estimation has a positive influence on performance in the construction projects in Malaysia. The findings are also in concurrence with Egboga and Hauwa (2022) findings that cost estimation affects project performance in construction firms in Abuja Nigeria.

In addition, there is a significant positive correlation between project planning practices and the performance of road construction projects ($r = 0.726$, $p\text{-value}=0.000$). This indicates that robust project planning practices are associated with better performance outcomes in road construction projects. The findings agree with Majumder et al. (2022) argument that effective construction planning has a positive effect on project performance improvement in India. The findings also agree with Tuyishime and Nyambane (2021) findings that there is a positive relationship between planning and project performance in public institutions in Rwanda.

Also, there is a significant positive correlation between project monitoring and the performance of road construction projects ($r = 0.521$, $p\text{-value}=0.000$). This suggests that thorough project monitoring contributes positively to the performance of road construction projects. The findings agree with Shema and Irechukwu (2022) observation that monitoring and evaluation practices have a positive correlation with performance of construction projects in Rwanda. The findings are also in agreement with Byaruhanga, Muzaale and Jarbandhan (2020) argument that contractor monitoring has a positive effect on performance of road infrastructure projects in Uganda.

4.9 Regression analysis

Regression analysis is a statistical method used to examine the relationship between a dependent variable and one or more independent variables by estimating the parameters of a linear equation that best fits the observed data. This section covers the model summary, analysis of variance and regression coefficients for the relationship between each of the independent variables and the dependent variable.

4.9.1 Resource Management Practices and Performance of Construction Projects

Linear regression analysis was conducted to examine the influence of the resource management practices on the performance of construction projects in Kenya. Table 4.21 shows the r-squared for resource management practices and performance of construction projects in Kenya.

Table 4.21: Model Summary for Resource Management Practices and Project Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.490 ^a	0.240	0.203	0.4536

a. Predictors: (Constant), Resource Management Practices

Source: Research Data (2024)

The r-squared, in the model summary, shows the variation in the dependent variable that can be explained by the independent variables. As depicted in Table 4.21, the R-squared for the relationship between resource management practices and performance of construction projects was 0.240 which means that 24.0% of the variation of dependent variable (performance of construction projects in Kenya) can be explain by resource management practices.

Table 4.22: ANOVA for Resource Management Practices and Project Performance

Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	10.116	1	10.116	251.203	.000 ^b
Residual	9.987	248	0.0403		
Total	20.103	249			

a. Dependent Variable: Performance of Road Construction Projects

b. Predictors: (Constant), Resource Management Practices

Source: Research Data (2024)

As shown in Table 4.22, the F-calculated value (251.203) was greater than the F-critical value (3.84) obtained from the F-distribution table. Additionally, the p-value (0.000) was less than the significance level of 0.05. This indicates that the regression model is statistically significant, meaning that the independent variables collectively have a meaningful effect on the dependent variable. In other words, the model provides a good fit for the data and is appropriate for examining the influence of resource management practices on the performance of road construction projects in Kenya. It confirms that variations in project performance can be reliably explained by the variations in the resource management practices included in the model.

Table 4.23: Coefficients for Resource Management Practices and Project Performance

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	0.602	0.124		4.855	0.000
Resource Management Practices	0.201	0.058	0.197	3.466	0.000

a. Dependent Variable: Performance of Road Construction Projects

Source: Research Data (2024)

Regression equation for the unstandardized coefficients was;

$$Y = 0.602 + 0.201X_1$$

The results show that resource management practices have a positive and significant effect on the performance of road construction projects ($\beta_1 = 0.201$, $p = 0.000$). With a p-value less than 0.05, resource management practices have a statistically significant effect on the performance of road construction projects. Specifically, for each unit increase in resource management practices, there is an increase of 0.201 units in the performance of road construction projects. The findings agree with Makori and James (2021) findings that resource management practices have a significant influence on performance of commercial housing projects.

The results indicate that resource management practices have a positive and significant effect on the performance of road construction projects ($\beta_1 = 0.201$, $p = 0.000$). With a p-value less than 0.05, this effect is statistically significant, suggesting that effective management of resources, including labor, materials, and equipment, directly contributes to improved project outcomes. Specifically, for each unit increase in resource management practices, the performance of road construction projects increases by 0.201 units. Based on this result, the null hypothesis indicating that PMIS-based resource management practices have no significant influence on the performance of road construction projects in Kenya was rejected. This finding is consistent with the Resource-

Based View (RBV) theory, which posits that organizations achieve competitive advantage and improved performance by effectively utilizing valuable, rare, inimitable, and non-substitutable resources (Barney, 1991). It also aligns with prior empirical studies: Raja and Murali (2020) found that strategic resource allocation significantly improves project efficiency; Okolocha, Anugwu, and Ukoh (2023) reported that resource management enhances timely delivery and cost control; Ajao, Ajayi, and Ojo (2024) observed a positive relationship between resource optimization and project success; and Kanamugire (2022) highlighted that efficient resource management is critical for road project performance. These findings confirm that effective resource management is a key driver of project performance in the Kenyan road construction sector.

4.9.2 Data Integration Practices and Performance of Construction Projects

Linear regression analysis was conducted to examine the influence of the data integration practices on the performance of construction projects in Kenya. Table 4.24 shows the r-squared for data integration practices and performance of construction projects in Kenya.

Table 4.24: Model Summary for Data Integration Practices and Project Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.434 ^a	0.188	0.167	0.5657

a. Predictors: (Constant), Data Integration Practices

Source: Research Data (2024)

The r-squared, in the model summary, shows the variation in the dependent variable that can be explained by the independent variables. As depicted in Table 4.24, the R-squared for the relationship between data integration practices and performance of construction projects was 0.188 which means that 18.8% of the variation of dependent variable (performance of construction projects in Kenya) can be explain by data integration practices.

Table 4.25: ANOVA for Data Integration Practices and Project Performance

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	19.234	1	19.234	251.200	.000 ^b
	Residual	18.989	248	0.077		
	Total	38.223	249			

a. Dependent Variable: Performance of Road Construction Projects

b. Predictors: (Constant), Data Integration Practices

Source: Research Data (2024)

As shown in Table 4.25, the F-calculated value (251.200) was greater than the F-critical value (3.84) from the F-distribution table, and the p-value (0.000) was less than the significance level of 0.05. This indicates that the regression model is statistically significant, meaning that the independent variables, in this case data integration practices, collectively have a meaningful effect on the performance of road construction projects. In other words, the model fits the data well and is appropriate for examining how variations in data integration practices influence project performance in Kenya.

Table 4. 26: Coefficients for Data Integration Practices and Project Performance

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.613	0.124		4.944	0.000
	Data Integration Practices	0.192	0.072	0.187	2.667	0.000

a. Dependent Variable: Performance of Road Construction Projects

Source: Research Data (2024)

Regression equation for the unstandardized coefficients was;

$$Y = 0.613 + 0.192X_2$$

The results indicate that data integration practices have a positive and significant effect on the performance of road construction projects ($\beta_2 = 0.192$, $p = 0.000$). With a p-value less than 0.05, this effect is statistically significant, suggesting that effective integration of

data, information systems, and digital tools directly contributes to improved project outcomes. Specifically, for each unit increase in data integration practices, the performance of road construction projects increases by 0.192 units. Based on this result, the null hypothesis H02, which states that PMIS-supported data integration practices have no significant influence on the performance of road construction projects in Kenya, is rejected. This finding is consistent with the Innovation Diffusion Theory, which posits that the adoption and effective use of innovative practices, such as PMIS-supported data integration, enhances organizational performance by facilitating knowledge sharing and process improvements (Akselrod, Shpakov & Shpakova, 2022). The result also aligns with prior empirical studies: Yousif, Zakaria, and Shamsuddin (2021) reported that big data integration positively influences digitalization and performance in the construction industry in Malaysia; Okwori, Viklander, and Hedström (2024) found that data integration improves project efficiency and decision-making; Al Mhdawi (2020) highlighted that digital information systems enhance coordination and productivity in construction projects; and Sharma and Gupta (2021) emphasized that effective data integration strengthens project monitoring and control. These findings confirm that PMIS-supported data integration is a significant driver of performance in road construction projects in Kenya.

4.9.3 Cost Management Practices and Performance of Construction Projects

Linear regression analysis was conducted to examine the influence of the cost management practices on the performance of construction projects in Kenya. Table 4.28 shows the r-squared for cost management practices and performance of construction projects in Kenya.

Table 4.27: Model Summary for Cost Management Practices and Project Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.528 ^a	0.279	0.251	0.2134

a. Predictors: (Constant), Cost Management Practices

Source: Research Data (2024)

The r-squared, in the model summary, shows the variation in the dependent variable that can be explained by the independent variables. As depicted in Table 4.27, the R-squared for the relationship between cost management practices and performance of construction projects was 0.279 which means that 27.9% of the variation of dependent variable (performance of construction projects in Kenya) can be explain by cost management practices.

Table 4.28: ANOVA for Cost Management Practices and Project Performance

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	15.102	1	15.102	249.720	.000 ^b
	Residual	14.998	248	0.0605		
	Total	30.1	249			

a. Dependent Variable: Performance of Road Construction Projects

b. Predictors: (Constant), Cost Management Practices

Source: Research Data (2024)

As shown in Table 4.29, the F-calculated value (249.710) was greater than the F-critical value (3.84) from the F-distribution table, and the p-value (0.000) was less than the significance level of 0.05. This indicates that the regression model is statistically significant, meaning that the independent variables, in this case cost management practices, collectively have a significant effect on the performance of road construction projects. In other words, the model fits the data well and is appropriate for examining how variations in cost management practices influence project performance in Kenya.

Table 4.29: Coefficients for Cost Management Practices and Project Performance

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	0.555	0.124		4.476	0.000
Cost Management Practices	0.245	0.071	0.238	3.451	0.000

a. Dependent Variable: Performance of Road Construction Projects

Source: Research Data (2024)

Regression equation for the unstandardized coefficients was;

$$Y = 0.555 + 0.245X_3$$

The results indicate that cost management practices have a positive and significant effect on the performance of road construction projects ($\beta_3 = 0.245$, $p = 0.000$). With a p-value less than 0.05, this effect is statistically significant, suggesting that effective planning, monitoring, and control of project costs directly contributes to improved project outcomes. Specifically, for each unit increase in cost management practices, the performance of road construction projects increases by 0.245 units. Based on this result, the null hypothesis H03, which states that PMIS-enabled cost management practices have no significant influence on the performance of road construction projects in Kenya, is rejected. This finding is consistent with the Theory of Constraints, which emphasizes that effective management of limiting factors, such as project costs, enhances overall system performance (Goldratt, 1990). The result also aligns with prior empirical studies: Albtouch, Doh, and Albtouch (2020) highlighted that cost control practices improve construction project efficiency; Fazil, Lee, and Fadzline (2021) found that effective cost management contributes to project quality and timely delivery; Egboga and Hauwa (2022) reported that construction cost management positively influences organizational performance; Okereke, Mohammed, and Eze (2022) emphasized that cost management practices enhance strategic performance in construction organizations; and Ahmodu, Ajao, and Shittu (2023) noted that monitoring and controlling project costs reduces delays

and budget overruns. These findings confirm that PMIS-enabled cost management practices are a key driver of road construction project performance in Kenya.

