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PROJECT DESIGN AND PERFORMANCE OF ROAD CONSTRUCTION PROJECTS IN KIRINYAGA COUNTY, KENYA

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ABSTRACT

This research aimed to investigate the project design and factors contributing to the performance of road construction projects in Kirinyaga County, Kenya. The construction and maintenance of roads are vital components of urban development, directly impacting economic growth, social well-being, and environmental sustainability. However, road projects in Kirinyaga County have faced numerous challenges, including delays, cost overruns, and suboptimal quality, leading to inefficiencies and hindered progress. The major objective of this study was to determine the project design factors that contribute to the performance of road construction projects in Kirinyaga County, Kenya. This study assessed the influence of stakeholder and technology on the performance of road construction projects in Kirinyaga County; Kenya. The study population comprised 4 residents per the selected 38 road construction projects that have been undertaken by KERRA within Kirinyaga County to give a total of 152 respondents. Data was collected through questionnaires administered to key informants across all leadership ranks within the organizations. The data was analyzed using, regression analysis, and correlation to establish relationships between variables relevant to project design and their impact on the performance of road construction projects. A pilot study was conducted to pretest the validity and reliability of data collection instruments. SPSS software version 27.0 will be used to produce frequencies, descriptive and inferential statistics were used to derive conclusions and generalizations regarding the population. A multiple regression model was used to show the relationship between the independent variables to the dependent variable. The study found out that stakeholder management, technology management had a positive and significant effect on the performance of road construction projects in Kirinyaga County. The study recommended that to improve road construction project outcomes, it is crucial to actively involve stakeholders in planning and decision-making while integrating their feedback through regular engagement; emphasizing innovative context-sensitive technologies and ensuring transparency with local users is essential.

Key Words: Project Design, Performance of Road Construction Projects, Stakeholder Management, Technology Management

Background of the Study

Road construction projects play a pivotal role in shaping the growth and development of urban areas, serving as essential lifelines that connect communities, facilitate commerce, and spur economic activity. In Kirinyga County, Kenya, the construction and maintenance of roads hold significant importance due to its status as the country's capital and its position as a major economic hub in East Africa. Efficient road networks are critical in fostering social well-being, supporting businesses, and promoting environmental sustainability by reducing traffic congestion and emissions. Despite the undeniable significance of road infrastructure, road construction projects in Kirinyaga County have not been without challenges. Delays, cost overruns, and substandard quality have been recurring issues that impede project performance and create inefficiencies in transportation systems (Shibani & Arumugam, 2015). As a result, there is a pressing need to address these challenges and identify factors that contribute to successful road construction projects within the region.

Statement of the Problem

In Kirinyaga County, Kenya, road infrastructure plays an important role in connecting rural areas to major trade centers, enhancing agricultural productivity, and improving access to essential services. Over the past five years, Kirinyaga County has seen a series of road construction projects initiated under KeRRA's management, aimed at improving the county's rural road network. Despite these efforts, a considerable number of these projects have had raised concerns regarding their design, execution, and long-term sustainability. Road infrastructure has been a source of concern due to the substandard quality in construction. This has had a big impact on local farmers and the general local community which has led to increased travel times, higher transportation costs, reduced income due to the inability to access markets on time and reduced accessibility to essential services (Munene, 2022).

The design parameters used in these projects may not adequately address the specific needs and challenges of the region. This is as a result of the inadequacies in the project design phase, where factors such as local topography, soil type, and climatic conditions were not adequately considered (Sakar et al., 2022). The occurrence of heavy rains and soil erosion in the area has led to premature deterioration of road surfaces, necessitating frequent and costly repairs. For instance, the Kiamutugu-Kianjege road project, intended to provide a direct link between Kiamutugu and Kianjege, has faced significant design flaws that have led to frequent flooding during the rainy season (Nation, 2019). Normally the distance between Kiamatugu and Kianjege is approximately a 30 minutes' drive. Due to the state of the roads, it may take more than 1 hour to cover the same distance. The road's poor drainage system has resulted in regular road closures, isolating communities and disrupting economic activities.

Secondly, the underperformance of these road projects is also reflected in the lack of adherence to project timelines, scope and budgets which are attribute to limited resources provided by the relevant bodies. This forces the contractors to change the project design in order to fit with the current available resources hence not meeting the required standards. For instance, road accidents have become rampant in Kirinyaga county due to the poor road designs that are in place. According to a report by Kinuthia (2019), several roads have been constructed but they have no speed bumps, road signs and even pedestrian crossings and side paths. This undermines road safety among the road users.

