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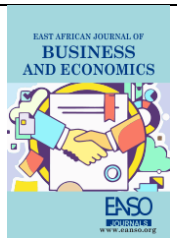

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Original Article

Technological Factors and Performance of Roads Construction Projects in Nairobi County, Kenya

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ABSTRACT

The successful construction of roads plays a pivotal role in driving Kenya's economic development, aligning with the objectives outlined in Kenya's Vision 2030. However, the suboptimal performance of road construction projects in Nairobi County can be attributed to the continually evolving environmental factors. Consequently, this study aimed to explore the relationship between technological factors and performance of roads construction projects in Nairobi County. The theoretical foundations guiding this study encompassed open system theory. Utilizing a positive research philosophy, the study adopted a descriptive and explanatory research design. This research focused on a target population comprising 176 concluded roads construction projects within the Nairobi Metropolitan Area, executed by the Kenya Rural Roads Authority (KERRA). The unit of analysis focused on the completed roads construction projects in Nairobi County. The unit of observation included road engineers, project planners, and directors associated with KERRA, along with road supervisors, inspectors, surveyors, contractors, and members of project implementation teams. Proportional stratified sampling was employed to determine a sample size of 253 respondents. Data collection involved the use of a structured questionnaire. The study embraced descriptive and inferential statistics. The results were presented through tables, and inferential statistics were carried out using linear regression. The study unveiled a positive and significant relationship between technological factors ($t=2.270$, $p<0.05$) with project performance. In conclusion, the study establishes a discernible relationship between technological and project performance. The research recommends that managers are urged to embrace digitization and automation, leveraging on technology to address complex technicalities before and during construction.

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INTRODUCTION

Inadequate performance has negative effects on the company's finances, client satisfaction, and reputation. Project completion timelines and quality are compromised, resulting in delays that obstruct the intended benefits of initiatives and drive-up project costs and completion times. As long as strategic objectives are accomplished, the environments in which projects are conducted play a critical role in determining how well they function and how decisions are made. These environments' comprise internal components like strategies, policies, financial resources, human resources, company image, and equipment, as well as external components like the political, economic, social, technological, environmental, and legal environments' (An et al., 2021).

The PESTEL framework—a term that refers to the political, economic, social, technical, environmental, and legal—has a significant impact on strategic management. According to Lu et al. (2020), this method aids strategists in recognizing large-scale opportunities and risks that may lead to important organizational changes. The project's competitiveness and survival depend heavily on how decisively it responds to the macroenvironment and strategic positioning. As such, it is imperative to perform a comprehensive macro environment scan in order to pinpoint both possible opportunities and hazards. Since the primary focus of this study is the macro environment, which encompasses the political, economic, technological, and legal contexts, government actions function as a moderating element. Both good and negative effects on project performance may result from these macroenvironmental elements.

An increasing amount of research demonstrates the relationship between global initiatives' performance and the macroenvironment (Sabahi & Parast, 2020). While businesses acknowledge that the macro environment has a big influence on performance, it's equally critical to comprehend how other elements, including governmental regulations and project stakeholders' involvement may have an impact on this relationship (Olawale & Sun, 2018). The upper echelons theory, contingency theory, open systems theory, and stakeholder theory work together to give a framework that explains the connection between government policies, the macroenvironment, stakeholder involvement in the project, and project performance. Understanding the responsibilities of project stakeholders and governmental policies is crucial as businesses struggle with how the macroenvironment affects performance (Olawale & Sun, 2018).

Effective risk management, according to contingency theory, occurs when contingent elements in the company's macroenvironment "fit," allowing strategies to be created that provide the desired organizational outcomes (Kaplan & Norton, 2015). The concept of higher echelons looks at the relationship between various organizational procedures, performance, laws, and strategic choices (Hambrick & Mason, 1984). Open systems theory states that an organization is a system that is always in communication with its environment, adapting to its needs based on its features and the external factors that are at play at the time (Bertalanffy, 1968). Stakeholder theory, on the other hand, holds that an organization's ability to generate value for a variety of stakeholders determines its performance (Freeman, 1984).