4.9.4 Project Planning Practices and Performance of Construction Projects

Linear regression analysis was conducted to examine the influence of the project planning practices on the performance of construction projects in Kenya. Table 4.30 shows the r-squared for project planning practices and performance of construction projects in Kenya.

Table 4.30: Model Summary for Project Planning Practices and Project Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.578 ^a	0.334	0.301	0.8978

a. Predictors: (Constant), Project Planning Practices

Source: Research Data (2024)

The r-squared, in the model summary, shows the variation in the dependent variable that can be explained by the independent variables. As depicted in Table 4.30, the R-squared for the relationship between project planning practices and performance of construction projects was 0.334 which means that 33.4% of the variation of dependent variable (performance of construction projects in Kenya) can be explain by project planning practices.

Table 4.31: ANOVA for Project Planning Practices and Project Performance

Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	8.101	1	8.101	251.194	.000 ^b
Residual	7.998	248	0.0323		
Total	16.099	249			

a. Dependent Variable: Performance of Road Construction Projects

b. Predictors: (Constant), Project Planning Practices

Source: Research Data (2024)

As shown in Table 4.31, the F-calculated value (251.194) was greater than the F-critical value (3.84) from the F-distribution table, and the p-value (0.000) was less than the significance level of 0.05. This indicates that the regression model is statistically significant, meaning that the independent variables, in this case project planning practices, collectively have a meaningful effect on the performance of road construction projects. In other words, the model fits the data well and is appropriate for examining how variations in project planning practices influence project performance in Kenya.

Table 4.32: Coefficients for Project Planning Practices and Project Performance

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	0.544	0.124		4.387	0.000
Project Planning Practices	0.385	0.095	0.365	4.053	0.000

a. Dependent Variable: Performance of Road Construction Projects

Source: Research Data (2024)

Regression equation for the unstandardized coefficients was;

$$Y = 0.544 + 0.385X_4$$

The results show that project planning practices have a positive and significant effect on the performance of road construction projects ($\beta_1 = 0.385$, $p = 0.00$). Project planning practices exhibit a highly significant effect on the performance of road construction projects, with a p-value much less than 0.05. For each unit increase in project planning practices, there is a substantial increase of 0.385 units in the performance of road construction projects. Based on this result, the null hypothesis H_{04} , which states that PMIS-facilitated project planning practices have no significant influence on the performance of road construction projects in Kenya, is rejected. This finding is consistent with the General Systems Theory, which emphasizes that organized and coordinated systems, such as structured project planning processes, improve overall performance by integrating various interdependent components (Von Bertalanffy, 1968). The result also

aligns with prior empirical studies: Majumder, Majumder, and Biswas (2022) found that structured project planning improves efficiency and reduces delays; Tuyishime and Nyambane (2021) reported that project planning enhances resource utilization and project outcomes; Wangai and Musembi (2023) highlighted that effective planning positively affects construction project performance in Kenya; Mwanza, Namusonge, and Makokha (2020) emphasized that project planning practices enhance project control and quality; and Kabiti and Kikwatha (2022) noted that detailed planning facilitates better decision-making and timely project completion. These findings confirm that PMIS-facilitated project planning practices are a significant driver of road construction project performance in Kenya.

4.10 Multivariate Regression Analysis

Multivariate regression analysis was used to show the influence of resource management practices, data integration practices, cost management practices and project planning practices on performance of roads construction projects in Kenya. The R-squared results were as shown in Table 4.33.

Table 4.33: Model Summary for PMIS Practices and Project Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.827 ^a	.684	.675	.25708

a. Predictors: (Constant), Project Planning Practices, Data Integration Practices, Cost Management Practices, Resource Management Practices

Source: Research Data (2024)

The model summary indicates that the regression model, which includes project planning practices, data integration practices, cost management practices, and resource management practices as predictors, has an R-squared value of 0.684, suggesting that approximately 68.4% of the variance in the performance of road construction projects can be explained by these predictors collectively. While this represents a substantial proportion of explained variance, it also indicates that 31.6% of the variation in project

performance is accounted for by factors not included in this study. This relatively low R-squared may be due to other important determinants of road construction project performance that were not captured in the model, such as stakeholder engagement, political interference, contractor experience, weather conditions, funding stability, or regulatory compliance. Additionally, contextual factors like local socio-economic conditions, supply chain disruptions, and unforeseen environmental challenges could have contributed to variability in project outcomes. Therefore, while the model demonstrates a good fit and significant predictors, future studies could explore additional variables to further explain the unexplained variance in project performance.

The analysis of variance is used to test whether or not the model is a good fit for the data. The F-statistic and its associated p-value in the ANOVA table are used to determine whether the overall regression model is statistically significant. The result were as shown in Table 4.34.

Table 4.34: Analysis of Variance for PMIS Practices and Project Performance

Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	9.102	1	9.102	251.173	.000 ^b
Residual	8.987	248	0.036		
Total	18.089	249			

a. Dependent Variable: Performance of Road Construction Projects

b. Predictors: (Constant), Project Planning Practices, Data Integration Practices, Cost Management Practices, Resource Management Practices

Source: Research Data (2024)

As shown in Table 4.34, the F-calculated value (251.173) was greater than the F-critical value (3.84) from the F-distribution table, and the p-value (0.000) was less than the significance level of 0.05. This indicates that the regression model is statistically significant, showing that the independent variables, project planning practices, data integration practices, cost management practices, and resource management practices, collectively have a meaningful effect on the performance of road construction projects. In

other words, the model fits the data well and is appropriate for examining how these predictors influence project performance in Kenya.

Table 4.35: Regression Coefficients for PMIS Practices and Project Performance

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	.044	.224		.197	.844
Resource Management Practices	.194	.075	.193	2.602	.010
Data Integration Practices	.186	.072	.206	2.571	.011
Cost Management Practices	.212	.071	.218	2.983	.003
Project Planning Practices	.394	.075	.365	5.279	.000

a. Dependent Variable: Performance of Road Construction Projects

Source: Research Data (2024)

Regression equation for the unstandardized coefficients was;

$$Y = 0.044 + 0.194X_1 + 0.186X_2 + 0.212X_3 + 0.394X_4$$

The results show that resource management practices have a positive and significant effect on the performance of road construction projects ($\beta_1 = 0.194$, $p = 0.010$). With a p-value less than 0.05, Resource management practices have a statistically significant effect on the performance of road construction projects. Specifically, for each unit increase in resource management practices, there is an increase of 0.194 units in the performance of road construction projects. The findings agree with Makori and James (2021) findings that resource management practices have a significant influence on performance of commercial housing projects. The findings are also in line with Baraka and Shukla (2021) observation that resource management practices have a significant influence on construction projects performance in Rwanda.

In addition, the results show that data integration practices have a positive and significant effect on the performance of road construction projects ($\beta_2 = 0.186$, $p = 0.011$). Data integration practices also have a statistically significant effect on the performance of road construction projects, with a p-value less than 0.05. For each unit increase in data integration practices, there is an increase of 0.186 units in the performance of road construction projects. The findings are in agreement with Yousif et al. (2021) argument that big data integration positively influences construction industry digitalization in Malaysia. The findings are also in agreement with Al Mhdawi (2020) argument that data integration management has an influence construction project management performance in an oil refining company in Iraq.

Further, the results show that cost management practices have a positive and significant effect on the performance of road construction projects ($\beta_3 = 0.212$, $p = 0.003$). Cost management practices show a statistically significant effect on the performance of road construction projects, with a p-value less than 0.05. For each unit increase in cost management practices, there is an increase of 0.212 units in the performance of road construction projects. The findings agree with Okereke et al. (2022) findings that construction cost management practices has positive influence on construction organizations' strategic performance. The findings are also in line with Yismalet and Alemu (2022) findings that project cost management practice has a positive effect on profitability of domestic contractors in Ethiopia.

Also, the results show that project planning practices have a positive and significant effect on the performance of road construction projects ($\beta_4 = 0.394$, $p < 0.001$). Project planning practices exhibit a highly significant effect on the performance of road construction projects, with a p-value much less than 0.05. For each unit increase in project planning practices, there is a substantial increase of 0.394 units in the performance of road construction projects. The findings agree with Wangai and Musembi (2023)) argument that project planning practices have a positive effect on performance of construction projects in Kenya, Kenya. The findings are also in line with Mwanza et al. (2020)

argument that project planning practice has a positive effect on performance of construction projects in Kenya.

4.11 Moderating Effect Analysis

Moderating effect analysis is used to explore how the relationship between an independent variable (IV) and a dependent variable (DV) changes when a third variable, known as a moderator, is introduced. The moderator can either strengthen, weaken, or change the direction of the relationship between the IV and DV.

Table 4.36: Model Summary for PMIS Practices, Project Monitoring and Project Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.827 ^a	.684	.675	.25708
2	.838 ^b	.703	.681	.25445

a. Predictors: (Constant), Project Planning Practices, Data Integration Practices, Cost Management Practices, Resource Management Practices

b. Predictors: (Constant), Project Planning Practices, Data Integration Practices, Cost Management Practices, Resource Management Practices, Project Monitoring, Project Planning Practices * Project Monitoring, Cost Management Practices * Project Monitoring, Data Integration Practices * Project Monitoring, Resource Management Practices * Project Monitoring

Source: Research Data (2024)

In Model, the R-squared was 0.684, which means that 68.4% of the variability in the Performance of Road Construction Projects can be explained by the four predictors (project planning practices, data integration practices, cost management practices, and resource management practices). In Model 2, the R-squared was 0.703. This indicates that 70.3% of the variability in the Performance of Road Construction Projects can be explained by the predictors when including Project Monitoring and the interaction terms (Project Planning Practices * Project Monitoring, Cost Management Practices * Project Monitoring, Data Integration Practices * Project Monitoring, Resource Management Practices * Project Monitoring). The increase from 68.4% (Model 1) to 70.3% (Model 2) suggests that adding Project Monitoring and its interaction terms provides a better fit to

the model, explaining an additional 1.9% of the variability in the performance of road construction projects.

Table 4.37: ANOVA for PMIS Practices, Project Monitoring and Project Performance

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	9.102	1	9.102	251.173	.000 ^b
	Residual	8.987	248	0.036		
	Total	18.089	249			
2	Regression	19.119	9	2.124	31.450	.000 ^c
	Residual	16.211	240	0.068		
	Total	35.33	249			

a. Dependent Variable: Performance of Road Construction Projects

b. Predictors: (Constant), Project Planning Practices, Data Integration Practices, Cost Management Practices, Resource Management Practices

c. Predictors: (Constant), Project Planning Practices, Data Integration Practices, Cost Management Practices, Resource Management Practices, Project Monitoring, Project Planning Practices * Project Monitoring, Cost Management Practices * Project Monitoring, Data Integration Practices * Project Monitoring, Resource Management Practices * Project Monitoring

Source: Research Data (2024)

In Model 1, as shown in Table 4.37, the F-calculated (251.173) was greater than the F-critical (3.84) and the p-value (0.000) was less than the significance level (0.05). This indicates that the predictors (project planning practices, data integration practices, cost management practices, resource management practices) collectively explain a significant amount of the variance in the performance of road construction projects.

In Model 2, the F-calculated (31.450) was greater than the F-critical (3.84) and the p-value (0.000) was less than the significance level (0.05). The F-statistic, while lower than that of Model 1, still indicates that the extended set of predictors (including project monitoring and interaction terms) explains a significant amount of the variance in the performance of road construction projects. Both models have highly significant F-statistics and p-values, indicating that the predictors used in each model significantly explain the variance in the Performance of Road Construction Projects.

