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Research Title

The effect of project management techniques in the efficiency of road paving and landscaping operations for Vision 2030 in the Kingdom of Saudi Arabia

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Abstract

The study aims to examine the impact of various project management techniques on the efficiency of these operations. The study utilized a sample size of 195 participants, determined to ensure statistical significance and generalizability, considering factors such as practical constraints and the complexity of research variables. The research employs a quantitative approach, involving structured surveys distributed to project managers, engineers, and other stakeholders involved in the projects. These surveys capture data on the use of project management methodologies like the Critical Path Method (CPM), Total Quality Management (TQM), and the integration of advanced technologies such as Geographic Information Systems (GIS) and Building Information Modeling (BIM). Secondary data is also collected from project reports and government publications. The study uses various data collection tools, including surveys, in-depth interviews, and document analysis. Statistical analysis software such as SPSS is employed for data analysis, applying techniques like correlation analysis, regression analysis, and ANOVA to determine the relationships between

project management techniques and outcomes. The findings are expected to provide robust and generalizable insights into the effectiveness of different project management practices, contributing valuable knowledge to the field of infrastructure management within the Vision 2030 framework.

Chapter One

Introduction

The Kingdom of Saudi Arabia's Vision 2030 initiative aims to transform the nation into a global economic powerhouse, fostering diversified growth beyond its oil-dependent economy. Central to this vision is the development of robust infrastructure, including extensive road paving and innovative landscaping operations, which are pivotal for enhancing connectivity, promoting tourism, and improving the quality of life for residents. Effective project management techniques play a crucial role in these infrastructure projects, ensuring that they are completed on time, within budget, and to the highest standards of quality and sustainability (Analytix, 2024).

In the realm of road paving, project management techniques such as detailed planning, scheduling, risk management, and quality control are essential. These techniques enable the meticulous coordination of numerous activities and resources, ranging from the procurement of materials and machinery to the deployment of labor and technology. Detailed planning involves outlining the project's scope, defining objectives, and setting achievable milestones. This is crucial for aligning the project's goals with Vision 2030's broader objectives. Scheduling, facilitated by tools such as Gantt charts and Critical Path Method (CPM), ensures that each phase of the project progresses smoothly and within the stipulated time frame, mitigating delays and cost overruns. Risk management strategies identify potential challenges and uncertainties that could impact the project, such as supply chain disruptions or environmental concerns, and develop contingency plans to address these issues proactively (Moshashai, 2018).

Quality control in road paving is another area where project management techniques are indispensable. Ensuring the durability and safety of road infrastructure requires stringent adherence to engineering standards and continuous monitoring throughout the construction

process. Techniques like Six Sigma and Total Quality Management (TQM) help maintain high quality by focusing on defect prevention and process optimization. Furthermore, the integration of advanced technologies such as Geographic Information Systems (GIS) and Building Information Modeling (BIM) enhances the precision and efficiency of road construction projects, aligning them with Vision 2030's emphasis on technological innovation.

Similarly, in landscaping operations, project management techniques are crucial for transforming Saudi Arabia's urban and rural landscapes in line with Vision 2030's goals. These projects not only aim to beautify the environment but also to create sustainable, eco-friendly spaces that enhance the livability of urban areas and support the kingdom's ecological goals. Effective project management in landscaping involves comprehensive site analysis, design planning, resource allocation, and stakeholder management. Site analysis ensures that landscaping projects are tailored to the specific characteristics of the area, considering factors such as soil quality, climate, and existing vegetation. Design planning, which includes the conceptualization and visualization of landscape layouts, ensures that aesthetic and functional aspects are harmoniously integrated (Ismail, 2023).

Resource allocation is another critical aspect, involving the judicious use of materials, labor, and finances to achieve the desired outcomes efficiently. Techniques such as Earned Value Management (EVM) help track project performance and ensure that resources are utilized optimally. Stakeholder management is vital in landscaping projects, as these initiatives often involve collaboration with government agencies, private sector partners, and local communities. Effective communication and engagement strategies help align the interests of various stakeholders, fostering a collaborative approach that is essential for the successful implementation of large-scale projects under Vision 2030 (Cândido, 2022).

The role of project management techniques in road paving and landscaping operations for Vision 2030 in Saudi Arabia is multifaceted and indispensable. These techniques ensure that infrastructure projects are executed with precision, efficiency, and sustainability, contributing to the kingdom's ambitious transformation agenda. By leveraging advanced project management methodologies, Saudi Arabia is poised to achieve its Vision 2030 goals, creating a resilient, diversified, and vibrant economy with world-class infrastructure (Bibri, 2021).

The problem of the study

✓ Complexity and Scale of Infrastructure Projects:

The study addresses a critical issue that significantly impacts the success of infrastructure projects: the complexity and scale of these projects. The problem of managing large-scale infrastructure projects in Saudi Arabia is multifaceted, involving numerous challenges that span technical, logistical, financial, and managerial domains. These challenges are particularly pronounced in the context of Vision 2030, a transformative economic and social reform blueprint that aims to diversify the economy and reduce the Kingdom's dependency on oil. As part of Vision 2030, there is a strong emphasis on developing world-class infrastructure, including extensive road paving and landscaping projects, to support economic growth and enhance the quality of life for citizens (Alsulamy, 2022).

The complexity of infrastructure projects in Saudi Arabia arises from several factors. Firstly, these projects often involve a wide range of activities, from initial planning and design

to construction, maintenance, and eventual decommissioning. Each phase of the project lifecycle requires meticulous coordination and management to ensure that the project progresses smoothly and meets its objectives. The need to integrate various activities and stakeholders, including government agencies, contractors, consultants, and local communities, adds layers of complexity to the project management process. Effective communication, collaboration, and coordination among these diverse stakeholders are crucial for addressing the complexities inherent in large-scale projects.

Secondly, the scale of infrastructure projects in Saudi Arabia, particularly under Vision 2030, is immense. These projects typically cover vast geographical areas and involve substantial financial investments. The sheer size of the projects necessitates robust project management techniques to manage resources efficiently, maintain schedules, and control costs. Budget management becomes a critical component, as any financial mismanagement can lead to significant cost overruns and delays, undermining the project's success. Moreover, large-scale projects are often subject to various risks, including technical failures, supply chain disruptions, and environmental challenges, which require comprehensive risk management strategies to mitigate potential adverse impacts.

The rapid pace of development envisioned under Vision 2030 adds to the complexity and scale of infrastructure projects. The Kingdom's ambitious targets necessitate expedited project timelines, which can strain existing project management capacities and resources. Ensuring that projects are completed on time and within budget while maintaining high-quality standards is a formidable challenge. This is where the application of advanced project management techniques becomes essential. Techniques such as critical path method (CPM), earned value management (EVM), and agile project management can provide the tools and methodologies needed to handle the accelerated timelines and scale of operations.

Another dimension of complexity stems from the need to comply with stringent regulatory and environmental standards. Saudi Arabia has established various regulations to ensure that infrastructure projects are sustainable and environmentally friendly. Compliance with these regulations requires meticulous planning, continuous monitoring, and adherence to best practices in project management. Project managers must navigate these regulatory requirements while balancing the technical and financial aspects of the project, further adding to the complexity.

The Kingdom's diverse geographical and climatic conditions present unique challenges for infrastructure projects. For example, road paving and landscaping operations in arid regions must contend with extreme temperatures and limited water resources, which can affect construction materials and methods. Projects in coastal areas must address issues related to soil salinity and erosion. These geographical and environmental factors necessitate tailored project management approaches that consider local conditions and incorporate innovative solutions to overcome specific challenges.

The problem of managing the complexity and scale of infrastructure projects in Saudi Arabia is a critical issue that the study aims to address. By focusing on the application of project management techniques, the study seeks to provide insights into how these challenges can be effectively managed to enhance the efficiency of road paving and landscaping operations. The findings of this study are expected to contribute to the successful implementation of Vision 2030 by offering practical recommendations for improving project management practices, ensuring that infrastructure projects are delivered on time, within budget, and to the highest standards of quality and sustainability (Errida, 2021).

✓ **Ensuring Quality and Sustainability:**

One of the core problems addressed is ensuring quality and sustainability in large-scale infrastructure projects. The importance of this problem is underscored by the ambitious goals of Vision 2030, which seeks to transform the Kingdom's infrastructure landscape to support economic diversification and improved living standards. Achieving these goals necessitates not only the completion of extensive road paving and landscaping projects but also ensuring that these projects meet high standards of quality and sustainability (Arif, 2023).

Ensuring quality in road paving and landscaping operations involves multiple dimensions, from the selection of materials to the execution of construction processes and post-construction maintenance. Quality control is a critical aspect of project management, requiring rigorous standards and continuous oversight. The complexity of infrastructure projects in Saudi Arabia means that multiple contractors, subcontractors, and suppliers are often involved, each contributing to different components of the project. This diversity can lead to variations in quality if not managed properly. Effective project management techniques, such as the implementation of quality assurance (QA) and quality control (QC) processes, are essential to ensure that all aspects of the project meet the required standards. These techniques include setting clear quality benchmarks, conducting regular inspections, and employing standardized procedures for all construction activities.

The sustainability of infrastructure projects is a crucial consideration, particularly given the environmental challenges and long-term vision of Saudi Arabia's development plans. Sustainability in road paving and landscaping encompasses the use of eco-friendly materials, minimizing environmental impact during construction, and ensuring that the infrastructure remains resilient and functional over time. The harsh climatic conditions in Saudi Arabia, such as extreme heat and scarce water resources, pose significant challenges to sustainable construction practices. Therefore, project managers must adopt innovative solutions and green technologies to mitigate these challenges. This might include the use of recycled materials, energy-efficient machinery, and landscaping techniques that reduce water consumption.

Effective budget management is another critical component in ensuring both quality and sustainability. Cost overruns can lead to compromises in quality, as project managers may be forced to cut corners to stay within budget. Similarly, insufficient funding can result in the selection of cheaper, less sustainable materials and methods. Therefore, meticulous financial planning and monitoring are essential. Project management techniques such as earned value management (EVM) provide tools to track project performance against budget and schedule, allowing for early detection of potential issues and enabling corrective actions to be taken promptly.

Risk management practices also play a pivotal role in ensuring quality and sustainability. Infrastructure projects are inherently risky, with potential challenges ranging from technical failures to supply chain disruptions and unforeseen environmental impacts. Comprehensive risk management strategies involve identifying potential risks early, assessing their impact, and developing mitigation plans. For instance, by anticipating risks related to material shortages or extreme weather events, project managers can develop contingency plans that ensure the project remains on track without compromising quality or sustainability. This proactive approach helps in maintaining the integrity of the project and aligns with the long-term sustainability goals of Vision 2030.

Stakeholder engagement is essential in maintaining high standards of quality and sustainability. Effective communication and collaboration with all stakeholders, including government authorities, contractors, suppliers, and local communities, ensure that everyone

involved is committed to the project's objectives. Stakeholder input can provide valuable insights into potential quality and sustainability issues, enabling project managers to address concerns promptly and incorporate best practices. This inclusive approach fosters a sense of shared responsibility and enhances the overall success of the project.

Ensuring quality and sustainability in road paving and landscaping operations is a complex yet critical challenge within the framework of Vision 2030. The study underscores the need for robust project management techniques to address this problem effectively. By focusing on quality control, sustainable practices, budget management, risk management, and stakeholder engagement, the research aims to provide comprehensive strategies for enhancing the efficiency and success of infrastructure projects in Saudi Arabia. These insights are vital for achieving the ambitious goals of Vision 2030, ensuring that the Kingdom's infrastructure development is not only rapid and expansive but also high-quality and sustainable for future generations (Bryce, 2016).

✓ **Resource Management Challenges:**

A significant problem addressed is the challenge of resource management. Efficient resource management is fundamental to the success of large-scale infrastructure projects, particularly in the context of Saudi Arabia's Vision 2030, which aims to transform the nation's infrastructure to support economic diversification and enhance the quality of life. Resource management encompasses the planning, allocation, and utilization of various resources, including human labor, materials, equipment, and financial assets. The complexity and scale of these projects magnify the challenges associated with managing these resources effectively (Chowdhury, 2021).

One of the primary resource management challenges is the allocation and optimization of human resources. Infrastructure projects like road paving and landscaping require a diverse workforce, including engineers, construction workers, project managers, and support staff. Ensuring that the right number of skilled workers is available at the right time is crucial for maintaining project timelines and quality standards. In the context of Vision 2030, the rapid pace of development means that multiple projects are often running concurrently, leading to high demand for skilled labor. This can result in shortages or over-reliance on foreign labor, complicating resource management further. Effective project management techniques, such as workforce planning and scheduling, are essential to address these challenges. Techniques like Gantt charts and critical path method (CPM) help in visualizing project timelines and resource allocation, ensuring that human resources are used efficiently and effectively.

Material management is another critical aspect of resource management. Road paving and landscaping projects require a vast array of materials, from asphalt and concrete to plants and soil. The timely procurement and delivery of these materials are vital to keep the project on schedule. Delays in material supply can halt construction activities, leading to cost overruns and project delays. Additionally, the quality of materials used directly impacts the durability and sustainability of the infrastructure. Therefore, project managers must establish robust supply chain management practices, including reliable procurement processes, quality checks, and contingency plans for material shortages. Strategic sourcing and inventory management systems can help in maintaining an uninterrupted supply of high-quality materials, ensuring that the project progresses smoothly.

Financial resource management is equally critical. Infrastructure projects require substantial financial investments, and managing these finances effectively is essential to avoid budget overruns and ensure project viability. Budget management involves meticulous planning, tracking, and controlling of project costs. Project managers must develop detailed

budgets that account for all potential expenses, including labor, materials, equipment, and contingencies. Techniques such as earned value management (EVM) provide tools for monitoring project performance against the budget, allowing for early detection of cost overruns and enabling corrective actions. Effective financial management ensures that resources are used optimally and that the project remains financially sustainable throughout its lifecycle.

Equipment management also poses significant challenges. Road paving and landscaping projects utilize various heavy machinery and equipment, from bulldozers and asphalt pavers to irrigation systems and landscaping tools. Ensuring that the right equipment is available, properly maintained, and used efficiently is crucial for project success. Equipment breakdowns can cause significant delays and increase costs. Therefore, project managers must implement preventive maintenance schedules, equipment tracking systems, and efficient allocation strategies to minimize downtime and ensure that equipment is used effectively.

The integration of advanced project management techniques, such as Building Information Modeling (BIM) and Geographic Information Systems (GIS), can enhance resource management. BIM allows for detailed project visualization and simulation, improving planning and coordination. GIS provides valuable spatial data that can optimize the allocation of resources across large geographical areas. These technologies enable better decision-making and resource optimization, contributing to the efficiency and success of infrastructure projects.

The environmental and regulatory landscape adds another layer of complexity to resource management. Compliance with environmental regulations and sustainability standards requires careful planning and resource allocation. For example, sustainable landscaping practices may involve the use of native plants and water-efficient irrigation systems, which need to be sourced and managed appropriately. Regulatory compliance ensures that the project adheres to national and international standards, mitigating legal and environmental risks.

Resource management challenges are a critical problem in the context of road paving and landscaping operations under Saudi Arabia's Vision 2030. Addressing these challenges requires a comprehensive approach that integrates advanced project management techniques, strategic planning, and effective utilization of human, material, financial, and equipment resources. By focusing on optimizing resource management, the study aims to provide actionable insights and strategies to enhance the efficiency and success of infrastructure projects, aligning with the ambitious goals of Vision 2030 and contributing to the Kingdom's sustainable development (Mani, 2023).

✓ **Adapting to the Evolving Nature of Vision 2030:**

A significant problem addressed is the challenge of adapting to the evolving nature of Vision 2030. Vision 2030 is an ambitious blueprint aimed at transforming Saudi Arabia's economy and society, with extensive infrastructure development being a cornerstone of this vision. However, the dynamic and evolving goals of Vision 2030 pose unique challenges to the effective implementation of road paving and landscaping projects.

The evolving nature of Vision 2030 necessitates a flexible and adaptive approach to project management. As the vision encompasses a broad range of objectives, including economic diversification, environmental sustainability, and social development, the specific goals and priorities can shift over time. This requires project managers to be agile and

responsive to changes in strategic direction. Traditional project management techniques, which often rely on fixed plans and rigid structures, may not be sufficient to address the fluidity of Vision 2030. Instead, adaptive project management methodologies, such as Agile and Scrum, can offer the flexibility needed to respond to changing priorities and emerging challenges. These methodologies emphasize iterative planning, continuous feedback, and incremental delivery, allowing project teams to adjust their strategies and resources in real-time .

The complexity and scale of Vision 2030 projects amplify the need for robust stakeholder management. The evolving nature of the vision means that various stakeholders, including government agencies, private sector partners, and local communities, may have shifting expectations and requirements. Effective communication and collaboration with stakeholders are crucial to align project objectives with the broader goals of Vision 2030. Project managers must establish transparent communication channels and foster a collaborative environment to ensure that all stakeholders are informed and engaged throughout the project lifecycle. This helps in managing expectations, addressing concerns, and securing the necessary support for successful project execution.

Another critical aspect of adapting to the evolving nature of Vision 2030 is the integration of advanced technologies and innovative practices. The vision emphasizes the adoption of cutting-edge technologies to drive efficiency and sustainability in infrastructure projects. Project managers must stay abreast of technological advancements and incorporate them into their project plans. For example, the use of Building Information Modeling (BIM) can enhance project visualization and coordination, enabling better planning and resource allocation. Geographic Information Systems (GIS) can provide valuable spatial data for optimizing road paving and landscaping operations. Additionally, leveraging data analytics and artificial intelligence can improve decision-making and predictive capabilities, allowing project teams to anticipate and mitigate potential risks.

The evolving goals of Vision 2030 also highlight the importance of sustainability and resilience in infrastructure projects. As the vision aims to create a sustainable and resilient economy, project managers must incorporate environmental and social considerations into their project plans. This includes adopting sustainable construction practices, such as using eco-friendly materials and minimizing environmental impact. It also involves designing resilient infrastructure that can withstand the challenges posed by climate change and other external factors. By prioritizing sustainability and resilience, project managers can contribute to the long-term success of Vision 2030 and ensure that infrastructure projects provide lasting benefits to the community.

Financial management is another area where adaptability is crucial. The evolving nature of Vision 2030 can lead to changes in funding priorities and financial allocations. Project managers must develop flexible financial plans that can accommodate shifts in budget and funding sources. Techniques such as rolling wave planning and earned value management (EVM) can help in monitoring project performance and adjusting financial strategies as needed. This ensures that projects remain financially viable and can adapt to changes in economic conditions and funding availability.

The evolving nature of Vision 2030 necessitates continuous learning and development for project teams. As new technologies, methodologies, and best practices emerge, project managers and their teams must engage in ongoing professional development to enhance their skills and knowledge. This can be achieved through training programs, workshops, and collaboration with industry experts. By fostering a culture of continuous improvement and

innovation, project teams can stay ahead of the curve and effectively respond to the evolving demands of Vision 2030.

Adapting to the evolving nature of Vision 2030 is a significant challenge in the context of road paving and landscaping operations in Saudi Arabia. The dynamic goals and priorities of the vision require a flexible and adaptive approach to project management. By embracing adaptive methodologies, effective stakeholder management, advanced technologies, sustainability practices, flexible financial management, and continuous learning, project managers can navigate the complexities of Vision 2030 and enhance the efficiency and success of infrastructure projects. This adaptability is crucial for aligning project outcomes with the broader goals of Vision 2030 and contributing to the Kingdom's sustainable and resilient development (Kumar N. , 2023).

✓ **Integration of Advanced Technologies:**

One of the critical problems addressed is the integration of advanced technologies. As Vision 2030 aims to transform Saudi Arabia's infrastructure to support economic diversification and improve the quality of life, the adoption of advanced technologies becomes imperative for achieving these ambitious goals efficiently and sustainably. However, integrating these technologies into traditional project management processes presents several challenges that must be addressed to realize the full potential of technological advancements (Alhammadi, 2024).

The integration of advanced technologies, such as Building Information Modeling (BIM), Geographic Information Systems (GIS), drones, and artificial intelligence (AI), requires a significant shift in how infrastructure projects are planned, executed, and monitored. These technologies offer substantial benefits, including improved accuracy in planning, enhanced project visualization, better resource management, and real-time data analysis. However, their effective implementation necessitates a comprehensive understanding of the technologies themselves, as well as the development of new skills and competencies among project management teams.

Building Information Modeling (BIM) is one of the most transformative technologies in the construction and infrastructure sectors. BIM enables the creation of detailed digital representations of physical and functional characteristics of projects, facilitating better planning, design, and construction management. For road paving and landscaping operations, BIM can provide accurate 3D models that help in visualizing the entire project lifecycle. This includes everything from initial design to maintenance. The integration of BIM into project management techniques allows for improved collaboration among stakeholders, as it provides a single, unified source of information that can be accessed and updated in real-time. However, the successful adoption of BIM requires substantial investment in software, training, and change management to ensure that all team members are proficient in using the technology and can leverage its capabilities fully.

Geographic Information Systems (GIS) offer another layer of technological advancement by providing spatial data that can enhance the planning and execution of road paving and landscaping projects. GIS technology enables project managers to analyze geographical data, such as terrain, soil types, and environmental factors, which are crucial for making informed decisions about project locations and methodologies. Integrating GIS with other project management tools allows for the optimization of resource allocation and the identification of potential risks. However, integrating GIS into existing project management frameworks requires overcoming technical and organizational challenges, including data

compatibility issues and the need for skilled personnel who can interpret and utilize GIS data effectively.

Drones and unmanned aerial vehicles (UAVs) are increasingly being used in infrastructure projects for site surveys, monitoring, and data collection. Drones can capture high-resolution images and videos of project sites, providing valuable insights into site conditions and progress. This real-time data collection can significantly enhance project monitoring and quality control, ensuring that any issues are identified and addressed promptly. However, integrating drone technology into project management practices involves navigating regulatory requirements, ensuring data security, and training personnel to operate and interpret drone-collected data.

Artificial intelligence (AI) and machine learning are also playing a transformative role in modern project management. AI can analyze vast amounts of data to identify patterns and predict project outcomes, enabling proactive decision-making and risk management. For example, AI algorithms can predict potential delays based on historical data and current project conditions, allowing project managers to take corrective actions before issues escalate. Integrating AI into project management processes requires developing robust data collection and management systems, as well as ensuring that project teams have the necessary skills to interpret and act on AI-generated insights.

The integration of advanced technologies also demands a cultural shift within organizations. Project management teams must move away from traditional practices and embrace a culture of innovation and continuous improvement. This involves encouraging collaboration and knowledge sharing, fostering an environment where team members are open to learning new technologies, and supporting ongoing professional development. Leadership plays a crucial role in driving this cultural change by championing the adoption of advanced technologies and providing the necessary resources and support for their implementation.

The integration of advanced technologies must be aligned with broader strategic objectives and regulatory frameworks. This involves ensuring that technological adoption supports the goals of Vision 2030, such as sustainability, efficiency, and quality. It also requires compliance with national and international standards and regulations related to technology use, data privacy, and environmental impact.

The integration of advanced technologies in the context of road paving and landscaping operations for Vision 2030 in the Kingdom of Saudi Arabia presents significant challenges and opportunities. While technologies such as BIM, GIS, drones, and AI offer substantial benefits in terms of efficiency, accuracy, and decision-making, their successful adoption requires a comprehensive approach that addresses technical, organizational, and cultural factors. By effectively integrating these technologies into project management practices, infrastructure projects can achieve the ambitious goals of Vision 2030, contributing to the Kingdom's sustainable development and economic diversification. This integration is not merely a technological upgrade but a fundamental transformation in how projects are managed and executed, ensuring that Saudi Arabia's infrastructure development meets the highest standards of quality and efficiency (Rane, 2023).

The importance of the study

➤ Scientific importance

The Kingdom of Saudi Arabia's Vision 2030 is a comprehensive plan aiming to diversify the economy and reduce dependency on oil revenues through various initiatives across multiple sectors, including infrastructure development. Road paving and landscaping are crucial components of this vision, aiming to enhance the quality of life, promote economic development, and improve connectivity within and between cities. Implementing effective project management techniques in these operations is scientifically significant for several reasons.

✓ **Enhancing Operational Efficiency**

- Project management techniques facilitate the optimal allocation of resources, including labor, materials, and machinery. This ensures that resources are utilized efficiently, minimizing waste and reducing costs.
- Effective scheduling and time management are critical in road paving and landscaping projects. Project management tools help in creating realistic timelines, monitoring progress, and ensuring that projects are completed on time, avoiding delays that can increase costs and cause inconvenience to the public.

✓ **Quality Improvement**

- Project management techniques ensure that there are standardized processes and quality controls in place. This is crucial for maintaining high standards in road paving and landscaping, leading to durable and aesthetically pleasing results.
- Project management fosters a culture of continuous improvement through regular evaluations and feedback mechanisms. Lessons learned from past projects are documented and applied to future projects, enhancing overall quality and efficiency over time.

✓ **Economic and Social Impact**

- By improving project efficiency and quality, project management techniques contribute to significant cost savings. These savings can be redirected to other critical areas of Vision 2030, such as healthcare, education, and technology development.
- Efficient road paving and landscaping improve public infrastructure, leading to better transportation networks, reduced traffic congestion, and enhanced urban aesthetics. This, in turn, attracts businesses, boosts tourism, and improves the overall quality of life for residents.