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Performance problems in road construction projects are frequently brought on by project delays brought on by government initiatives' hierarchical bureaucracy. The chairman of the Standish Group expressed unhappiness with the results of a road construction project in a report from Boston, Massachusetts, USA (Chaouk et al., 2020). The report states that 32% of road construction projects were completed on schedule, under budget, and to the expected standard of quality. Nevertheless, 24% were terminated prior to completion owing to failure, while 44% went over budget and over schedule. Deliverability problems impede the effective use of donated funds in donor-funded road construction projects in Sri Lanka (San Santoso & Gallage, 2019). Poor performance on these projects could result in costly implementation costs and contract cancellations.

According to Ahmed (2021), better road construction practices and technology in Europe result in quicker and more efficient project completion. In contrast, modern building materials and techniques, such as prefabricated and modular construction, enable road construction projects in China to be completed with minimal resource consumption (Opawole et al., 2019). Interestingly, building roads in China raises living standards and gives the less fortunate jobs. This viewpoint is supported by Masovic (2018) who states that building new roads not only increases local revenue during the construction phase but also promotes greater trade and makes access to healthcare services easier.

Project performance is a struggle for the Nigerian assembly sector, especially given the enduring problem of project delays. One major challenge in Nigeria is the large discrepancy between the budget that is allotted and the real amount of money needed for road development (Mahmud et al., 2021). In donor-funded projects, Uganda has a high rate of project delays and non-completion. According to Elong et al. (2019), this state of affairs is caused by political instability and unrest that has a detrimental effect on project implementation, especially in a few districts of Uganda. The study claims that from March to July 2019, the road project activities were substantially delayed by the closing of special accounts, interruptions in the procurement process, and the expiration of special commitments.

By offering necessary public facilities, the roads and infrastructure sector contributes significantly to the attainment of the Sustainable Development Goals and Kenya Vision 2030 goals. Road rehabilitation and construction, upkeep, and repair are the means by which these facilities are built. The Kenyan government has boosted financing for the road subsector to encourage infrastructure development in an effort to forward the big four agenda. On the other hand, Kenya faces a high rate of stopped projects and delayed road building (Odhiambo, 2021). In Kenya, project time and cost performance is considered inadequate, with over 70% of established projects likely to have schedule overruns greater than 50%. Furthermore, it is projected that cost overruns above 20% occur in 50% of projects (Muriithi & Kiiru, 2021). Interestingly, projects like Thika Road and Langata Road, which were finished above budget and ahead of schedule, did not follow the 'iron triangle' projected relationship between time, cost, and scope.

The Kenyan government actively supports and oversees the construction of roads, which is one of the transportations sector's main areas of focus. The country's road network coverage, which is currently valued at almost Kshs. 3.5 trillion as of 2021 and stands at 161.45 km, illustrates the attention to the transport industry, according to the Kenya Roads Board's Annual Public Roads Programme 2021/2022. There are now 939.6 km of road building and repair projects in the Nairobi Metropolitan Area (NMA) worth Ksh. 62.4 billion; projects that were finished in 2021 total 99.7 km and cost Ksh. 4.3 billion (Cytonn, 2021).

According to Omondi and Kinoti (2020), cost overruns have been a recurring theme in government-funded construction projects over the past few decades. In fact, some projects have seen increases in excess of 60% over their original contract value. The most alarming finding is that, according to historical data, cost performance has

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not improved, suggesting that there has not been much meaningful learning in this area (Flyvbjerg et al., 2019). According to Kanyeria and Karugu (2020), the political, technological, social, and economic environments are among the external factors that shape the project environment.

Construction firms operate in dynamic business environments, and it may be difficult for them to prosper if they don't adapt to these changes (Chileshe et al., 2022). The duration of road improvements is causing increasing concern among stakeholders. Stress issues for road construction projects include rising commercial bank borrowing rates, inflation, cost overruns, sponsor demands, and the potential for disputes that end up in court or arbitration (Ahmed, 2021). The most common reason for performance problems in the construction sector is project delays. In Kenya, political meddling, inefficient reporting systems, and corruption are the main causes of poor project performance in road construction projects. Inadequate infrastructure, tense interpersonal connections, low employee motivation, political and cultural difficulties, difficult economic circumstances, and inefficient political leadership and management are some other negative factors that negatively impact the execution of road construction projects in Kenya.

