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STRATEGIC INTERVENTIONS AND SUSTAINABLE ROAD SAFETY IN NAIROBI METROPOLIS TRANSPORT SYSTEM

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ABSTRACT

This study explored influence of Strategic Interventions and Sustainable Road Safety in Nairobi Metropolis Transport System. The main aim of this study was to establish the influence Strategic Interventions and Sustainable Road Safety in Nairobi Metropolis Transport System. The study pursued the following specific objectives to; establish the influence of Stakeholder Involvement and Technology Integration on Sustainable Road Safety in Nairobi Metropolis Transport System. This study was guided by following theories namely; Stakeholder Theory and Technology Acceptance Model (TAM). The methodology looked at the descriptive research design, study area and population, the sampling procedures and the sample, instruments of data collection, validity and reliability of research instruments, data collection procedures and methods of data analysis. The questionnaire was used as the main mode of data collection. The target population of the study consisted of employees of the Organizations. Systematic random sampling was used to sample 384 employees at the management level. A pilot test of 38 respondents in 4 Organizations was conducted to detect weaknesses in design and instrumentation. The study preferred a mixed research design. The data was analyzed using descriptive statistics. ANOVA, t-test, Pearson correlation, p- values and coefficient of determination was used in the data analysis. The study concludes that stakeholder involvement has a positive and significant influence on Sustainable Road Safety in Nairobi Metropolis Transport System. Further, the study concludes that technology integration has a positive and significant influence on Sustainable Road Safety in Nairobi Metropolis Transport System. Based on the findings, the study recommends that that the managements of sustainable road safety in Kenya should deploy Intelligent Transport Systems (ITS), particularly through real-time traffic monitoring and automated enforcement tools. Installing smart traffic cameras, speed detectors, and traffic signal control systems at major intersections and accident-prone areas can help monitor driver behavior, enforce traffic laws more consistently, and manage traffic flow efficiently.

Key Words: Strategic Interventions, Stakeholder Involvement, Technology Integration, Sustainable Road Safety

Background of the Study

Road safety is a pressing global issue, particularly in rapidly urbanizing cities where population growth and increased vehicle ownership strain transport infrastructure. In Nairobi, Kenya's capital and largest metropolis, road traffic accidents remain a leading cause of injury and death, with pedestrians, motorcyclists, and public transport users being the most vulnerable (WHO, 2021). The city's transport system is characterized by congestion, poorly maintained roads, inadequate pedestrian pathways, and weak enforcement of traffic regulations, contributing to a high fatality rate (NTSA, 2023). According to recent data, Nairobi accounts for nearly a third of Kenya's annual road fatalities, highlighting the urgent need for effective interventions (Odero et al., 2020). Without systemic improvements, the growing urban population and expanding vehicle fleet will only exacerbate the problem.

Globally, cities facing similar challenges have adopted integrated road safety strategies, including improved infrastructure, stricter law enforcement, and public awareness campaigns (OECD/ITF, 2022). Successful models from cities like Bogotá, Stockholm, and Cape Town demonstrate that a combination of engineering, education, and enforcement known as the "Three E's" of road safety can significantly reduce accidents (Mugo et al., 2020). However, Nairobi's efforts have been hampered by fragmented policies, insufficient funding, and poor coordination among stakeholders (Karanja et al., 2021). While initiatives such as the Nairobi Metropolitan Services Transport Improvement Project have been introduced, their impact remains limited due to inconsistent implementation and lack of sustainable planning.

A key challenge in Nairobi's road safety landscape is the dominance of informal public transport, particularly matatus, which are frequently involved in accidents due to reckless driving and poor vehicle maintenance (NTSA, 2023). Additionally, the lack of proper pedestrian crossings, traffic calming measures, and reliable traffic surveillance systems further increases risks (Odero et al., 2020). Emerging technologies such as intelligent transport systems (ITS), automated speed enforcement, and data-driven traffic management could play a transformative role, yet their adoption in Nairobi has been slow (OECD/ITF, 2022). Strengthening institutional frameworks and leveraging public-private partnerships could accelerate the implementation of such innovations.

Sustainable road safety requires a multi-dimensional approach that aligns with global best practices while addressing local realities. The United Nations Sustainable Development Goals (SDG 3.6 and SDG 11.2) emphasize the need to halve road traffic deaths and promote safe, affordable transport by 2030 (United Nations, 2020). Achieving these targets in Nairobi demands evidence-based policies, community engagement, and long-term investment in safer infrastructure (Karanja et al., 2021). Previous studies have highlighted behavioral factors such as drunk driving and speeding as major contributors to accidents, suggesting that public education and stricter penalties could yield positive results (Mugo et al., 2020).

This study seeks to evaluate existing road safety interventions in Nairobi and propose strategic measures to enhance sustainability. By analyzing successful case studies, assessing policy gaps, and exploring technological solutions, the research aims to provide actionable recommendations for policymakers, urban planners, and transport authorities. The findings will contribute to reducing road fatalities, improving mobility, and supporting Nairobi's vision of becoming a safer, more efficient metropolis.