Table 4.38: Regression Coefficients for PMIS Practices, Project Monitoring and Project Performance

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	0.044	0.224		0.196	0.844
Resource Management Practices	0.194	0.075	0.193	2.587	0.010
Data Integration Practices	0.186	0.072	0.206	2.583	0.011
Cost Management Practices	0.212	0.071	0.218	2.986	0.003
Project Planning Practices	0.394	0.075	0.365	5.253	0.000
2 (Constant)	2.671	1.222		2.186	0.031
Resource Management Practices	0.596	0.216	0.556	2.759	0.004
Data Integration Practices	0.677	0.168	0.607	4.030	0.001
Cost Management Practices	0.473	0.126	0.413	3.754	0.004
Project Planning Practices	0.323	0.127	0.31	2.543	0.024
Project Monitoring	0.788	0.333	0.789	2.366	0.020
Resource Management Practices * Project Monitoring	0.261	0.123	0.233	2.122	0.032
Data Integration Practices * Project Monitoring	0.389	0.117	0.354	3.325	0.018
Cost Management Practices * Project Monitoring	0.759	0.267	0.759	2.843	0.005
Project Planning Practices * Project Monitoring	0.195	0.073	1.163	2.671	0.009

a. Dependent Variable: Performance of Road Construction Projects

Source: Research Data (2024)

Regression equation for the unstandardized coefficients was;

$$Y = 2.671 + 0.596X_1 + 0.677X_2 + 0.473X_3 + 0.323X_4 + 0.788Z + 0.261X_1Z + 0.389X_2Z + 0.759X_3Z + 0.195X_4Z + \varepsilon$$

In Model 1, resource management practices ($\beta_1 = 0.194$, $p = 0.010$), data integration practices ($\beta_2 = 0.186$, $p = 0.011$), cost management practices ($\beta_3 = 0.212$, $p = 0.003$), and

project planning practices ($\beta_4 = 0.394$, $p = 0.000$) all demonstrate significant positive effects on the performance of road construction projects.

The results demonstrate the moderating effects of Project Monitoring on the relationship between the independent variables (IVs) and the dependent variable (DV), Performance of Road Construction Projects. In Model 2, the coefficients for the interactions between the IVs and Project Monitoring indicate the extent to which the effect of each IV on the DV is modified by the presence of Project Monitoring. Specifically, Resource Management Practices * Project Monitoring ($\beta_{1z} = 0.261$, $p = 0.032$), Data Integration Practices * Project Monitoring ($\beta_{2z} = 0.389$, $p = 0.018$), Cost Management Practices * Project Monitoring ($\beta_{3z} = 0.759$, $p = 0.005$), and Project Planning Practices * Project Monitoring ($\beta_{4z} = 0.195$, $p = 0.009$) all exhibit significant interactions. These results suggest that project monitoring plays a moderating role in enhancing the impact of resource management practices, data integration practices, cost management practices, and project planning practices on the performance of road construction projects. The findings agree with Gathenge (2020) findings that project monitoring and evaluation has a significant relationship with performance of road infrastructure projects constructed by local firms in Kenya.

4.12 Test of Hypothesis

The first hypothesis indicated that resource management practices have no statistically significant influence on the performance of roads construction projects in Kenya. The results show that resource management practices have a positive and significant effect on the performance of road construction projects ($\beta_1 = 0.201$, $p = 0.000$). The p-value was 0.000, which was less than the significance level of 0.05 and hence we reject the null hypothesis and conclude that resource management practices have a positive and statistically significant influence on performance of road construction projects in Kenya. Specifically, for each unit increase in resource management practices, there is an increase of 0.201 units in the performance of road construction projects. The findings agree with

Makori and James (2021) findings that resource management practices have a significant influence on performance of commercial housing projects.

The second hypothesis indicated that data integration practices have no statistically significant influence on the performance of roads construction projects in Kenya. The results show that data integration practices have a positive and significant effect on the performance of road construction projects ($\beta_2 = 0.192$, $p = 0.000$). The p-value was 0.000, which was less than the significance level of 0.05 and hence we reject the null hypothesis and conclude that data integration practices have a positive and statistically significant influence on performance of road construction projects in Kenya. For each unit increase in data integration practices, there is an increase of 0.192 units in the performance of road construction projects. The findings are in agreement with Yousif, Zakaria and Shamsuddin (2021) argument that big data integration positively influences construction industry digitalization in Malaysia.

The third hypothesis indicated that cost management practices have no statistically significant influence on the performance of roads construction projects in Kenya. The results show that cost management practices have a positive and significant effect on the performance of road construction projects ($\beta_3 = 0.245$, $p = 0.000$). The p-value was 0.000, which was less than the significance level of 0.05 and hence we reject the null hypothesis and conclude that cost management practices have a positive and statistically significant influence on performance of road construction projects in Kenya. For each unit increase in cost management practices, there is an increase of 0.245 units in the performance of road construction projects. The findings agree with Okereke et al. (2022) findings that construction cost management practices has positive influence on construction organizations' strategic performance.

The fourth hypothesis indicated that project planning practices have no statistically significant influence on the performance of roads construction projects in Kenya. The results show that project planning practices have a positive and significant effect on the performance of road construction projects ($\beta_4 = 0.385$, $p\text{-value}=0.000$). The p-value was

0.000, which was less than the significance level of 0.05 and hence we reject the null hypothesis and conclude that project planning practices have a positive and statistically significant influence on performance of road construction projects in Kenya. For each unit increase in project planning practices, there is a substantial increase of 0.385 units in the performance of road construction projects. The findings agree with Wangai and Musembi (2023) argument that project planning practices have a positive effect on performance of construction projects in Kenya, Kenya.

The fifth hypothesis indicated that project monitoring has no statistically significant moderating effect on the relationship between PMIS practices and performance of roads construction projects in Kenya. The coefficients for the interactions between the IVs and Project Monitoring indicate the extent to which the effect of each IV on the DV is modified by the presence of Project Monitoring. Specifically, Resource Management Practices * Project Monitoring ($\beta_{1z} = 0.261$, $p = 0.032$), Data Integration Practices * Project Monitoring ($\beta_{2z} = 0.389$, $p = 0.018$), Cost Management Practices * Project Monitoring ($\beta_{3z} = 0.759$, $p = 0.005$), and Project Planning Practices * Project Monitoring ($\beta_{4z} = 0.195$, $p = 0.009$) all exhibit significant interactions. These results suggest that project monitoring plays a moderating role in enhancing the impact of resource management practices, data integration practices, cost management practices, and project planning practices on the performance of road construction projects. The findings agree with Musyimi and Ondara (2022) findings that project monitoring and evaluation has a significant relationship with performance of road infrastructure projects constructed by local firms in Kenya. The Table 4.39 below presents the summary of the hypothesis of the study

Table 4.39: Summary of Hypothesis Testing

Hypothesis	Model	Results	Verdict	Interpretation	Collaboration with Literature
H₀₁: Resource Management Practices have no statistically significant influence on the performance of roads construction projects in Kenya.	$Y = \beta_0 + \beta_1 X_1 + \varepsilon$	$Y = 0.602 + 0.201 X_1$	Reject the null hypothesis	Resource management practices have a positive and significant effect on the performance of road construction projects ($\beta_1 = 0.201$, $p = 0.000$)	Kanamugire (2022) Raja and Murali (2020) Makori and James (2021) Baraka and Shukla (2021)
H₀₂: Data integration practices have no statistically significant influence on the performance of roads construction projects in Kenya.	$Y = \beta_0 + \beta_2 X_2 + \varepsilon$	$Y = 0.613 + 0.192 X_2$	Reject the null hypothesis	Data integration practices have a positive and significant effect on the performance of road construction projects ($\beta_1 = 0.192$, $p = 0.00$)	Akselrod et al. (2022) Demirkesen and Bayhan (2020) Yousif et al. (2021) Al Mhdawi (2020)
H₀₃: Cost management practices have no statistically significant influence on the performance of roads construction projects in Kenya.	$Y = \beta_0 + \beta_3 X_3 + \varepsilon$	$Y = 0.555 + 0.245 X_3$	Reject the null hypothesis	Cost management practices have a positive and significant effect on the performance of road construction projects ($\beta_1 = 0.245$, $p = 0.000$).	Fazil et al. (2021) Egboga and Hauwa (2022) Okereke et al. (2022) Yismalet and Alemu (2022)
H₀₄: Project planning practices have no statistically significant influence on the performance of roads construction projects in Kenya.	$Y = \beta_0 + \beta_3 X_3 + \varepsilon$	$Y = 0.544 + 0.385 X_4$	Reject the null hypothesis	Project planning practices have a positive and significant effect on the performance of road construction projects ($\beta_1 = 0.385$, $p = 0.00$).	Majumder et al. (2022) Tuyishime and Nyambane (2021) Kabiti and Kikwatha (2022) Mwanza et al. (2020)
H₀₅: Project monitoring has no statistically significant moderating effect on the relationship between PMIS practices and performance of roads construction projects in Kenya.	$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_z X + \beta_{1z} X_1 Z + \beta_{2z} X_2 Z + \beta_{3z} X_3 Z + \beta_{4z} X_4 Z + \varepsilon$	$Y = 2.671 + 0.596 X_1 + 0.677 X_2 + 0.473 X_3 + 0.323 X_4 + 0.788 Z + 0.261 X_1 + 0.389 X_2 + 0.759 X_3 + 0.195 X_4 + \varepsilon$	Reject the null hypothesis	Project monitoring has a moderating effect on the relationship between project management information system practices and performance of road construction projects in Kenya (P-value=0.000)	Shema and Irechukwu (2022) Amin, Scheepers and Malik (2023) Amin (2024)

Source: Research Data (2024)

4.13 Optimal Model

An optimal model, in the context of statistical modeling and analysis, refers to a model that best fits the data and provides the most accurate predictions or explanations of the relationships between variables. It typically involves selecting the most relevant predictors (independent variables) that have significant impacts on the dependent variable of interest, while also considering the model's overall fit and interpretability. The optimal model in this study comprise of the four independent variables and the dependent variable.

Table 4.40: Model Summary for the Optimal Model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.827 ^a	.684	.675	.25708

a. Predictors: (Constant), Project Planning Practices, Data Integration Practices, Cost Management Practices, Resource Management Practices

Source: Research Data (2024)

The model summary indicates that the regression model, which includes project planning practices, data integration practices, cost management practices, and resource management practices as predictors, has an R-squared value of 0.684, suggesting that approximately 68.4% of the variance in the dependent variable (performance of road construction projects) can be explained by these predictors collectively.

Table 4.41: Analysis of Variance for the Optimal Model

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	9.001	1	9.001	248.083	.000 ^b
Residual	8.998	248	0.036		
Total	17.999	249			

a. Dependent Variable: Performance of Road Construction Projects

b. Predictors: (Constant), Project Planning Practices, Data Integration Practices, Cost Management Practices, Resource Management Practices

Source: Research Data (2024)

As shown in Table 4.41, the F-calculated (248.083) was greater than F-critical from F-distribution table (3.84). In addition, the p-value (0.000) was less than the significance level of 0.05. Therefore, there is a significant relationship between the predictors (project planning practices, data integration practices, cost management practices, and resource management practices) and the dependent variable (performance of road construction projects).