A report released by the National Transport and Safety Authority have shown that since 1st January to 1st April, at least 33 people have died as a result of road accidents which raises concerns on issues of road safety (Oruta, 2024). Similarly, with the partnership of the county and KERRA, the Nyorosha Barabara Mashinani project, which aimed to cover over 500 kilometers of roads, has only managed to grade 327 kilometers and murram 150 kilometers as of the current financial year (County Government of Kirinyaga, 2024). The initial project design was to use hardcore and quarry dust as the main building materials for roads instead of

the normal murram but for now they opted to use the normal murram in some areas and in most areas, they only did road grading hence making the roads unsustainable.

These challenges raise critical questions about the effectiveness of the current project design frameworks and the performance management practices employed by KeRRA in Kirinyaga County. The failure to deliver on these projects not only undermines the economic potential but also erodes public trust in government agencies responsible for infrastructure development (Tanny, 2019). Given the critical role of roads in supporting economic activities, improving livelihoods, and enhancing social development, the suboptimal performance of KERRA roads in Kirinyaga County constitutes a significant challenge. There is an urgent need to investigate the factors contributing to these problems and to develop evidence-based strategies for improving project design, implementation, and maintenance.

Objectives of the Study

General Objectives

The main objective of this research was to determine the relationship between project design and performance of road construction projects in Kirinyaga County, Kenya.

Specific Objectives

i. To assess the influence of stakeholder management and the performance of road construction projects in Kirinyaga County, Kenya.
ii. To determine the influence of technology management and the performance of road construction projects in Kirinyaga County, Kenya.

LITERATURE REVIEW

Theoretical Review

Stakeholder Theory

Stakeholder Theory provides a relevant framework for understanding the role of stakeholders in influencing project outcomes. Originally developed by Freeman (1984), Stakeholder Theory suggests that an organization's success is closely linked to how effectively it manages its relationships with its stakeholders. In road construction projects, stakeholders include a wide range of individuals and groups, from government bodies, contractors, and road users to local communities, environmental agencies, and advocacy groups. These stakeholders possess varying interests, and project success often depends on how well these diverse interests are balanced and managed. One of the main contributions of Stakeholder Theory to road construction projects is its emphasis on the systematic identification of stakeholders. For projects in Kirinyaga County, this includes recognizing road users, local communities, businesses, and regulatory authorities as key stakeholders whose views and interests must be considered throughout the project lifecycle. Proper identification allows project managers to engage these groups early in the design and planning stages, ensuring that their input is incorporated and potential conflicts are mitigated before they escalate (Mitchell et al., 1997).

A critical aspect of Stakeholder Theory is the recognition of stakeholder interests and potential conflicts. In road construction, conflicts can arise when stakeholder interests diverge. For example, road users may prioritize safety and long-term road durability, while contractors may be more concerned with staying within budget constraints. Local communities may express concerns about noise, displacement, or environmental degradation caused by construction activities. According to Chinyio and Olomolaiye (2010), effectively managing these conflicts requires project managers to not only understand these differing interests but also to employ strategies for conflict resolution that align with overall project objectives.

Power dynamics are another significant factor within Stakeholder Theory. Not all stakeholders have equal influence over project decisions. In road construction, governmental authorities and project sponsors may wield significant power, but neglecting the concerns of less powerful

stakeholders, such as local residents or road users, can lead to dissatisfaction and opposition to the project. Eskerod and Huemann (2013) argue that project managers need to balance power dynamics by giving a voice to less powerful stakeholders through meaningful engagement and participation strategies. This ensures that the needs of road users and local communities are not overlooked, contributing to the overall success of the project.

Technology Acceptance Model

Technology Acceptance Model (TAM) provides a well-suited theoretical framework for understanding how technology management influences the performance of road construction projects. Originally developed by Davis (1989), TAM is a widely accepted theory used to explain and predict how users come to accept and use technology. The model posits that two main factors—Perceived Usefulness (PU) and Perceived Ease of Use (PEOU)—determine whether users will adopt a new technology. In the context of road construction projects, technology management involves the selection, implementation, and adoption of various technological tools that enhance project efficiency, quality, and performance.