Statement of the Problem

The advancement of road construction plays a crucial role in propelling economic development in Kenya, aligning with the objectives of Kenya Vision 2030. Zhanglan et al. (2019) emphasize that these road construction projects, however, need to adjust their designs to take into consideration the ever-changing environmental conditions. The Kenyan government has actively approved and carried out a number of infrastructure development projects, with an emphasis on the transportation industry. Within the Nairobi Metropolitan Area (NMA), there are 939.6 km of ongoing road building and maintenance projects; of these, 99.7 km of projects worth Ksh 4.3 billion were finished in 2021 (Kenya Roads Board, 2021).

Under the State Department of Infrastructure, a branch of the Ministry of Transport, Infrastructure, Housing, Urban Development, and Public Works (MoTIHUDPW), the Kenya Rural Roads Authority functions as a State Corporation. The Authority is in charge of creating, managing, and fixing Kenya's rural roads. However, a number of problems frequently prevent it from accomplishing its goals, including uneven resource distribution, inexperienced contractors, hold-ups in certification and payment of finished work, excessive project spending and cost increases, political meddling, subpar quality control, low contractor motivation, and elevated agency risks (World Bank, 2017). By the end of the 2020–2021 Financial Year, only 4208 km of bitumen grade roads had been constructed, with revised completion deadlines (KeRRA, 2021). The Authority had planned and purchased 8,841.6 km of bitumen-standard roads by 2020 (KeRRA, 2018). Due to claims for unused physical and human resources as well as interest on past-due payments, this delay has resulted in higher expenses. In order to implement a performance-based road maintenance (PBRM) strategy, the KeRRA's 2018–2022 Strategic Plan called for expanding the capacity for citizen contracting, hiring 12 supervision consultants by 2020, putting in place a Public Private Partnership Model to complete 700 km and 68 km by 2021, respectively, and issuing Infrastructure Bonds. However, the implementation of these strategies has not yet been finished.

The impact of stakeholders' actions on the macroenvironmental functioning of road development projects in the Nairobi Metropolitan Area remains unclear despite their existence. Stakeholders are expected to influence top management of the project and help mitigate risks resulting from the macroenvironment. This indicates flaws that necessitate more investigation into the connection between these variables (Mwangi, 2020). Operating halts' have occasionally occurred for developers during construction because of a variety of obstacles, including shifting water pipes, power cables, and vendors who had set up business along the route.

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Take the 9.8-kilometre Ngong Road as an example, where uneven construction resulted in project termination halfway through. KERRA had to start over in order to overcome engineering obstacles on the same road, such as sharp lane ends, landscaping, and road markers. Over time, the sector's growth has been hampered by safety issues like theft and vandalism of infrastructure equipment, such as fibre cables, power lines, and gasoline. Tribal conflict has also caused a number of significant road projects to be postponed. The Lironi-Mau Summit Expressway is one example of a road project that has been delayed due to the enormous amount of capital needed for design and construction. If this issue is not resolved, it will be challenging for devolved governments to achieve sufficient and noteworthy growth.

The connection between project success and the macroenvironment has been the subject of numerous studies. In Kilifi County, Kenya, Wambui and Kisimbii (2020) looked into the ways in which social-cultural factors influenced the effectiveness of community-based programs. Maina and Gathenya (2014) investigated the impact of economic determinants on the project management performance of petroleum marketing enterprises in Kenya, whereas Owuze (2018) investigated the relationship between the sociocultural environment and the performance of manufacturing organizations in Nigeria. Kigera (2016) looked at the impact of political issues on the performance of international hotel chains in Nairobi, Kenya, while Musyoka et al. (2017) explored the impact of technological components on the success of gated community housing complexes in Nairobi County, Kenya. These studies, however, have several flaws, including a disregard for location, methodology, road construction projects, and performance metrics. Therefore, there was a need to conduct research to determine the relationship between the technological factors and the performance of road construction projects in Nairobi County, Kenya.