Table 4.42: Regression Coefficients for the Optimal Model

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.044	.224		.197	.844
	Resource Management Practices	.194	.075	.193	2.602	.010
	Data Integration Practices	.186	.072	.206	2.571	.011
	Cost Management Practices	.212	.071	.218	2.983	.003
	Project Planning Practices	.394	.075	.365	5.279	.000

a. Dependent Variable: Performance of Road Construction Projects

Source: Research Data (2024)

Regression equation for the unstandardized coefficients was;

$$Y = 0.044 + 0.194X_1 + 0.186X_2 + 0.212X_3 + 0.394X_4$$

The results show that resource management practices have a positive and significant effect on the performance of road construction projects ($\beta_1 = 0.194$, $p = 0.010$). With a p-value less than 0.05, Resource management practices have a statistically significant effect on the performance of road construction projects. In addition, the results show that data integration practices have a positive and significant effect on the performance of road construction projects ($\beta_2 = 0.186$, $p = 0.011$). Further, the results show that cost management practices have a positive and significant effect on the performance of road construction projects ($\beta_3 = 0.212$, $p = 0.003$). Also, the results show that project planning

practices have a positive and significant effect on the performance of road construction projects ($\beta_4 = 0.394$, $p < 0.001$).

4.14 Revised Conceptual Framework

The revised conceptual framework provides an updated and comprehensive representation of the essential concepts, variables, and interrelationships that underpin a research study. By delineating these components, it serves as a guiding structure that clarifies the connections among various elements of the study. This framework not only highlights how each variable interacts with others but also illustrates the dynamics at play within the research context. Furthermore, it aids in identifying the pathways through which these interactions can affect the outcomes of the study, ensuring a deeper understanding of the phenomena being investigated. Ultimately, the conceptual framework is crucial for grounding the research design and informing the analytical approach.

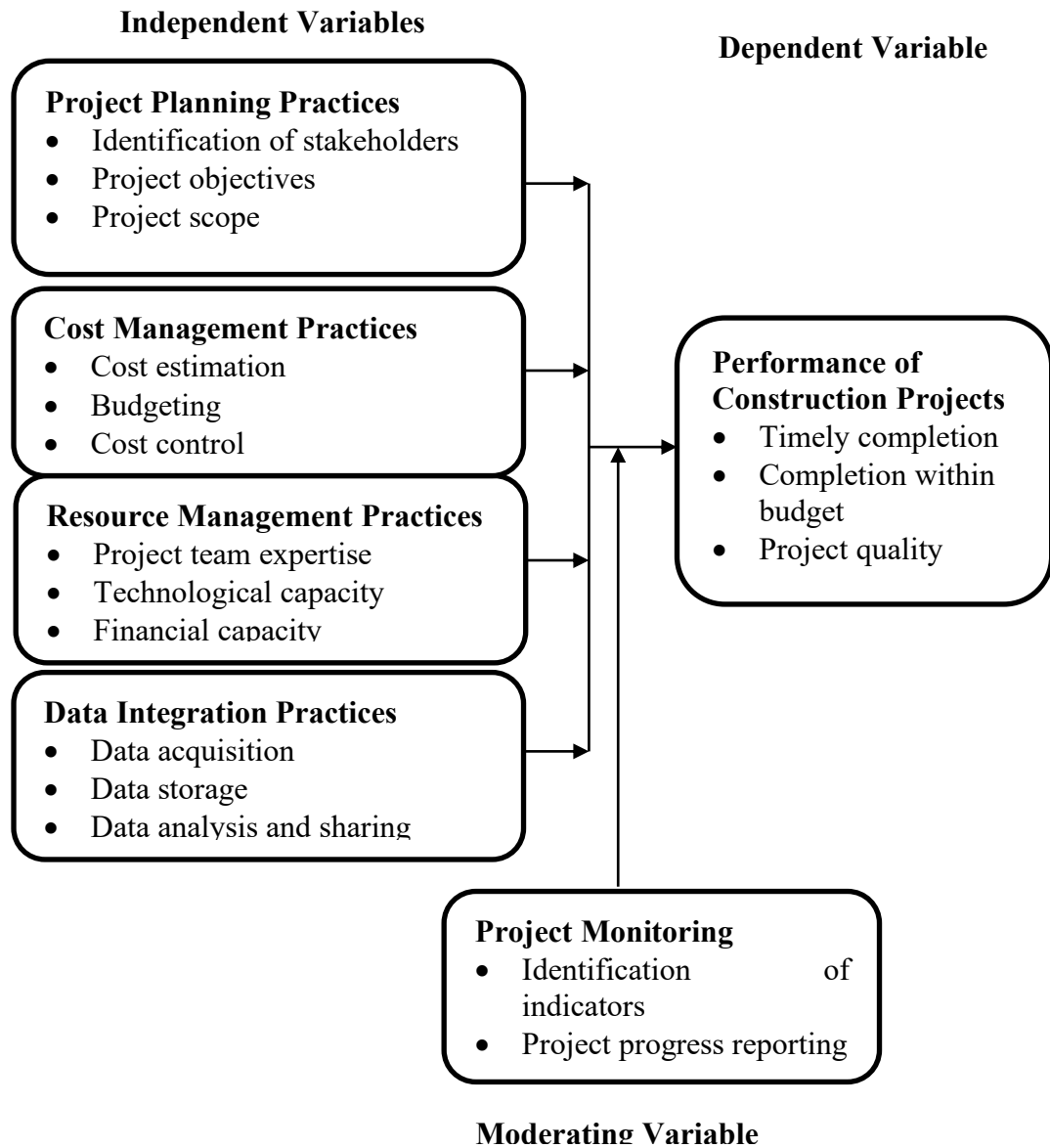


Figure 4.9: Revised Conceptual Framework

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This section presents a summary of the study's findings, conclusions, and recommendations. The general objective of this study was to investigate the influence of project management information system practices on the performance of roads construction projects in Kenya. The specific objectives were to examine the influence of the resource management practices, data integration practices, cost management practices and project planning practices on the performance of construction projects in Kenya and the moderating effect of project monitoring.

5.2 Summary of the Findings

This section summarizes the findings of the study in regard to the influence of the resource management practices, data integration practices, cost management practices and project planning practices on the performance of construction projects in Kenya and the moderating effect of project monitoring.

5.2.1 Resource Management Practices

From correlation analysis, the study found that there is a significant positive correlation between resource management practices and the performance of road construction projects in Kenya. Regression results revealed that resource management practices have a positive and significant effect on the performance of road construction projects in Kenya. The study found that a unit increase in resource management practices, in terms of project team expertise, technological capacity and financial capacity, have a positive and significant influence on the performance of road construction projects in Kenya. Based on these results, the null hypothesis H_{01} , which stated that PMIS-based resource management practices have no significant influence on the performance of road construction projects

in Kenya, was rejected, indicating that resource management practices are indeed a key driver of project performance.

From descriptive analysis, the study found that project teams possessed the necessary technological expertise and a deep understanding of the project's technological requirements, enabling them to execute the project successfully. They effectively utilized technology to enhance collaboration and communication, applying their knowledge and skills to overcome challenges and fulfil their roles and responsibilities. However, the study also identified shortcomings in financial management, as project teams did not effectively manage financial resources, and road projects were not adequately funded to meet their objectives, despite some aspects of financial management being transparent and accountable. Sustainable practices, such as using eco-friendly materials and minimizing waste, are increasingly important for reducing environmental impact and saving costs. They also noted that adopting technological advancements like Building Information Modeling (BIM) and ensuring high-quality materials and workmanship are crucial for improving resource management and project outcomes.

5.2.2 Data Integration Practices

From correlation analysis, the study found that there is a significant positive correlation between data integration practices and the performance of road construction projects in Kenya. Regression results revealed that data integration practices have a positive and significant effect on the performance of road construction projects in Kenya. The study found that a unit increase in data integration practices, in terms of data acquisition, data storage as well as data analysis and sharing, have a positive and significant influence on the performance of road construction projects in Kenya. Based on the results, the null hypothesis H_02 , which stated that PMIS-supported data integration practices have no significant influence on the performance of road construction projects in Kenya, was rejected, indicating that data integration practices significantly contribute to improved project performance.

From descriptive analysis, the study found that the use of Project Management Information Systems (PMIS) was effective in collecting and recording accurate data, with project teams successfully identifying data requirements and managing data storage throughout the project. Organizations in road construction had dedicated teams for managing knowledge initiatives, and projects employed appropriate techniques and technologies to ensure data quality, capture valuable knowledge, and protect stored data with effective backup and recovery strategies. However, the study also revealed that these organizations lacked a culture that encourages knowledge sharing and collaboration. The study showed the importance of standardizing data from various sources to ensure integration and interoperability in road construction projects. Real-time data collection via IoT sensors and telematics enhances decision-making and project management. Geographic Information Systems (GIS) are crucial for spatial analysis and planning, while cloud-based solutions offer scalable and collaborative environments for data integration and sharing.

5.2.3 Cost Management Practices

From correlation analysis, the study found that there is a significant positive correlation between cost management practices and the performance of road construction projects in Kenya. Regression results revealed that cost management practices have a positive and significant effect on the performance of road construction projects in Kenya. The study found that a unit increase in cost management practices, in terms of cost estimation, budgeting and cost control, have a positive and significant influence on the performance of road construction projects in Kenya. Based on the results, the null hypothesis H_03 , which stated that PMIS-enabled cost management practices have no significant influence on the performance of road construction projects in Kenya, was rejected, indicating that cost management practices play a significant role in enhancing project performance.

From descriptive analysis, the study found that effective cost control involves closely monitoring and managing project expenditures, utilizing appropriate cost estimation methods and tools, and using the project budget to guide decision-making throughout the

project. It was established that project teams ensure cost estimates align with project objectives and effectively communicate cost control measures to stakeholders. However, despite making necessary adjustments to the project budget to ensure success, the study revealed that project teams do not consistently monitor and track expenditures against the budget, even in road projects where cost control is applied. Also, the findings highlight key challenges in cost management for road construction projects, including inaccurate initial cost estimations and the impact of changes to project scope or design. Effective cost management practices, such as realistic cost estimation, proper change order management, regular cost monitoring and reporting, efficient resource allocation, and maintaining a contingency budget, are essential to avoid budget overruns and ensure project success.

5.2.4 Project Planning Practices

From correlation analysis, the study found that there is a significant positive correlation between project planning practices and the performance of road construction projects in Kenya. Regression results revealed that project planning practices have a positive and significant effect on the performance of road construction projects in Kenya. The study found that a unit increase in project planning practices, in terms of identification of stakeholders, project objectives and project scope, have a positive and significant influence on the performance of road construction projects in Kenya. Based on the results, the null hypothesis H_04 , which stated that PMIS-facilitated project planning practices have no significant influence on the performance of road construction projects in Kenya, was rejected, indicating that effective project planning practices are crucial for improving project performance.

From descriptive analysis, the study found that changes to the project scope were well-documented and managed effectively, with sufficient flexibility to accommodate changes as the project progressed. The work breakdown structure (WBS) played a crucial role in helping the project team identify dependencies, track progress, and ensure timely completion of tasks. The project schedule was effectively used to monitor progress, identify potential issues, and was clearly communicated to all team members.

Furthermore, project teams demonstrated a clear understanding of the project scope and objectives, with the WBS helping to define the scope and align the project schedule with objectives and milestones. The findings emphasize the importance of conducting thorough Environmental Impact Assessments (EIA) in road construction projects to mitigate environmental consequences and ensure regulatory compliance. Involving local communities and stakeholders from the planning stage is crucial for addressing concerns and minimizing conflicts. Additionally, securing necessary permits and adhering to legal and environmental regulations is critical for successful project planning.