The Perceived Usefulness (PU) of technology refers to the degree to which an individual believes that using a particular technology will improve their job performance. In the context of road construction projects in Kirinyaga County, road users, construction workers, and project managers may perceive technology as useful if it enhances road safety, reduces traffic congestion, or improves construction quality. For example, innovations like automated traffic control systems, GPS-based road mapping, and automated machinery for road paving are technological advancements that can positively impact project performance. TAM suggests that if these technologies are perceived as improving the quality or speed of construction projects, stakeholders will be more likely to support and adopt them.

Perceived Ease of Use (PEOU), on the other hand, refers to the degree to which an individual believes that using a particular technology will be free from effort. In road construction projects, ease of use is critical when introducing new technology to workers who may have varying levels of technical expertise. For instance, the adoption of advanced road construction machinery or digital tools for project management may be hindered if workers or road users find the technologies difficult to use or overly complex. TAM argues that the easier a technology is to use, the more likely it is to be adopted, leading to more effective technology management in construction projects (Davis, 1989).

The TAM framework is particularly relevant in road construction projects where new technologies are being introduced to improve project outcomes. By understanding how perceived usefulness and ease of use impact technology adoption, project managers in Kirinyaga County can make more informed decisions about which technologies to implement and how to ensure their successful adoption. For instance, road construction projects that incorporate automation, digital planning tools, and advanced machinery can benefit from the TAM framework by focusing on addressing user concerns, offering training, and demonstrating the practical advantages of the new technologies.

Conceptual Framework

The dependent and independent variables are systematically linked inside the conceptual framework according to their theoretical relationships. The research found that stakeholder management, technology management are the four main factors that determine whether road building projects are successful or not.

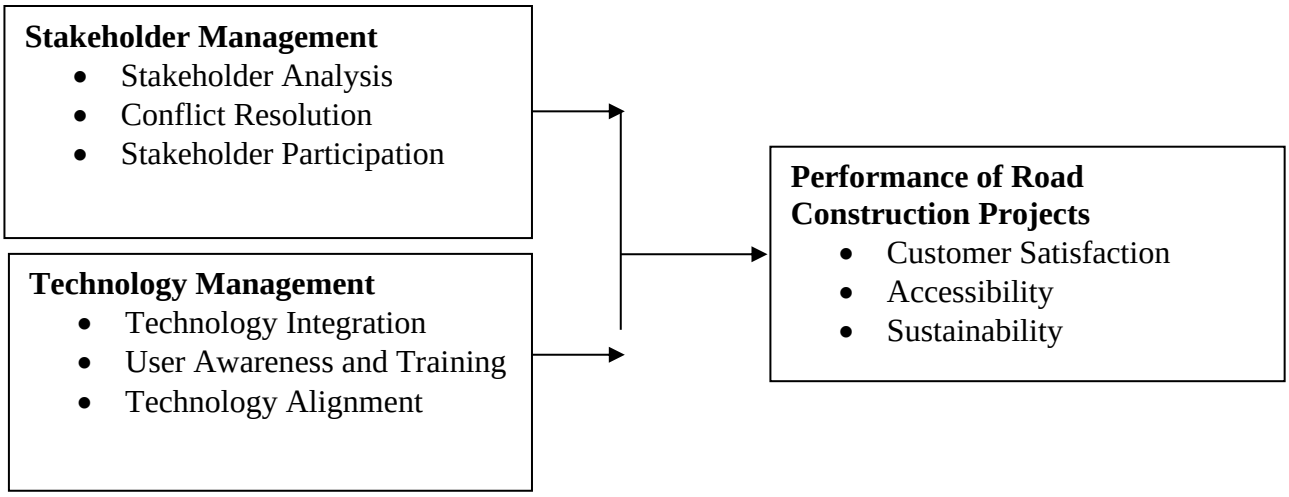

Figure 2. 1 Conceptual Framework

Stakeholder Management

Stakeholder management refers to the systematic identification, engagement, and alignment of the interests of individuals, groups, or organizations that have a vested interest in the project. In road construction projects, stakeholders include government bodies, contractors, local communities, road users, and environmental groups, each with distinct expectations and levels of influence (Prebanić et al., 2023). Stakeholder management ensures that these varying interests are balanced to achieve project objectives while minimizing conflict and resistance.