Objectives of the Study

The study sought to investigate the relationship between technological factors and performance of roads construction projects in Nairobi County, Kenya

LITERATURE REVIEW

Theoretical Review

The study was hinged on the Open System Theory that was first proposed by Ludwig von Bertanlanffy in 1956. It depicts a system in which each part is interconnected with all other elements and depends on these relationships to function. To maintain a competitive edge, organizations must either strategically align with their environment or adapt to it. According to Roth (2019), an organization is a system that has clear boundaries separating it from its surroundings. This builds on the initial viewpoint. Businesses operating in the global business environment face a variety of challenges in the social, technological, political, legal, and economic spheres. These challenges affect the businesses' capacity to obtain the instruments and tactics needed to endure and enhance performance via adaptation.

Scott (2019) asserts that macroenvironmental factors are uncontrollable and exist outside of an organization's physical walls. Although these factors are unpredictable and unstable, they also provide resources that are essential for an organization to thrive. Because of this, businesses must engage in strategic risk management to reduce the impact of environmental uncertainties and maximize the resources available to them in order to survive. Pressures from the political, economic, social, technological, and legal domains shape the environments in which organizations function (Van Assche et al., 2019). This suggests that senior managers should always take environmental hazards into account when making strategic decisions because they are influenced by the macroenvironment while developing strategies.

Open systems theorists contend that an organization's ability to survive depends on how it interacts with its surroundings. Nevertheless, opponents of the open systems approach argue that while powerful firms can impact the environment in which they function, organizations are more

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stable when they are separated (Fernandes et al., 2019). In addition, the theory has been criticism for neglecting to adopt an integrated, interactional strategy that utilizes many approaches for resource reliance, leaving a great deal of information regarding the interplay between various strategic management techniques unknown. This highlights how crucial it is to look into different resource dependencies, like the impact of different strategic alliances and organizational leadership (Van Assche et al., 2019).

The open systems theory clarifies how many environmental factors interact with road development projects in Nairobi County by including all aspects of the project's macro-environment. As a result, the theory is applicable to our research and offers an explanation for how the technological factors affect how well road construction projects in Nairobi County operate.

Empirical Review

Musyoka et al. (2017) conducted an assessment of the impact of technological factors on the performance of gated community housing projects in Nairobi County, Kenya. The study encompassed all active gated community housing projects initiated between 2009 and 2014. Descriptive statistics revealed that respondents acknowledged, to a very great extent, the utilization of locally made plant and equipment in their projects. Additionally, there was a consensus that skills for operating the plant and equipment were readily available, along with team members possessing the necessary skills for effective operation. The study further indicated a high level of satisfaction with the use of advanced construction information and communication technology (ICT), computer-aided drafting (CAD), 3D visual illustrations (Building Information Modelling), and electronic mails for communication. The results suggested that the adopted technological infrastructure had a moderately strong influence on the performance of gated community housing projects. Moreover, the technology environment demonstrated a statistically significant influence on project performance. It is noteworthy that while the study concentrated on the construction industry, it did not specifically address roads construction projects.

Zorić et al. (2021) explored the contribution of modern technologies to the success of IT projects. Employing a Quantitative Mono Method, the research examined the application of modern technologies in project management within the IT sector of Serbia. It assessed the extent to which experts believed that technology incentives positively impacted project success by analysing their influence on success factors. However, it is important to highlight that this study did not centre on the macro-environmental aspect, which is a focal point of the current study.

RESEARCH METHODOLOGY

This research adhered to a positivist research philosophy, rooted in the collection of quantitative data from respondents. Positivism, as an epistemological philosophy, asserts that observation relies on objective criteria rather than subjective ones, and emphasizes the independence of the observer from the subject of study (Creswell & Clark, 2017). This study employed an explanatory and descriptive research design.

This research focused on a target population comprising 176 concluded roads construction projects within the Nairobi Metropolitan Area, executed by the Kenya Rural Roads Authority (KERRA). The unit of observation included road engineers, project planners, and directors associated with KERRA, along with road supervisors, inspectors, surveyors, contractors, and members of project implementation teams.