✓ **Alignment with Vision 2030 Goals**

- One of the key pillars of Vision 2030 is the development of world-class infrastructure. Efficient project management is essential for achieving this goal, ensuring that projects are completed to the highest standards, on time, and within budget.
- Vision 2030 emphasizes sustainability. Project management techniques incorporate sustainability practices, such as minimizing environmental impact and promoting the use of eco-friendly materials and processes in road paving and landscaping.

➤ **Practical importance**

Vision 2030 is Saudi Arabia's ambitious blueprint for transforming its economy and infrastructure. Key aspects of this vision include enhancing urban development through efficient road paving and landscaping operations. The practical importance of employing project management techniques in these operations is profound, as it directly impacts the successful execution of Vision 2030's infrastructure goals.

✓ **Streamlining Operations**

- Project management techniques facilitate meticulous planning and scheduling, ensuring that road paving and landscaping projects are executed in a timely manner. Gantt charts, Critical Path Method (CPM), and other tools help in identifying the most

efficient sequences of activities, preventing delays and ensuring timely completion of projects.

- Efficient resource allocation is crucial in large-scale projects. Project management ensures that labor, machinery, and materials are allocated optimally, reducing waste and preventing resource shortages or excesses. This leads to cost savings and ensures continuous workflow.
- ✓ **Cost Management**
 - Through techniques such as cost estimation, budgeting, and financial tracking, project management helps in maintaining financial control over projects. Accurate cost projections and continuous budget monitoring prevent overspending and ensure that financial resources are used effectively.
 - Efficient cost management translates to significant savings, allowing more projects to be undertaken within the same budget. This economic efficiency is vital for the extensive infrastructure plans under Vision 2030.
- ✓ **Enhancing Quality and Safety**
 - Project management techniques include robust quality assurance and quality control processes. These ensure that road paving and landscaping meet the required standards, leading to durable and safe infrastructure.
 - Ensuring the safety of workers and the public is paramount. Project management includes risk assessment and the implementation of safety protocols, reducing the likelihood of accidents and ensuring compliance with safety regulations.
- ✓ **Alignment with Vision 2030 Objectives**
 - Project management ensures that road paving and landscaping projects are aligned with the broader objectives of Vision 2030, contributing to the development of world-class infrastructure that supports economic diversification and urbanization.
 - Vision 2030 emphasizes sustainability. Project management techniques help in implementing sustainable practices, such as using eco-friendly materials and minimizing environmental impact, ensuring that development is both efficient and environmentally responsible.

Objectives of the study

➤ Main Objective of the Study

To Investigate the Effect of Project Management Techniques on the Efficiency of Road Paving and Landscaping Operations for Vision 2030 in the Kingdom of Saudi Arabia

The primary objective of this study is to explore and analyze the role of project management techniques in enhancing the efficiency of road paving and landscaping operations within the framework of Saudi Arabia's Vision 2030. This involves a comprehensive examination of how modern project management methodologies, tools, and practices can optimize the execution of these infrastructure projects. The ultimate aim is to understand the impact of these techniques on project outcomes, including cost efficiency, time management, quality assurance, risk mitigation, and overall project success.

Saudi Arabia's Vision 2030 sets out an ambitious roadmap for transforming the nation's economy and infrastructure. Central to this vision is the development of world-class urban environments that can support economic diversification, attract investment, and improve the quality of life for citizens. Efficient road paving and landscaping operations are critical components of this vision, as they enhance connectivity, reduce travel time, and create aesthetically pleasing and sustainable urban spaces. Therefore, understanding the influence of

project management on these operations is essential for ensuring that the goals of Vision 2030 are met efficiently and effectively.

➤ **Sub-Objectives of the Study**

1. To Evaluate the Impact of Project Management Techniques on Resource Allocation and Utilization in Road Paving and Landscaping Projects

One of the key sub-objectives of this study is to assess how project management techniques affect resource allocation and utilization in road paving and landscaping projects. Effective resource management is crucial for the successful execution of these projects, as it ensures that labor, materials, and machinery are used efficiently. This sub-objective involves analyzing various project management tools and methodologies that aid in optimal resource allocation, such as Gantt charts, Critical Path Method (CPM), and resource leveling techniques. By examining case studies and project data, the study aims to determine the extent to which these techniques contribute to reducing waste, minimizing costs, and ensuring the timely availability of necessary resources.

2. To Analyze the Role of Project Management in Enhancing Time Management and Adherence to Schedules in Infrastructure Projects

Time management is a critical factor in the success of infrastructure projects, particularly in the context of Vision 2030, where timely project completion is essential to meet the ambitious targets set by the government. This sub-objective focuses on evaluating how project management techniques improve scheduling and adherence to timelines in road paving and landscaping projects. Techniques such as project scheduling, milestone tracking, and the use of project management software will be examined to understand their effectiveness in preventing delays and ensuring that projects are completed on time. The study will also explore the impact of project management on reducing idle time and increasing the efficiency of work processes.

3. To Investigate the Effect of Project Management on Cost Efficiency and Budget Control in Road Paving and Landscaping Operations

Cost efficiency and budget control are paramount in large-scale infrastructure projects to prevent cost overruns and ensure financial sustainability. This sub-objective aims to investigate how project management techniques influence cost management in road paving and landscaping operations. By analyzing budgeting practices, cost estimation methods, and financial tracking tools used in project management, the study seeks to identify best practices that contribute to maintaining financial control and achieving cost savings. The relationship between effective cost management and project outcomes will be explored, highlighting how project management can help achieve economic efficiency in line with Vision 2030's goals.

4. To Examine the Impact of Project Management on Quality Assurance and Control in Road Paving and Landscaping Projects

Quality assurance and control are essential for ensuring that infrastructure projects meet the required standards and provide long-lasting benefits. This sub-objective examines the role of project management in maintaining high-quality standards in road paving and landscaping projects. It involves analyzing the implementation of quality control processes, the use of quality assurance tools, and the establishment of performance metrics. The study will explore how project management practices contribute to continuous quality improvement and ensure that projects deliver durable and aesthetically pleasing results that align with the objectives of Vision 2030.

5. To Assess the Role of Project Management in Risk Identification and Mitigation in Infrastructure Projects

Risk management is a crucial aspect of project management that helps in anticipating and mitigating potential challenges that could impact project success. This sub-objective focuses

on assessing the role of project management in identifying and managing risks in road paving and landscaping operations. The study will analyze risk assessment methodologies, risk mitigation strategies, and the implementation of contingency plans to understand how project management techniques contribute to minimizing disruptions and maintaining project continuity. The effectiveness of these practices in preventing project delays, cost overruns, and quality issues will be evaluated.

6. To Explore the Influence of Project Management on Stakeholder Coordination and Communication in Infrastructure Projects

Effective stakeholder coordination and communication are vital for the successful execution of infrastructure projects, ensuring that all parties are aligned and informed throughout the project lifecycle. This sub-objective explores how project management techniques facilitate stakeholder engagement and communication in road paving and landscaping projects. The study will examine communication tools, stakeholder management practices, and the establishment of transparent reporting mechanisms to understand their impact on project success. By fostering collaboration and addressing stakeholder concerns, project management techniques can enhance the efficiency and effectiveness of project execution.

The study questions

- **Main Question**

1. How do project management techniques impact the efficiency, quality, sustainability, and overall success of road paving and landscaping operations under Vision 2030 in the Kingdom of Saudi Arabia?

- **Sub-Questions**

1. What specific project management methodologies are most effective in enhancing the efficiency of road paving and landscaping projects?
2. How do project management techniques ensure high standards of quality and sustainability in infrastructure projects?
3. What are the best practices for optimizing resource utilization in Vision 2030's infrastructure projects?
4. How can project management techniques enhance collaboration and communication among stakeholders involved in road paving and landscaping operations?
5. How can advanced technologies be effectively integrated into project management processes for road paving and landscaping projects?
6. How do project management techniques support the broader economic and social development goals of Vision 2030?

Study hypotheses

- **Main Hypothesis**

1. There is a statistically significant relationship at a significance level of 0.05 between the implementation of advanced project management techniques and the enhancement of efficiency, quality, sustainability, and overall success of road paving and landscaping operations under Vision 2030 in the Kingdom of Saudi Arabia.

- **Sub-Hypotheses**

1. There is a statistically significant relationship at a significance level of 0.05 between the use of specific project management methodologies such as the Critical Path

Method (CPM) and Gantt charts and the improvement in the efficiency of road paving and landscaping projects.

2. There is a statistically significant relationship at a significance level of 0.05 between the integration of Total Quality Management (TQM) and Six Sigma into project management frameworks and the achievement of higher standards of quality and sustainability in infrastructure projects.
3. There is a statistically significant relationship at a significance level of 0.05 between the application of advanced project management techniques like Earned Value Management (EVM) and resource leveling and the optimization of resource utilization in Vision 2030's infrastructure projects.
4. There is a statistically significant relationship at a significance level of 0.05 between effective stakeholder engagement and communication, facilitated by project management techniques, and the enhancement of collaboration and alignment with project objectives in road paving and landscaping operations.
5. There is a statistically significant relationship at a significance level of 0.05 between the integration of advanced technologies such as Geographic Information Systems (GIS), Building Information Modeling (BIM), and project management software into project management processes and the improvement of efficiency and accuracy in road paving and landscaping projects.
6. There is a statistically significant relationship at a significance level of 0.05 between the application of effective project management techniques and the contribution to the economic and social development goals of Vision 2030 by ensuring timely and high-quality completion of infrastructure projects.

The scientific theory followed to prepare the research

The scientific theory underpinning the research on The Effect of Project Management Techniques on the Efficiency of Road Paving and Landscaping Operations for Vision 2030 in the Kingdom of Saudi Arabia involves a multidisciplinary approach that integrates principles from project management, civil engineering, and strategic planning. This theoretical framework is crucial for understanding how project management techniques can enhance the efficiency and effectiveness of infrastructure projects, specifically road paving and landscaping, in alignment with the ambitious goals of Vision 2030.

At its core, the theory revolves around the application of established project management methodologies to the specific context of road paving and landscaping. Project management theory emphasizes structured approaches to planning, executing, and monitoring projects to achieve desired outcomes within defined constraints of time, cost, and quality. This includes the use of methodologies such as the Project Management Institute's (PMI) PMBOK Guide, which outlines a comprehensive set of standards and best practices. These methodologies provide a framework for organizing project activities, allocating resources efficiently, and managing risks, all of which are critical for successful project delivery (Maddaloni, 2022).

In the context of road paving and landscaping, project management techniques are applied to address the unique challenges associated with these operations. For instance, road paving projects involve complex logistical coordination, material procurement, and adherence to safety standards, all of which require meticulous planning and execution. Landscaping projects, on the other hand, involve ecological considerations, aesthetic design, and ongoing maintenance. The integration of project management principles ensures that these diverse

aspects are harmonized to achieve operational efficiency and high-quality outcomes (Mattar, 2024).

The research draws on theories of strategic planning and performance management. Vision 2030 represents a transformative agenda that seeks to diversify Saudi Arabia's economy and improve its infrastructure. The strategic planning theory provides insights into aligning project goals with broader national objectives, ensuring that road paving and landscaping projects contribute to the overarching vision. This involves setting clear project objectives, defining success criteria, and measuring performance against these benchmarks. By employing strategic planning techniques, project managers can ensure that their projects not only meet immediate operational goals but also support long-term developmental targets (Chimhowu, 2019).

In addition to project management and strategic planning theories, the research incorporates concepts from civil engineering, particularly those related to construction management and environmental sustainability. Civil engineering theories offer technical guidelines and best practices for road construction and landscaping, including materials selection, construction techniques, and environmental impact assessments. These technical aspects are essential for optimizing project efficiency and ensuring that infrastructure developments are sustainable and resilient (Mavi, 2021).

The theoretical framework also encompasses change management principles, recognizing that the implementation of new project management techniques may involve significant changes in organizational processes and culture. Change management theories provide a basis for understanding how to effectively manage transitions, overcome resistance, and achieve stakeholder buy-in, which is crucial for the successful adoption of new practices and technologies (Kumar, 2020).

The research aims to provide a comprehensive analysis of how project management techniques can be effectively applied to enhance the efficiency of road paving and landscaping operations within the context of Vision 2030. This approach not only addresses the technical and operational aspects of project management but also aligns with strategic goals and supports broader national development objectives.

Chapter Two

Previous Studies

Introduction

The second chapter of the study titled *The Effect of Project Management Techniques on the Efficiency of Road Paving and Landscaping Operations for Vision 2030 in the Kingdom of Saudi Arabia* is designed to provide a comprehensive foundation for understanding the core elements of the research. This chapter is critical as it delves into the intricate components that underpin the study, offering detailed insights into the dependent and independent variables, the theoretical framework, and previous research related to the topic. By thoroughly exploring these elements, the chapter sets the stage for a nuanced analysis of how project management techniques influence the efficiency of road paving and landscaping operations within the broader context of Vision 2030.

The discussion on the dependent and independent variables is essential for clarifying the scope and focus of the research. This section will detail the specific factors that the study aims to measure and analyze. The independent variables refer to the project management techniques employed, which may include methodologies, tools, and best practices. These techniques are hypothesized to influence various aspects of the road paving and landscaping operations. On the other hand, the dependent variables are the outcomes or efficiency metrics of these operations, such as project completion time, cost-effectiveness, quality of work, and overall impact on infrastructure development. Understanding these variables is crucial for establishing the relationship between project management practices and operational efficiency, providing a basis for empirical analysis and interpretation.

The theoretical framework presented in this chapter serves as the conceptual lens through which the research is conducted. It integrates various theories and models that inform the study, offering a structured approach to examining the impact of project management techniques. The framework includes established project management methodologies, strategic planning principles, and civil engineering concepts, all of which contribute to understanding how these techniques can enhance project efficiency. By articulating the theoretical underpinnings, this section helps contextualize the study within existing knowledge and demonstrates how theoretical perspectives guide the research approach and methodology.

An equally important aspect of this chapter is the review of previous studies. This section provides a detailed examination of existing literature related to project management techniques and their impact on infrastructure projects, particularly road paving and landscaping. It identifies gaps in the current research, highlights key findings from relevant studies, and establishes a basis for the current study's contributions. By synthesizing previous research, this review not only situates the study within the broader academic discourse but also underscores its relevance and potential to address unresolved issues or extend existing knowledge.

The importance of this chapter lies in its role in framing the research within a well-defined theoretical and empirical context. By exploring the dependent and independent variables, the theoretical framework, and previous studies, the chapter provides a robust foundation for understanding the dynamics at play in road paving and landscaping operations. It ensures that the research is grounded in established theories and practices, while also identifying areas where new insights can be gained. This comprehensive approach is essential for conducting rigorous and meaningful analysis, ultimately contributing to the effective implementation of project management techniques and their alignment with the goals of Vision 2030.

The dependent and independent variable

The variables under investigation are meticulously delineated to establish a clear framework for assessing how specific project management techniques influence operational outcomes. The dependent variable in this context is the efficiency of road paving operations, while the independent variables include communication plans, budget management, and risk management practices. Each of these variables plays a critical role in shaping the overall efficiency and effectiveness of road paving projects.

The Dependent Variable: The Efficiency of Road Paving Operations

The efficiency of road paving operations is the central dependent variable in this study. This variable encapsulates various aspects of performance and effectiveness in road construction projects. Efficiency, in this context, refers to the optimal use of resources, time, and effort to achieve the desired outcomes in road paving. Key indicators of efficiency might include project completion time, adherence to budgetary constraints, quality of the finished road surface, and the minimization of disruptions during construction. Assessing efficiency involves examining how well the project meets its goals while balancing cost, quality, and time factors. A high level of efficiency signifies that the project is executed smoothly with minimal waste, delays, and deviations from the planned objectives. By focusing on this variable, the study aims to understand how project management techniques can enhance the overall performance and outcomes of road paving operations.

Independent Variable 1: Communication Plans

Communication plans are one of the independent variables that significantly impact the efficiency of road paving operations. Effective communication is critical for coordinating various aspects of a project, including stakeholder interactions, team collaboration, and information dissemination. A well-structured communication plan ensures that all parties involved in the project, from project managers to contractors and stakeholders, are informed and aligned with the project goals and progress. This variable encompasses strategies for internal and external communication, including regular updates, feedback mechanisms, and

clarity in reporting procedures. By evaluating the role of communication plans, the study examines how well-developed communication strategies contribute to reducing misunderstandings, improving coordination, and ultimately enhancing the efficiency of road paving operations.

Independent Variable 2: Budget Management

Budget management is another pivotal independent variable. Effective budget management involves planning, monitoring, and controlling project costs to ensure that the project is completed within the allocated financial resources. This includes detailed budgeting practices, cost estimation, financial tracking, and expense control. Proper budget management helps prevent cost overruns, ensures that resources are allocated efficiently, and supports financial sustainability throughout the project lifecycle. In road paving operations, effective budget management can lead to timely project completion, high-quality outcomes, and optimal use of financial resources. The study explores how budget management practices impact the efficiency of road paving by assessing how well financial constraints are managed and how they influence project performance.

Independent Variable 3: Risk Management Practices

Risk management practices are crucial for anticipating, assessing, and mitigating potential risks that could affect the efficiency of road paving operations. This variable involves identifying potential risks, evaluating their impact, and implementing strategies to mitigate or manage them. Effective risk management helps in minimizing the likelihood of issues such as project delays, cost escalations, and quality defects. It includes risk assessment procedures, contingency planning, and proactive problem-solving approaches. By focusing on risk management practices, the study aims to understand how well these practices contribute to maintaining project efficiency and addressing challenges that arise during road paving operations.

the study explores how project management techniques—specifically communication plans, budget management, and risk management practices—affect the efficiency of road paving operations. By examining these independent variables in relation to the dependent variable of efficiency, the research aims to provide insights into how effective project management contributes to achieving successful outcomes in road paving projects, aligning with the strategic goals of Vision 2030.

Previous studies

The significance of developing nations experiencing rapid economic growth in reducing greenhouse gas emissions and so mitigating climate change is receiving more and more attention. According to estimates, in 2011 developing countries accounted for roughly 63% of global carbon dioxide (CO₂) emissions, while developed countries accounted for only 37%. Therefore, developing nations must play a key role in international efforts to combat climate change. With 6937.23 kg of oil equivalent used per person in 2014, Saudi Arabia had the seventh-highest per capita CO₂ emissions globally, and its per capita energy use was 3.6 times higher than the global average. The nation's delicate ecosystems, finite freshwater supplies, and significant coastal development make it susceptible to climate change. As a result, the nation has started using some sustainable urban design techniques in its main cities as a part of its attempts to mitigate and adapt to climate change. Few research, nonetheless, have evaluated how widely the tactics are being used. This article's research of secondary data

revealed that, while urban greening, public transit, and green building initiatives are steadily gaining importance, the methods are still in their infancy as far as implementation goes. The report suggests concentrating more on increasing population and building densities, requiring diverse land uses, and educating the public on the effects of climate change and energy-related decisions (Abubakar, 2020).

(Alhubashi, 2024) This study provides an in-depth analysis of Jeddah's urban development trajectory. Jeddah is a major port city in Saudi Arabia that has developed into a thriving metropolis that represents both its ambitious future and distinguished past. The study carefully looks at Jeddah's journey through a number of lenses, including its strategic location as a gateway for trade and pilgrimage, its historical development dating back to the seventh century, and its transformation owing to a variety of cultural and economic contacts. It looks closely at Jeddah's social and economic composition, changes in the population, and how all of these things impact the city's urban environment. This article looks at the governance and regulatory frameworks that Jeddah uses to form development strategies. It also discusses how these frameworks are made to meet the problems of modern urbanization, such as environmental sustainability, infrastructural needs, and rapid population increase. The study also looks at how the city has responded to these issues, with a particular emphasis on infrastructure development, strategic planning, and sustainable urban programs that support Saudi Vision 2030. This paper presents Jeddah as a case study for managing modernization and growth in fast-growing urban environments, offering a thorough grasp of the city's urban dynamics.

In the contemporary era, Saudi Arabia's urban sprawl has intensified due to population and economic growth. The nation's natural resources, such as water, energy, and raw materials, are under extreme strain as a result of this. Since it has been shown that conventional methods of growing the built environment contribute significantly to climate change and global warming, they are therefore no longer appropriate. In industrialized nations, the concepts of sustainable development first appeared in the early 1970s as a solution to this worldwide problem. Saudi Arabia witnessed significant growth in every industry during this time, but the concepts of sustainable development were mostly disregarded. Nonetheless, Saudi Arabia has recently unveiled its ambitious Vision 2030, which includes promoting better sustainability as one of its goals. Through the adoption of practical steps for putting sustainable development concepts into reality, this study aims to support decision makers in recognizing the potential and challenges presented by Saudi Arabia's current city design methods, as well as the operational issues that are associated with them. Using an ethnographic study methodology, the fieldwork entails a site inspection and a public opinion survey to gain an insider's perspective of the state of sustainable practice in the city of Najran. Well-informed residents are given a survey to complete in order to get their opinions and gauge how likely they are to support green cities. A site inspection visit is then conducted in order to gather comprehensive information on the site's layout and management procedures. A set of sustainable standards is derived from well-established frameworks. The study's main findings indicate that applying the concepts of green cities is fraught with difficulties. The report provides practical methods and calculated steps to overcome these obstacles (Alyami, 2019).

The Green Saudi Initiative is one of the Saudi Vision 2030 programs. Its goals are energy conversion, environmental preservation, and sustainability projects to create a sustainable future. The current study used GIS and the Analytic Hierarchy Process-based Multi-Criteria Decision-Making Method (AHP-MCDM) to evaluate, analyze, and map green infrastructures (GI). The housing income group high (high-income people) map, employment in the agricultural sector, land use land change, wind speed, rainfall, topographic position

index, slope, and wind speed were the ten criteria that were chosen to elaborate the GI suitability map. Four categories of suitability were identified by the results: poor, fair, good, and excellent. For GI planning, the "Good" area covered 36% (3987 km²), while the "Excellent" region was anticipated to be 983 km² (9%). The central regions of Al Bahah, Elmandaq, Alatawlah, and the central portion of Buljurshi were more concentrated in the excellent and good zones for GI. The enormous area of sand and barren land in the southern half of the research makes it unsuitable for GI design, as indicated by the collected data. Managers and decision-makers in the Al Baha region may find the research's findings useful in their future planning for GI zones (Mobarak, 2022).

The government and associated stakeholders are growing increasingly concerned about enhancing the quality of road building project execution as the country's road infrastructure develops at a faster rate. Both the failure of construction products and the rise in work accident rates can be attributed to the subpar project execution method of national road building. In order to evaluate and then recommend to stakeholders how best to implement quality control management in road construction projects, this paper examines government regulations regarding the practices of quality control procedures, quality assurance systems, and safety control. There must be quality documentation available, with quality goals to be met during the building phase. All road building materials must be completely secured to meet the necessary quality and safety standards. This is the responsibility of quality control and safety control. Much less is expected of the quality assurance system, which the government and building firms alike need to establish in order to guarantee that the safety and quality control procedures are appropriately focused and efficient. In order to create qualified road infrastructure projects that function in accordance with their life duration, the review's findings can be used to encourage the adoption of quality control and quality assurance of road construction projects integrated with occupational health and safety. The review's importance advances our understanding of how to manage construction projects' quality control. In order for policymakers and construction professionals to consistently achieve the quality-safety of infrastructure project delivery, the review will help raise awareness among them (Willar, 2022).

Theoretical framework

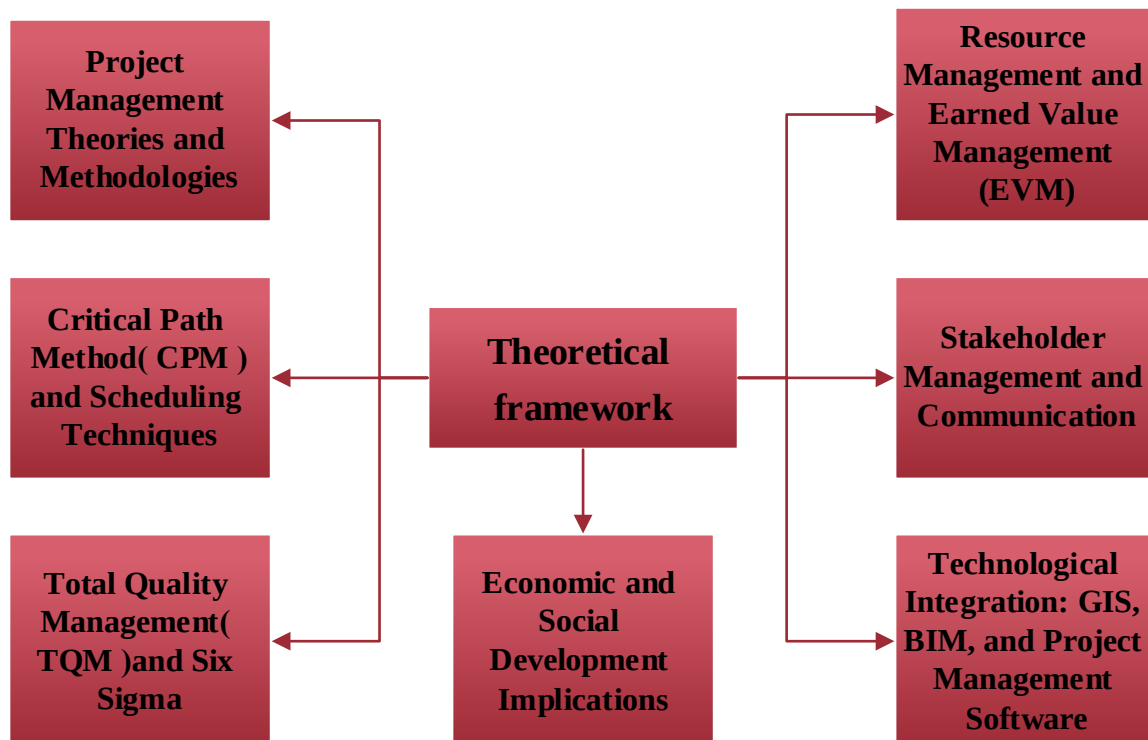


Figure 1 :Theoretical framework

Project Management Theories and Methodologies:

At the core of understanding the role of project management techniques in road paving and landscaping operations under Vision 2030 are foundational project management theories and methodologies. These include traditional frameworks like the Project Management Body of Knowledge (PMBOK) and modern agile methodologies. PMBOK, developed by the Project Management Institute (PMI), offers a comprehensive set of standard terminologies and guidelines for project management. It emphasizes five process groups initiating, planning, executing, monitoring and controlling, and closing which are essential for the structured execution of complex projects. Agile methodologies, on the other hand, prioritize flexibility, iterative progress, and stakeholder collaboration, which are critical in adapting to the dynamic nature of large-scale infrastructure projects. The adoption of these theoretical frameworks ensures that project managers can systematically plan, execute, and monitor road paving and landscaping operations, aligning them with the strategic objectives of Vision 2030 (Bierwolf, 2017).