In road construction projects, particularly in Kirinyaga County, stakeholder management is vital to address socio-political, environmental, and economic challenges that may arise. For instance, local communities may express concerns regarding displacement, environmental degradation, or disruptions caused by the construction process. Engaging stakeholders early through participatory consultations can help mitigate opposition, reduce delays, and foster trust between the project team and the public (Waris et al., 2022). Structured tools like stakeholder mapping and analysis can help project managers prioritize the needs of key stakeholders, ensuring their concerns are incorporated into the project plan. Effective stakeholder management positively correlates with project success by improving transparency, accountability, and communication (Waris et al., 2022). However, managing conflicting interests remains a significant challenge, as stakeholders may have divergent priorities. A balance must be struck between addressing local concerns, such as environmental protection, and meeting the technical and financial demands of road construction.

Technology Management

Technology management involves the planning, development, and application of technological innovations and systems to improve project efficiency, quality, and overall performance. In the road construction industry, this includes the adoption of advanced tools like Building Information Modeling (BIM), Geographic Information Systems (GIS), and automated machinery for construction tasks (Xie et al., 2022). Effective technology management ensures that appropriate technologies are selected, implemented, and integrated into project workflows, thus optimizing project outcomes.

In Kirinyaga County, the effective management of technology is essential to enhance construction quality and reduce project timelines. For instance, the use of drones for site inspections or GIS for road mapping can significantly improve the accuracy and efficiency of the construction process. Recent advancements in automation and digital technologies, such as

project management software, have streamlined construction project workflows and improved collaboration among project teams (Manzoor et al., 2021). However, in resource-constrained environments like Kirinyaga, the costs of acquiring and maintaining such technologies can pose challenges, especially in terms of training personnel and ensuring long-term sustainability.

Technology Acceptance Model (TAM), developed by Davis (1989) and expanded upon in more recent studies, provides insights into how road users and construction teams may adopt new technologies. The perceived usefulness and ease of use of these technologies play a critical role in determining whether they are successfully integrated into the project (Dyah Sugandini et al., 2018). In road construction, resistance from construction workers or contractors unfamiliar with digital systems may impede the full utilization of technology. Providing adequate training and demonstrating the tangible benefits of these technologies is crucial to overcoming such resistance.

Empirical Review

Stakeholder Management and Performance of Road Construction Projects

Stakeholder management is recognized as a critical component in the performance of road construction projects since diverse stakeholder interests must be harmonized. Effective stakeholder management involves identifying all project stakeholders, understanding their interests and influence, and engaging them in a way that aligns with the project's objectives. Recent empirical studies underscore the importance of early and continuous stakeholder engagement throughout the project lifecycle. According to a study by Irfan et al., (2019), involving stakeholders in the planning phase of construction projects leads to a greater alignment of goals, which enhances project outcomes.

In road construction projects, stakeholders can range from local communities and government authorities to contractors and financiers. Each group has distinct expectations, and their support is crucial for the smooth execution of the project. Research conducted by Lehtinen et al., (2019) shows that stakeholder management practices that are inclusive and transparent contribute to higher stakeholder satisfaction, which in turn positively affects project performance. This is particularly relevant in public infrastructure projects, where community acceptance is essential for project continuity and performance. Moreover, the use of structured stakeholder analysis tools, such as the Stakeholder Salience Model, has been highlighted as effective in identifying and prioritizing stakeholders based on their power, legitimacy, and urgency. Studies by Raha et al., (2021) emphasize that applying such models allows project managers to tailor their communication strategies effectively, ensuring that critical stakeholders are adequately informed and engaged. This targeted approach minimizes resistance and fosters a collaborative project environment.

Stakeholder management must also consider the socio-political dynamics that may influence project execution. A Study carried out by Smith (2020) have shown that political stakeholders can have a significant impact on project timelines and resource allocation. Therefore, proactive engagement with political entities, along with regular consultations with community leaders, can mitigate potential disruptions. The challenges of stakeholder management in road construction projects are further compounded by the need for balancing the often-competing interests of stakeholders. Stakeholder management is indispensable for the performance of road construction projects. By adopting a strategic approach that includes early engagement, continuous communication, and conflict resolution, project managers can navigate the complexities of stakeholder relationships and ensure performance of road projects.