The sample size was determined using Yamane (1967) model, and the study sought to use a sample size of 253 respondents. According to Yamane (1967) Model:

$$n = \frac{N}{1+N(e^2)} = 692/1+692\ (0.05^2) = 253$$

Where: n = the desired sample size, e = margin of error; the probability of error (i.e., the desired

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precision, in this case, 0.05 for 95 percent confidence level), N = the total population size

The primary sampling method employed in this study was stratified random sampling. This approach was chosen to ensure that each stratum, representing specific respondent categories, contributed to the overall sample in a representative manner (Snyder, 2019). Strata were formed based on distinct categories of respondents, each representing a group of units with unique characteristics. The utilization of stratified random sampling allowed for the systematic selection of respondents from each stratum through the application of simple random sampling techniques. The sample was distributed among the strata as shown in *Table 1*.

Table 1: Sample Size Determination

Population	Frequency	Ratio	Sampling
Road engineers	17	0.366	6
Project planners and Directors (KERRA)	16	0.366	6
Road supervisors	81	0.366	30
Road inspectors	98	0.366	36
Road surveyors	194	0.366	71
Contractors	119	0.366	44
Project Implementation teams members (KERRA)	167	0.366	61
Total	692		253

The structured questionnaires employed for primary data collection featured questions with limited choices, allowing respondents to select from predefined options. Respondents were instructed to provide their responses in the form of a Likert scale ranging from 1 to 5 (1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, and 5-Strongly Agree). A letter of introduction from the researcher's university was provided to the respondents to secure permission for posing questions. Additionally, the researcher obtained a permit from NACOSTI to collect necessary data. Participants were allotted a week to complete the questionnaire, a strategic approach to enhance response rates given their busy work schedules. The researcher, aided by assistants, administered the questionnaires using a drop-and-pick-later strategy, occasionally employing Google Docs for optimal response rates. Two days prior, the researcher scheduled appointments with the firms to ensure smooth questionnaire delivery. Ethical considerations were paramount, and the researcher communicated the study's significance, ensuring respondents of confidentiality and identity protection.

The gathered field data was carefully sorted, cleaned, and filtered to meet the goals of the study. The information was then coded and entered into SPSS, Version 27.0, a statistical program, for analysis. Both descriptive and inferential statistics were used in this investigation. For every quantitative element of data, descriptive statistics were produced, including frequencies, percentages, mean scores, and standard deviation. The results were displayed in tables. Linear regression, an inferential statistical technique, was utilized to evaluate the importance of every independent variable. Linear regression, a statistical technique, quantifies the relationship between independent and dependent variables based on observations. The following linear regression model was conducted to establish the relationship between project performance and the independent study variable.

$$Y=\alpha+\beta_1 X + \varepsilon$$

Where; ε= error term, β=coefficient of independent variable (β_1=regression coefficient) and α= constant ceteris[1] paribus; Y= performance of Roads construction projects in Nairobi County; X_1= Composite index for technological factors;

RESEARCH FINDINGS AND DISCUSSIONS

The study sought to investigate the relationship between technological factors and performance of roads construction projects in Nairobi County,

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Kenya. The descriptive results of technological factors are presented in *Table 2*.

The results presented in *Table 2* indicate that the respondents generally agreed (mean of 4.02) that advanced construction technology is readily available and enhances the performance of road construction projects. The relatively low standard deviation of 0.657 suggests a moderate level of consensus among participants, indicating a shared perception. Further, 46 respondents (22.2%) strongly agreed with the statement, 121 respondents (58.5%) agreed, and 39 respondents (18.8%) were unsure. This result is consistent with Rugenyi's (2016) assertion that the use of contemporary information systems and building technologies can lead to institutional sustainability and expansion.