5.2.5 Project Monitoring

From correlation analysis, the study found that there is a significant positive correlation between project monitoring and the performance of road construction projects in Kenya. Regression results revealed that project monitoring has a moderating effect on the relationship between project management information system practices and performance of road construction projects in Kenya. The study found that a unit improvement in project monitoring, in terms of identification of indicators, project progress reporting and utilization of results, have a positive and significant moderating effect on the relationship between project monitoring and the performance of road construction projects in Kenya. Based on the results, the null hypothesis H_{05} , which stated that project monitoring has no significant moderating effect on the relationship between PMIS practices and the performance of road construction projects in Kenya, was rejected, indicating that project monitoring positively strengthens the impact of PMIS practices on project performance.

From descriptive analysis, the study established that stakeholders are given opportunities to provide feedback on project progress reports, and project teams effectively use project results to inform decision-making. Relevant indicators are identified to measure progress, providing specific and measurable insights into the project's success. The use of technology aids in generating progress reports, ensuring that project results align with objectives and are communicated clearly to stakeholders. The study identified specific and measurable indicators of project monitoring, though further exploration of these indicators

is needed. While stakeholders have opportunities to provide feedback on progress reports, further investigation into their satisfaction and the incorporation of their input into decision-making would be valuable. In addition, the study also found that project teams do not effectively communicate issues or challenges related to project progress.

5.3 Conclusions

This section presents the conclusions made for the study as per the objectives of the study

5.3.1 Resource Management Practices

The study concludes that resource management practices have a positive and significant effect on the performance of road construction projects in Kenya. The study found that project team expertise, technological capacity and financial capacity on the performance of road construction projects in Kenya. This implies that an improvement in resource management practices leads to an improvement in the performance of road construction projects in Kenya.

5.3.2 Data Integration Practices

In addition, the study concludes that data integration practices have a positive and significant effect on the performance of road construction projects in Kenya. The study established that data acquisition, data storage and data analysis and sharing have an effect on performance of road construction projects in Kenya. This shows that an improvement in data integration practices would lead to an improvement in the performance of road construction projects in Kenya.

5.3.3 Cost Management Practices

Further, the study concludes cost management practices have a positive and significant effect on the performance of road construction projects in Kenya. The study revealed that cost estimation, budgeting and cost control have an effect on performance of road construction projects in Kenya. This implies that an improvement in cost management

practices would lead to an improvement in the performance of road construction projects in Kenya.

5.3.4 Project Planning Practices

The study further concludes that project planning practices have a positive and significant effect on the performance of road construction projects in Kenya. The study found that identification of stakeholders, project objectives and project scope have an effect on the performance of road construction projects in Kenya. This shows that an improvement in project planning practices would lead to an improvement in the performance of road construction projects in Kenya.

5.3.5 Project Monitoring

The study also concludes that project monitoring has a moderating effect on the relationship between project management information system practices and performance of road construction projects in Kenya. The study established that identification of indicators, project progress reporting and utilization of results have an effect on performance of road construction projects in Kenya. The findings imply that an improvement in project monitoring would lead to an improvement in the relationship between project management information system practices and performance of road construction projects in Kenya.

5.4 Recommendations

This section covers recommendations for policy and practice as per the objectives of the study.

5.4.1 Recommendations for Policy

Based on the study findings, it is recommended that policymakers in Kenya develop and enforce guidelines and standards for resource management in road construction projects. This should include policies promoting the strategic allocation of financial, human, and

technological resources, ensuring that project teams possess the necessary expertise and capacity to optimize performance. Additionally, policies should encourage the adoption of digital tools and PMIS-supported practices for data integration, cost management, and project planning to enhance efficiency, accuracy, and timely decision-making. Institutional frameworks could also be strengthened to ensure that all road construction projects comply with standardized procedures for stakeholder identification, project scoping, budgeting, and monitoring to improve overall project outcomes.

Furthermore, policymakers should implement monitoring and evaluation policies that emphasize performance tracking and utilization of project data to strengthen the link between PMIS practices and project performance. This could involve mandatory reporting on key performance indicators, regular audits of project progress, and capacity-building programs for project managers and stakeholders. By integrating these policies, the government can ensure that resource management, data integration, cost management, and project planning practices are consistently applied, thereby improving the success rate of road construction projects across Kenya and maximizing the value of public infrastructure investments.

5.4.2 Recommendations for Practice

5.4.2.1 Resource Management Practices

The study found that project teams do not effectively manage financial resources to achieve their objectives. To address this issue, it is recommended to implement a comprehensive financial management framework. This framework should include periodic budget reviews to regularly assess the financial status of the project, compare actual expenditures with the planned budget, and make necessary adjustments. Real-time financial tracking using advanced software will also be crucial, as it allows for continuous monitoring of expenditures, identification of discrepancies, and prompt decision-making. Additionally, a detailed financial reporting system should be established to ensure that

financial data is consistently reported and reviewed by project managers and stakeholders, helping to keep financial management aligned with project goals.

The findings revealed that road projects are not adequately funded to achieve their objectives. To remedy this, it is recommended to actively engage with governmental and private sector stakeholders to advocate for increased budget allocations. This can be achieved by developing a targeted engagement plan that includes presentations, detailed project proposals, and cost-benefit analyses to highlight the necessity of additional funding. Establishing advocacy groups or committees to lobby for increased financial support can also be beneficial. These groups should work on raising awareness about the project's significance and its potential impact on the community. Additionally, exploring alternative funding sources, such as public-private partnerships, international grants, and corporate sponsorships, can provide the necessary financial support for the project's success.

The study found that the project's financial management was not transparent and accountable. To improve this, it is recommended to implement stricter financial oversight mechanisms. Regular independent audits conducted by external firms should be scheduled to review and verify financial records and practices, with results made publicly available to ensure accountability. Transparent reporting practices should be developed and enforced, requiring detailed financial reports to be shared with stakeholders through accessible online platforms or dashboards. An accountability framework should also be established, outlining clear roles and responsibilities for financial management, oversight committees, and compliance officers. This framework should include procedures for addressing financial mismanagement, with corrective actions and penalties for non-compliance to maintain financial integrity.

5.4.2.2 Data Integration Practices

Although knowledge management practices are effective in capturing and sharing valuable knowledge, the study found that road project organizations lack a culture that encourages knowledge sharing and collaboration. It is recommended to develop and

promote a culture that values and incentivizes knowledge sharing. This can be achieved by implementing formal knowledge management systems, creating collaborative platforms, and providing training on the importance of knowledge sharing. Encouraging team collaboration through regular meetings, workshops, and cross-departmental projects can also help in building a collaborative environment.

The study revealed that project teams utilize appropriate technologies and systems for data storage. To build on this strength, it is recommended to continuously evaluate and upgrade data storage technologies to ensure they meet the evolving needs of road construction projects. Investing in scalable and secure data storage solutions will enhance data management and accessibility. Additionally, ensure that data storage systems are integrated with other project management tools to streamline data flow and improve overall project efficiency.

Despite having effective knowledge management practices, the study found that organizations lack a culture of collaboration. It is recommended to establish formal systems and processes to facilitate knowledge sharing and collaboration across project teams. This includes creating shared knowledge repositories, collaborative workspaces, and communication channels that support the exchange of information and ideas. Encourage regular interactions among team members and stakeholders to foster a collaborative culture and improve project performance through enhanced teamwork and shared expertise.

5.4.2.3 Cost Management Practices

The study found that project teams do not effectively monitor and track project expenditures against the budget. To address this issue, it is recommended to implement a robust financial monitoring system that provides real-time tracking of project expenditures. This system should include automated alerts for budget variances, detailed expenditure reports, and regular reconciliation processes. Establishing a dedicated financial oversight team to review expenditures and ensure alignment with the budget can also help in maintaining financial control and preventing cost overruns.

The study revealed that project teams utilize the project budget and cost estimates to inform decision-making throughout the project. It is recommended to enhance this practice by integrating advanced budgeting and cost estimation tools that provide more accurate forecasts and scenario analysis. Regularly update cost estimates and budget projections based on project progress and any changes in scope or conditions. Ensuring that these updates are communicated effectively to all relevant stakeholders will support informed decision-making and better alignment with project objectives.

The study found that project teams effectively communicate cost control measures to stakeholders. To build on this strength, it is recommended to formalize and standardize communication protocols for cost control measures. This includes creating comprehensive cost control plans, regularly scheduled briefings, and detailed documentation of cost control actions. Establishing feedback mechanisms for stakeholders to provide input and raise concerns about cost control measures can also enhance transparency and collaborative management of project finances.

While project teams communicate cost control measures effectively, the study highlights the need for improved monitoring and tracking of expenditures. It is recommended to develop a comprehensive financial reporting framework that includes detailed tracking of all project expenses, periodic budget reviews, and performance metrics. Ensure that financial reports are regularly reviewed by project managers and stakeholders to identify any discrepancies or issues promptly. This will help in maintaining budget discipline and making timely adjustments to keep the project on track financially.

5.4.2.4 Project Planning Practices

The study found that the project scope is flexible enough to accommodate changes as the project progresses. It is recommended to continue leveraging this flexibility by implementing a formal change management process that includes clear procedures for evaluating and incorporating scope changes. This process should involve assessing the impact of changes on project timelines, resources, and costs. Ensuring that all scope

adjustments are documented and communicated to relevant stakeholders will help maintain project alignment and manage expectations effectively.

The study established that the work breakdown structure (WBS) enabled the project team to identify dependencies and ensure timely completion of tasks. To build on this, it is recommended to regularly review and update the WBS to reflect any changes in project scope or requirements. Incorporate feedback from team members to refine the WBS and improve its accuracy in tracking project progress. Utilizing advanced project management tools that integrate WBS with scheduling and resource management can further enhance its effectiveness in managing dependencies and task completion.

The study found that the WBS provided an effective framework for tracking progress. To optimize this, it is recommended to integrate the WBS with real-time project tracking systems that provide up-to-date information on task status and progress. Implement performance metrics and key performance indicators (KPIs) aligned with the WBS to measure progress and identify potential delays or issues early. Regularly review progress reports and adjust project plans as needed to ensure timely completion of tasks.

The study found that the project schedule is communicated clearly to all team members. To maintain and enhance this practice, it is recommended to establish standardized communication protocols for project scheduling. This includes using project management software to share and update schedules in real-time, holding regular schedule review meetings, and providing accessible schedule documentation. Additionally, encourage feedback from team members to ensure that the schedule is practical and accommodates any constraints or concerns, facilitating better coordination and adherence to project timelines.

5.4.2.5 Project Monitoring

The study found that project teams utilize project results to inform decision-making. To enhance this practice, it is recommended to establish a systematic approach for analyzing and incorporating project results into decision-making processes. This approach should

include regular review sessions where project results are evaluated against objectives, and any insights or lessons learned are used to guide future decisions. Developing a framework for integrating these insights into project plans and strategies will help ensure that decisions are data-driven and aligned with project goals.

The study revealed that technology aids in generating project progress reports. To maximize the benefits of this technology, it is recommended to invest in advanced project management software that offers comprehensive reporting features, real-time updates, and customizable dashboards. Ensure that all team members are trained in using these tools effectively to maintain accurate and timely progress reports. Regularly review and upgrade technology tools to keep up with advancements and enhance reporting capabilities.