Critical Path Method (CPM) and Scheduling Techniques:

The Critical Path Method (CPM) is a vital theoretical principle in the context of infrastructure projects like road paving and landscaping. CPM involves identifying the longest sequence of tasks in a project that must be completed on time for the entire project to be finished by its due date. This method is crucial for scheduling and resource allocation, as it highlights the critical tasks that cannot be delayed without affecting the project's overall timeline. By applying CPM, project managers can prioritize activities, allocate resources more efficiently, and anticipate potential delays, thereby enhancing the efficiency and effectiveness of project execution. This scheduling technique is particularly important for Vision 2030, which involves numerous large-scale, time-sensitive infrastructure projects (Bakkah, 2024).

Total Quality Management (TQM) and Six Sigma:

Total Quality Management (TQM) and Six Sigma are theoretical frameworks that focus on quality control and continuous improvement. TQM is an organizational approach that seeks to improve quality and performance to meet or exceed customer expectations. It involves all employees in the process of improving processes, products, and services. Six Sigma, a data-driven methodology, aims to reduce defects and variability in processes, striving for near perfection. In the context of Vision 2030, these quality management principles are critical for ensuring that road paving and landscaping projects meet high standards of quality and durability. Implementing TQM and Six Sigma ensures that infrastructure projects are completed to the highest quality standards, which is essential for long-term sustainability and reliability (Jansson, 2022).

Resource Management and Earned Value Management (EVM):

Efficient resource management is a fundamental theoretical principle in project management, especially in large-scale infrastructure projects. Earned Value Management (EVM) is a comprehensive project management technique that integrates project scope, time, and cost variables. EVM provides a framework for measuring project performance and progress in an objective manner. By comparing the planned amount of work with what has actually been completed, and the cost incurred, project managers can gain insights into cost performance and schedule performance indices. This technique is crucial for managing the vast resources involved in Vision 2030 projects, ensuring that labor, materials, and finances are used efficiently and effectively. EVM helps in identifying variances early, allowing for corrective actions to keep the projects on track (Bakkah, 2024).

Stakeholder Management and Communication:

Effective stakeholder management and communication are critical theoretical principles in the realm of project management. Stakeholder theory emphasizes the importance of identifying all stakeholders those affected by or having an influence on the project and managing their expectations and interests. In the context of Vision 2030, which involves multiple stakeholders including government agencies, private sector partners, and local communities, effective communication and engagement are vital. Techniques such as stakeholder analysis, communication planning, and the use of collaboration platforms ensure that all stakeholders are informed, engaged, and aligned with the project objectives. This theoretical framework helps in building trust, facilitating better decision-making, and enhancing the overall success of infrastructure projects (Rajablu, 2015).

Technological Integration: GIS, BIM, and Project Management Software:

The integration of advanced technologies is a crucial theoretical principle for modern project management. Technologies such as Geographic Information Systems (GIS), Building Information Modeling (BIM), and advanced project management software play a significant role in enhancing the precision and efficiency of project execution. GIS technology is essential for planning and managing spatial data in road paving and landscaping projects, providing valuable insights into geographical conditions and helping in optimal route planning. BIM offers a digital representation of the physical and functional characteristics of a facility, enabling better visualization, coordination, and collaboration among project stakeholders. Advanced project management software tools facilitate real-time tracking, reporting, and analysis of project progress. These technological integrations ensure that projects are executed with greater accuracy, efficiency, and transparency, aligning with the advanced infrastructure goals of Vision 2030 (Pan, 2022).

Economic and Social Development Implications:

The theoretical principles of project management extend to the broader economic and social development goals of Vision 2030. Effective project management ensures that infrastructure projects are completed on time, within budget, and to high standards of quality, providing a solid foundation for economic growth and diversification. Improved infrastructure enhances connectivity, facilitates trade, and attracts investment, contributing to the overall economic development of the Kingdom. Additionally, well-executed landscaping projects improve urban environments, making them more livable and attractive, thereby enhancing the quality of life for residents. The application of project management principles thus supports Vision 2030's objectives of transforming Saudi Arabia into a diversified and sustainable economy with a high standard of living for its citizens (Darwish, 2022).

Chapter Three

Study Methodology

Introduction

The third chapter of the study titled "The Effect of Project Management Techniques on the Efficiency of Road Paving and Landscaping Operations for Vision 2030 in the Kingdom of Saudi Arabia" is pivotal in detailing the research design and execution plan. This chapter is crucial as it outlines the structured approach to gathering and analyzing data, providing clarity on how the research will be conducted and ensuring that the study's findings are both credible and relevant. It encompasses a comprehensive explanation of the methodology and research methods, the research community, sample size determinants, data collection steps, and the research limits, including human, temporal, and spatial factors. Understanding these elements is essential for evaluating the robustness and applicability of the study.

The methodology and research methods section will elaborate on the systematic approach adopted to investigate the relationship between project management techniques and the efficiency of road paving and landscaping operations. This part of the chapter will outline the research design, including the specific methods used for data collection and analysis. It will detail whether the study employs qualitative, quantitative, or mixed methods, explaining how each method aligns with the research objectives. The chosen methodology is fundamental for ensuring that the study produces reliable and valid results, as it dictates how data will be gathered, analyzed, and interpreted in the context of the research questions.

Additionally, this chapter will provide an in-depth discussion of the research community, which refers to the population from which data will be collected. Understanding the characteristics of the research community is essential for contextualizing the findings and ensuring that the results are representative of the broader population. This section will describe the criteria for selecting participants, including any relevant demographic or professional characteristics that align with the study's objectives. By clearly defining the research community, the study can ensure that its findings are relevant and applicable to the intended audience.

Another critical aspect covered in this chapter is the determinants of sample size. Determining the appropriate sample size is crucial for achieving statistical significance and ensuring that the findings are generalizable. This section will explain how the sample size is determined, taking into account factors such as the total population size, the desired level of confidence, and the margin of error. By providing a detailed rationale for the sample size, the chapter ensures that the research is methodologically sound and capable of producing meaningful results.

The data collection steps are also a focal point of this chapter. This section will outline the procedures for gathering data, including the tools and techniques used, the timeline for data collection, and any protocols followed to ensure accuracy and reliability. Effective data collection is vital for capturing relevant information and addressing the research questions, making this section crucial for understanding how the study will be conducted and how data will be managed.

The chapter will address the research limits, including human, temporal, and spatial factors. Understanding these limitations is important for assessing the scope and generalizability of the study's findings. Human limits refer to potential biases or constraints related to the researchers or participants, while temporal limits involve constraints related to the time frame of the study. Spatial limits pertain to the geographic scope of the research. By acknowledging these limitations, the chapter provides a transparent account of the factors that may influence the study's results, thereby enhancing the credibility and interpretability of the research outcomes.

The third chapter is fundamental for laying out the detailed plan for conducting the research. By explaining the methodology and research methods, the research community, sample size determinants, data collection steps, and research limits, the chapter ensures that the study is well-structured and capable of producing reliable and relevant findings. This comprehensive approach is essential for validating the study's conclusions and contributing valuable insights to the field of project management in the context of Vision 2030.

Methodology and research methods

The methodology for studying the role of project management techniques in road paving and landscaping operations for Vision 2030 in the Kingdom of Saudi Arabia is primarily quantitative. This approach allows for the systematic collection and analysis of numerical data to understand the extent to which project management techniques impact project efficiency, quality, sustainability, and overall success. A quantitative research design is suitable for this study as it facilitates the measurement of variables and the determination of statistical relationships between them, providing objective and generalizable findings. The research design includes the formulation of hypotheses, the selection of appropriate data collection methods, and the application of statistical analyses to test the hypotheses.

Data Collection Methods:

The data collection for this quantitative study involves multiple methods to ensure comprehensive coverage and accuracy. The primary method is the use of structured surveys distributed to project managers, engineers, and other stakeholders involved in road paving and landscaping projects under Vision 2030. The survey includes closed-ended questions designed to quantify various aspects of project management practices, such as the use of specific methodologies (e.g., Critical Path Method, Total Quality Management), resource management techniques, and the integration of advanced technologies (e.g., GIS, BIM). Additionally, secondary data is collected from project reports, government publications, and existing databases that track project performance metrics such as completion times, cost adherence, quality ratings, and sustainability scores. This mixed approach to data collection ensures a robust dataset that can be used for detailed statistical analysis.

Sample Selection:

The sample selection process is crucial to ensure the representativeness and validity of the study's findings. The study employs a stratified random sampling technique to select a representative sample of projects from different regions and scales within the Kingdom. This stratification ensures that the sample includes a diverse range of projects, from small-scale local initiatives to large-scale national projects. The target population includes project managers, engineers, planners, and other key stakeholders who are directly involved in the planning, execution, and monitoring of road paving and landscaping operations. By including a broad spectrum of projects and stakeholders, the study aims to capture a comprehensive picture of the impact of project management techniques across different contexts.

Data Analysis:

Once the data is collected, it is subjected to rigorous statistical analysis to test the study's hypotheses. The analysis begins with descriptive statistics to summarize the data and provide an overview of the key variables. This includes measures of central tendency (mean, median) and variability (standard deviation, range) to describe the general characteristics of the dataset. Next, inferential statistics are employed to test the hypotheses and determine the strength and significance of relationships between variables. Techniques such as correlation analysis, regression analysis, and Analysis of Variance (ANOVA) are used to explore the associations between the use of project management techniques and project outcomes (efficiency, quality, sustainability, and success). The use of these statistical methods allows for the identification of patterns and the determination of causal relationships, providing evidence-based insights into the effectiveness of different project management practices.

Validity and Reliability:

Ensuring the validity and reliability of the study is a critical aspect of the research methodology. Validity refers to the accuracy and truthfulness of the measurements, while reliability refers to the consistency and repeatability of the results. To enhance validity, the survey instruments and data collection methods are carefully designed and pre-tested through pilot studies. This helps to identify and rectify any ambiguities or biases in the survey questions. Reliability is ensured by standardizing the data collection procedures and using established statistical techniques for analysis. Additionally, triangulation is employed by comparing the survey results with secondary data from project reports and databases, thereby validating the findings through multiple sources of evidence.

Ethical Considerations:

The study adheres to ethical guidelines to ensure the integrity and ethical conduct of the research. Informed consent is obtained from all participants, ensuring that they are fully aware of the study's purpose, their role, and their rights. Confidentiality and anonymity are maintained to protect the privacy of the respondents and the confidentiality of the data. Any potential conflicts of interest are disclosed, and the data is stored securely to prevent unauthorized access. By adhering to these ethical considerations, the study ensures that the research is conducted in a responsible and ethical manner.

Expected Outcomes:

The quantitative methodology is expected to yield robust and generalizable findings that provide a clear understanding of the role of project management techniques in road paving and landscaping operations under Vision 2030. The statistical analysis will highlight the most effective project management practices and their impact on project performance metrics. The findings will inform policymakers, project managers, and other stakeholders about the best

practices that can be adopted to enhance the efficiency, quality, sustainability, and success of infrastructure projects. Ultimately, the study aims to contribute to the successful realization of Vision 2030's ambitious infrastructure goals, supporting Saudi Arabia's broader economic and social development objectives.

Research community

The research community represents the diverse group of individuals and entities that are central to understanding the impact of project management techniques on infrastructure projects. This community encompasses a broad spectrum of stakeholders directly or indirectly involved in road paving and landscaping operations, each playing a crucial role in shaping project outcomes and contributing to the overall efficiency of these operations.

To begin with, project managers and engineers are at the heart of this research community. These professionals are responsible for the strategic planning, execution, and oversight of road paving and landscaping projects. Their roles involve coordinating various aspects of the project, from initial design and budgeting to implementation and quality control. Project managers apply specific project management techniques, including communication plans, budget management, and risk management practices, to ensure that projects are completed efficiently and effectively. Their insights and experiences are invaluable in understanding how these techniques impact project outcomes, as they deal directly with the challenges and intricacies of managing large-scale infrastructure projects. By examining their perspectives, the study aims to gain a comprehensive understanding of the practical application of project management techniques and their influence on operational efficiency.

Equally significant are the construction and landscaping contractors who carry out the physical work involved in road paving and landscaping projects. These contractors implement the plans developed by project managers and are responsible for the execution of tasks according to technical specifications and timelines. Their feedback on project management practices provides a practical viewpoint on how communication, budgeting, and risk management are handled on the ground. Contractors face various challenges during project execution, and their experiences highlight the effectiveness of project management techniques in overcoming these challenges and achieving desired results. Their involvement in the study helps to bridge the gap between strategic planning and operational execution, providing a holistic view of how project management practices impact efficiency.

Government officials and regulatory bodies are also integral to the research community. These entities oversee and regulate infrastructure projects, ensuring that they adhere to national standards, regulations, and the objectives of Vision 2030. They are involved in setting guidelines, approving project plans, and monitoring project progress. Their perspectives on project management techniques are crucial for understanding the regulatory and policy context within which road paving and landscaping projects are executed. By including government officials and regulatory bodies in the research community, the study can assess how well project management practices align with regulatory requirements and contribute to the achievement of broader national goals.

Consultants and industry experts bring specialized knowledge and insights to the research community. These professionals offer advisory services and conduct assessments related to project management and infrastructure development. Their expertise in best practices, industry standards, and innovative solutions enriches the study by providing an informed perspective on how project management techniques can be optimized to enhance

project efficiency. Consultants and experts contribute to the theoretical and practical understanding of the subject, helping to contextualize the research within the broader landscape of infrastructure development and project management.

Local communities and end-users of the infrastructure projects represent another critical segment of the research community. These stakeholders are the ultimate beneficiaries of road paving and landscaping operations, and their feedback provides valuable insights into the real-world impact of project management practices. Understanding their experiences and satisfaction levels helps to evaluate the effectiveness of project management techniques from the perspective of those who directly interact with the completed infrastructure. Their input is essential for assessing the practical benefits and shortcomings of project management practices, ensuring that the study's findings are grounded in the realities of infrastructure use and community needs.

The research community for this study is diverse and multifaceted, encompassing project managers, contractors, government officials, consultants, and local communities. Engaging with this broad group of stakeholders ensures that the study captures a comprehensive and representative picture of how project management techniques affect the efficiency of road paving and landscaping operations. By integrating the perspectives and experiences of these various stakeholders, the study aims to provide valuable insights that can enhance project management practices and contribute to the successful implementation of Vision 2030 objectives in Saudi Arabia.

Satellite size determinants

Determining the sample size is a critical component in ensuring that the research findings are both reliable and representative. The sample size of 195 participants has been carefully determined based on a variety of factors that ensure the validity and applicability of the study's results. The process of establishing this sample size involves several key considerations, each of which contributes to the overall robustness and credibility of the research.

The primary determinant for the sample size is the need to achieve statistical significance and generalizability. To ensure that the research findings are not due to chance and can be applied to the broader population involved in road paving and landscaping operations, the sample must be sufficiently large. In this study, a sample size of 195 was selected to balance the need for a manageable yet statistically robust dataset. This size is adequate to provide a high level of confidence in the results and to detect meaningful relationships between project management techniques and operational efficiency.

Another important factor in determining the sample size is the diversity and representativeness of the research community. The study aims to include a wide range of stakeholders involved in road paving and landscaping projects, including project managers, contractors, government officials, consultants, and local communities. By selecting a sample of 195 participants, the research ensures that various perspectives are adequately represented. This diverse sample allows for a comprehensive analysis of how different project management techniques impact efficiency across different roles and responsibilities within the industry. Ensuring representation from all relevant stakeholder groups enhances the study's ability to provide actionable insights that reflect the experiences and challenges faced by various individuals and organizations involved in the projects.

Practical considerations also play a role in determining the sample size. Factors such as the availability of participants, resource constraints, and the time required for data collection influence the final decision on sample size. A sample of 195 participants strikes a balance between these practical constraints and the need for a robust dataset. This size is manageable within the scope of the research project, allowing for efficient data collection and analysis while still providing a sufficiently large sample to draw meaningful conclusions.

Additionally, the complexity of the research variables and the desired level of detail in the analysis affect the sample size. The study examines the impact of several project management techniques, including communication plans, budget management, and risk management practices, on the efficiency of road paving and landscaping operations. To explore these variables comprehensively and to identify significant patterns and relationships, a sample size of 195 participants provides the statistical power needed to perform detailed analyses and to ensure that the findings are reliable and valid.

The determination of the sample size is also guided by the need for precision in the research results. A larger sample size reduces the margin of error and increases the reliability of the statistical estimates. By selecting a sample size of 195, the study aims to achieve a high degree of precision in the results, allowing for accurate and confident interpretations of how project management techniques influence operational efficiency. This level of precision is essential for making informed recommendations and for contributing valuable insights to the field of infrastructure management.

The sample size of 195 participants for the study on the effect of project management techniques on the efficiency of road paving and landscaping operations is determined through careful consideration of statistical significance, representativeness, practical constraints, and the complexity of the research variables. This sample size ensures that the research findings are both reliable and applicable, providing a robust foundation for understanding the impact of project management practices on infrastructure projects within the framework of Vision 2030 in the Kingdom of Saudi Arabia.

Data collection steps

To comprehensively examine the impact of project management techniques on road paving and landscaping operations under Vision 2030 in Saudi Arabia, several study tools are essential. These tools encompass both qualitative and quantitative approaches to gather, analyze, and interpret data effectively.

Surveys and Questionnaires:

Surveys and questionnaires constitute primary tools for collecting quantitative data from stakeholders directly involved in road paving and landscaping projects. These tools are designed to elicit structured responses regarding the utilization and effectiveness of various project management techniques. Survey questions are tailored to capture insights on methodologies such as the Critical Path Method (CPM), Total Quality Management (TQM), Earned Value Management (EVM), and the integration of advanced technologies like Geographic Information Systems (GIS) and Building Information Modeling (BIM). By employing surveys, the study can quantify perceptions, practices, and outcomes related to project management, providing empirical evidence to support hypotheses about their impact on project efficiency, quality, sustainability, and overall success.

Interviews:

In-depth interviews complement surveys by offering qualitative insights from key stakeholders and experts involved in Vision 2030 projects. Interviews are structured to explore nuanced aspects of project management techniques, such as stakeholder engagement strategies, communication effectiveness, and adaptation to local environmental and regulatory conditions. Stakeholders including project managers, engineers, governmental officials, and community representatives provide firsthand perspectives on challenges, successes, and best practices in implementing project management methodologies. Interviews allow for a deeper understanding of the contextual factors influencing project outcomes, enhancing the richness and depth of the study's findings beyond numerical data.

Document Analysis:

Document analysis serves as a critical tool for collecting secondary data from project reports, government publications, and official documents related to infrastructure projects under Vision 2030. These documents provide historical context, project specifications, performance metrics, and regulatory frameworks that shape project management decisions and outcomes. By analyzing these documents, the study can validate survey findings, cross-check quantitative data, and supplement qualitative insights. Document analysis also aids in identifying trends, patterns, and discrepancies in project management practices and outcomes over time, contributing to a comprehensive understanding of the study area.

Statistical Analysis Software:

Quantitative data collected through surveys and supplemented by document analysis requires rigorous statistical analysis to test hypotheses and derive meaningful conclusions. Statistical analysis software such as SPSS (Statistical Package for the Social Sciences) or SAS (Statistical Analysis System) is instrumental in processing data, conducting descriptive statistics, and performing inferential analyses. Techniques such as correlation analysis, regression analysis, and ANOVA (Analysis of Variance) are applied to examine relationships between variables, determine statistical significance, and model predictive factors influencing project management effectiveness. These tools enable the study to quantify the impact of project management techniques on key performance indicators, providing empirical evidence to support recommendations for enhancing project outcomes in Saudi Arabia's infrastructure development.

Geographic Information Systems (GIS) and Building Information Modeling (BIM):

Advanced technologies like GIS and BIM serve as specialized tools for analyzing spatial and architectural data in road paving and landscaping projects. GIS facilitates spatial analysis, site selection, and environmental impact assessment by integrating geographical data layers such as terrain, land use, and infrastructure networks. BIM offers a digital representation of physical and functional characteristics of infrastructure, supporting collaborative design, construction planning, and facility management. By incorporating GIS and BIM into the study, researchers can visualize project complexities, simulate scenarios, and optimize resource allocation based on spatial and architectural considerations. These tools enhance the accuracy, efficiency, and sustainability of project management practices, aligning with Vision 2030's objectives of smart infrastructure development and environmental stewardship.

Limitations of the study

Research endeavors, particularly those examining complex and expansive topics such as the role of project management techniques in infrastructure development under Vision 2030 in Saudi Arabia, are inevitably bound by several inherent limitations. These limitations can stem from human, spatial, and temporal constraints, which are crucial to acknowledge in interpreting and applying the study's findings effectively.

- Human Limits

One significant limitation lies in the human aspect of the study. Despite efforts to gather diverse perspectives from stakeholders involved in road paving and landscaping projects such as project managers, engineers, governmental officials, and community representatives the study may still be subject to biases and limited viewpoints. The responses collected through surveys and interviews are inherently subjective, influenced by respondents' experiences, interpretations, and perceptions. Variability in understanding project management methodologies and their application can impact the accuracy and completeness of data gathered. Moreover, the availability and willingness of key stakeholders to participate in interviews and surveys may vary, potentially skewing the representation of perspectives within the study sample. Addressing these human limits requires careful consideration in data interpretation and the triangulation of findings across multiple sources to mitigate bias and ensure comprehensive coverage of viewpoints.

- Spatial Limits

Spatial limitations also pose challenges to the study's scope and generalizability. Infrastructure projects under Vision 2030 span diverse geographic regions across Saudi Arabia, each characterized by unique environmental conditions, cultural contexts, and logistical challenges. The study may focus on specific regions or projects due to practical constraints such as accessibility, resource availability, and project visibility. As a result, findings derived from selected regions or projects may not be fully representative of the entire spectrum of road paving and landscaping operations under Vision 2030. Variations in regional priorities, infrastructure needs, and local governance structures can influence the applicability of project management techniques and their outcomes. To mitigate spatial limitations, researchers must acknowledge the context-specific nature of findings and contextualize recommendations within the broader framework of Vision 2030's national objectives and regional dynamics.

- Time Limits

Time constraints present another significant limitation in studying infrastructure projects aligned with Vision 2030. The implementation of road paving and landscaping projects is often characterized by long planning cycles, phased construction timelines, and extended monitoring periods to assess long-term impacts. The study's timeframe for data collection and analysis may not fully capture the evolving nature of project management practices and their outcomes over time. Changes in policy frameworks, economic conditions, technological advancements, and stakeholder dynamics can influence project performance and management strategies throughout different project phases. Moreover, the availability of historical data and project documentation may vary, limiting the ability to conduct longitudinal analyses or assess trends in project management effectiveness comprehensively. Researchers must acknowledge these temporal constraints and interpret findings within the context of the study's specific timeframe, recognizing potential limitations in capturing evolving project dynamics and long-term sustainability impacts.

Chapter Four

Study Results

Introduction

The fourth chapter of the study titled The Effect of Project Management Techniques on the Efficiency of Road Paving and Landscaping Operations for Vision 2030 in the Kingdom of Saudi Arabia is a crucial segment that delves into the interpretation and presentation of the research findings. This chapter is integral as it provides a comprehensive analysis of the data collected, interprets the results in the context of the research objectives, and offers actionable recommendations based on the findings. The chapter is designed to bridge the gap between theoretical insights and practical applications, thereby demonstrating the impact of project management techniques on operational efficiency.

The chapter begins with an in-depth examination of the data analysis process. This section will detail how the data collected throughout the study is processed and analyzed to draw meaningful conclusions. The analysis involves applying statistical methods and analytical tools to interpret the data accurately. This step is crucial for uncovering patterns, trends, and relationships between project management techniques and the efficiency of road paving and landscaping operations. By systematically analyzing the data, the chapter aims to provide evidence-based insights that validate or challenge the hypotheses posed in the earlier stages of the research.