Technology Management and Performance of Road Construction Projects

Technology management in road construction projects has become increasingly critical as advancements in construction technology offer new opportunities for improving efficiency, reducing costs, and enhancing the quality of infrastructure. Technology management

encompasses the selection, implementation, and ongoing management of technological tools and systems that support the construction process. Automation and the use of advanced machinery in road construction have also been highlighted as key factors in improving project efficiency and reducing labor costs. A Study carried out by Iturralde et al., (2022) indicate that automated construction equipment, such as robotic pavers and automated grading systems, can significantly speed up construction processes while maintaining high levels of precision. This not only reduces the overall project timeline but also leads to better project coordination, fewer design errors, and more accurate cost estimates. This is particularly beneficial in complex projects where multiple stakeholders need to be aligned on the project's scope and specifications.

The rapid pace of technological change poses a challenge for project managers who must continuously update their knowledge and skills to keep pace with new developments. A study by Albi (2024) discusses the strategic role of technology management in optimizing project performance. It highlights the need for road construction projects to incorporate cutting-edge technologies, such as drones for surveying and AI-driven project management tools, to enhance efficiency and accuracy. These technologies enable real-time data collection and analysis, allowing for more informed decision-making and better resource allocation.

The role of technology management extends beyond just the implementation of tools and systems; it also involves ensuring that the project team is adequately trained to use these technologies effectively. The research underscores the importance of investing in human capital to maximize the benefits of technology adoption in road construction projects. In addition, the integration of technology in road construction must also consider the project's environmental impact. A study by Ademilade et al. (2020) explores the role of green technologies in reducing the carbon footprint of construction projects. The research highlights the use of environmentally friendly materials and energy-efficient machinery as key factors in promoting sustainable construction practices Environmental sustainability is also a growing concern therefore adopting green technologies can contribute to both the project's performance and its long-term viability. Technology management plays a pivotal role in the performance of road construction projects.

RESEARCH METHODOLOGY

For this study a descriptive research design was employed. The study population comprised 4 residents per the selected 38 road construction projects that have been undertaken by KERRA within Kirinyaga County to give a total of 152 respondents. The unit of Analysis is the road projects in Kirinyaga county while the unit of observation were the road users. This are roads projects which have been tendered by KERRA since 2020 to 2024. This targeted group provided observable traits that enable the researcher to make generalizations about road construction projects in Kirinyaga County (Kothari, 2014).

Questionnaires were employed as the primary data collection method in this research. Data was processed and analyzed using version 26 of the Statistical Package for Social Science (SPSS) software. Data was cleaned, processed, and coded before being tabulated for further analysis. For categorical data, frequency tables were created to display ratios, rates, and percentages, while for continuous variables, measures of central tendency (Mean/Median) were constructed. The qualitative data analysis aims to arrange and interpret the material gathered via questionnaires and focus group talks (Babbie, 2015). It included descriptive and thematic analyses, as well as data transformation and triangulation. The researchers used a contemporaneous data analysis technique (Creswell & Plano-Clark, 2019), which included doing preliminary data analysis on both qualitative and quantitative data sets at the same time. The data sets were then combined to answer the study questions. comprehensively. A multiple regression model was used to show the relationship between the independent variables to the dependent variable

RESEARCH FINDINGS

During the research, 110 questionnaires were administered but only 88 were returned completely filled. This translated to a response rate of 80%. According to Saunders (2011), for a good statistical analysis, the response rate should be at least 50% therefore, the response rate can be considered adequate and the results found can be used the generalize the entire population under study.

Study Variables

The study aimed to examine the relationship between project design and the performance of road construction projects in Kirinyaga county. The study defined the independent and dependent variables. The independent variables in the study were stakeholder management, technology management,. The dependent variable was the performance of road construction projects in Kirinyaga county.

Stakeholder Management

The respondents were asked to rate their degree of agreement the various statements in relation to stakeholder management and the performance of road construction projects in Kirinyaga County. Using a 1–5 Likert scale, 1 was strongly disagree, 2 was disagree, 3 was neutral, 4 was agree, and 5 was strongly agree. The descriptive statistics of the examined data are shown in the table below under percentages.