The study found that indicators of project monitoring are specific and measurable. To build on this strength, it is recommended to continuously refine and expand the set of monitoring indicators to cover all critical aspects of project performance. Implement regular reviews of these indicators to ensure they remain relevant and accurately reflect project progress. Using a balanced scorecard approach can also help in assessing performance across various dimensions, such as financial, operational, and strategic metrics.

The study found that project teams do not effectively communicate issues or challenges related to project progress. To address this, it is recommended to establish clear communication protocols for reporting and addressing project issues. This should include regular status meetings, structured issue reporting systems, and designated channels for raising concerns. Implementing a feedback mechanism where team members can openly discuss challenges and propose solutions will improve transparency and collaborative problem-solving. Ensuring that communication about issues is timely and comprehensive will help in proactively managing project risks and maintaining alignment with project objectives.

5.5 Contribution to Existing Knowledge

This study makes a significant contribution to the body of knowledge on project management information systems (PMIS) and road construction project performance in Kenya in three key dimensions. Empirically, it provides comprehensive, data-driven insights into the actual practices of PMIS usage within Kenya's road construction sub-sector. By capturing information on resource management, data integration, cost management, and project planning practices, the study addresses a notable gap in local literature, offering evidence on how these practices influence project performance in a context that is rarely documented with such depth.

Practically, the findings offer actionable guidance for national agencies such as KURA, KeNHA, and KeRRA, highlighting areas where PMIS practices can be strengthened to improve project efficiency, reduce cost overruns, and enhance timely delivery. These insights are directly relevant for policy formulation, capacity building, and strategic resource allocation. Methodologically, the study demonstrates the utility of regression-based analyses for examining complex, multi-variable relationships in project management, providing a template for future empirical investigations in infrastructure projects.

From a theoretical perspective, the study advances existing knowledge by linking empirical findings to multiple dominant theories. It is anchored on the Resource-Based View (RBV) theory, emphasizing that strategic utilization of valuable, rare, inimitable, and non-substitutable resources drives project performance. The Innovation Diffusion Theory is reinforced through findings on data integration, highlighting how adoption of PMIS-supported innovations enhances efficiency and decision-making. The Theory of Constraints is applied in explaining the role of cost management practices in overcoming limiting factors that hinder project success, while General Systems Theory underpins insights on project planning, emphasizing integration and coordination of interdependent project components. Finally, the study incorporates elements of the Theory of Change to

illustrate how project monitoring moderates the relationship between PMIS practices and project performance, providing a nuanced understanding of causal pathways.

Collectively, these contributions strengthen both empirical and theoretical understanding of PMIS practices in road construction projects and offer several avenues for advancing project management knowledge. By situating the findings within the Kenyan context, the study challenges the assumption that global project management frameworks, such as PMBOK and PRINCE2, are universally applicable without adaptation. It demonstrates that contextual factors, such as resource availability, technological capacity, and local organizational practices, significantly influence the effectiveness of PMIS interventions.

5.6 Areas for Further Research

The general objective of the study was to investigate the influence of project management information system practices on the performance of roads construction projects in Kenya. However, the study focused on roads constructed by KURA and KeNHA and hence the findings cannot be generalized to other organizations. Therefore, the study recommends further research on the influence of project management information system practices on the performance of roads construction projects by Kenya Rural Roads Authority (KeRRA). In addition, there is a need to explore how PMIS practices impact different types of infrastructure projects, such as bridges, airports, or railway systems, to assess their applicability across various sectors. Researchers could also examine the role of emerging technologies, such as artificial intelligence and blockchain, in enhancing PMIS practices for road construction projects. Further research could analyze how PMIS practices impact sustainability and environmental considerations in road construction, addressing the growing emphasis on green infrastructure.

The research recommends further research to be done to examine the effect of organizational culture and leadership styles on the successful adoption and implementation of PMIS practices. Studies could also explore the influence of external factors, such as political stability, funding mechanisms, and climate variability, on the

relationship between PMIS practices and project performance. Moreover, there is potential for research to examine the long-term impacts of PMIS practices on road durability and maintenance outcomes. Investigating the role of end-user feedback and stakeholder engagement in shaping PMIS practices and their effectiveness would also provide valuable insights. Also, the study found that resource management practices, data integration practices, cost management practices and project planning practices explain 68.5% of performance of roads construction projects in Kenya. As such, further studies should be conducted on factors influencing performance of roads construction projects in Kenya.

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APPENDICES

Appendix I: Questionnaire

This questionnaire will be used to collect data on the influence of project management information system practices on the performance of roads construction projects in Kenya. The data collected will be handled with confidentiality and with academic professionalism. Kindly fill in the information as directed in the various sections provided.

PART A: GENERAL INFORMATION

1. For how long have you been working in your organization?

Less than 5 years ☐ 5 to 10 years ☐

11 to 20 years ☐ Above 20 years ☐

2. What is your highest level of education? (Please tick as appropriate)

PhD/Doctorate ☐ Master's Degree ☐

Undergraduate degree ☐ College Diploma ☐

College Certificate ☐ School Certificate ☐

Others, (please specify)

3. For how long has your organization been operational?

Less than 5 years ☐ 5 to 14 years ☐

15 to 24 years ☐ 25 to 34 years ☐

35 to 44 years ☐ 45 to 54 years ☐

55 years and above ☐

4. For how long have you been working in the organization?

Below 2 years [] 2 to 5 years []

6 to 8 years [] 9 to 11 years []

More than 11 years []

PART B: Resource Management Practices

5. This section seeks to obtain information on resource management practices in road construction projects. Please indicate the extent to which you agree with the following statements. Kindly use the key provided below to TICK as appropriate.

Key: | **1-Strongly Disagree** | **2- Disagree** | **3- Neutral** | **4-Agree** | **5-Strongly Agree**

	Project team expertise	1	2	3	4	5
1	The project team members were skilled in their respective roles and responsibilities					
2	The project team has the necessary knowledge and skills to deliver the project successfully.					
3	The project team members effectively applied their expertise to overcome any challenges.					
	Technological capacity					
1	The project team utilizes technology to enhance collaboration and communication					
2	The project team had the necessary technological expertise to execute the project successfully					
3	The project team demonstrated a deep understanding of the technological requirements of the project					
	Financial capacity					
1	Road projects are adequately funded to achieve its objectives					
2	The project's financial management was transparent and accountable					
3	The project team effectively managed financial resources to achieve its objectives					

6. Please comment on any other issues regarding resource management practices in road construction projects
- i.
 - ii.
 - iii.

Part C. Data Integration Practices

7. This section seeks to obtain information on data integration practices in road construction projects. Please indicate the extent to which you agree with the following statements. Kindly use the key provided below to TICK as appropriate.

Key: | **1-Strongly Disagree** | **2-Disagree** | **3-Neutral** | **4-Agree** | **5-Strongly Agree**

	Data acquisition	1	2	3	4	5
1	Our project team effectively identified the data requirements for the project					
2	The use of PMIS successfully helps in collecting and recording accurate data					
3	Our projects use appropriate techniques to ensure data quality					
	Data storage					
1	Our project team effectively managed data storage throughout the project					
2	Our project team utilizes appropriate technologies and systems for data storage					
3	Our projects utilize appropriate backup and recovery strategies to protect stored data.					
	Data analysis and sharing					
1	Our project team effectively analyses data to inform decision-making					
2	Our project team effectively managed the security and confidentiality of shared data					
3	Road projects use appropriate technologies and systems for data sharing					

8. Please comment on any other issues regarding data integration practices in road construction projects
- i.
 - ii.
 - iii.

Part D. Cost Management Practices

9. This section seeks to obtain information on cost management practices in road construction projects. Please indicate the extent to which you agree with the following statements. Kindly use the key provided below to TICK as appropriate.

Key: | **1-Strongly Disagree** | **2-Disagree** | **3-Neutral** | **4-Agree** | **5-Strongly Agree**

	Cost estimation	1	2	3	4	5
1	Our project team utilizes appropriate methods and tools for cost estimation.					
2	Our project team ensures that cost estimates were aligned with project objectives					
3	Our project team utilizes cost estimates to inform decision-making throughout the project.					
	Budgeting					
1	Our project team utilizes the project budget to inform decision-making throughout the project.					
2	Our project team effectively monitor and track project expenditures against the budget.					
3	The project team makes adjustments to the project budget as needed to ensure project success.					
	Cost control					
1	Road projects make use of cost control					
2	Our project team effectively communicates cost control measures to stakeholders.					
3	Cost control involves monitoring and managing project expenditures					

10. Please comment on any other issues regarding cost management practices in road construction projects

- i.
- ...
- ii.
- ...
- iii.
- ...

Part E. Project Planning Practices

11. This section seeks to obtain information on project planning practices in road construction projects. Please indicate the extent to which you agree with the following statements. Kindly use the key provided below to TICK as appropriate.

Key: | **1-Strongly Disagree** | **2-Disagree** | **3-Neutral** | **4-Agree** | **5-Strongly Agree**

	Identification of stakeholders	1	2	3	4	5
1	Our project team effectively identifies all relevant stakeholders.					
2	The project team ensures that stakeholder identification is comprehensive and inclusive.					
3	Project managers ensure that all issues or challenges related to stakeholder identification are addressed					
	Project objectives					
1	The project team ensures that projects objectives are clear and achievable					
2	Our project team ensures that project objectives remain relevant and aligned with evolving project needs					
3	Our project team monitors progress towards project objectives throughout the project lifecycle.					
	Project scope					
1	Road projects have well defined project scope					
2	Our project team makes of project scope to inform decision-making throughout the project.					

3	Our project team utilizes appropriate methods and tools for scoping the project					
---	---	--	--	--	--	--

14. Please comment on any other issues regarding project planning practices in road construction projects:

- i.
- ii.
- iii.

Part F. Project Monitoring

1. This section seeks to obtain information on project monitoring in road construction projects. Please indicate the extent to which you agree with the following statements. Kindly use the key provided below to TICK as appropriate.

Key:	1-Strongly Disagree	2-Disagree	3-Neutral	4-Agree	5-Strongly Agree
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	Identification of indicators	1	2	3	4	5
1	Indicators of project monitoring are specific and measurable					
2	Indicators provide information on the progress or success of a project.					
3	Our project team effectively identifies relevant indicators to measure project progress.					
	Project progress reporting					
1	The use of technology helps in generating project progress reports					
2	Our project team effectively communicates any issues or challenges related to project progress.					
3	Stakeholders are given opportunities to provide feedback on project progress reports.					
	Utilization of results					
1	Our project team utilizes project results to inform decision-making					
2	Our project team ensures that project results were aligned with project objectives and goals.					

3	Our project team ensures that project results were communicated to stakeholders in a clear and understandable manner.					
---	---	--	--	--	--	--

14. Please comment on any other issues regarding project monitoring in road construction projects:

- i.
- ii.
- iii.

PART F: Performance of Road Construction Projects

15 This section seeks to obtain information on performance of road construction projects in Kenya. Please indicate the extent to which you agree with the following statements. Kindly use the key provided below to TICK as appropriate.