Following the data analysis, the chapter presents the results of the study. This section is dedicated to communicating the findings in a clear and organized manner. It will outline the key outcomes of the analysis, highlighting significant trends and correlations observed in the data. The results section is essential for illustrating how project management techniques have influenced the efficiency of road paving and landscaping operations. By presenting the findings, this section allows readers to understand the practical implications of the research and how it contributes to the broader goals of Vision 2030.

The final part of the chapter focuses on recommendations derived from the study's results. This section is designed to offer practical advice and guidance based on the insights gained from the data analysis. Recommendations are crucial for informing stakeholders, including project managers, policymakers, and industry professionals, about best practices and strategies for improving project efficiency. By providing actionable suggestions, the chapter aims to contribute to the successful implementation of project management techniques and enhance the overall effectiveness of road paving and landscaping projects.

The importance of this chapter lies in its role in translating research findings into practical outcomes. By thoroughly analyzing the data, presenting clear results, and offering well-grounded recommendations, the chapter ensures that the study delivers valuable insights that can influence real-world practices. This section not only validates the research but also provides a roadmap for implementing improvements in project management techniques, thereby supporting the achievement of Vision 2030 objectives. It bridges the gap between theoretical research and practical application, making it a critical component of the study's contribution to the field.

Data analysis

- **Data collection**

The questionnaire questions were created by relying on many previous studies and the views of experts and engineers in the field of roads and construction. I relied on Google Forms to create the questionnaire and distribute it to the concerned persons and stakeholders, to review it and reach the responses. In a period of 25 days, I collected 195 responses from the respondents in the experiment. By relying on the SPSS program to analyze and reach the data, we will result in presenting the statistical description and overall analysis of the data.

- **The importance of data analysis**

Statistics is a critical component of data analytics, which entails gathering, analyzing, interpreting, and presenting numerical data that may be utilized to make sound choices. It is a method for identifying significant links in massive data sets and determining the chance of certain occurrences happening. Data analytics uses two kinds of statistical methods: descriptive statistics and inferential statistics.

- Descriptive statistics is the process of describing a dataset using measurements such as mean and standard deviation.
- In contrast, inferential statistics is the process of generating predictions or drawing inferences about a population based on a sample data set.

Both approaches are critical to the data analysis process, allowing for precise and thorough examination of vast volumes of data.

The strategic application of statistical analysis processes enables firms to obtain insights from data and make educated choices. Statistical analysis approaches, which range from data mining to making actionable suggestions, provide a methodical approach to comprehending, interpreting, and using massive data sets. Working through these complicated procedures allows firms to identify hidden patterns in their data and extract valuable insights that may be used as a compass for strategic decision-making (Pace, 2023).

Statistics

	N	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
	Valid					
Age	195	1.125	0.378	0.174	-0.722	0.346
Gender	195	0.501	-0.031	0.174	-2.020	0.346
Degree	195	1.331	-0.123	0.174	-1.184	0.346
Project management techniques are essential for the successful completion of road paving projects.	195	1.330	0.310	0.174	-1.026	0.346
Effective project management improves the quality of road paving operations.	195	1.309	0.389	0.174	-0.879	0.346
The use of project management techniques ensures timely completion of landscaping projects.	195	1.229	0.228	0.174	-0.807	0.346
Budget management through project management techniques reduces cost overruns in road paving projects.	195	1.286	0.168	0.174	-1.039	0.346
Risk management practices in project management mitigate potential issues in landscaping operations.	195	1.220	0.278	0.174	-0.914	0.346
Project management techniques enhance	195	1.351	0.313	0.174	-1.114	0.346

coordination among different stakeholders in road paving projects.						
Scheduling and timeline management are critical for the success of landscaping projects.	195	1.327	0.433	0.174	-0.897	0.346
Project management software tools are effectively used in road paving operations.	195	1.285	0.447	0.174	-0.737	0.346
Communication plans developed through project management practices improve project outcomes in landscaping.	195	1.222	0.182	0.174	-0.961	0.346
Scope management in project management helps in preventing project scope creep in road paving projects.	195	1.301	0.175	0.174	-1.069	0.346
Resource allocation through project management techniques optimizes manpower and materials in landscaping projects.	195	1.217	0.289	0.174	-0.762	0.346
Quality control procedures in project management ensure high standards in road paving projects.	195	1.367	0.227	0.174	-1.115	0.346

The integration of project management techniques with technology improves efficiency in landscaping operations.	195	1.313	0.356	0.174	-0.991	0.346
Continuous monitoring and evaluation in project management contribute to the success of road paving projects.	195	1.184	0.170	0.174	-0.841	0.346
Stakeholder engagement in project management enhances the execution of landscaping projects.	195	1.300	0.363	0.174	-0.843	0.346
Change management strategies in project management are effective in handling modifications in road paving projects.	195	1.206	0.315	0.174	-0.838	0.346
Project management training and development are crucial for improving landscaping project outcomes.	195	1.321	0.341	0.174	-1.087	0.346
Environmental considerations in project management are	195	1.277	0.359	0.174	-0.812	0.346

adequately addressed in road paving operations.						
The role of project managers is vital for the successful implementation of landscaping projects.	195	1.366	0.343	0.174	-1.070	0.346
Project management techniques facilitate compliance with regulatory requirements in road paving projects.	195	1.266	0.379	0.174	-0.885	0.346
Lessons learned from previous projects are effectively utilized in current landscaping operations through project management.	195	1.247	0.186	0.174	-0.886	0.346
The overall success of Vision 2030's infrastructure goals depends on the effective application of project management techniques in road paving and landscaping operations.	195	1.235	0.105	0.174	-1.151	0.346

Table 1: Statistical description of the data.

Results

1. The age of the participants in the survey.

The age range of the poll respondents was wide, ranging from 20 to 60. The deliberate incorporation of several age groups was intended to encompass a wide range of perspectives. The resulting age distribution produced a rich dataset that enhanced the validity of the inferences made on the impact of project management techniques on the implementation of road and landscape improvements in line with Vision 2030. With 30.3% of the responders in this age group, the 30–40 age group was found to be the most common demographic.

The age of the participants in the survey.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20-30	49	25.1	25.1	25.1
	30-40	59	30.3	30.3	55.4
	40-50	51	26.2	26.2	81.5
	50-60	29	14.9	14.9	96.4
	60+	7	3.6	3.6	100.0
	Total	195	100.0	100.0	

Table 2: Statistical description of the ages of participants in the experiment.

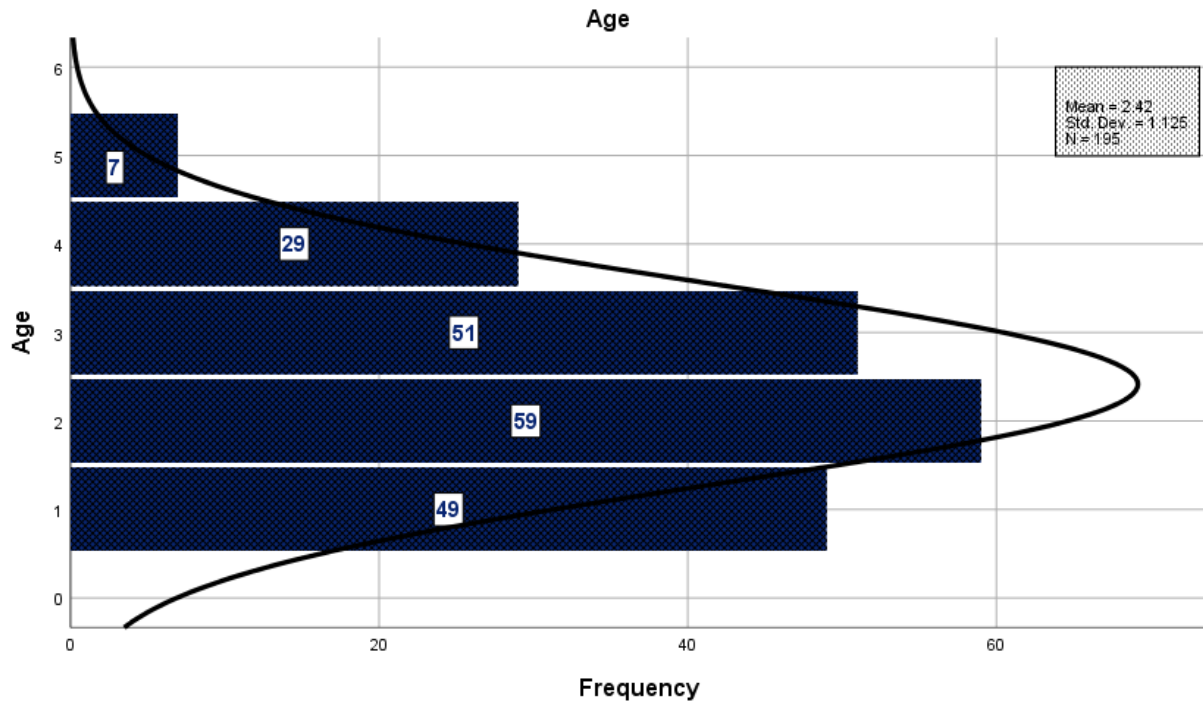


Figure 2: Graphical representation of the ages of participants in the experiment

2. The Gender of the participants in the survey.

In order to ensure a balanced representation of male and female opinions, the survey recruited a varied sample of participants from both genders. The findings were enhanced by gender diversity, as disparities in experiences between the sexes could indicate different aspects of how project management approaches affect performance and efficiency in the carrying out of national projects. Interestingly, 50.8% of the participants in the sample were men, making up the bulk of the sample.

The Gender of the participants in the survey.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	"Female"	96	49.2	49.2	49.2
	Male	99	50.8	50.8	100.0
	Total	195	100.0	100.0	

Table 3: Statistical description of the gender of participants in the experiment.

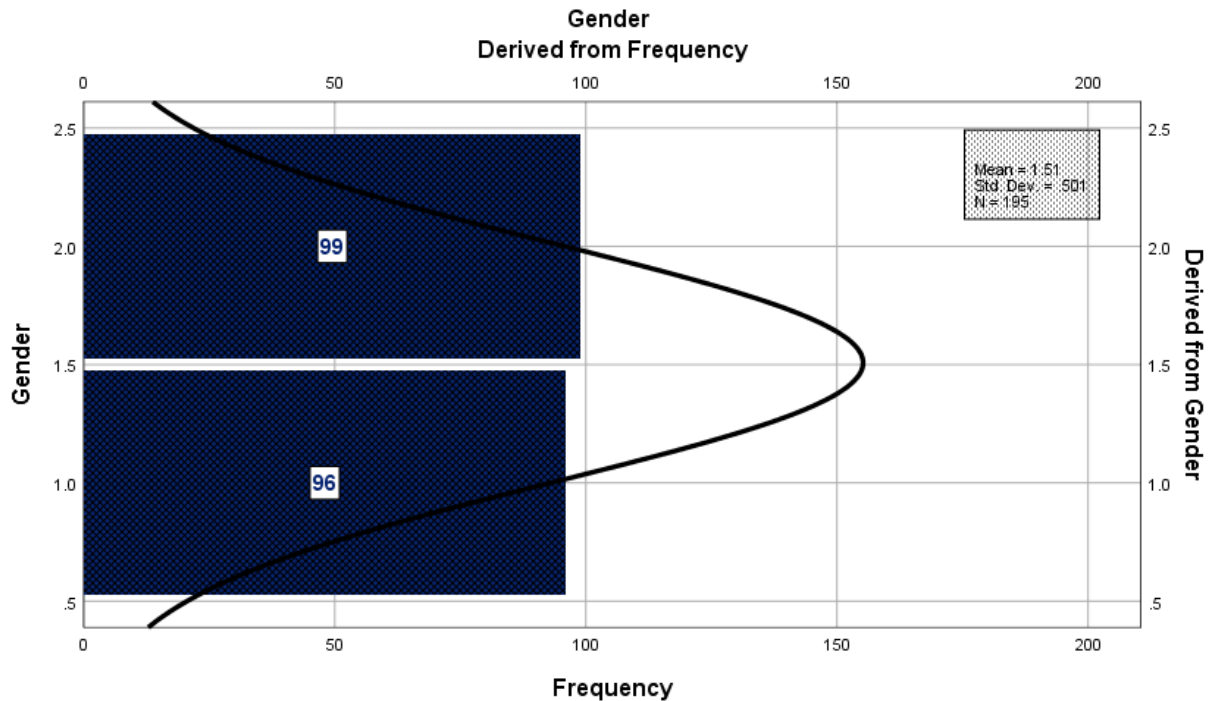


Figure 3: Graphical representation of the gender of experimental participants

3. Academic degree of participants in the survey.

The respondents to the study came from a wide variety of educational backgrounds. The sample consisted of people with master's and doctoral degrees who were highly knowledgeable in their respective fields, as well as those with university degrees in a variety of subjects. Participants with technical and vocational backgrounds were also included in the survey, which gave the assessment of project management methods a more grounded perspective. The intellectual diversity among the participants aided in the collecting of rich and diverse data, which reflected their nuanced and thorough grasp of the ways in which project management practices might improve efficiency and achieve desired results. Remarkably, 27.2% of the population have postgraduate degrees.

Degree					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelor's degree	46	23.6	23.6	23.6
	Doctorate	25	12.8	12.8	36.4
	Master's	50	25.6	25.6	62.1
	Postgraduate degree	53	27.2	27.2	89.2

	Secondary school certificate	21	10.8	10.8	100.0
	Total	195	100.0	100.0	

Table 4: Statistical description of the academic degree of the participants in the experiment.

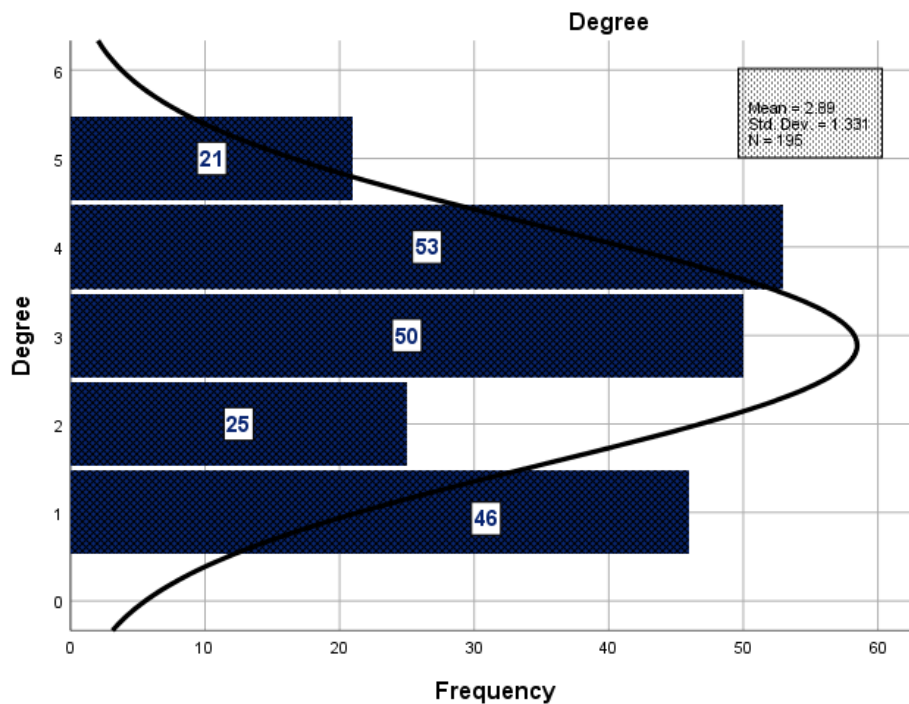


Figure 4: Graphical representation of the academic degrees of the participants in the experiment

4. Project management techniques are essential for the successful completion of road paving projects.

In order to ensure that road paving projects are completed successfully and efficiently, project management strategies are essential. These big projects require careful planning, continuous supervision, and close monitoring to ensure that everyone stays within the allocated budget and schedule. These methods also make it easier to capture every stage of a project, giving rise to a comprehensive record that can be used for performance evaluation and ongoing development. Notably, this assertion was agreed with by 29.2% of the participants.

Project management techniques are essential for the successful completion of road paving projects.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	57	29.2	29.2	29.2
	Disagree	36	18.5	18.5	47.7

	Neither agree nor disagree	53	27.2	27.2	74.9
	Strongly Agree	28	14.4	14.4	89.2
	Strongly Disagree	21	10.8	10.8	100.0
	Total	195	100.0	100.0	

Table 5: Statistical description of project management techniques necessary to successfully complete road paving projects.

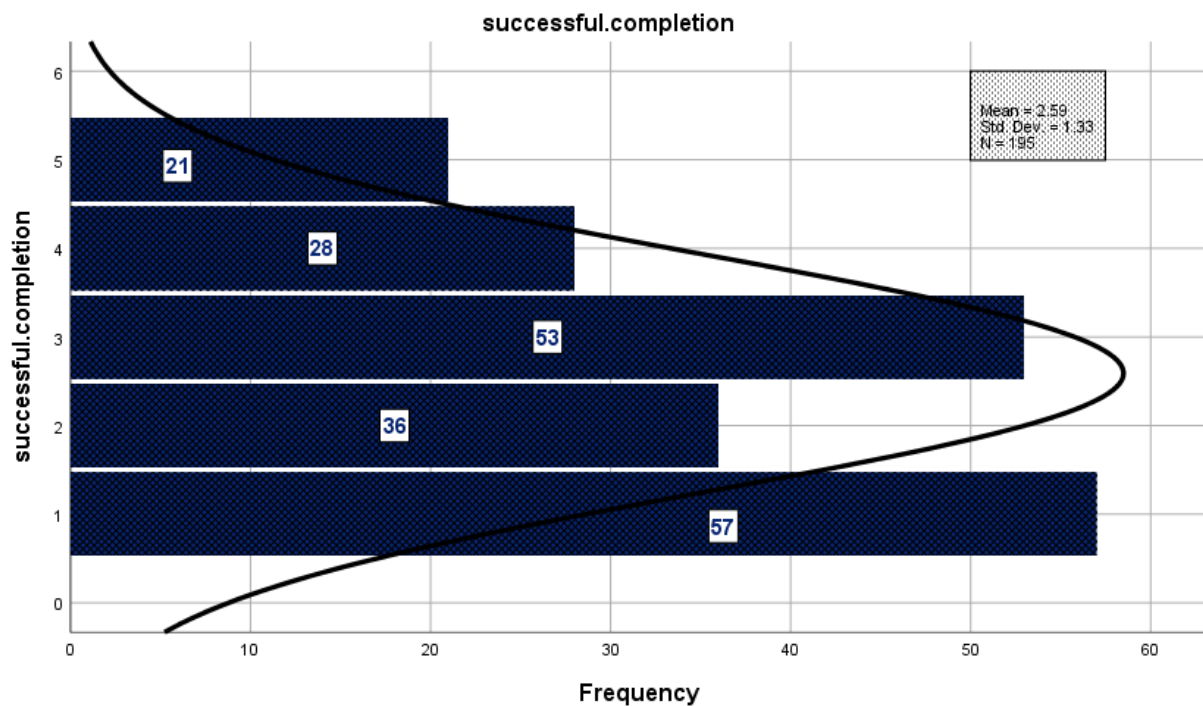


Figure 5: Graphical representation of project management techniques necessary to successfully complete road paving project.

5. Effective project management improves the quality of road paving operations.

There was an equal percentage of acceptance and neutrality regarding this opinion, with both standing at 29.7%. There was an equal percentage of acceptance and neutrality regarding this opinion, with both standing at 29.7%. High technical and engineering standards are adhered to by employing organized approaches and stringent procedures that are implemented by effective project managers, which greatly improves the quality of road paving operations. This management strategy is predicated on a careful examination of every stage of the project, from planning and design to implementation and oversight, which makes it possible to identify possible problems early on and find creative solutions.

Effective project management improves the quality of road paving operations.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	58	29.7	29.7	29.7
	Disagree	37	19.0	19.0	48.7
	Neither agree nor disagree	58	29.7	29.7	78.5
	Strongly Agree	21	10.8	10.8	89.2
	Strongly Disagree	21	10.8	10.8	100.0
	Total	195	100.0	100.0	

Table 6: Statistical description of the effective project management work to improve the quality of road paving operations.

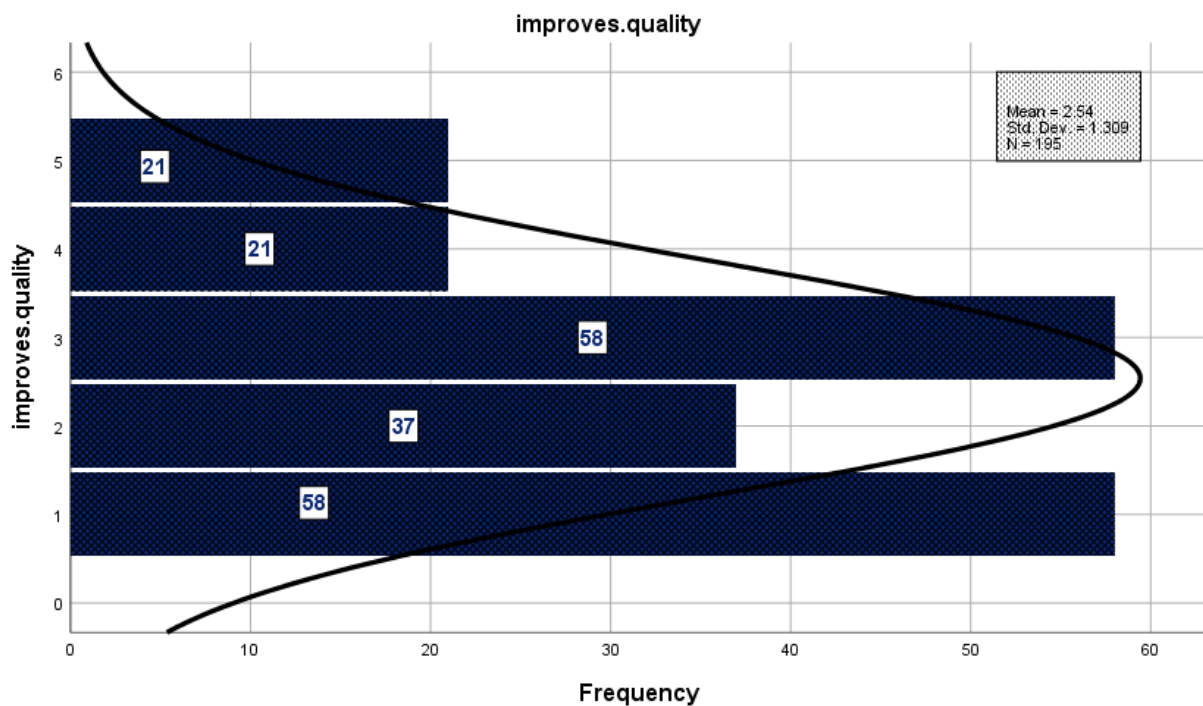


Figure 6: Graphical representation of effective project management work to improve the quality of road paving operations

6. The use of project management techniques ensures timely completion of landscaping projects.

Project management strategies guarantee that landscaping projects are completed on time by establishing thorough plans and exact timetables that arrange all work phases. These strategies

rely on clear objectives and appropriate job allocation, ensuring that all concerned teams work together to accomplish the intended results. Notably, the biggest number, 32.8%, reflected neutral views.

The use of project management techniques ensures timely completion of landscaping projects.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	43	22.1	22.1	22.1
	Disagree	42	21.5	21.5	43.6
	Neither agree nor disagree	64	32.8	32.8	76.4
	Strongly Agree	28	14.4	14.4	90.8
	Strongly Disagree	18	9.2	9.2	100.0
	Total	195	100.0	100.0	

Table 7: Statistical description of the use of project management techniques to complete landscaping projects in a timely manner.

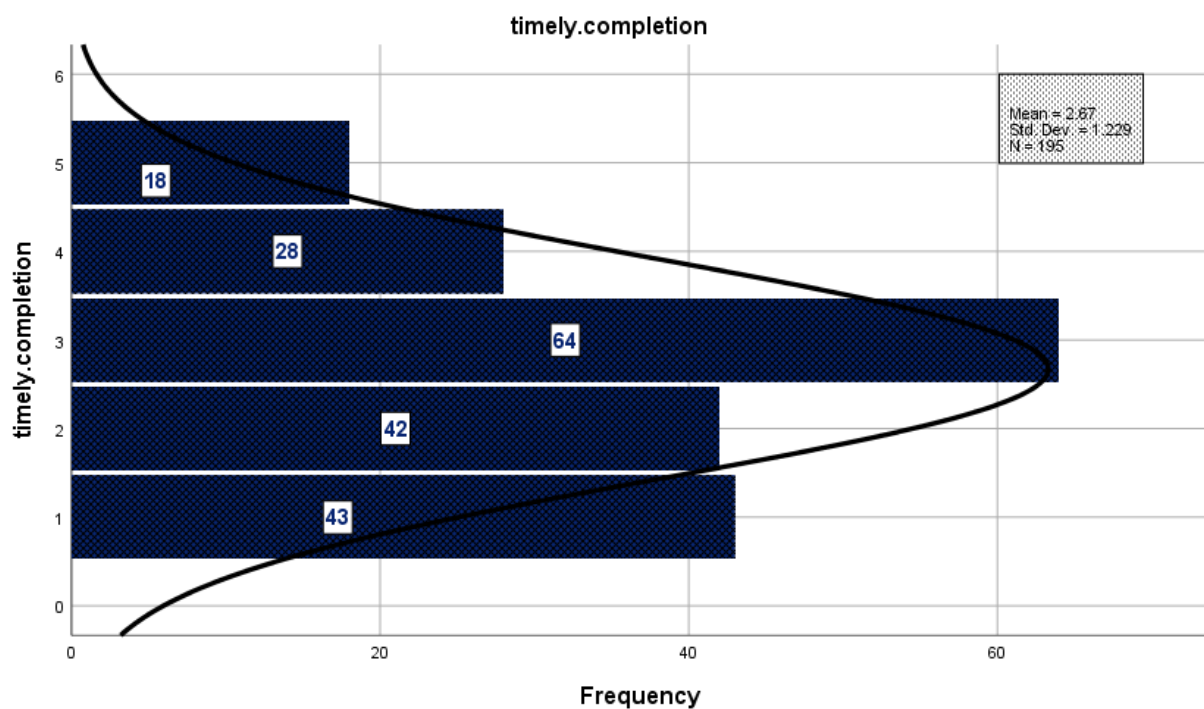


Figure 7: Graphical representation of using project management techniques to complete landscaping projects in a timely manner

7. Budget management through project management techniques reduces cost overruns in road paving projects.

Neutral opinions accounted for the biggest percentage, 30.3%. Budget management, supported by project management techniques, helps to reduce cost overruns in road paving projects by implementing strong financial plans and thorough spending monitoring. These strategies rely on a thorough study of probable expenditures and the creation of a precise budget for each project phase, allowing for accurate expense forecasting and control.