Participants expressed agreement (mean of 4.05) with the statement that employing advanced construction methods and materials provides a clear advantage in project efficiency and quality. The standard deviation of 0.765 suggests a moderate level of variability in responses, indicating some diversity of opinion among participants. Moreover, 60 respondents (29.0%) strongly agreed with the statement, 103 respondents (49.8%) agreed, 40 respondents (19.3%) were unsure, 3 respondents (1.4%) disagreed, and 1 respondent (0.5%) strongly disagreed. This conclusion is consistent with the explanation provided by Gruden and Stare (2018), who explain that process digitization leads to new methods of project delivery and enhances the manner that different project stages are carried out.

Respondents generally agreed (mean of 4.04) that digitization and automation enable contractors to address complex technicalities before construction begins. The moderate standard deviation of 0.706 indicates a degree of variability in responses, suggesting some diversity in viewpoints among participants. Further, 49 respondents (23.7%) strongly agreed with the statement, 125 respondents (60.4%) agreed, 26 respondents (12.6%) were unsure, and 7 respondents (3.4%) disagreed. This result is consistent with the study conducted by Sirisomboonsuk et al. (2018), which found that IT sophistication moderates the association between service practice and performance. The study examined the relationship between project performance, service practices and performance, and IT sophistication.

The mean of 3.99 indicates a generally positive perception regarding the pursuit of research and development to enhance road construction processes. The standard deviation of 0.845 suggests a moderate level of variability, indicating some diversity in respondents' opinions on this matter. Also, 63 respondents (30.4%) strongly agreed with the statement, 86 respondents (41.5%) agreed, 51 respondents (24.6%) were unsure, 6 respondents (2.9%) disagreed, and 1 respondent (0.5%) strongly disagreed. This result is consistent with that of Memon et al. (2012), who discovered that, for the typical company, IT investments are regarded as a major and value-adding activity. In his conclusion, Bergeron et al. (2020) make the argument that information technology must be tailored to the goals, structure, and environment of a company.

Participants strongly agreed (mean of 4.57) that technology incentives motivate contractors to incorporate advanced technology. The low standard deviation of 0.594 suggests a high level of consensus among respondents, indicating a shared belief in the motivating influence of technology incentives. In addition, 130 respondents (62.8%) strongly agreed with the statement, 66 respondents (31.9%) agreed, and 11 respondents (5.3%) were unsure. This result is consistent with Assaad et al.[1] (2020) observation that, in order to improve an organization’s information system and revenue collection marking system, it is imperative to impart management and marketing expertise to rural residents.

The mean of 3.50 indicates a moderate level of agreement regarding the effective utilization of technological infrastructure to enhance project efficiency. The high standard deviation of 1.153 suggests a notable diversity of opinions among participants, indicating a range of perspectives on

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the effectiveness of technological infrastructure utilization. Further, 47 respondents (22.7%) strongly agreed with the statement, 67 respondents (32.4%) agreed, 41 respondents (19.8%) were unsure, 46 respondents (22.2%) disagreed, and 6 respondents (2.9%) strongly disagreed. This result is consistent with the observations made by Musyoka et al. (2017) regarding the technological forces influencing the construction industry. These forces include the increased use of computer programs, sophisticated building materials and methods, technological innovations and trends in construction automation, faster unit production rates, smart systems, advancements in artificial intelligence, and diversification.

Table 2: Technological Factors

Statement	SA	A	NS	D	SD	Mean	StD
	f(%)	f(%)	f(%)	f(%)	f(%)		
Advanced construction technology is readily available in the market that helps improve the performance of our road construction projects	46 (22.2)	121 (58.5)	39 (18.8)	0 (0.0)	0 (0.0)	4.02	.657
There is a clear advantage in terms of project efficiency and quality when advanced construction methods and materials are employed in road construction projects	60 (29.0)	103 (49.8)	40 (19.3)	3 (1.4)	1 (0.5)	4.05	.765
Digitization/automation of processes has enabled contractors to solve and foresee complex technicalities when even before construction begins	49 (23.7)	125 (60.4)	26 (12.6)	7 (3.4)	0 (0.0)	4.04	.706
Investments in research and development are actively pursued to improve road construction processes in Nairobi County	63 (30.4)	86 (41.5)	51 (24.6)	6 (2.9)	1 (0.5)	3.99	0.845
The availability of technology incentives motivates contractors to incorporate advanced technology in their construction processes	130 (62.8)	66 (31.9)	11 (5.3)	0 (0.0)	0 (0.0)	4.57	0.594
We effectively utilize available technological infrastructure to enhance the efficiency of our road construction projects	47 (22.7)	67 (32.4)	41 (19.8)	46 (22.2)	6 (2.9)	3.50	1.153