Table 4. 1 Stakeholder Management

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Descriptive Statistics	
						Mean	SD
The project team should always involve representatives from different groups within the community during the planning phase.	0.0%	0.0%	20.5%	13.6%	65.9%	4.45	.82
The project planners should consider the needs of different road user groups (e.g., pedestrians, drivers) when identifying stakeholders.	0.0%	0.0%	0.0%	21.6%	78.4%	4.78	.41
Conflict resolution mechanisms should be in place to handle disagreements that may affect road project timelines and performance	0.0%	0.0%	0.0%	29.5%	70.5%	4.70	.46
Stakeholder's concerns should be addressed promptly and fairly when to avoid delays in road construction projects.	0.0%	0.0%	0.0%	38.6%	61.4%	4.61	.49
The community members should be involved in decision-making processes of the road construction projects.	0.0%	0.0%	19.3%	27.3%	53.4%	4.34	.79
The community should be allowed to contribute feedback during the various stages of the road construction project.	0.0%	0.0%	0.0%	36.4%	63.6%	4.64	.48

According to the findings, most respondents (79.5%) agreed that the project team should always involve representatives from different groups within the community during the planning phase. 20.5% of the respondents remained neutral none disagreed that the project team should always involve representatives from different groups within the community during the planning phase. All respondents also agreed that the project planners should consider the needs of different road user groups (e.g., pedestrians, drivers) when identifying stakeholders. The findings also indicated that all respondents agreed that Stakeholder's concerns should be addressed promptly and fairly to avoid delays in road construction. The findings also found out that 80.7% of the responds agreed that the community members should be involved in decision-making processes of the road construction projects. Only 19.3% of the respondents remained neutral. The results clearly show that, for the various road projects in Kirinyaga county the projects have been carried without implementing proper community members involvement in decision-making processes of the road construction projects. The findings also showed that the respondents agreed that the community should be allowed to contribute feedback during the various stages of the road construction project.

Model Summary (Stakeholder Management)

Table 4. 2 Model Summary (Stakeholder Management)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.967[a]	.936	.935	.10757

a. Predictors: (Constant), Stakeholder Management

Stakeholder management was identified as an essential variable in assuring the execution of road construction projects in Kirinyaga County. The findings indicate that the R square value of 0.967, or the coefficient of determination, accounts for 96.7% of the variance in the dependent variable, which is the performance of road construction projects, hence demonstrating a satisfactory relationship between the variables. The model summary reveals that stakeholder management is a significant predictor of road construction project performance.

Analysis of Variance of Stakeholder Management

Table 4. 3 Analysis of Variance of Stakeholder Management

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.480	1	14.480	1251.436	.000[b]
	Residual	.995	86	.012		
	Total	15.475	87			

a. Dependent Variable: Performance of Road Construction Projects

b. Predictors: (Constant), Stakeholder Management

The above results show that the F value (1251.436) is higher than the F critical value (3.95), which means that the model explains a large part of the variation in the dependent variable.

Also, the p value (0.000) is less than 0.05, which proves that there is a strong significance. The results show that stakeholder management is a strong indicator of how well road construction projects can perform. The statistical significance of the model shows that incorporating technology into these projects in an appropriate way can have a substantial impact on how well they perform.

Regression Coefficient Analysis (Stakeholder Management)

Table 4. 4 Regression Coefficient Analysis (Stakeholder Management)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.102	.129		.792	.430
	Stakeholder Management	.988	.028	.967	35.376	.000

a. Dependent Variable: Performance of Road Construction Projects

The study assessed the beta coefficient of stakeholder management in relation to the Performance of road construction Projects. The beta coefficient was found to be 0.988, with a p-value of 0.000, which is below 0.05 significance level. Therefore, there is a positive and significant relationship between technology management and Performance of road construction Projects (β=0.988, p<0.000). The regression model is as follows:

$Y=0.988 + 0.984X_1$

Whereby,

Y - Performance of Road Construction Projects

X_1 – Stakeholder Management.

The coefficients table indicates that technology management has a significant and positive impact on the Performance of road construction projects. The relationship is both statistically significant and practically meaningful, as evidenced by the significant p-values and the magnitude of the coefficients. This is consistent with the research findings by Iturralde et al., (2022), which identified a positive and significant relationship between stakeholder management and performance of projects. The findings were also supported by Albi (2024) who found out that technology management is very critical in optimizing project performance.