Budget management through project management techniques reduces cost overruns in road paving projects.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	53	27.2	27.2	27.2
	Disagree	32	16.4	16.4	43.6
	Neither agree nor disagree	59	30.3	30.3	73.8
	Strongly Agree	34	17.4	17.4	91.3
	Strongly Disagree	17	8.7	8.7	100.0
	Total	195	100.0	100.0	

Table 8: Statistical description of budget management through project management techniques reduces cost overruns in road paving projects.

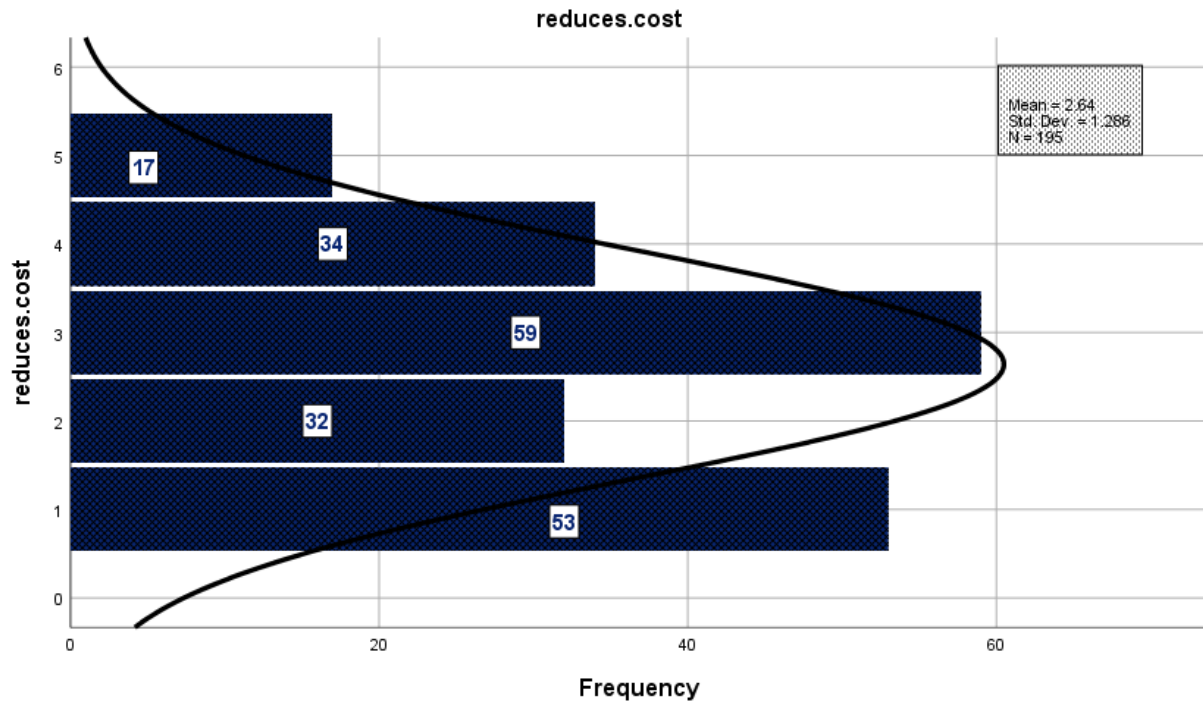


Figure 8: Graphical analysis of budget management through project management techniques reduces cost overruns in road paving projects

8. Risk management practices in project management mitigate potential issues in landscaping operations.

With a clear vision and careful analysis, proactive methods may be devised to handle possible issues before they become real hurdles. Risk management procedures in project management help to mitigate any hazards that may emerge in landscaping operations by conducting detailed risk assessments and developing effective reaction strategies. These techniques entail recognizing and analyzing potential negative impacts on the process, whether they are environmental, technological, or human-related. When we combine the proportion of agreement and strong agreement, we get 43.1% support for this perspective.

Risk management practices in project management mitigate potential issues in landscaping operations.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	52	26.7	26.7	26.7
	Disagree	44	22.6	22.6	49.2
	Neither agree nor disagree	55	28.2	28.2	77.4

	Strongly Agree	32	16.4	16.4	93.8
	Strongly Disagree	12	6.2	6.2	100.0
	Total	195	100.0	100.0	

Table 9: Statistical description of how risk management practices in project management mitigate potential problems in landscaping operations.

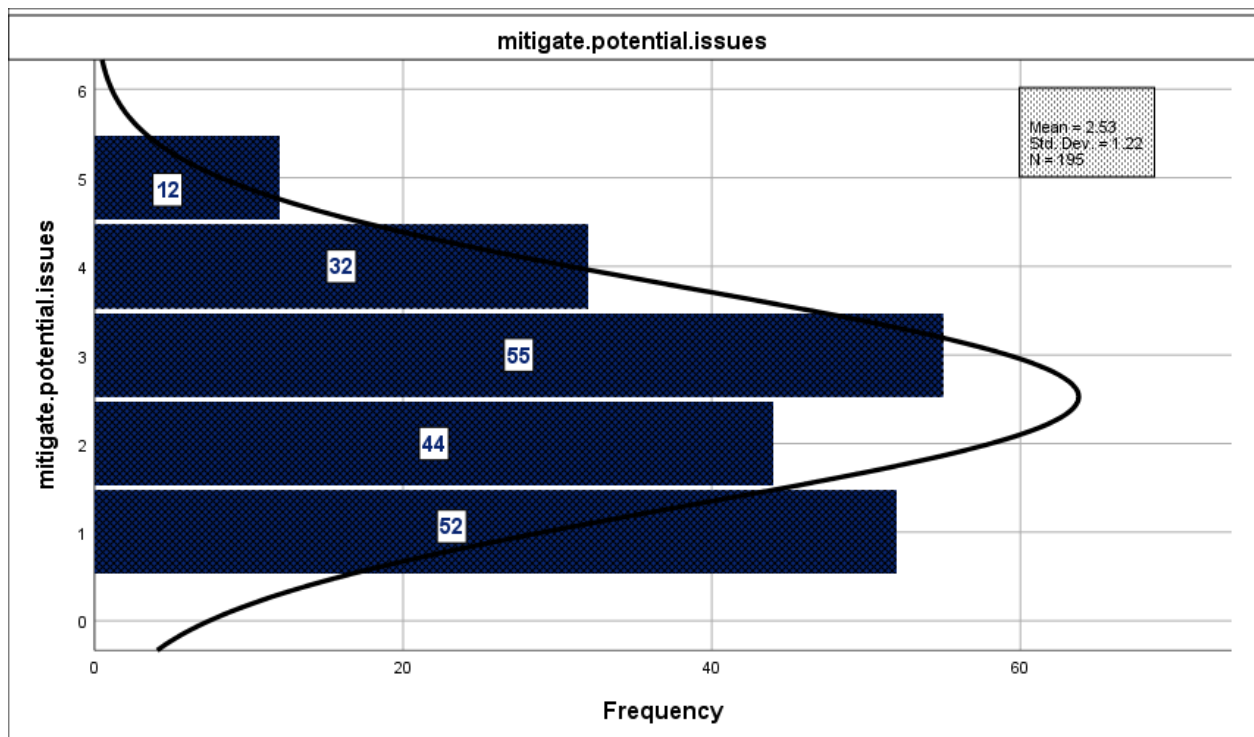


Figure 9: Graphical representation of how risk management practices in project management mitigate potential problems in landscaping operations

9. Project management techniques enhance coordination among different stakeholders in road paving projects.

With a 31.3% consensus, project management strategies were discovered to considerably improve coordination among diverse stakeholders in road paving projects by developing efficient communication channels and clear communication procedures. These strategies enable the exact defining of roles and responsibilities for each stakeholder, assuring everyone's commitment to project goals and deadlines.

Project management techniques enhance coordination among different stakeholders in road paving projects.				
	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	Agree	61	31.3	31.3	31.3
	Disagree	35	17.9	17.9	49.2
	Neither agree nor disagree	47	24.1	24.1	73.3
	Strongly Agree	32	16.4	16.4	89.7
	Strongly Disagree	20	10.3	10.3	100.0
	Total	195	100.0	100.0	

Table 10: Statistical description of project management techniques to enhance coordination among various stakeholders in road paving projects.

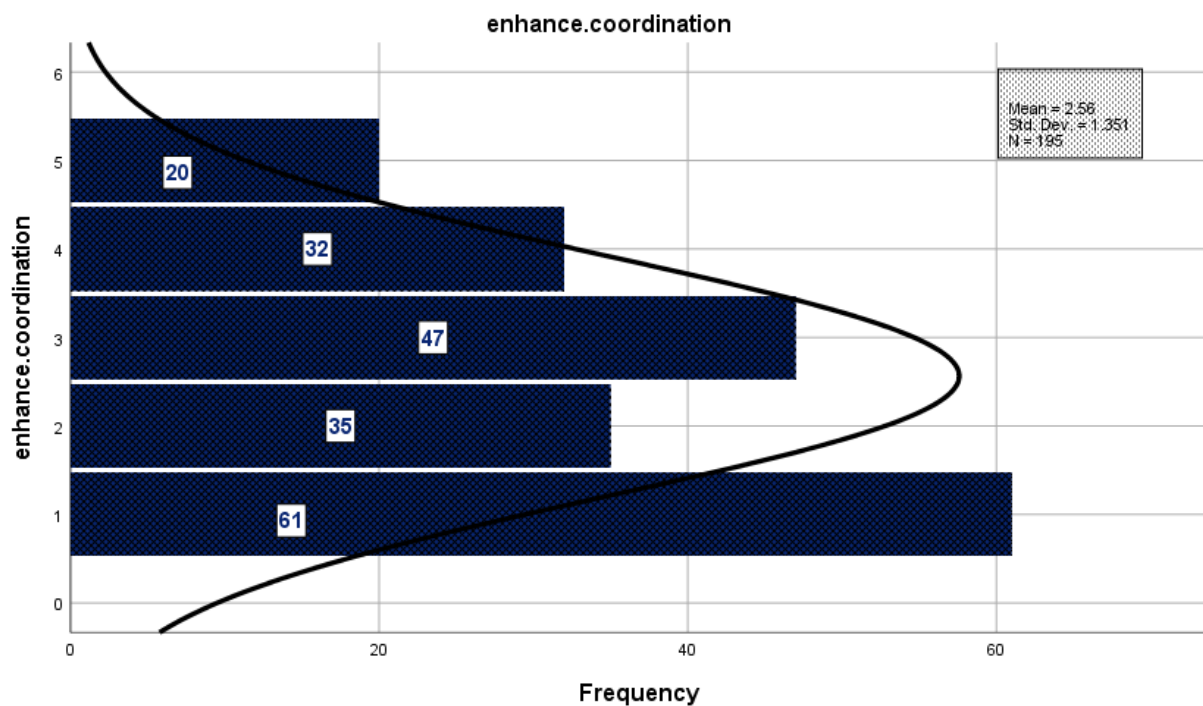


Figure 10: Graphical representation of project management techniques to enhance coordination among various stakeholders in road paving projects

10. Scheduling and timeline management are critical for the success of landscaping projects.

Scheduling and time management are regarded as critical components in determining the success of landscaping projects. They allow for the establishment of a well-structured timetable that arranges all work stages in a consistent and organized manner. This methodical approach not only guarantees that targeted objectives are met on time, but it also helps to increase efficiency and job quality, demonstrating the project's dedication to high standards

and generating great landscaping outcomes. The highest percentage of agreement, at 27.2%, was recorded for this statement.

Scheduling and timeline management are critical for the success of landscaping projects.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	53	27.2	27.2	27.2
	Disagree	47	24.1	24.1	51.3
	Neither agree nor disagree	49	25.1	25.1	76.4
	Strongly Agree	22	11.3	11.3	87.7
	Strongly Disagree	24	12.3	12.3	100.0
	Total	195	100.0	100.0	

Table 11: Statistical Description Scheduling and schedule management is critical to the success of landscaping projects.

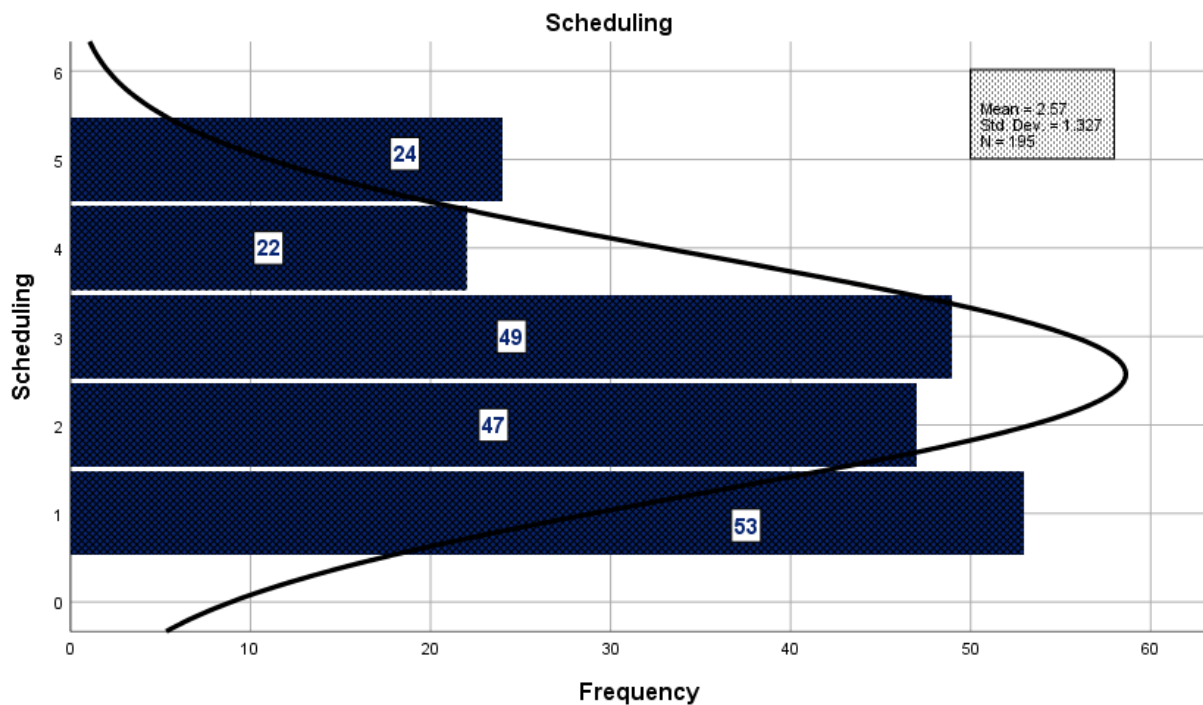


Figure 11: Graphical representation of scheduling and schedule management is critical to the success of landscaping projects.

11. Project management software tools are effectively used in road paving operations.

Neutral sentiments received the greatest proportion 30.3% once more. Project management software is widely used in road paving operations because it provides a comprehensive platform for efficiently and precisely controlling all areas of the project. These technologies help with the methodical organizing and planning of tasks, making it simpler to measure progress, manage resources, and meet deadlines.

Project management software tools are effectively used in road paving operations.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	53	27.2	27.2	27.2
	Disagree	44	22.6	22.6	49.7
	Neither agree nor disagree	59	30.3	30.3	80.0
	Strongly Agree	17	8.7	8.7	88.7
	Strongly Disagree	22	11.3	11.3	100.0
	Total	195	100.0	100.0	

Table 12: Statistical description of the effective use of project management software tools in road paving operations.

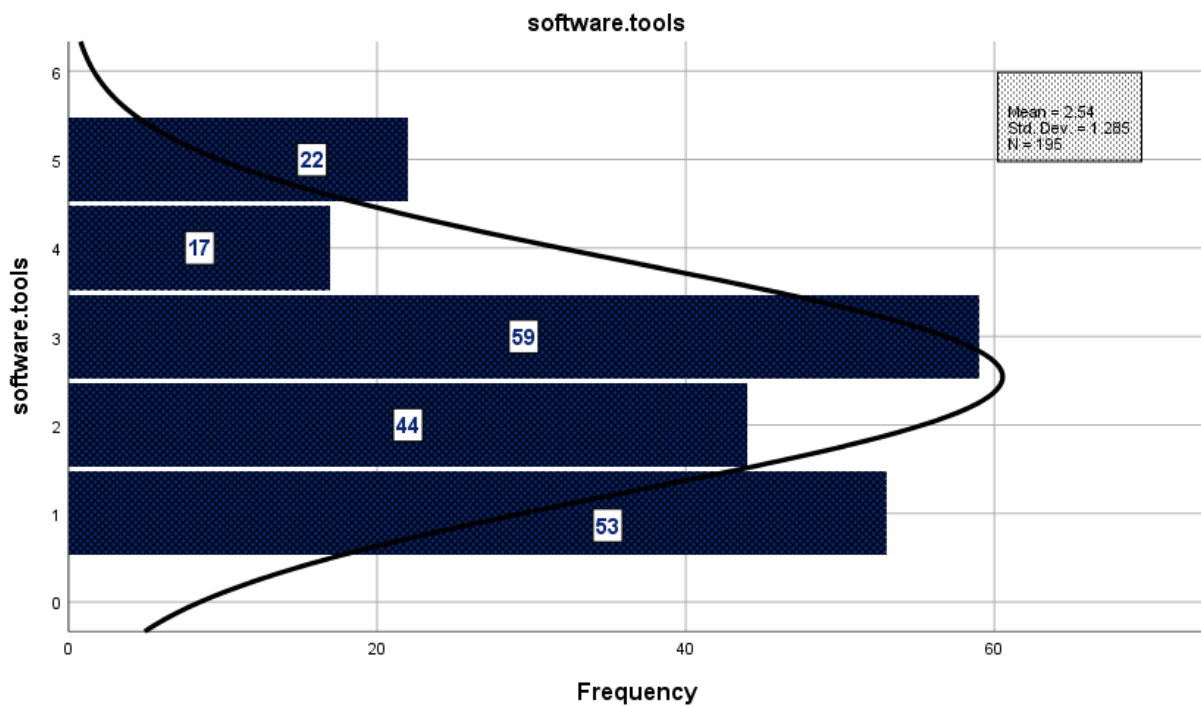


Figure 12: Graphic representation of the effective use of project management software tools in road paving operations

12. Communication plans developed through project management practices improve project outcomes in landscaping.

Communication plans made via project management approaches improve landscaping project outcomes by ensuring that all stakeholders share information in an organized and effective manner. Clear and accurate communication allows each partner to fully comprehend the project's requirements and expectations, resulting in choices based on exact and current facts. Notably, when we combine the agreement and strong agreement categories, 43.6% accepted this viewpoint.

Communication plans developed through project management practices improve project outcomes in landscaping.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	51	26.2	26.2	26.2
	Disagree	38	19.5	19.5	45.6
	Neither agree nor disagree	60	30.8	30.8	76.4
	Strongly Agree	34	17.4	17.4	93.8
	Strongly Disagree	12	6.2	6.2	100.0
	Total	195	100.0	100.0	

Table 13: Statistical description of the work of communication plans developed through project management practices improve project outcomes in the field of landscaping.

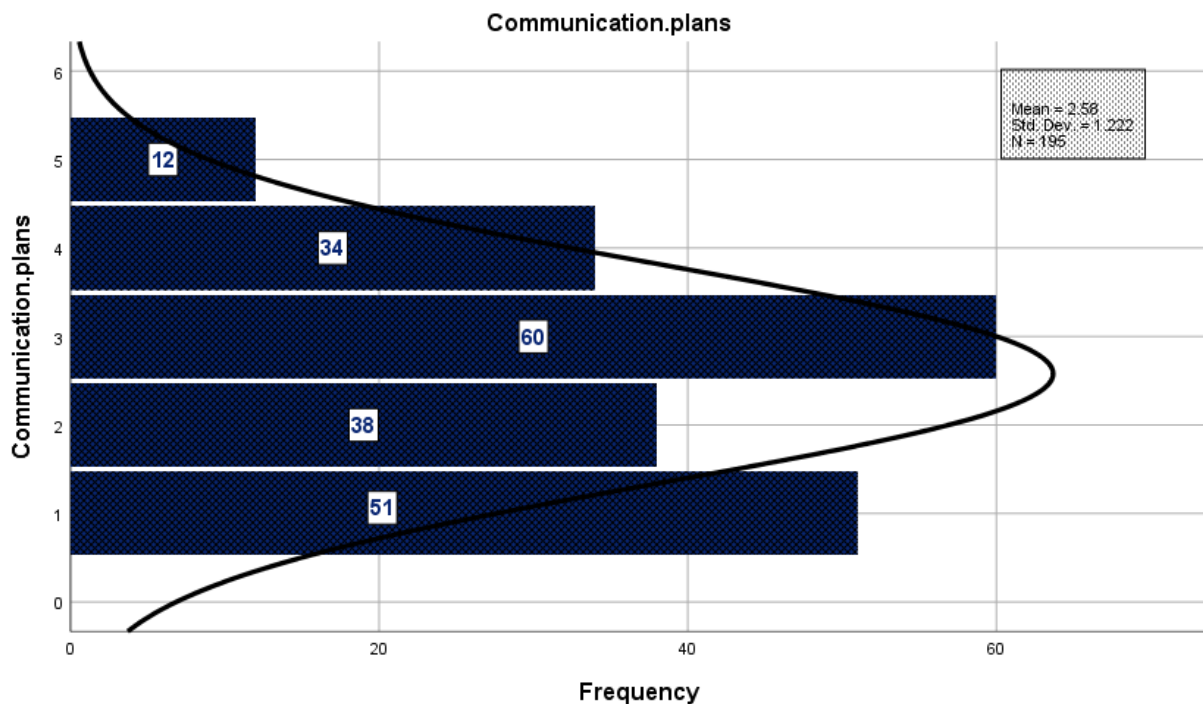


Figure 13: Graphic representation of the work of communication plans developed through project management practices improves project outcomes in the field of landscaping

13. Scope management in project management helps in preventing project scope creep in road paving projects.

We observe a 2.1% increase in neutral responses compared to agreement. Scope management in project management is critical for limiting project scope creep in road paving projects by clearly specifying project requirements and expected outputs. By defining a defined framework for activities and desired outcomes, scope management allows the team to stay focused on core tasks while avoiding unplanned adjustments or improvements that might cause schedule delays or budget overruns.

Scope management in project management helps in preventing project scope creep in road paving projects.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	47	24.1	24.1	24.1
	Disagree	40	20.5	20.5	44.6
	Neither agree nor disagree	51	26.2	26.2	70.8
	Strongly Agree	37	19.0	19.0	89.7
	Strongly Disagree	20	10.3	10.3	100.0
	Total	195	100.0	100.0	

Table 14: Statistical description of scope management assistance in project management in preventing project scope creep in road paving projects.