Key: | 1-Strongly Disagree | 2-Disagree | 3-Neutral | 4-Agree | 5-Strongly Agree

	Timely Completion					
1	Projects in our organization are completed within schedule					
2	Some projects in our organization take longer period to be completed than required					
3	Some projects in our organization take shorter period to be completed					
4	I am satisfied with the time taken to complete projects					
	Completion within Budget					
1	Projects in our organization are completed within the set budget					
2	Some projects incur cost overrun					
3	Some projects in our organization have been left incomplete due to insufficient budget					
4	Our organization has put proper strategies to ensure projects are completed within the set budget					
	Project quality	1	2	3	4	5

1	The beneficiaries are satisfied with the road projects					
2	The financiers are satisfied with the quality of the roads projects					
3	The project was completed to a high standard of quality					
4	The project met all of the specified requirements and objectives					

Appendix II: Data Extraction Checklist

Project name	Estimated Budget	Completion budget	Cost Overrun	Estimated time	Completion time	Time Overrun

Appendix III: Introduction Letter

F-2-10-1-1



**JOMO KENYATTA UNIVERSITY
OF
AGRICULTURE AND TECHNOLOGY
NAIROBI CBD CAMPUS**
JKUAT Towers, City Square, Kenyatta Avenue
P.O. Box 62000 - 00200, Nairobi, KENYA Tel: +254705- 950712
Office of the Director

REF: JKU/6/2/6/2022

DATE: 14th September, 2022

TO WHOM IT MAY CONCERN

SUBJECT: HDE414-C004-2075/2021 TAWFIO BASHIR SAMO

This is to certify that the above mentioned is a *bona fide* student of Jomo Kenyatta University of Agriculture and Technology at the Nairobi Campus, undertaking a Doctorate degree in Project Management. He has completed his *Coursework* and is currently working on *Research Thesis*.

Any assistance given to him will be highly appreciated. Please do not hesitate to contact our office in case the need for further clarification arises.

Yours Faithfully


Esther Mutai

For Director



JKUAT is ISO 9001: 2015 and ISO 14001: 2015 Certified
Setting Trends in Higher Education, Research, Innovation and Entrepreneurship



Appendix IV: NACOSTI Permit

 REPUBLIC OF KENYA NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION Ref No: 794826	 NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION Date of Issue: 30/June/2023
RESEARCH LICENSE	
	
This is to Certify that Mr.. Tawfiq Bashir Samo of Jomo Kenyatta University of Agriculture and Technology, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kiambu, Nairobi on the topic: PROJECT MANAGEMENT INFORMATION SYSTEM PRACTICES AND PERFORMANCE OF ROADS CONSTRUCTION PROJECTS IN KENYA for the period ending : 30/June/2024.	
License No: NACOSTI/P/23/27202	
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See overleaf for conditions	

Appendix V: List of Road Projects

KeNHA ROAD PROJECTS

1. Eldoret Town by pass
2. Nairobi Western Bypass
3. Loichangamatak - Lodwar
4. Kalobeiyei River – Nadapal/Nakodok
5. Lokitang Junction - Kalobeiyei River
6. Mteza – Kibundani (MPARD Pk3)
7. Ahero - Kisii
8. Nairobi Expressway
9. Mombasa – Kwa Jomvu Rd (A109)
10. Posta (Naibor) - Kisima- Maralal
11. Lamu – Witu – Garsen
12. Nyaru – Iten
13. Naivasha – Njabini Road
14. Makupa Causeway
15. T-Mall Overpass
16. Kibwezi – Mutomo – Kitui (A9/B64)
17. Lodwar - Lokitaung
18. Kainuk Bridge
19. Link Road to Lamu Port
20. Weiwei bridge
21. Thika road foot bridge (Witeithie and Mangu)
22. Likoni Floating Bridge
23. Nuno-Modogashe (A13)
24. Kakamega - Kaburengu
25. Chiakariga – Meru (C92)
26. Ugunja-Nyadorera-Ruambwa C776
27. Narok – Sekenani C728

28. Kisumu – Kakamega road
29. Webuye – Kitale road
30. Miritini - Mwache - Kipevu Link Road
31. Port Reitz / Moi International Airport Access (C110) Road
32. Oljororok - Dundori (B20)
33. Chebilat – Ikonge – Chabera (C750)
34. Construction of EASA Access Road
35. Construction of 3 interchanges at Mau Summit Turnoff, Njoro Turnoff, Nyahururu Turnoff
36. Nginyang Bridge
37. Bachuma Gate - Maji ya Chumvi
38. Voi-Mwatate (A6)
39. Rumuruti – Naibor (A4)
40. Karen Round- About (C63)/(C60)
41. Nairobi Southern Bypass
42. Kisumu Airport – Kisian
43. Merille River –Marsabit (A2)
44. Turbi – Moyale (A2)
45. Eldoret – Webuye (A104)
46. Webuye – Malaba (A104)
47. Enjinja-Bumala (C30)
48. Mwatate – Taveta Road Project
49. Kaloleni – Kilifi (C107)
50. Kangema – Gacharage (C70)
51. Siaya - Ruambwa Road (C29) Road
52. Masara-Suna-Kehancha Road (C13) and Reinstatement of Awendo -Mariwa Road (D202) Road
53. Mbita causeway and approach roads on Homa Bay - Mbita (C19) road
54. Marsabit – Turbi (A2) Road
55. Homa Bay – Mbita (C19)

56. Chepterit – Kimondi (Baraton) (C37)
57. Kericho – Nyamasaria(B1)
58. Kericho – Mau Summit (B1)
59. Timboroa – Eldoret Road (A104)
60. Londiani – Fortenan Road (C35)
61. Modika – Nuno Road (C81)
62. Bellevue Footbridge
63. General Motors Footbridge (A104)
64. Kendu Bay- Homa Bay
65. Lanet - Dundori
66. Ndori – Ngiya (C28)
67. KCC (Sotik)-Ndanai-Gorgor (C15) Phase II
68. Isiolo – Merille River road

KURA ROAD PROJECTS

1. Nairobi Outerring Road Improvement Project
2. Waiyaki Way - Redhill Link Road
3. Ngong Road - Kibera - Kungu Karumba - Langata Road (Missing Link No. 12)
4. Rehabilitation and Upgrading of Eastlands Roads (Phase II)
5. Nyahururu BypassConstruction of Kangundo Road - Greater Eastern Bypass Link Road
6. Thika Bypass
7. Kiogoro - Gesure - Itibo - Masongo Roads
8. Hunters - Githurai Missing Link
9. Githurai - Kimbo Road (Phase III)
10. Upgrading to Bitumen Standards of Marsabit County Headquater Roads
11. Improvement of Access Roads to Starehe Affordable Housing Project
12. Improvement of Lady Irene-Mandizini-Muslim-Nambaya-Junction D258 & Wakili Road
13. Improvement to Bitumen Standards of Nakuru CBD Roads

14. Upgrading of Hola Township Roads
15. Wajir Bypass (Phase 1)
16. Improvement and Maintenance of Kisumu Milimani Link Roads
17. Improvement of Mother Kelvin Road
18. Improvement to paved standards of Bomet-Kapsimotwa Road
19. Upgrading to Bitumen Standard and Maintenance of Machakos - Mombasa Road - Lukenya (K4) Roads
20. Upgrading to Bitumen Standards of Mandera Town Roads
21. Dualling of Nairobi Eastern Bypass (From Baraka Roundabout to Ruiru/Kamiti Junction)
22. Road Annuity Programme Lot 18
23. Improvement to Bitumen Standards of Eldoret Township Roads, Uasin Gishu County
24. Upgrading to Bitumen Standards Kapenguria Town Roads, West Pokot County
25. Access to Stoni Athi Housing Project
26. Opening of Corridor for Garsen Town Roads
27. Road Annuity Programme Lot 15
28. Garissa Ndogo-Sankuri Link Road
29. Improvement to Bitumen Standards of Kapkwen-Kapsimotwa-Silibwet Road, Bomet County
30. Upgrading to Bitumen Standard and Performance Based Routine Maintenance of Garissa Township Roads
31. Upgrading to Bitumen Standards of Othaya Level 6 Hospital Access Roads
32. Rehabilitation of Old Malindi Road, Mombasa County
33. Dualling of Ngong Road (Dagoretti Corner - Karen Roundabout Section)
34. Upgrading of Lucky Summer - Gitwamba - Kasarani Mwiki Road
35. Upgrading to Bitumen Standard of Kwale and Ukunda Township Roads
36. Access to Embu University
37. Opening of Corridor for Gatundu Town Roads
38. Upgrading to Bitumen Standards of Othaya Town Roads
39. Access to Park Road Housing Project

40. Improvement of Maua Town Roads
41. Rehabilitation of Kasarani - Mwiki Road
42. Improvement to Bitumen Standards of Mokowe Township Roads, Lamu County
43. Construction to Bitumen Standards of Rhino Park & other access roads.
44. f Kajiado Town Roads Phase I
45. Upgrading To Bitumen Standards of Roads within East Africa Portland Housing Scheme in Machakos County
46. Jomvu Kuu – Jitoni – Rabai Road
47. Narok Town Roads
48. Improvement of Nairobi Roads Lot 2 (Part of Likoni Road, Enterprise Road and Shreeji Road)
49. Upgrading to Bitumen Standards of Mandera Town Roads Phase II
50. Ruai (Housing Project) Roads
51. Improvement of Affordable
52. Housing Access Roads in Shauri Moyo
53. Kipangaway - Kibowen Pry -Access/Mwiriki Sec School-Pembe Mbili- Eldoret
54. Improvement to Bitumen Standards of A3 Jn - Bulla Madina - Sankuri - Kengen Road in Garissa County
55. Mlolongo - Athi River Joska Road
56. Construction of Ngong Road Footbridges
57. Construction of Access Roads to Maai Mahiu and Suswa SGR Stations
58. Upgrading to Bitumen Standards of Mukuyu - Kambwe - Sewerage Road in Murang'a
59. Rehabilitation of Thika Town roads
60. Eldas Township Roads
61. Upgrading to Bitumen Standards of Nyeri Town Roads
62. Upgrading to Bitumen Standards of Kirinyaga Town Roads
63. Upgrading of Roads in Meru County Headquarters
64. Upgrading to Bitumen Standard of Mombasa Road(Devki)- Kinanie Park/Kinanie Leather Park Machakos County
65. Upgrading to Bitumen Standards of

66. Mwanyani - Katoloni Road
67. Improvement of Access to Kibera Housing Project
68. Rehabilitation of Innercore Estate Roads
69. Upgrading of Tom Mboya Estate Roads
70. Bute Town Roads
71. Banisa Township Roads
72. Upgrading to Bitumen Standards of Tartar Junction-Kamuino Chewoyet-Sakas in West Pokot County
73. Construction of Valley Road/Ngong Road/Nyerere Road Interchange and Upperhill Overpasses
74. Upgrading to Bitumen Standards of Kigumo Town Roads
75. Upgrading of Bitumen Standards of Isiolo Town Roads
76. Tarbaj Town Roads in Wajir County
77. Upgrading to Bitumen Standard of Mariguini (Housing Project) Roads
78. Habaswein Township Roads
79. Homabay Town Roads Phase 1
80. Access to Donholm Phase 8
81. Kisii By-Pass Phase II
82. Improvement of Nakuru Chief's Office - Ndaragu River Road
83. Water Supply-High Point Estate Road
84. Kayahwe-Muchungucha-Gacharu Road
85. Upgrading to Bitumen Standards of Huhi-Rescue Centre Road
86. Upgrading to Bitumen Standards of Moyale Biashara Street
87. Corridor Opening and Upgrading to Bitumen Standards of Goromuda (Moyale Boys Junction - Moyale Water Office) Road
88. MTN-KAG-Grogon-Jakasa Road
89. Kandundu Junction-Kandundu ACK Road
90. Mjini-Chief's Office-Bishop Kairu Road