Technology Management

The respondents were asked to rate their degree of agreement the various statements in relation to technology management and the performance of road construction projects in Kirinyaga County. Using a 1–5 Likert scale, 1 was strongly disagree, 2 was disagree, 3 was neutral, 4 was agree, and 5 was strongly agree. The descriptive statistics of the examined data are shown in the table below under percentages.

Table 4. 5 Technology Management

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Descriptive Statistics	
						Mean	SD
The adoption of new technologies in road construction projects can lead to better road designs and functionality.	0.0%	0.0%	18.2%	11.4%	70.5%	4.52	.79
The integration of technology into the construction process reduces the time required to complete the projects.	0.0%	0.0%	0.0%	20.5%	79.5%	4.80	.41
Local road users should be informed about the new technologies used in road construction projects.	0.0%	0.0%	0.0%	30.7%	69.3%	4.69	.46
Road construction technologies should be selected based on the specific needs of the local environment	0.0%	0.0%	18.2%	29.5%	52.3%	4.34	.77
The technology implemented in road construction projects should be regularly updated to keep pace with industry standards	0.0%	0.0%	0.0%	38.6%	61.4%	4.61	.49

According to the findings, majority of the respondents (81.9%) agreed that the adoption of new technologies in road construction projects can lead to better road designs and functionality. 18.2% of the respondents remined neutral whereby none of the respondents disagreed that the adoption of new technologies in road construction projects cannot lead to better road designs and functionality. The research further found out that all respondents agreed that the integration of technology into the construction process reduces the time required to complete the projects. The respondents also agreed that local road users should be informed about the new technologies used in road construction projects. The study also found out that road construction technologies should be selected based on the specific needs of the local environment. The research also found out that 81.8% of the respondents agreed that road construction technologies should be selected based on the specific needs of the local environment while 18.2% of the respondents remained neutral. Further, all respondents agreed that the technology implemented in road construction projects should be regularly updated to keep pace with industry standards.

Regression Analysis Model for Technology Management and Performance of Road Construction Projects

Model Summary

Table 4. 6 Model Summary (Technology Management)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.981[a]	.962	.962	.08225

a. Predictors: (Constant), Technology Management

Technology management was identified as an essential variable in assuring the execution of road construction projects in Kirinyaga County. The findings indicate that the R square value of 0.962, or the coefficient of determination, accounts for 96.2% of the variance in the dependent variable, which is the performance of road construction projects, hence demonstrating a satisfactory relationship between the variables. The model summary reveals that technology management is a significant predictor of road construction project performance.

Analysis of Variance for Technology Management

Table 4. 7 Analysis of Variance for Technology Management

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.893	1	14.893	2201.708	.000[b]
	Residual	.582	86	.007		
	Total	15.475	87			

a. Dependent Variable: Performance of Road Construction Projects

b. Predictors: (Constant), Technology Management

The above results show that the F value (2201.708) is higher than the F critical value (3.95), which means that the model explains a large part of the variation in the dependent variable. Also, the p value (0.000) is less than 0.05, which proves that there is a strong significance. The results show that technology management is a strong indicator of how well road construction projects can perform. The statistical significance of the model shows that incorporating technology into these projects in an appropriate way can have a substantial impact on how well they perform.

Regression Coefficient Analysis

Table 4. 8 Regression Coefficient Analysis (Technology Management)

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	.097	.097		1.001	.320
	Technology Management	.984	.021	.981	46.922	.000

a. Dependent Variable: F

The study assessed the beta coefficient of technology management in relation to the Performance of road construction Projects. The beta coefficient was found to be 0.984, with a p-value of 0.000, which is below 0.05 significance level. Therefore, there is a positive and significant relationship between technology management and Performance of road construction Projects (β=0.984, p<0.000). The regression model is as follows:

$Y=0.097 + 0.984X_1$

Whereby,

Y - Performance of Road Construction Projects

X_1 – Technology Management.

The coefficients table indicates that technology management has a significant and positive impact on the Performance of road construction projects. The relationship is both statistically significant and practically meaningful, as evidenced by the significant p-values and the magnitude of the coefficients. This is consistent with the research findings by Iturralde et al., (2022), which identified a positive and significant relationship between technology management and performance of road projects. The findings were also supported by Albi (2024) who found out that technology management is very critical in optimizing project performance.