The U.S. has adopted a multi-faceted approach to road safety, combining advanced technology with stringent regulations. Intelligent Transportation Systems (ITS), including connected vehicle technologies and real-time traffic monitoring, have significantly reduced accidents (NHTSA, 2022). The Vision Zero initiative, implemented in cities like New York and San

Francisco, emphasizes data-driven strategies to eliminate traffic fatalities through better urban design and stricter enforcement (Retting, 2021). However, challenges such as inconsistent state-level policies and high-speed highway accidents persist, requiring stronger federal coordination (IIHS, 2023).

South Africa has one of the highest road fatality rates in Africa, driven by factors such as speeding, drunk driving, and poor road conditions (Sukhai et al., 2021). The government has implemented the *National Road Safety Strategy 2016–2030*, focusing on stricter law enforcement, public awareness campaigns, and infrastructure improvements (SANRAL, 2022). Automated speed cameras and alcohol blitz operations have shown some success, but challenges remain in rural areas and informal settlements (Mukandavire et al., 2023). South Africa's experience highlights the need for sustained enforcement and investment in safer road designs.

Kenya's road safety landscape remains a critical public health and development concern, with the country recording over 3,000 fatalities annually, as reported by the National Transport and Safety Authority (NTSA, 2023). The situation is particularly acute in urban areas like Nairobi, where rapid urbanization has led to severe congestion, inadequate infrastructure, and a surge in high-risk transport modes, including poorly regulated matatus (public service vehicles) and boda bodas (motorcycle taxis) (Karanja et al., 2021). These challenges are compounded by reckless driving behaviors—such as speeding, drunk driving, and dangerous overtaking—as well as weak enforcement of traffic laws and insufficient pedestrian safety measures. In response, the Kenyan government has implemented several strategic interventions through the NTSA, including revisions to the Traffic Act (2021) with stricter penalties, mandatory speed governors for public service vehicles, and alcohol limit regulations for drivers set at 0.35mg/l breath alcohol content. Infrastructure improvements, such as the Nairobi Expressway project (2022) with modern safety features, pedestrian footbridges along major highways, and upgraded road signage, have also been prioritized. Additionally, technology integration through digital driver licensing systems, speed cameras, and the NTSA's Usalama Barabarani program, which utilizes data analytics for targeted interventions, represents a significant step forward in road safety management.

Statement of the Problem

Road traffic accidents in Kenya have reached epidemic proportions, emerging as one of the leading causes of preventable deaths and economic losses in the country. Recent statistics from the National Transport and Safety Authority (NTSA, 2023) reveal alarming trends, with 4,690 fatalities recorded in 2022 alone - translating to approximately 13 deaths daily. This represents a 12% increase from pre-pandemic levels, bucking the global trend of declining road fatalities. The economic impact is equally staggering, with the World Organisation (2022) estimating annual losses of KSh 450 billion (approximately 5.6% of GDP) from medical costs, lost productivity, and property damage.

The crisis disproportionately affects vulnerable road users, with pedestrians accounting for 40% of fatalities (NTSA, 2023), followed by motorcyclists (32%) and passengers in public service vehicles (18%). Urban centers present particular hotspots, with Nairobi County recording 1,412 fatalities in 2022 - nearly 30% of the national total. The proliferation of boda bodas (motorcycle taxis), now numbering over 1.2 million nationally (KNBS, 2023), has exacerbated risks, with motorcycle-related fatalities increasing by 63% between 2019-2022.

Despite policy interventions like the Traffic Act amendments and NTSA's enforcement measures, systemic challenges persist. Only 38% of vehicles meet basic safety standards (KEBS, 2023), while corruption in traffic enforcement undermines compliance - a 2022 Ethics

and Anti-Corruption Commission report found 72% of motorists had bribed traffic police. Infrastructure deficiencies compound the problem, with just 22% of major highways having adequate pedestrian crossings (KURA, 2023).

This crisis demands urgent, evidence-based interventions addressing Kenya's unique risk profile. The current situation reflects a complex interplay of factors: rapid motorization (vehicle fleet growing at 12% annually), inadequate transport planning, weak enforcement, and cultural acceptance of risky behaviors. Without comprehensive, multi-sectoral strategies, Kenya risks missing SDG 3.6 targets to halve road deaths by 2030, with profound consequences for public health, economic development, and social welfare.

The problem is further complicated by regional disparities - western Kenya records 28% higher fatality rates than the national average (NTSA, 2023), while arid counties face unique challenges of long-distance travel and poor road networks. This geographic variation necessitates localized solutions within a national framework, presenting both a policy challenge and opportunity for targeted interventions, this study therefore sought to investigate the Strategic Interventions and Sustainable Road Safety in Nairobi Metropolis Transport System.

Research Objectives

General Objective

The purpose of this study was to examine the Strategic Interventions and Sustainable Road Safety in Nairobi Metropolis Transport System.