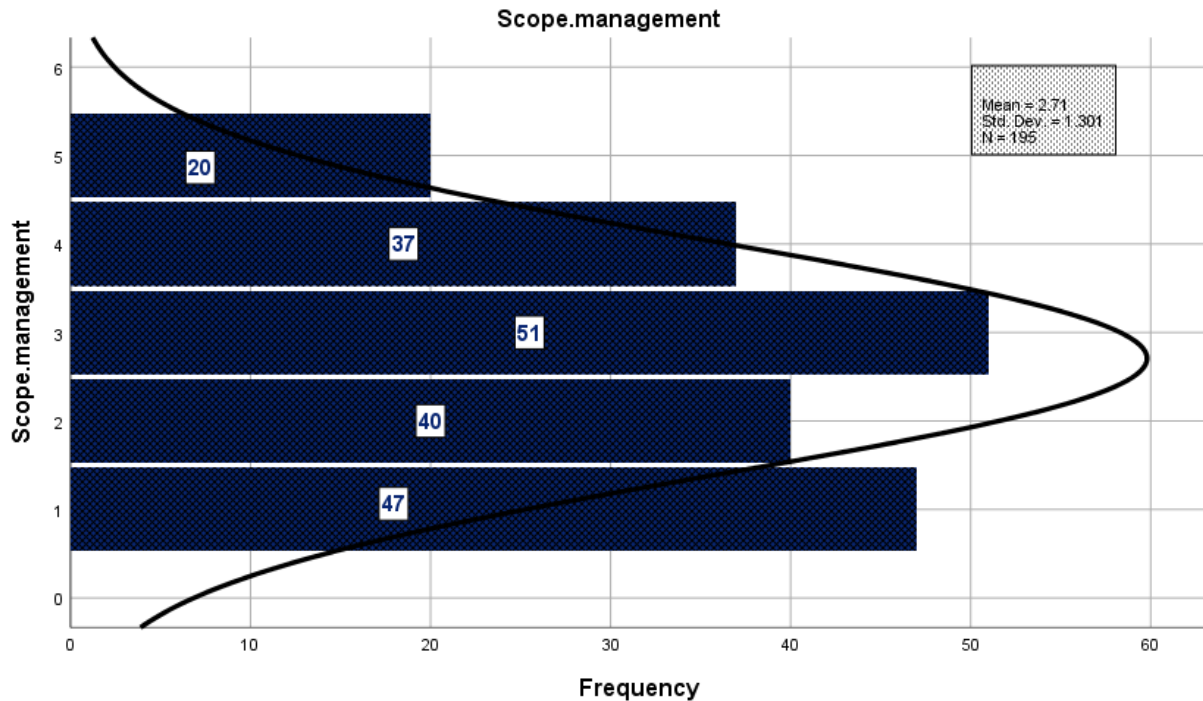


Figure 14: Graphic representation of scope management assistance in project management in preventing project scope creep in road paving projects

14. Resource allocation through project management techniques optimizes manpower and materials in landscaping projects.

Project management strategies optimize resource allocation by making the best use of labor and resources in landscaping projects through careful and efficient distribution. These strategies aid in determining the exact requirements of each project phase, allowing for the allocation of people and material resources based on task priorities and particular timetables. Despite this, this statement received the most dissent, at 24.1%.

Resource allocation through project management techniques optimizes manpower and materials in landscaping projects.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	43	22.1	22.1	22.1
	Disagree	47	24.1	24.1	46.2
	Neither agree nor disagree	61	31.3	31.3	77.4
	Strongly Agree	27	13.8	13.8	91.3
	Strongly Disagree	17	8.7	8.7	100.0
	Total	195	100.0	100.0	

Table 15: Statistical description of resource allocation through project management techniques to optimize manpower and materials in landscaping projects

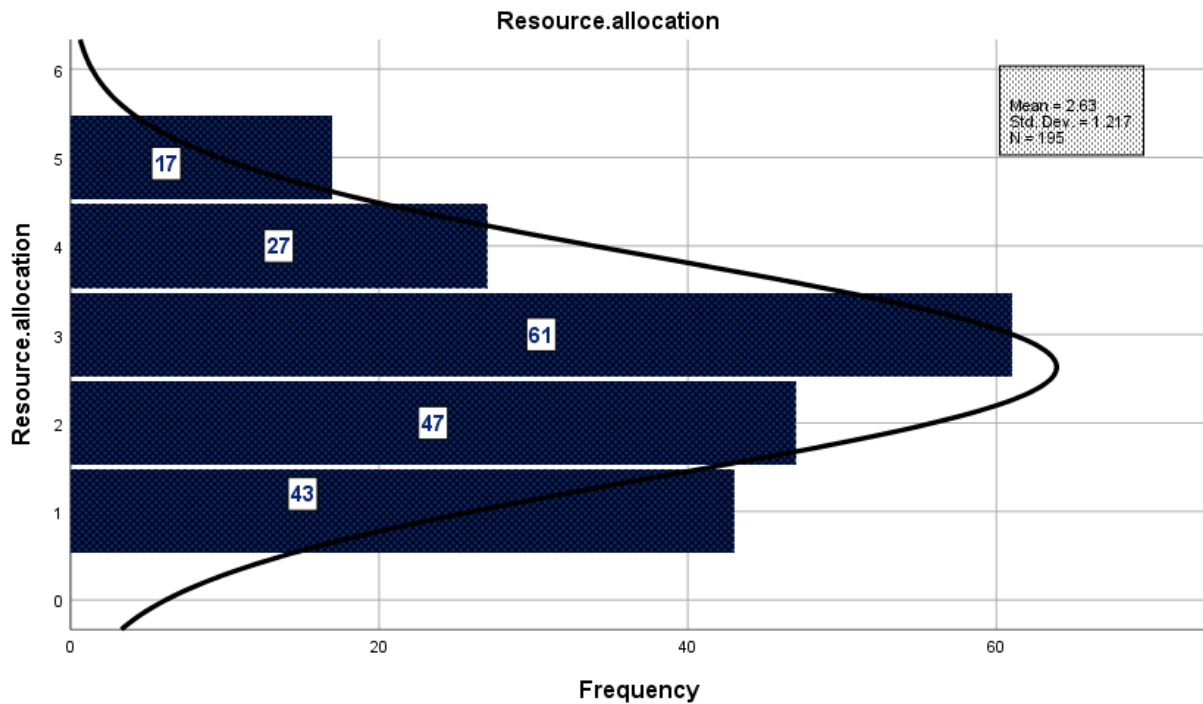


Figure 15: Graphical representation of resource allocation through project management techniques to optimize manpower and materials in landscaping projects

15. Quality control procedures in project management ensure high standards in road paving projects.

A substantial 37% of respondents agreed and strongly agreed that a constant commitment to quality assurance demonstrates a desire to achieve great outcomes and ensure long-term superior performance. Quality assurance processes in project management help to attain high standards in road paving projects by creating a rigorous system for monitoring all aspects of execution. These processes entail creating explicit standards and establishing particular checkpoints to guarantee that all actions follow technical specifications and needed norms.

Quality control procedures in project management ensure high standards in road paving projects.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	44	22.6	22.6	22.6
	Disagree	43	22.1	22.1	44.6

	Neither agree nor disagree	49	25.1	25.1	69.7
	Strongly Agree	28	14.4	14.4	84.1
	Strongly Disagree	31	15.9	15.9	100.0
	Total	195	100.0	100.0	

Table 16: Statistical description of quality control procedures in project management ensuring high standards in road paving projects.

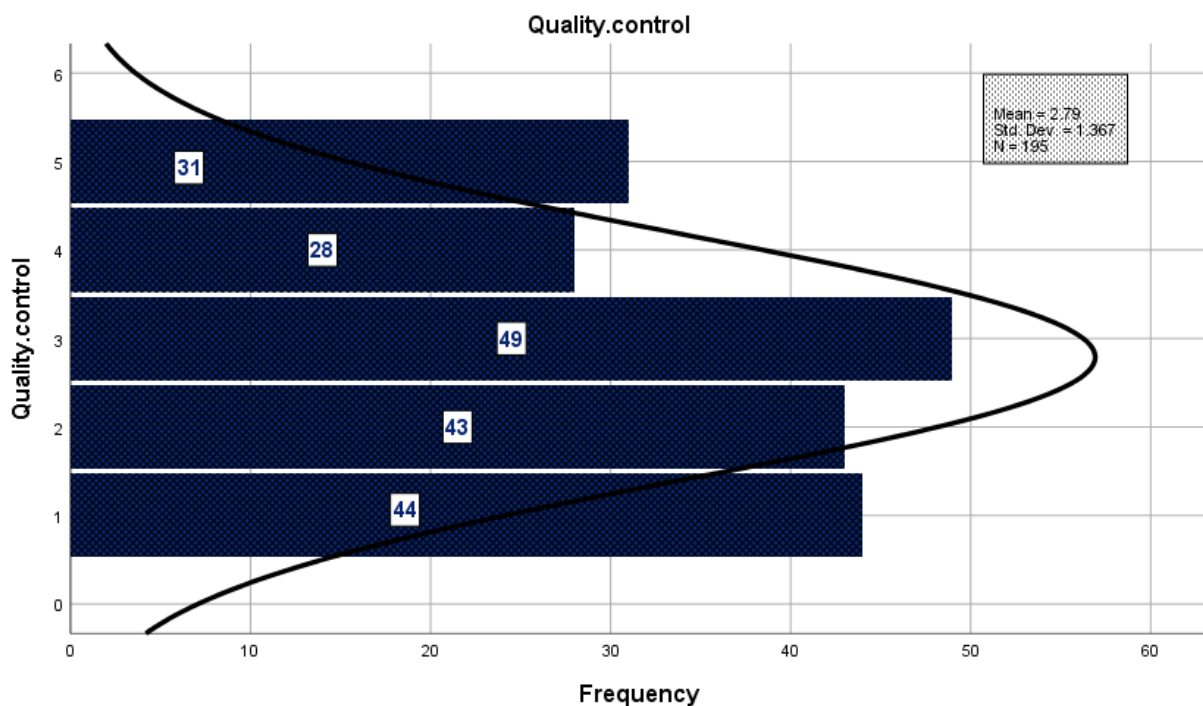


Figure 16: Graphic representation of quality control procedures in project management ensures high standards in road paving projects

16. The integration of project management techniques with technology improves efficiency in landscaping operations.

Continuous monitoring and assessment in project management are critical to the success of road paving projects because they ensure frequent verification of work progress and alignment with established objectives. These techniques provide a systematic framework for measuring performance at many stages, allowing deviations from initial goals to be identified and addressed quickly and efficiently. The vast majority of responders, 29.2%, agreed with this assertion.

The integration of project management techniques with technology improves efficiency in landscaping operations.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	57	29.2	29.2	29.2
	Disagree	41	21.0	21.0	50.3
	Neither agree nor disagree	49	25.1	25.1	75.4
	Strongly Agree	29	14.9	14.9	90.3
	Strongly Disagree	19	9.7	9.7	100.0
	Total	195	100.0	100.0	

Table 17: Statistical description of the integration of project management techniques with technology to improve efficiency in landscaping operations

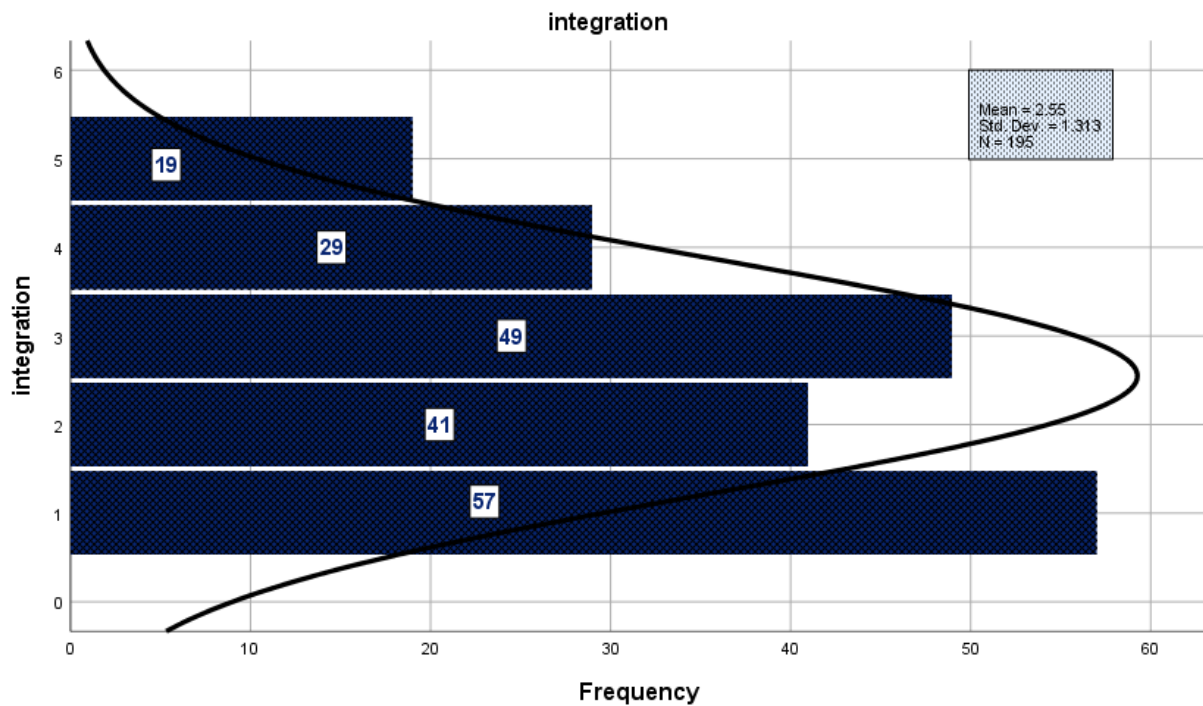


Figure 17: Graphic representation of the integration of project management techniques with technology to improve efficiency in landscaping operations

17. Continuous monitoring and evaluation in project management contribute to the success of road paving projects.

Continuous monitoring and assessment in project management are critical to the success of road paving projects because they ensure frequent verification of work progress and alignment with established objectives. These techniques provide a systematic framework for measuring performance at many stages, allowing deviations from initial goals to be identified and addressed quickly and efficiently. Most responders, 32.3%, neutral with this assertion.

Continuous monitoring and evaluation in project management contribute to the success of road paving projects.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	44	22.6	22.6	22.6
	Disagree	43	22.1	22.1	44.6
	Neither agree nor disagree	63	32.3	32.3	76.9
	Strongly Agree	33	16.9	16.9	93.8
	Strongly Disagree	12	6.2	6.2	100.0
	Total	195	100.0	100.0	

Table 18: Statistical description of the contribution of continuous monitoring and evaluation in project management to the success of road paving projects.

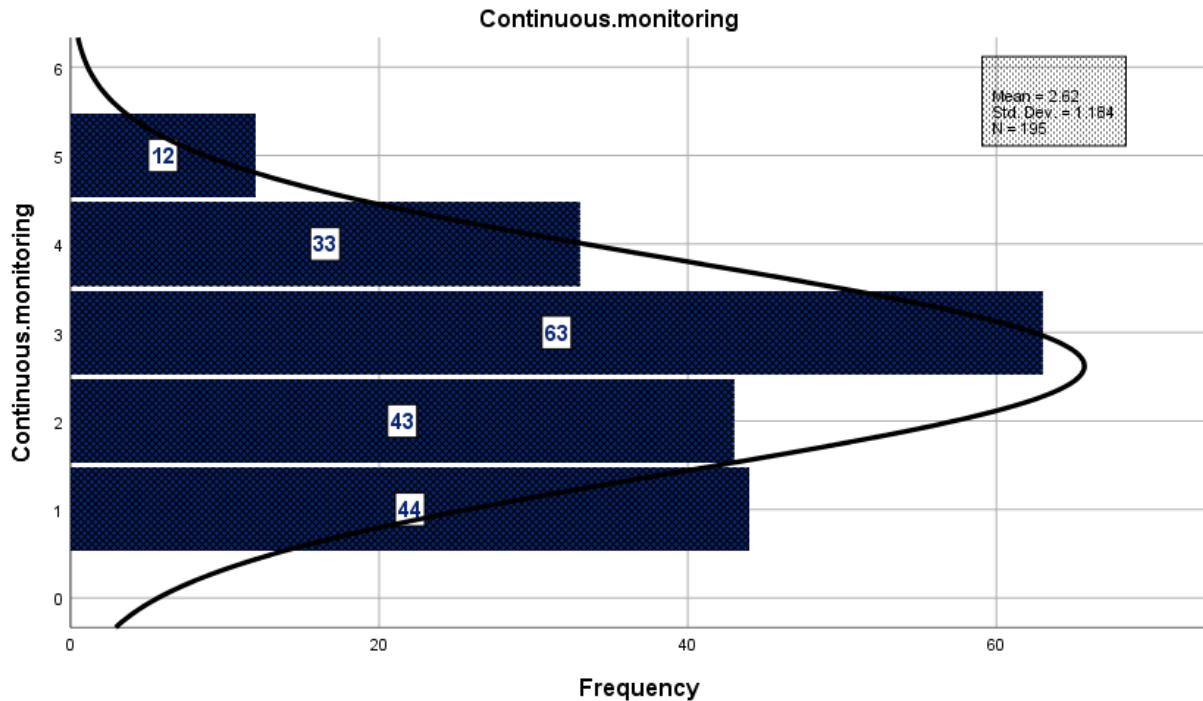


Figure 18: Graphical representation of the contribution of continuous monitoring and evaluation in project management to the success of road paving projects

18. Stakeholder engagement in project management enhances the execution of landscaping projects.

Effective stakeholder engagement in project management improves the implementation of landscaping projects by encouraging collaboration and coordination among all parties involved. When stakeholders, such as the local community, designers, engineers, and contractors, participate in all project phases, ideas and requirements are directly shared, resulting in better project design and planning that meets everyone's needs and expectations. This might explain the 1% increase in strong agreement vs neutral replies.

Stakeholder engagement in project management enhances the execution of landscaping projects.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	41	21.0	21.0	21.0
	Disagree	49	25.1	25.1	46.2
	Neither agree nor disagree	58	29.7	29.7	75.9

	Strongly Agree	19	9.7	9.7	85.6
	Strongly Disagree	28	14.4	14.4	100.0
	Total	195	100.0	100.0	

Table 19: Statistical description of stakeholder involvement in project management in enhancing the implementation of landscaping projects.

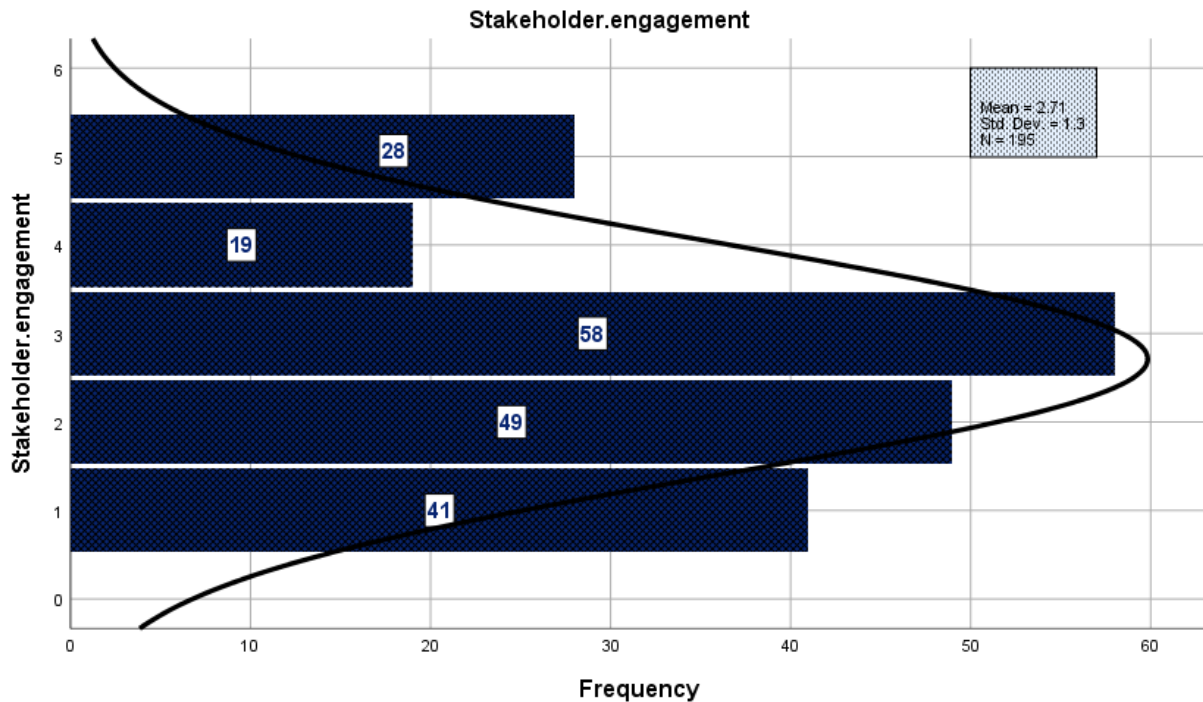


Figure 19: Statistical representation of stakeholder engagement in project management to enhance the implementation of landscaping projects

19. Change management strategies in project management are effective in handling modifications in road paving projects.

Neutral replies have risen to the greatest level, 32.3%. Change management helps to evaluate the feasibility of modifications and prioritise them appropriately by providing a formal framework for handling any project changes flexibly and efficiently. It also allows for efficient communication with all stakeholders to explain the rationale for the changes and their potential consequences, assuring everyone's consent and support for essential adjustments.

Change management strategies in project management are effective in handling modifications in road paving projects.

		Frequenc y	Percent	Valid Percent	Cumulative Percent
Valid	Agree	59	30.3	30.3	30.3
	Disagree	37	19.0	19.0	49.2
	Neither agree nor disagree	63	32.3	32.3	81.5
	Strongly Agree	25	12.8	12.8	94.4
	Strongly Disagree	11	5.6	5.6	100.0
	Total	195	100.0	100.0	

Table 20: Statistical description of change management strategies in project management effective in dealing with modifications in road paving projects.

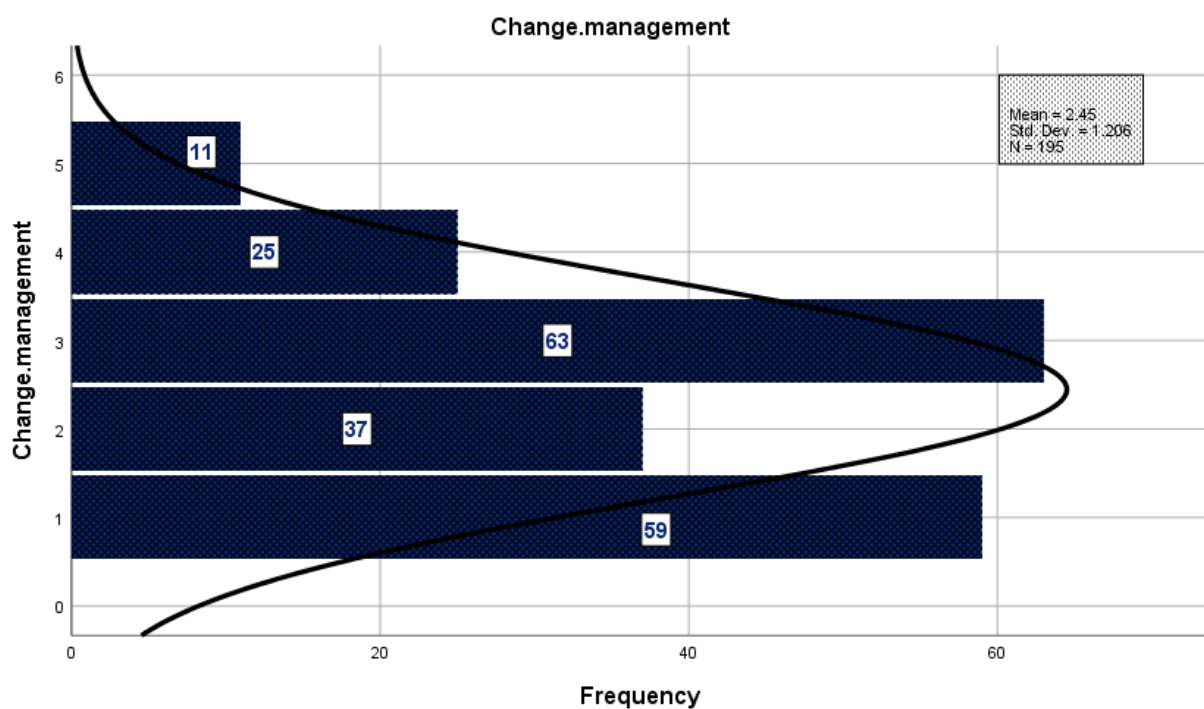


Figure 20: Statistical representation of change management strategies in project management are effective in dealing with modifications in road paving projects

20. Project management training and development are crucial for improving landscaping project outcomes.

Training and development in project management are essential for enhancing execution quality and performance efficiency. Individuals may learn the essential skills to effectively handle potential obstacles and changes by investing time and money in educating teams on the newest project management methods and processes. With 30.3% of perspectives in agreement, enhancing management skills improves the team's capacity to communicate among diverse stakeholders and solve challenges in novel ways, resulting in better landscaping project execution and increased customer and beneficiary satisfaction.

Project management training and development are crucial for improving landscaping project outcomes.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	59	30.3	30.3	30.3
	Disagree	42	21.5	21.5	51.8
	Neither agree nor disagree	42	21.5	21.5	73.3
	Strongly Agree	35	17.9	17.9	91.3
	Strongly Disagree	17	8.7	8.7	100.0
	Total	195	100.0	100.0	

Table 21: Statistical description of project management training and development is essential to improving the outcomes of landscape projects.