Performance of Road Construction Projects

The respondents were asked to rate their degree of agreement the various statements in relation to stakeholder management and the performance of road construction projects in Kirinyaga County. Using a 1–5 Likert scale, 1 was strongly disagree, 2 was disagree, 3 was neutral, 4 was agree, and 5 was strongly agree. The descriptive statistics of the examined data are shown in the table below under percentages.

Table 4. 9 Performance of Road Construction Projects

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Descriptive Statistics	
						Mean	SD
The overall design and layout of the new roads should meet the community's expectations.	0.0%	0.0%	18.2%	9.1%	72.7%	4.55	.79
The road construction projects should be completed within a reasonable timeframe, minimizing inconvenience to road users	0.0%	0.0%	0.0%	18.2%	81.8%	4.82	.39
High quality constructed roads improve access to key services and facilities e.g., markets, schools.	0.0%	0.0%	0.0%	27.3%	72.7%	4.73	.45
The presence of high-quality roads significantly reduces travel time to key facilities like markets and government offices.	0.0%	0.0%	0.0%	27.3%	72.7%	4.73	.45
The new roads should be designed to withstand environmental challenges, ensuring their sustainability over time	0.0%	0.0%	18.2%	27.3%	54.5%	4.36	.78
The materials and methods used in the road construction projects should be environmentally sustainable.	0.0%	0.0%	0.0%	36.4%	63.6%	4.64	.48

According to the findings, 81.8% of respondents agreed that the design and layout of the new roads should meet the community's expectations, while 18.2% remained neutral. The results also indicate that all respondents agreed that road construction projects should be completed within a reasonable timeframe to minimize inconvenience to road users. The research also found out that all respondents agreed that high-quality constructed roads improve access to key services and facilities such as markets and schools. The study also found out that all respondents agreed that the presence of high-quality roads significantly reduces travel time to

key facilities like markets and government offices. 81.8% of respondents agreed that roads should be designed to withstand environmental challenges, ensuring their sustainability, while 18.2% remained neutral. The respondents agreed that the materials and methods used in road construction projects should be environmentally sustainable.

Conclusion of the Study

The study underscores the importance of community involvement and stakeholder engagement in road construction projects. Respondents highlighted the value of involving representatives from various community groups in the planning phase, ensuring that the needs of different road user groups are considered. While most supported community participation, some neutrality suggests that this engagement may not always be fully realized. The findings stress that addressing stakeholder concerns promptly and fairly is crucial to avoid delays, and consistent engagement throughout the project is necessary to ensure a collaborative and inclusive process. The findings reveal strong support for the adoption of new technologies in road construction. Respondents unanimously agreed that technology improves road designs, functionality, and reduces project completion times, emphasizing its positive impact on efficiency. There is a clear need for transparency, with respondents calling for local road users to be informed about the technologies being utilized. The study highlights the importance of selecting context-specific technologies tailored to local conditions, as well as the regular updating of technology to stay aligned with evolving industry standards.

Recommendations of the Study

Stakeholders Management and Performance of Road Construction Projects

To enhance stakeholder management in road construction projects, it is recommended that project planners actively involve community representatives from diverse groups in the planning phase and decision-making processes. Clear mechanisms should be established to ensure that community feedback is fully integrated into project plans, minimizing the neutrality seen in previous responses. Regular engagement sessions should be held throughout the project to keep stakeholders informed and address their concerns promptly, thereby preventing potential delays. Additionally, it is crucial to develop a transparent communication strategy to ensure the voices of all road user groups are heard and considered.

Technology Management and Performance of Road Construction Projects

It is recommended that road construction projects continue to prioritize the adoption of innovative technologies to improve efficiency and road functionality. Projects should ensure that the chosen technologies are specifically tailored to the local environment, providing practical and context-sensitive solutions. To foster transparency and community support, stakeholders and local road users should be regularly informed about the technologies being used. Additionally, a system for continuously reviewing and updating construction technologies should be implemented to keep pace with evolving industry standards and improve overall project outcomes.

Areas for Further Research

Further research could focus on the impact of project design approaches on the performance of road construction projects. This would involve examining how different design methodologies affect key performance aspects, such as cost, timelines, and project sustainability. By exploring the adaptability of designs to local conditions like the terrain and climate in Kirinyaga County, future studies could provide insights into how design choices influence the overall success of construction projects. Such research would help identify best practices in design that minimize delays, cost overruns, and ensure the long-term durability of roads.

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