Keyword: Sa = Strongly Agree, A = Agree, NS = Not sure. D = Disagree, SD = Strongly Disagree

Inferential Analysis

To find out how one variable affected another, regression analysis was used. Regressing technological factors influences on project performance allowed for this realization. *Tables 3, 4,* and *5* present the combined regression analysis results, respectively.

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.78	0.614	0.612	0.586

The outcomes presented in *Table 4* reveal that the adjusted R-squared value stood at 0.612 (61.2%), indicating the proportion of the performance of road construction projects in Nairobi County, Kenya, determined by technological factors. Consequently, the remaining percentage (38.8%) is attributed to variables not specifically investigated in this study. Scholars such as Hair et al. (2019) emphasize that the adjusted R-squared serves as a valuable metric for assessing how effectively independent variables account for variability in the dependent variable. A higher adjusted R-squared value suggests a more robust fit of the model.

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Table 4: Analysis of Variance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	112.017	1	112.017	326.552	2.73E-44
	Residual	70.321	205	0.343		
	Total	182.338	206			

Table 4 presents the results, which indicate that the significant value is less than 0.05, precisely at 2.73E-44. Moreover, the statistical f value—which is 326.552—is higher than the statistical mean—which is 3.8872. As thus, this confirms the model's significance.

Table 5: Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.704	.218		3.229	.001
Technological factors	.799	.352	.784	2.270	.024

The established regression equation was as follows;

$Y = 0.704 + 0.799X_1$

Where; Y= Composite index for performance of Roads construction projects; X_1= Composite index for Technological factors;

The findings in *Table 5* revealed that a constant value (constant) of 0.704 implies that when all factors are zero, the dependent variable is anticipated to be 0.704. The technological factor's coefficient, which stands at 0.799, is statistically significant at 0.024, indicating that technological variables have a beneficial impact on the success of road development projects in Nairobi County. Research by White and Johnson (2020) provided insight into how technology affects the performance of construction projects.

> *H_{01}: There is no significant relationship between technological factors and the performance Road's construction projects in Nairobi County, Kenya.*

The investigation confirmed that technological factors exhibited a positive and significant relationship with the performance of road construction projects in Nairobi County, Kenya, as evidenced by the t-value ($t=2.270$, $p<0.05$). Consequently, the hypothesis was rejected, leading to the conclusion that there exists a significant relationship between technological factors and the performance of road construction projects in Nairobi County, Kenya. This result is consistent with research by Zorić et al. (2021) that examined the role that contemporary technology has in the accomplishment of IT projects. The study demonstrated how contemporary technologies are being used in Serbia's IT industry for project management, and it highlighted the benefits of technological incentives for project success by examining how they affect different success criteria.

CONCLUSIONS

The results of the study showed a strong and favourable correlation between technological parameters and project performance. The findings indicate that the availability and use of advanced construction technologies significantly enhance project performance. This consensus suggests that stakeholders recognize the importance of integrating modern technologies to achieve better efficiency, quality, and timeliness in construction projects. Moreover, the study found that digitization and automation are crucial in addressing complex technical issues, allowing for more precise and efficient project execution.

Furthermore, the research underscores the importance of incentives in motivating contractors to adopt advanced technologies. The high level of agreement on the motivational impact of these incentives reflects their

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effectiveness in promoting technological adoption. Additionally, investments in research and development were found to be vital for continuous improvement in road construction processes, supporting the notion that sustained innovation is key to long-term project success.

Recommendation and Policy Implication

The study encourages enhancing incentives for technology adoption to motivate contractors to incorporate advanced methods and materials in road construction projects. Project managers are urged to embrace digitization and automation, leveraging technology to address complex technicalities both before and during construction.

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