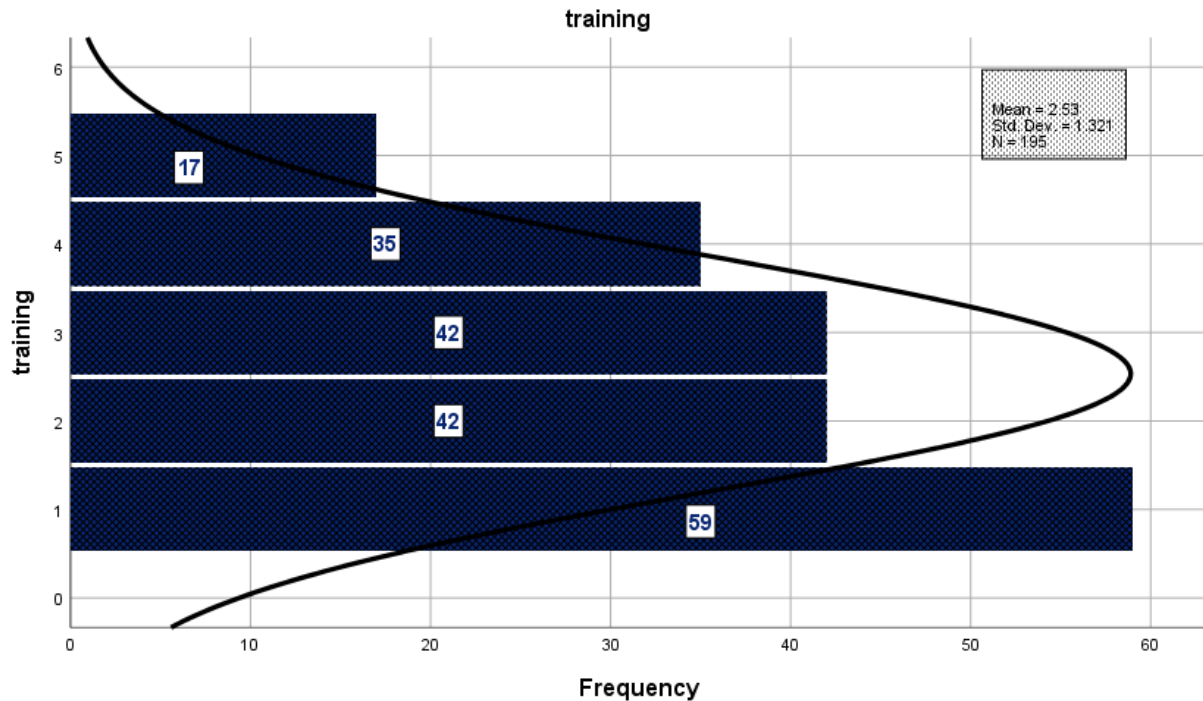


Figure 21: Graphic representation of project management training and development is essential to improving the outcomes of landscape projects

21. Environmental considerations in project management are adequately addressed in road paving operations.

Strongly agree and agree replies account for the biggest number, 34.4%. This demonstrates that environmental factors in project management are addressed fully and systematically in road paving projects by incorporating sustainability and environmental protection criteria into all stages of planning and execution. This is accomplished by performing comprehensive studies of the project's possible environmental impact, which aids in identifying and mitigating detrimental effects on nearby ecosystems.

Environmental considerations in project management are adequately addressed in road paving operations.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	45	23.1	23.1	23.1
	Disagree	47	24.1	24.1	47.2
	Neither agree nor disagree	58	29.7	29.7	76.9

	Strongly Agree	22	11.3	11.3	88.2
	Strongly Disagree	23	11.8	11.8	100.0
	Total	195	100.0	100.0	

Table 22: Statistical description of the appropriate handling of environmental considerations in project management in road paving operations.

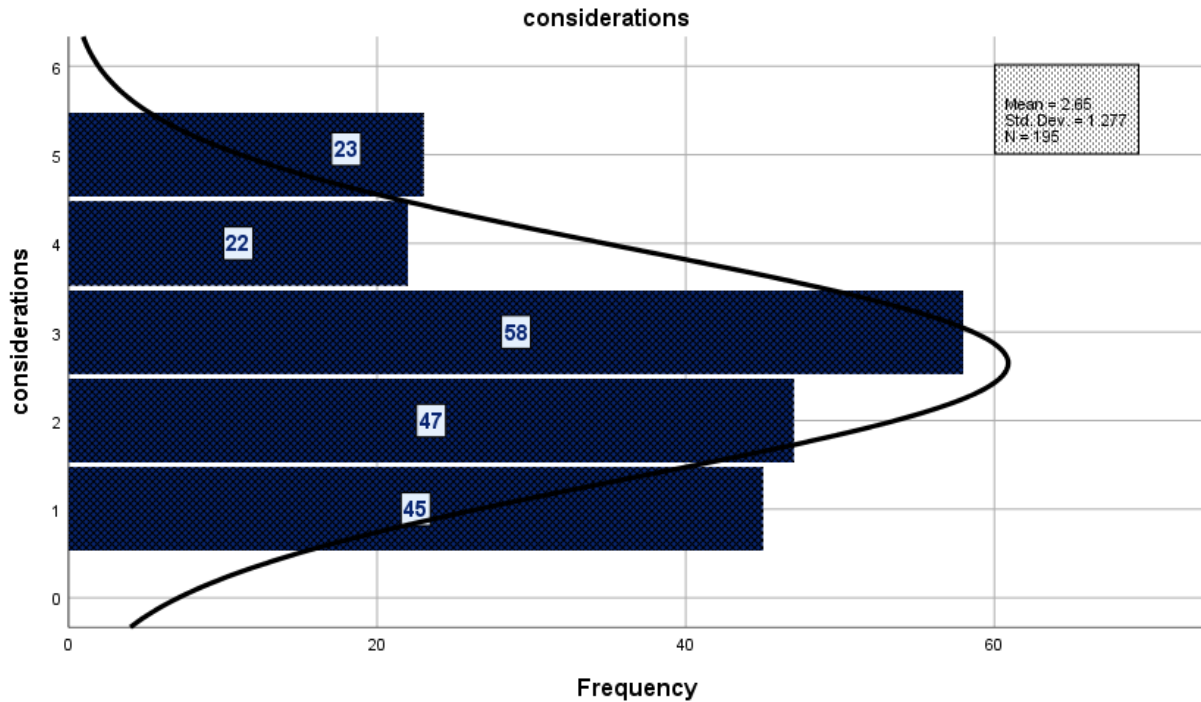


Figure 22: Graphic representation to adequately address environmental considerations in project management in road paving operations

22. The role of project managers is vital for the successful implementation of landscaping projects.

28.7% of respondents believe that project managers play an important role in the successful implementation of landscaping projects by providing strategic direction and advice to ensure that goals are met quickly and effectively. Project managers are in charge of managing all parts of the task, from planning and design to execution and follow-up, to ensure that efforts are integrated and that there are no overlaps or errors. Project managers help to identify and allocate resources in accordance with project needs by making decisions based on comprehensive data analysis and continual progress review.

The role of project managers is vital for the successful implementation of landscaping projects.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	56	28.7	28.7	28.7
	Disagree	40	20.5	20.5	49.2
	Neither agree nor disagree	47	24.1	24.1	73.3
	Strongly Agree	27	13.8	13.8	87.2
	Strongly Disagree	25	12.8	12.8	100.0
	Total	195	100.0	100.0	

Table 23: The statistical description of the role of project managers is of vital importance to the successful implementation of landscaping projects.

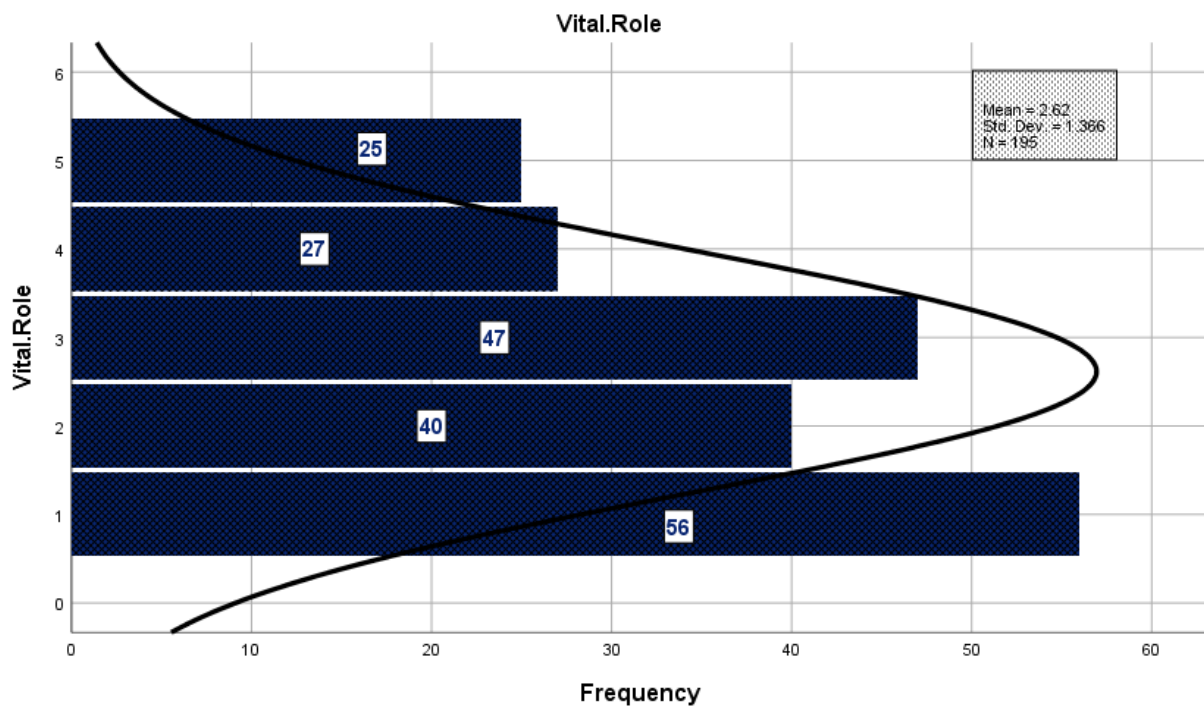


Figure 23: Graphic representation of the role of project managers is vital to the successful implementation of landscaping projects

23. Project management techniques facilitate compliance with regulatory requirements in road paving projects.

Project management strategies enable road paving projects to comply with regulatory requirements by offering integrated tools for tracking and documenting the necessary standards and regulations. These solutions also allow for constant information updates and simple access, which improves the team's capacity to respond to changes or additions to rules and regulations. This viewpoint was shared by 28.2% of respondents.

Project management techniques facilitate compliance with regulatory requirements in road paving projects.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	55	28.2	28.2	28.2
	Disagree	45	23.1	23.1	51.3
	Neither agree nor disagree	51	26.2	26.2	77.4
	Strongly Agree	28	14.4	14.4	91.8
	Strongly Disagree	16	8.2	8.2	100.0
	Total	195	100.0	100.0	

Table 24: Statistical description of project management techniques to facilitate compliance with regulatory requirements in road paving projects.

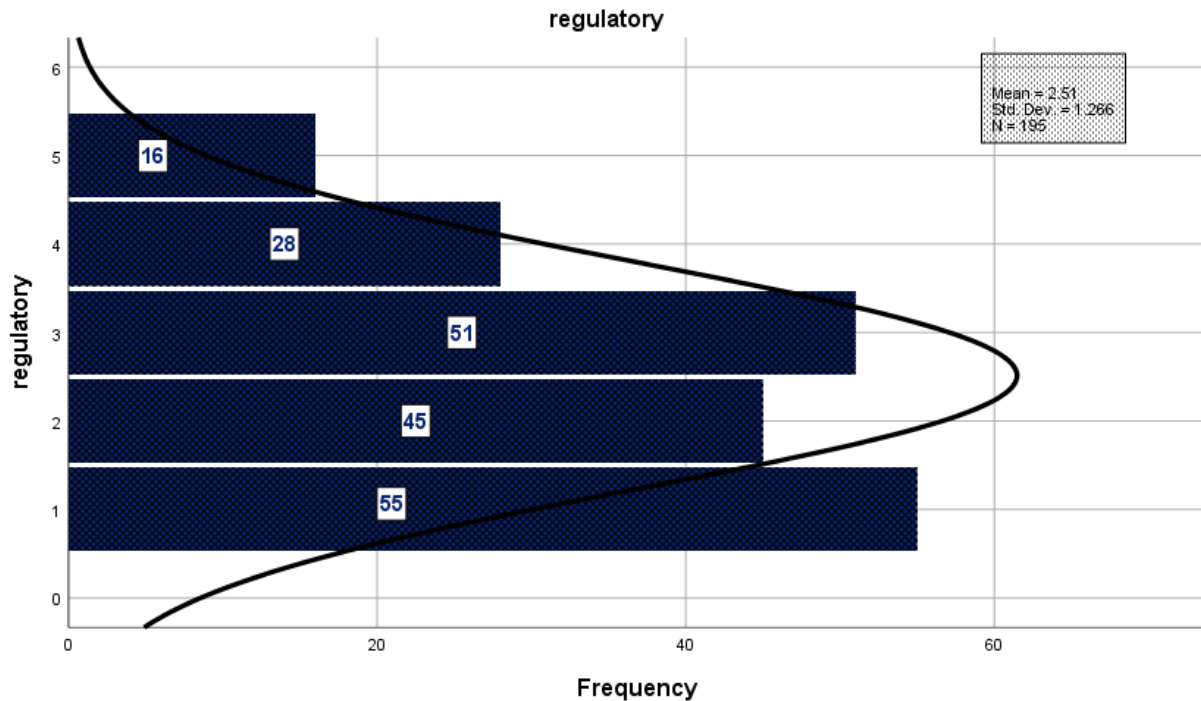


Figure 24: Graphical representation to assist project management techniques in facilitating compliance with regulatory requirements in road paving projects

24. Lessons learned from previous projects are effectively utilized in current landscaping operations through project management.

A neutral position formed at a rate of 30.8%, despite project management improving the effective application of lessons acquired from earlier landscaping initiatives in ongoing projects. This is accomplished by incorporating previous experiences into the planning and execution phases. Analyzing prior project successes and obstacles, as well as recording successful solutions and methodologies, improves the ability to address future challenges in a more planned and effective manner. Continuous learning from previous experiences improves the entire project management process.

Lessons learned from previous projects are effectively utilized in current landscaping operations through project management.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	40	20.5	20.5	20.5
	Disagree	43	22.1	22.1	42.6

	Neither agree nor disagree	60	30.8	30.8	73.3
	Strongly Agree	32	16.4	16.4	89.7
	Strongly Disagree	20	10.3	10.3	100.0
	Total	195	100.0	100.0	

Table 25: Statistical description of how to effectively leverage lessons learned from previous projects into current landscaping operations through project management.

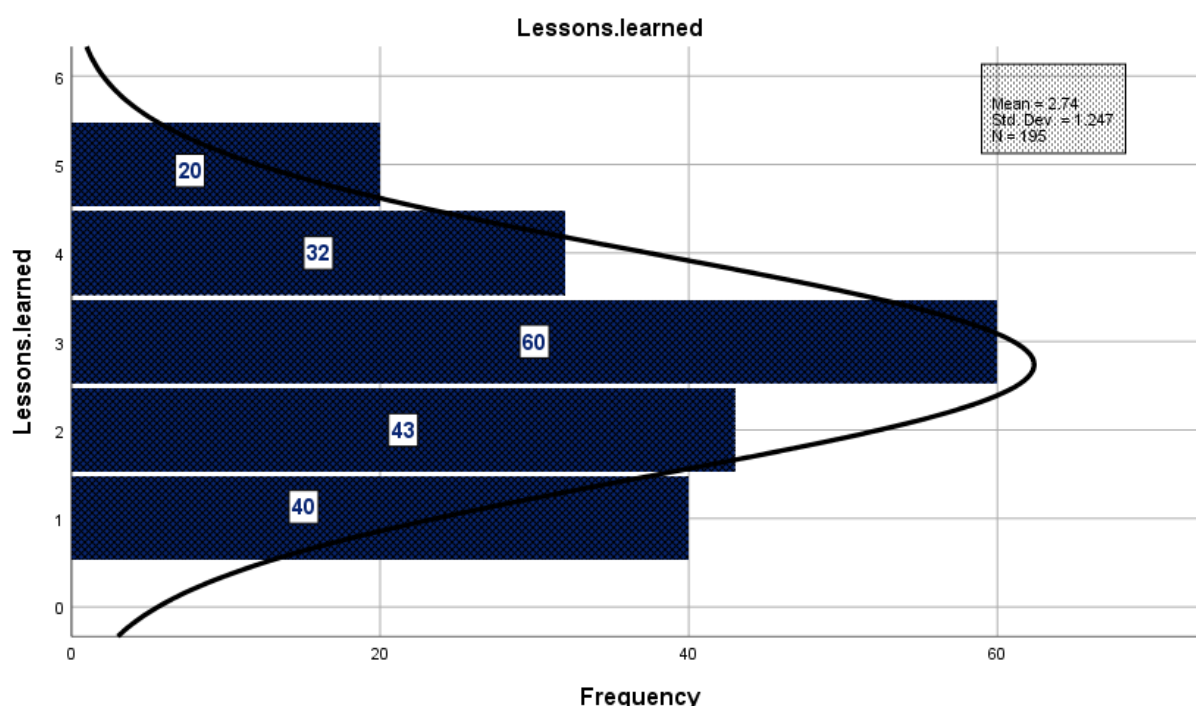


Figure 25: Graphical representation to effectively leverage lessons learned from previous projects into current landscaping operations through project management

25. The overall success of Vision 2030's infrastructure goals depends on the effective application of project management techniques in road paving and landscaping operations.

The entire achievement of Vision 2030's infrastructure ambitions depends on the systematic use of project management techniques in road paving and landscaping projects. These strategies provide the necessary efficiency and quality throughout the project's lifecycle. This successful application not only helps to achieve the needed infrastructure, but it also improves the implementation of sustainable development goals and urban development, hence improving the Kingdom's quality of life and well-being. The percentages of indifferent and agreeing replies were equal, at 28.2%.

The overall success of Vision 2030's infrastructure goals depends on the effective application of project management techniques in road paving and landscaping operations.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	55	28.2	28.2	28.2
	Disagree	34	17.4	17.4	45.6
	Neither agree nor disagree	55	28.2	28.2	73.8
	Strongly Agree	42	21.5	21.5	95.4
	Strongly Disagree	9	4.6	4.6	100.0
	Total	195	100.0	100.0	

Table 26: Statistical description of the overall success of the infrastructure goals of Vision 2030 depend on the effective application of project management techniques in road paving and landscaping operations

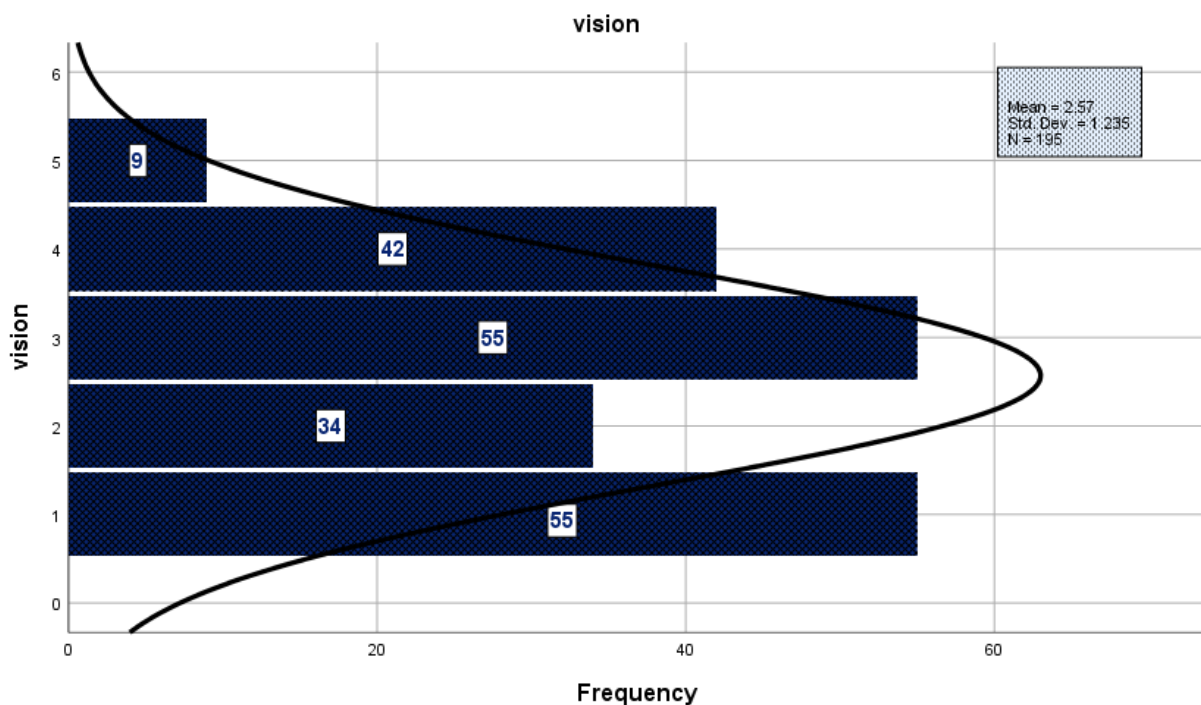


Figure 26: Graphic representation of the overall success of the infrastructure goals of Vision 2030 depends on the effective application of project management techniques in road paving and landscaping operations

- **Study variables**

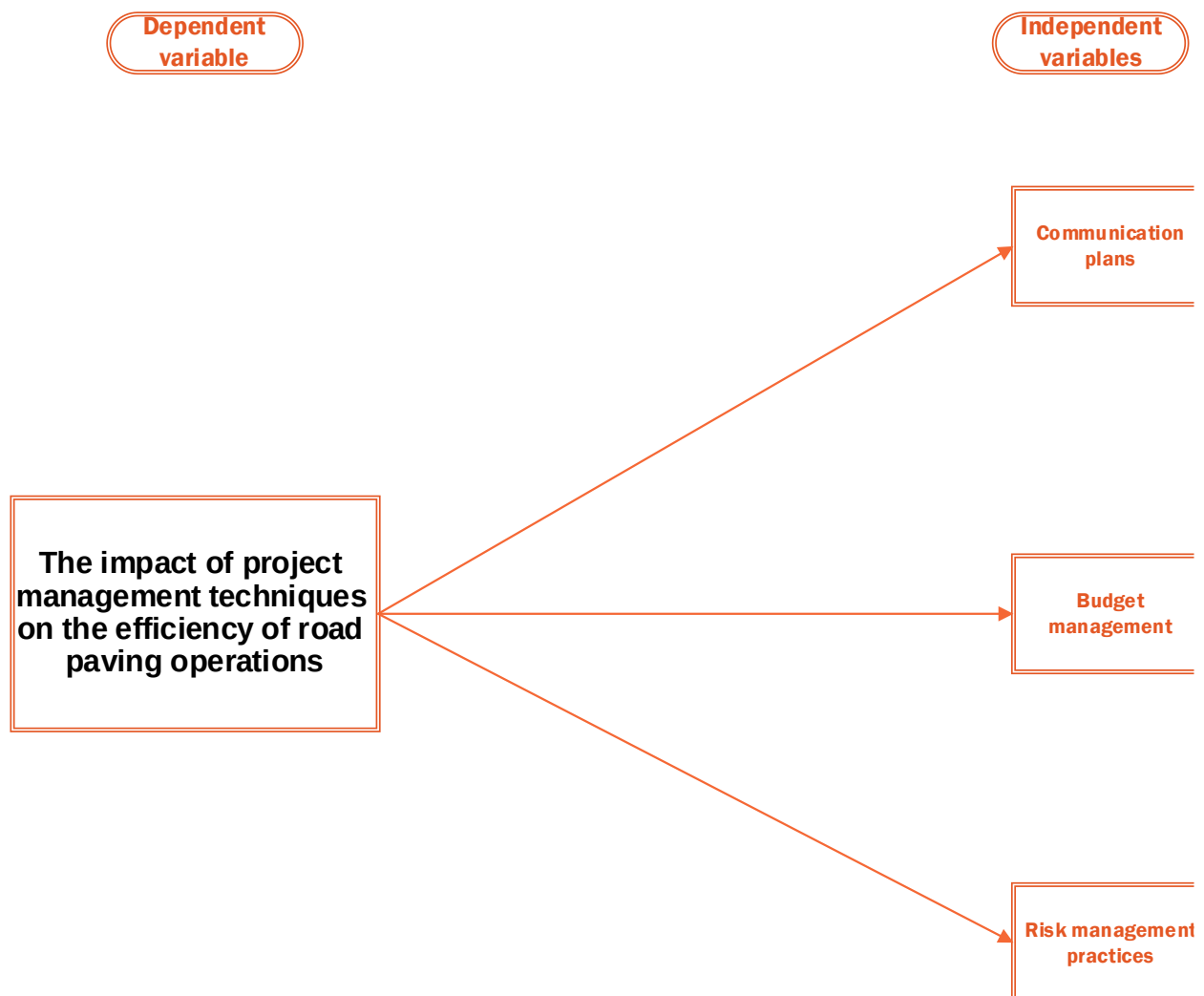


Figure 27: Dependent and independent study variables

- **The Impact of Communication plans in Project Management Techniques on the Efficiency of Road Paving and Landscaping Operations to Achieve Vision 2030 in the Kingdom of Saudi Arabia**

Communication is the foundation of project management. It ensures that all stakeholders, including project managers, team members, contractors, and clients, are on the same page regarding project goals, timelines, and final products. Effective communication helps to:

- **Clarify objectives:** Clearly defined objectives ensure that all team members understand the project goals and their respective responsibilities in achieving them.
- **Coordinate activities:** Complex operations such as paving and landscaping require the coordination of multiple functions.
- **Manage expectations:** Regular updates and feedback help manage stakeholder expectations and prevent misunderstandings.
- **Identify and address concerns:** Prompt communication allows potential difficulties to be identified early and resolved quickly, avoiding delays and cost overruns (Doheim, 2019).