KeRRA ROAD PROJECTS

1. Rashid – Chebukwabi Grading
2. Kibingei Salvation Army Grading
3. Mapela - Marofu – Onyili Road
4. Moi Girls – Kamusinga Road
5. Kamukuywa – Nakalira Primary School Road
6. Mamukuya – Musembe RC Primary School
7. Mukuyuini – Makunga Road
8. Kahuruko - Abadare Road
9. Kihumbu – Murungaru Road
10. Runo – Masol Road
11. Karati – Mwendandu Road
12. Kaisa – Kalikwon Road
13. Chemakogen Lotongot Road
14. Haraka – Rwanyambo Road
15. Koinange – Munyaka Road
16. Subuku – Makereka Road
17. Totum – Kopoch – Marcha Road
18. Mahihu – Mutanga Road
19. Gakoe – Kaka Road
20. Tamarukwo – Tipet Road
21. Kona – Gathanji Road
22. Kari – Ngano Road
23. Loywokor – Lokna Road
24. Katukumwok- Kongelai Road
25. Nayhururu – Ngomongo Road
26. Cheptumet – Kukumwok Road
27. Ngomongo – Busara Road
28. Busara – Mugetho Road
29. Kanyarkwat – Cheptumet Road
30. Kagaa – Primary – Mawingu Road
31. Rurii – Mukindi – Kariama Road
32. Katopoton Jnct- Cherangan Road
33. Ngorika – Kanjuiri Kanyiriri Road
34. Alale- Kasitet Road
35. Alale – Lengorok Road
36. Mbaruk – Ngorika – Ithagani Road
37. Roliondo – Mawingu Road
38. Orolwo Kompos Road
39. Uhuru – Mawingu Road
40. Magomano – Huhirio Road
41. Ndemi – Miharati Road

42. Konambaya – Satima Road
43. Ndinda – Mumui Road
44. Mumui – Turasha Road
45. Rironi – Kaka Road
46. Wanjohi - Kiambogo Road
47. Kiambigo – Geta Road
48. Munyaka – Matundura – Murungaru Road
49. Siongiroi – Kipsuter Road
50. Asilong – Abongoi Road
51. Kodich – Kakwijit Road
52. Sirwach – Riting Road
53. Kangoletiang – Sirwach Road
54. Konyao – Kongoletiang Road
55. Lokna – Namuro Road
56. Simotwo – Tomena – Muruny Road
57. Ringring – Chorok Road
58. Muruny – Kokoyan Road
59. Kabichbich – Kapkunyuk Road
60. Plalang – Sugut Road
61. Lotongot - Lotiruk Road
62. Nasolot – Talon Road
63. Wakor – Onoch Road
64. Tsawe – Nyaliangi Road
65. Sosiot – Chepkiono – Cheribo Road
66. Sigor – Sangat – Cheptesok Road
67. Kiapamayos - Sekerr Road
68. Loreng – Nakitongo Road
69. Manyanga Usweni Road
70. Oropoi – Nalapatui Road
71. Kilgoris – Geteri Road
72. DB Meru – Gatithini – Sharui Road
73. Kajuki – Makanyanga Road
74. Lokangae – Nasinyono Road
75. Kabuburu – Makutano – Makanyi Road
76. Kamwimbi – Kiathitha Road
77. Maralal – DB West Road
78. Itugururu – Mamwimbi Road
79. Magutuni – Kaare Road
80. Ntulele – Emarti Road
81. Kamanoro – Itangi Road
82. Kaare – Kanthanje Road

- 83. Kakuma – Lokangae Road
- 84. Kwatoto Orus Aquichatis Road
- 85. Kanoro – Makutano Road
- 86. Kaikor – Kokuro Road
- 87. Kaare – Tunyai Road
- 88. Lokore Junct- Nalekan Road
- 89. Kabunga Junct – Marimanti Road
- 90. Kaaling – Kakelae Road
- 91. Kataboi – Nayana Road
- 92. Atapar – Kanukurudio Road
- 93. Lowerengak – Todongany Road
- 94. Nadunga – Lokolio Road
- 95. Mahihu – Mairo Inya Road
- 96. Magenka – Itugururu Road
- 97. Kibugua – Magenka Road
- 98. Kabururu – Kamaende Road
- 99. Ithagani – Ngorika Road
- 100. Munyugu – Kimbo Road
- 101. Turasha – Jura Road
- 102. Jura – Kihumbu Road
- 103. Kibura – Kanoro Road
- 104. Katharaka – Karumi Road

Appendix VI: F-Distribution Table

d.f.N. = degrees of freedom in numerator
d.f.D. = degrees of freedom in denominator

d.f.D.	$\alpha = 0.005$																		
	d.f.N.																		
	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	16211	20000	21615	22500	23056	23437	23715	23925	24091	24224	24426	24630	24836	24940	25044	25148	25253	25359	25465
2	198.5	199.0	199.2	199.2	199.3	199.3	199.4	199.4	199.4	199.4	199.4	199.4	199.4	199.5	199.5	199.5	199.5	199.5	199.5
3	55.55	49.80	47.47	46.19	45.39	44.84	44.43	44.13	43.88	43.69	43.39	43.08	42.78	42.62	42.47	42.31	42.15	41.99	41.83
4	31.33	26.28	24.26	23.15	22.46	21.97	21.62	21.35	21.14	20.97	20.70	20.44	20.17	20.03	19.89	19.75	19.61	19.47	19.32
5	22.78	18.31	16.53	15.56	14.94	14.51	14.20	13.96	13.77	13.62	13.38	13.15	12.90	12.78	12.66	12.53	12.40	12.27	12.14
6	18.63	14.54	12.92	12.03	11.46	11.07	10.79	10.57	10.39	10.25	10.03	9.81	9.59	9.47	9.36	9.24	9.12	9.00	8.88
7	16.24	12.40	10.88	10.05	9.52	9.16	8.89	8.68	8.51	8.38	8.18	7.97	7.75	7.65	7.53	7.42	7.31	7.19	7.08
8	14.69	11.04	9.60	8.81	8.30	7.95	7.69	7.50	7.34	7.21	7.01	6.81	6.61	6.50	6.40	6.29	6.18	6.06	5.95
9	13.61	10.11	8.72	7.96	7.47	7.13	6.88	6.69	6.54	6.42	6.23	6.03	5.83	5.73	5.62	5.52	5.41	5.30	5.19
10	12.83	9.43	8.08	7.34	6.87	6.54	6.30	6.12	5.97	5.85	5.66	5.47	5.27	5.17	5.07	4.97	4.86	4.75	4.64
11	12.23	8.91	7.60	6.88	6.42	6.10	5.86	5.68	5.54	5.42	5.24	5.05	4.86	4.76	4.65	4.55	4.44	4.34	4.23
12	11.75	8.51	7.23	6.52	6.07	5.76	5.52	5.35	5.20	5.09	4.91	4.72	4.53	4.43	4.33	4.23	4.12	4.01	3.90
13	11.37	8.19	6.93	6.23	5.79	5.48	5.25	5.08	4.94	4.82	4.64	4.46	4.27	4.17	4.07	3.97	3.87	3.76	3.65
14	11.06	7.92	6.68	6.00	5.56	5.26	5.03	4.86	4.72	4.60	4.43	4.25	4.06	3.96	3.86	3.76	3.66	3.55	3.44
15	10.80	7.70	6.48	5.80	5.37	5.07	4.85	4.67	4.54	4.42	4.25	4.07	3.88	3.79	3.69	3.58	3.48	3.37	3.26
16	10.58	7.51	6.30	5.64	5.21	4.91	4.69	4.52	4.38	4.27	4.10	3.92	3.73	3.64	3.54	3.44	3.33	3.22	3.11
17	10.38	7.35	6.16	5.50	5.07	4.78	4.56	4.39	4.25	4.14	3.97	3.79	3.61	3.51	3.41	3.31	3.21	3.10	2.98
18	10.22	7.21	6.03	5.37	4.96	4.66	4.44	4.28	4.14	4.03	3.86	3.68	3.50	3.40	3.30	3.20	3.10	2.99	2.87
19	10.07	7.09	5.92	5.27	4.85	4.56	4.34	4.18	4.04	3.93	3.76	3.59	3.40	3.31	3.21	3.11	3.00	2.89	2.78
20	9.94	6.99	5.82	5.17	4.76	4.47	4.26	4.09	3.96	3.85	3.68	3.50	3.32	3.22	3.12	3.02	2.92	2.81	2.69
21	9.83	6.89	5.73	5.09	4.68	4.39	4.18	4.01	3.88	3.77	3.60	3.43	3.24	3.15	3.05	2.95	2.84	2.73	2.61
22	9.73	6.81	5.65	5.02	4.61	4.32	4.11	3.94	3.81	3.70	3.54	3.36	3.18	3.08	2.98	2.88	2.77	2.66	2.55
23	9.63	6.73	5.58	4.95	4.54	4.26	4.05	3.88	3.75	3.64	3.47	3.30	3.12	3.02	2.92	2.82	2.71	2.60	2.48
24	9.55	6.66	5.52	4.89	4.49	4.20	3.99	3.83	3.69	3.59	3.42	3.25	3.06	2.97	2.87	2.77	2.66	2.55	2.43
25	9.48	6.60	5.46	4.84	4.43	4.15	3.94	3.78	3.63	3.54	3.37	3.20	3.01	2.92	2.82	2.72	2.61	2.50	2.38
26	9.41	6.54	5.41	4.79	4.38	4.10	3.89	3.73	3.60	3.49	3.33	3.15	2.97	2.87	2.77	2.67	2.56	2.45	2.33
27	9.34	6.49	5.36	4.74	4.34	4.06	3.85	3.69	3.56	3.45	3.28	3.11	2.93	2.83	2.73	2.63	2.52	2.41	2.29
28	9.28	6.44	5.32	4.70	4.30	4.02	3.81	3.65	3.52	3.41	3.25	3.07	2.89	2.79	2.69	2.59	2.48	2.37	2.25
29	9.23	6.40	5.28	4.66	4.26	3.98	3.77	3.61	3.48	3.38	3.21	3.04	2.86	2.76	2.66	2.56	2.45	2.33	2.24
30	9.18	6.35	5.24	4.62	4.23	3.95	3.74	3.58	3.45	3.34	3.18	3.01	2.82	2.73	2.63	2.52	2.42	2.30	2.18
40	8.83	6.07	4.98	4.37	3.99	3.71	3.51	3.35	3.22	3.12	2.95	2.78	2.60	2.50	2.40	2.30	2.18	2.06	1.93
60	8.49	5.79	4.73	4.14	3.76	3.49	3.29	3.13	3.01	2.90	2.74	2.57	2.39	2.29	2.19	2.08	1.96	1.83	1.69
120	8.18	5.54	4.50	3.92	3.55	3.28	3.09	2.93	2.81	2.71	2.54	2.37	2.19	2.09	1.98	1.87	1.75	1.61	1.43
∞	7.88	5.30	4.28	3.72	3.35	3.09	2.90	2.74	2.62	2.52	2.36	2.19	2.00	1.90	1.79	1.67	1.53	1.36	1.00