The results reveal that the degree of freedom for assessing the impact of communication plans in project management techniques on the efficiency of road paving and landscaping operations is equal to 2. This degree of freedom value signifies the number of independent variables or categories being analyzed within the context of the study. Specifically, it indicates that the analysis involved testing how communication plans, as one of the independent variables, influence the dependent variable efficiency in road paving and landscaping operations. A degree of freedom of 2 suggests that the study incorporated a relatively simplified model or framework where the impact of communication plans was examined across a limited number of variables or factors. In terms of the strength of the study variables, this degree of freedom value reflects a focused analysis with a manageable scope, allowing for a clear and direct examination of how communication plans affect project efficiency. It implies that the study has the capacity to provide meaningful insights into the role of communication strategies within the broader context of project management practices, contributing valuable findings to the goal of enhancing operational efficiency in alignment with Vision 2030.

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)

Pearson Chi-Square	17.675 ^a	2	.343
Likelihood Ratio	19.832	2	.228
Linear-by-Linear Association	.588	1	.443
N of Valid Cases	195		

Table 27: Chi-square test The Impact of Communication plans in Project Management Techniques on the Efficiency of Road Paving and Landscaping Operations to Achieve Vision 2030 in the Kingdom of Saudi Arabia.

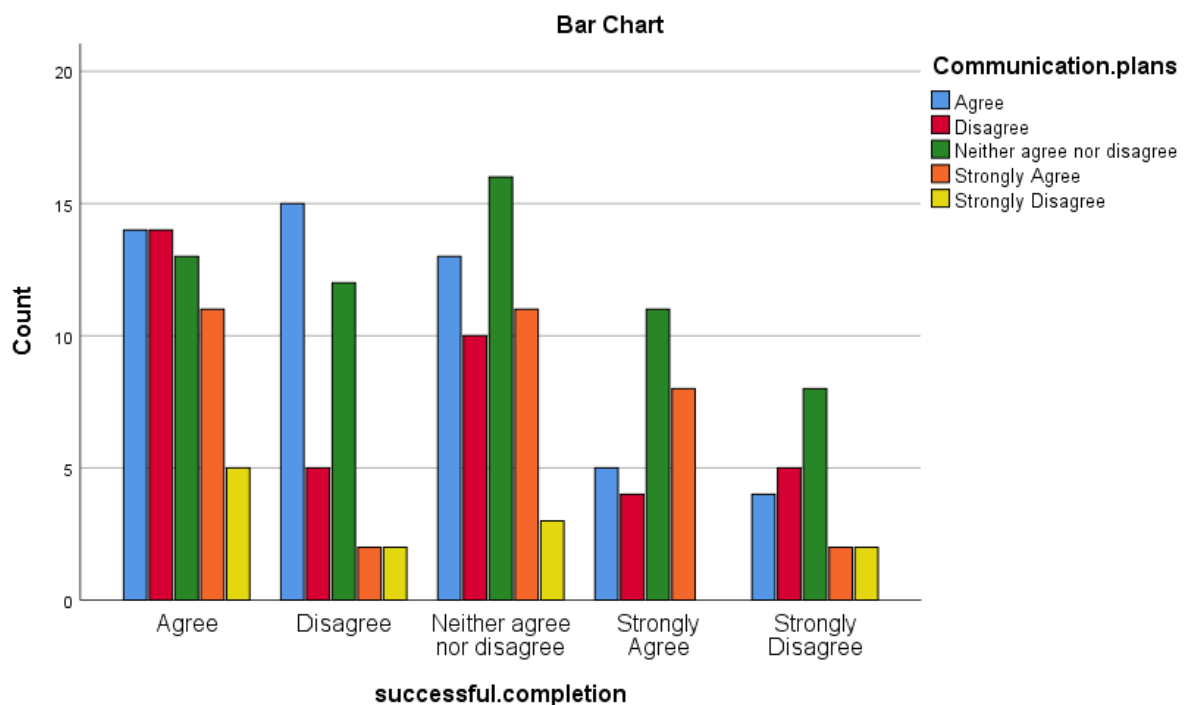


Figure 28 Similar measures in relationship analysis The Impact of Communication plans in Project Management Techniques on the Efficiency of Road Paving and Landscaping Operations to Achieve Vision 2030 in the Kingdom of Saudi Arabia

- **The Impact of Budget Management in Project Management Techniques on the Efficiency of Road Paving and Landscaping Operations to Achieve Vision 2030 in the Kingdom of Saudi Arabia**

Budget management include planning, monitoring, and regulating financial resources to ensure that a project stays within the specified budget. Effective budget management in project management has the following key benefits:

- Ensuring that financial resources are properly allocated to various project tasks.
- Cost management entails monitoring expenses to avoid cost overruns and discovering cost-saving options.

- Financial accountability entails maintaining openness in financial activities and promoting responsibility among project team members.
- Risk management is the early identification of financial concerns and the development of mitigation methods.
- Establishing trust among stakeholders via transparent and competent financial management (Daniel, 2018).

The results show that the degree of freedom for evaluating the impact of budget management within project management techniques on the efficiency of road paving and landscaping operations is equal to 4. This degree of freedom indicates that the analysis was conducted with a more complex framework involving multiple factors or categories related to budget management. Specifically, a degree of freedom of 4 suggests that the study considered several dimensions or aspects of budget management, such as cost estimation, allocation, tracking, and control, in relation to their impact on project efficiency. This greater degree of freedom reflects a more detailed and nuanced examination of how budget management practices influence the effectiveness of road paving and landscaping operations. It implies that the study's framework is robust enough to capture a broader range of variables and their interactions, providing a comprehensive analysis of the role of budget management in achieving operational efficiency and aligning with the objectives of Vision 2030. This complexity in the analysis contributes to a deeper understanding of how effective budget management can enhance project performance and supports the overall goal of improving infrastructure development within the Kingdom of Saudi Arabia.

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12.957 ^a	4	.676
Likelihood Ratio	14.085	4	.592
Linear-by-Linear Association	.039	1	.843
N of Valid Cases	195		

Table 28: Chi-square test The Impact of Budget Management in Project Management Techniques on the Efficiency of Road Paving and Landscaping Operations to Achieve Vision 2030 in the Kingdom of Saudi Arabia.

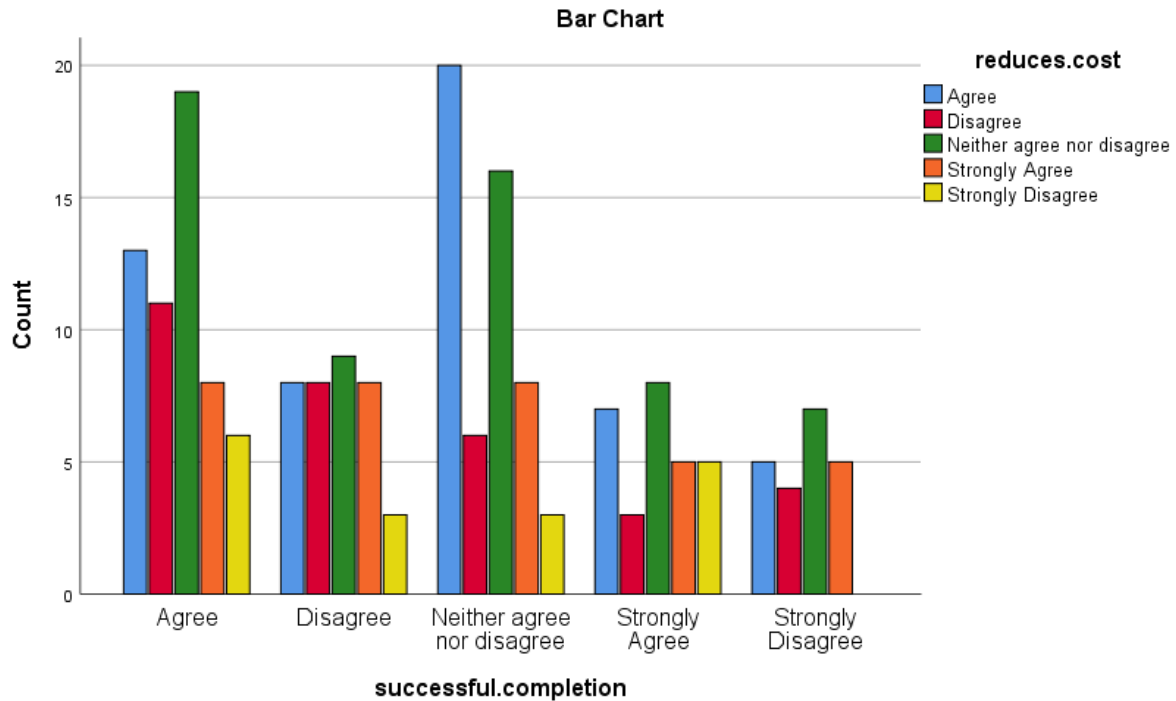


Figure 29: Similar measures in relationship analysis The Impact of Budget Management in Project Management Techniques on the Efficiency of Road Paving and Landscaping Operations to Achieve Vision 2030 in the Kingdom of Saudi Arabia

- The Impact of Risk Management Practices in Project Management Techniques on the Efficiency of Road Paving and Landscaping Operations to Achieve Vision 2030 in the Kingdom of Saudi Arabia**

Risk management involves identifying potential risks, analyzing their impact, and adopting mitigation techniques. Effective risk management in project management ensures that projects are completed on time, within budget, and to the required quality standards. Key benefits include:

- Improved decision-making:** By identifying risks early, project managers can make more informed choices and develop proactive solutions.
- Reduced uncertainty:** Effective risk management reduces uncertainty and enhances the predictability of project outcomes.
- Reduced impact of risk:** Implementing mitigation techniques reduces the impact of risks on a project.
- Improved resource allocation:** Understanding and managing potential risks allows for more effective allocation of resources.
- Increased stakeholder confidence:** Effective risk management builds trust among stakeholders, including government officials, contractors, and the public (Alsadi, 2021).

The results reveal that the degree of freedom for assessing the impact of risk management practices within project management techniques on the efficiency of road paving and landscaping operations is equal to 4. This degree of freedom suggests that the analysis encompasses a relatively broad and intricate examination of risk management practices,

incorporating multiple dimensions or categories that affect project efficiency. Specifically, a degree of freedom of 4 indicates that the study addressed various aspects of risk management, such as risk identification, assessment, mitigation strategies, and contingency planning. This level of detail reflects a comprehensive approach to understanding how different elements of risk management influence the overall success and efficiency of infrastructure projects. The higher degree of freedom enhances the study's ability to capture a wide range of risk management factors and their interactions, providing a nuanced and in-depth analysis of their impact on project performance. This complexity in the analysis strengthens the study's findings by offering a thorough evaluation of how effective risk management practices contribute to achieving operational efficiency and meeting the strategic objectives of Vision 2030 in the Kingdom of Saudi Arabia.

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	20.152 ^a	4	.213
Likelihood Ratio	20.485	4	.199
Linear-by-Linear Association	.044	1	.834
N of Valid Cases	195		

Table 29: Chi-square test The Impact of Risk Management Practices in Project Management Techniques on the Efficiency of Road Paving and Landscaping Operations to Achieve Vision 2030 in the Kingdom of Saudi Arabia.

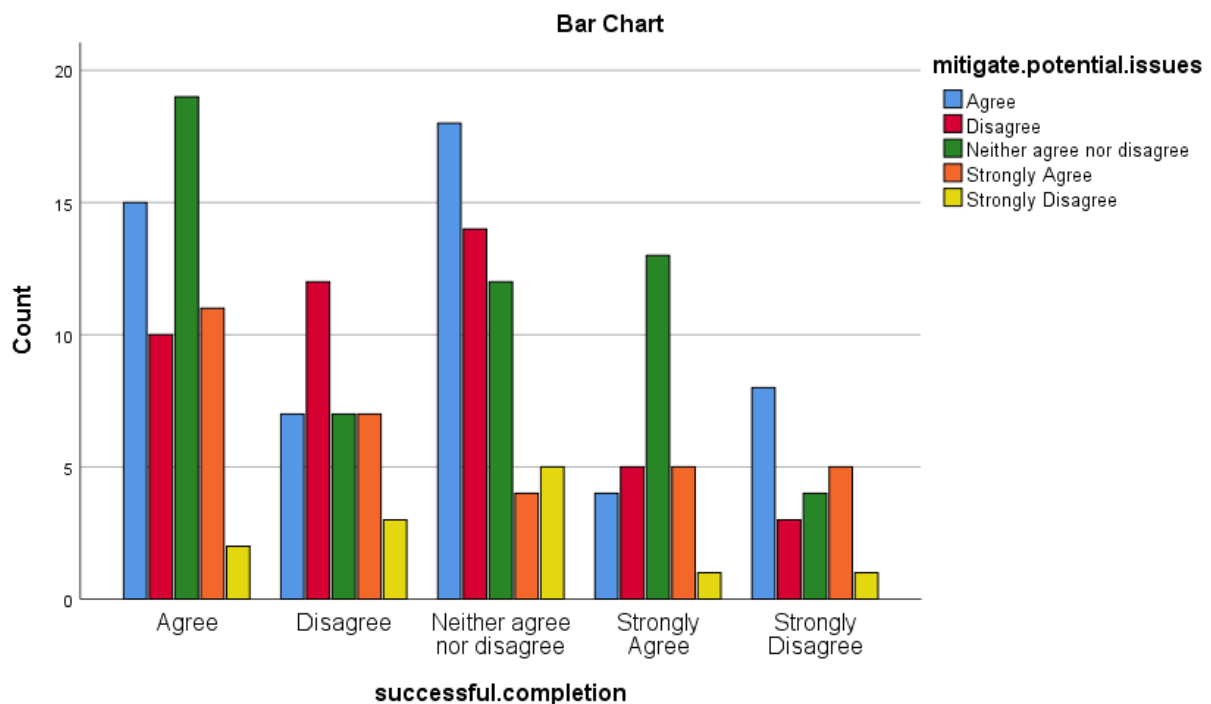


Figure 30: Similar measures in relationship analysis The Impact of Risk Management Practices in Project Management Techniques on the Efficiency of Road Paving and Landscaping Operations to Achieve Vision 2030 in the Kingdom of Saudi Arabia

- **Standard of credibility and reliability according to alpha Cronbach**

Cronbach's alpha is a common measure of internal consistency reliability of instruments and scales. A Cronbach's alpha of 0.7 or higher is generally considered to demonstrate strong reliability. Values below 0.7 indicate poor reliability, while values above 0.8 are considered excellent. It is important to ensure that the instrument is appropriate for the research situation (Adamson, 2013).

By looking at the data validity analysis, we can find that the collected data has a validity of %100, which indicates the strength of the validity of the data we have. As for the Cronbach's alpha coefficient, which is equal to .929 and is very close to one, it can indicate the strength of the credibility and reliability of the data.

Case Processing Summary			
		N	%
Cases	Valid	195	100.0
	Excluded ^a	0	.0
	Total	195	100.0

Table 30: Case Processing Summary.

Reliability Statistics		
Cronbach's Alpha ^a	Cronbach's Alpha Based on Standardized Items ^a	N of Items
.929	0.914	25

Table 31: Reliability Statistics.

- **ANOVA Analysis**

- ✓ **Hypotheses**

The hypotheses for the one-way ANOVA were developed as follows:

- **Null Hypothesis (H0):** There is no substantial difference in project efficiency between good communication planning, budget management, and risk management techniques.
- **Alternative Hypothesis (H1):** Implementing good communication strategies, financial management, and risk management methods results in a considerable increase in project efficiency.

- ✓ **Interpretation of Results**

The ANOVA results will show if the variations in project efficiency means between various levels of each independent variable are statistically significant. If the p-value is less than the specified significance threshold of 0.05, we reject the null hypothesis, suggesting that the independent variable has a significant influence on project efficiency.

Collecting information on project management efficiency and three independent variables:

- Measures for effective communication plans may include stakeholder participation, frequency of updates, and clarity of goals.
- Budget Management: Data may include budget adherence rates, cost overruns, and financial prediction accuracy.
- Consider the amount of hazards identified, risk mitigation techniques used, and incident reports.

- **Check Assumptions:**

- **Independence of Observations:** Each endeavor should be independent of the others.
- **Normal Distribution:** The efficiency ratings within each category should be roughly normal.
- **Homogeneity of Variance:** The variances across groups should be about equal.

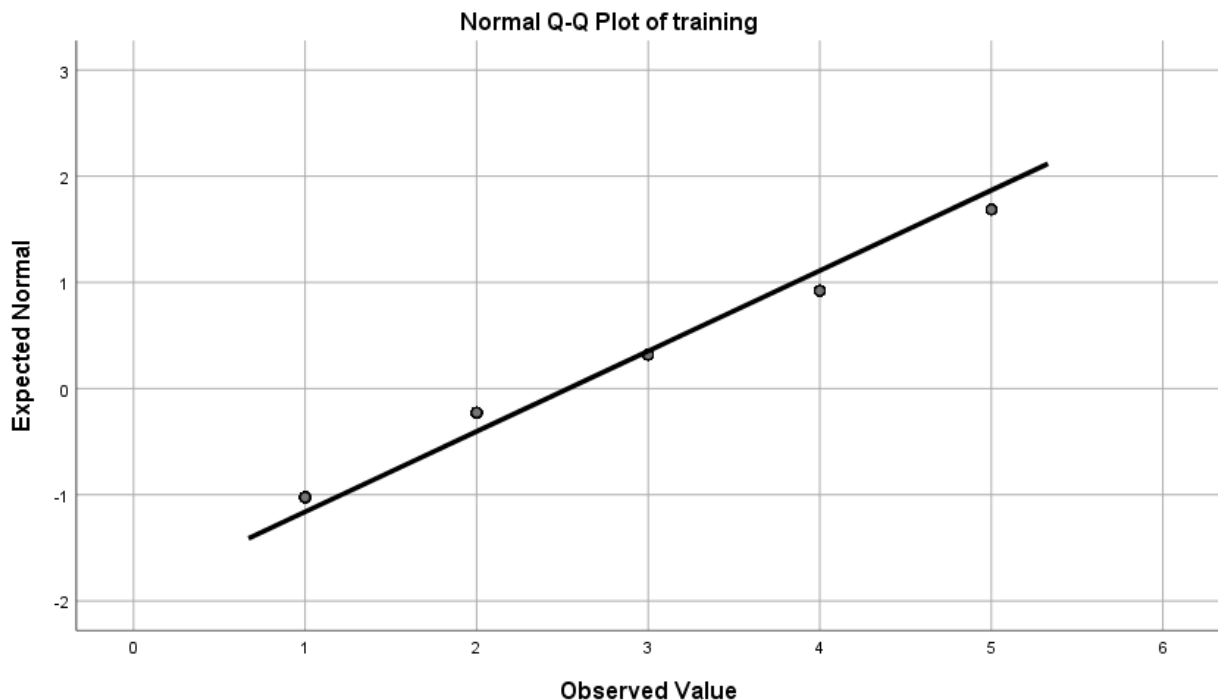


Figure 31: ANOVA Analysis.

Bayes Factor Model Summary^{a, b}				
Bayes Factor ^c	R	R Square	Adjusted R Square	Std. Error of the Estimate
.000	.165	.027	.037	1.35

Table 32: Bayes Factor Model Summary.

Conclusion

Project management approaches are critical for enhancing the efficiency of infrastructure operations, and they contribute considerably to national objectives such as Vision 2030. Focusing on continual training and modifying strategies can improve future project success rates. This framework demonstrates how project management influences the

effectiveness of road paving and landscaping operations, which directly supports Saudi Arabia's Vision 2030 aims.

Effective budget management is critical to effective project management, particularly for large-scale infrastructure projects. Vision 2030 is an ambitious program in Saudi Arabia that aims to diversify the economy and improve infrastructure. Road paving and landscaping activities are essential components of this concept, which improves connectivity and urban aesthetics. This article investigates the influence of budget management on operational efficiency, emphasizing how strong financial planning and control may assist accomplish the Vision 2030 objectives.

Recommendations

- Based on the findings of the study, it is clear that the successful implementation of project management techniques is crucial for enhancing the efficiency of road paving and landscaping operations, particularly within the ambitious framework of Vision 2030 in Saudi Arabia. One of the primary recommendations is the enhancement of communication plans. Effective communication has been identified as a cornerstone of project success, ensuring that all stakeholders are adequately informed and aligned with the project goals. The study suggests that project managers develop and implement comprehensive communication strategies that involve regular updates, transparent dissemination of information, and active engagement with all stakeholders, including project teams, clients, and the public. By establishing clear communication channels and protocols, misunderstandings can be minimized, and project objectives can be achieved more effectively.

- Another critical recommendation revolves around the management of project budgets and financial planning. The study underscores the importance of stringent financial controls and accurate forecasting in preventing cost overruns, which are a common challenge in large-scale infrastructure projects. It is recommended that project managers adopt advanced financial tracking tools, such as Earned Value Management (EVM), to monitor the financial health of the project throughout its lifecycle. These tools can provide real-time insights into budget adherence, allowing for timely interventions if deviations occur. Additionally, it is advised that projects incorporate flexible financial planning mechanisms to accommodate unexpected expenses, thus ensuring financial stability and project continuity.
- Risk management emerges as another key area of focus. The study highlights the necessity of robust risk management strategies to mitigate potential challenges that may arise during project execution. It is recommended that project teams develop detailed risk management plans that include the identification of potential risks, assessment of their impact, and formulation of mitigation strategies. Regular risk assessments should be conducted to adapt to changing project conditions and external factors, ensuring that the project can navigate uncertainties and maintain its course toward successful completion.
- The integration of advanced technologies is also strongly recommended. The study finds that technologies such as Geographic Information Systems (GIS) and Building Information Modeling (BIM) play a pivotal role in enhancing project planning, execution, and monitoring. These technologies provide valuable insights into spatial analysis, design optimization, and resource allocation, thereby improving overall project efficiency and sustainability. The adoption of such technologies is particularly relevant in the context of Vision 2030, which emphasizes modernization and technological advancement in infrastructure projects.
- Continuous training and development of project management professionals are crucial for sustaining high levels of efficiency. The study advocates for the investment in training programs that focus on the latest project management methodologies, technological tools, and best practices. By equipping project managers and teams with up-to-date knowledge and skills, organizations can enhance their capacity to handle complex projects and adapt to evolving industry trends. This, in turn, will contribute to the overall success of infrastructure projects under Vision 2030.
- The study also stresses the importance of stakeholder collaboration and involvement. It is recommended that project managers establish frameworks that facilitate active stakeholder participation throughout the project lifecycle. By engaging stakeholders early and often, project managers can ensure that their needs and expectations are adequately addressed, which can significantly enhance project relevance, acceptance, and support. This collaborative approach is essential for achieving the broad and ambitious goals set forth in Vision 2030, as it fosters a sense of ownership and commitment among all parties involved.
- The study recommends aligning projects with national policies and regulatory frameworks to ensure compliance and smooth implementation. It is advised that project managers develop clear guidelines and protocols that adhere to local governance structures and regulations. This alignment is essential for minimizing legal and bureaucratic obstacles, thereby facilitating timely project execution. Furthermore, given the growing emphasis on sustainable development, it is recommended that project managers incorporate environmental considerations into their planning and execution processes. This includes implementing green building practices, minimizing resource consumption, and mitigating environmental impacts, all of which are critical

for supporting Saudi Arabia's commitment to sustainable urban development under Vision 2030. By embracing these comprehensive recommendations, the study provides a roadmap for enhancing the efficiency and effectiveness of road paving and landscaping operations, thereby contributing to the broader goals of economic diversification and modernization in Saudi Arabia.

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Appendices

The questionnaire

➤ General questions

- The age
- Sex
- Class

➤ Questionnaire questions

- Project management techniques are essential for the successful completion of road paving projects.
- Effective project management improves the quality of road paving operations.
- The use of project management techniques ensures timely completion of landscaping projects.
- Budget management through project management techniques reduces cost overruns in road paving projects.
- Risk management practices in project management mitigate potential issues in landscaping operations.
- Project management techniques enhance coordination among different stakeholders in road paving projects.
- Scheduling and timeline management are critical for the success of landscaping projects.
- Project management software tools are effectively used in road paving operations.
- Communication plans developed through project management practices improve project outcomes in landscaping.
- Scope management in project management helps in preventing project scope creep in road paving projects.
- Resource allocation through project management techniques optimizes manpower and materials in landscaping projects.

- Quality control procedures in project management ensure high standards in road paving projects.
 - The integration of project management techniques with technology improves efficiency in landscaping operations.
 - Continuous monitoring and evaluation in project management contribute to the success of road paving projects.
 - Stakeholder engagement in project management enhances the execution of landscaping projects.
 - Change management strategies in project management are effective in handling modifications in road paving projects.
 - Project management training and development are crucial for improving landscaping project outcomes.
 - Environmental considerations in project management are adequately addressed in road paving operations.
 - The role of project managers is vital for the successful implementation of landscaping projects.
 - Project management techniques facilitate compliance with regulatory requirements in road paving projects.
 - Lessons learned from previous projects are effectively utilized in current landscaping operations through project management.
 - The overall success of Vision 2030's infrastructure goals depends on the effective application of project management techniques in road paving and landscaping operations.
- ✓ https://docs.google.com/forms/d/1x_zW52shXI-Qfcn1nja6zYy48nQZBNmE-WcKBK6UOVA/edit