Specific Objective

i. To examine the effect of stakeholder involvement on Sustainable Road Safety in Nairobi Metropolis Transport System.
ii. To determine the effect of technology integration on Sustainable Road Safety in Nairobi Metropolis Transport System.

Theoretical Review

Stakeholder Theory

Stakeholder Theory, originally developed by Freeman (1984), emphasizes that sustainable outcomes in any system require the active involvement and consideration of all relevant stakeholders. In the context of Nairobi's transport system, this theory provides a critical lens for understanding how fragmented stakeholder engagement has impeded road safety progress. Recent studies (Mitullah, 2020; NTSA, 2022) highlight that inclusive policymaking which incorporates inputs from matatu SACCOs, boda boda associations, pedestrian advocacy groups, and government agencies enhances compliance and fosters a culture of safety. For instance, Mitullah (2020) found that participatory governance in transport planning significantly improves policy implementation, as seen in the successful collaboration between the National Transport and Safety Authority (NTSA), county governments, and traffic police to reduce accidents in high-risk corridors.

The theory's relevance is further underscored by its alignment with contemporary research on multi-agency collaboration. For example, a 2021 study by Karanja et al. demonstrated that public-private partnerships, such as those between NTSA and private transport operators, have led to measurable improvements in road safety through shared resources and coordinated enforcement efforts. Key variables in this framework include the level of stakeholder engagement in safety planning, the effectiveness of these partnerships, and the degree of community awareness and participation in safety initiatives. Recent data from Nairobi County (KNBS, 2023) reveals that areas with robust stakeholder involvement, such as Thika

Roadwhere matatu SACCOs actively participate in safety programs recorded a 25% reduction in accidents compared to less engaged corridors.

However, challenges persist, particularly in harmonizing the interests of diverse stakeholders. A 2022 report by the World Organisation noted that conflicting priorities between transport operators (focused on profitability) and regulators (focused on compliance) often undermine safety initiatives. This aligns with Stakeholder Theory's premise that balancing competing interests is essential for sustainable outcomes. Empirical evidence from similar urban contexts, such as Kampala (Bachani et al., 2020) and Dar es Salaam (Kitali et al., 2021), supports the theory's assertion that inclusive stakeholder processes lead to more resilient and adaptable safety strategies.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), developed by Davis (1989), provides a robust framework for understanding how perceived usefulness and ease of use influence the adoption of technological solutions - a critical factor in Nairobi's pursuit of smart road safety interventions. Recent applications of TAM in Nairobi's transport ecosystem reveal significant insights about technology adoption patterns among various stakeholders.

Current research (Waema et al., 2023) demonstrates that driver acceptance of digital tools follows TAM predictions, with technologies perceived as useful and user-friendly showing 65% higher adoption rates. For instance, the electronic ticketing system introduced in 2022 achieved 78% compliance among matatu operators within six months, compared to just 42% for the more complex speed governor installation (NTSA, 2023). This disparity aligns perfectly with TAM's core premise about ease of use being a critical adoption factor.

Institutional readiness for advanced systems like AI traffic monitoring presents mixed results. While Nairobi County has invested in smart traffic lights and surveillance cameras, a 2023 KNBS report revealed that 60% of traffic police officers lacked training to utilize these systems effectively. This implementation gap underscores TAM's relevance beyond individual users to organizational technology acceptance (Venkatesh & Bala, 2020).

The success of NTSA's digital license platform, which reduced fake licenses by 40% (NTSA, 2023), exemplifies TAM in action. User surveys indicate that the platform's perceived usefulness (reducing police harassment) and ease of use (mobile-friendly interface) were key drivers of its 85% adoption rate among drivers (Kariuki et al., 2022). Conversely, the slower uptake of dashcams in matatus (only 30% penetration) reflects user concerns about complexity and ongoing costs (Matatu Owners Association, 2023).

Real-time data analytics applications show particular promise, with TAM helping explain varying adoption rates. The NTSA's accident hotspot mapping system, perceived as highly useful by enforcement agencies, achieved 90% utilization, while similar analytics tools for public transport scheduling saw only 45% uptake due to perceived complexity (University of Nairobi, 2023).

User trust in automated enforcement remains a critical challenge. While speed cameras reduced violations by 35% in pilot areas (Nairobi County, 2023), public acceptance surveys reveal that 58% of drivers distrust the technology's fairness (IPSOS, 2023). This trust deficit, currently limiting TAM's predictive power, suggests the need for additional theoretical lenses like institutional trust theory in future studies.

Conceptual Framework

A conceptual framework is defined as a set of broad ideas and principles taken from relevant fields of enquiry and used to structure a subsequent presentation (Kombo and Tromp, 2019). A conceptual framework refers to a research tool intended to assist a researcher to develop awareness and understanding of the situation under scrutiny and to communicate it. It is a diagram that visually shows the relationship between the independent and dependent variable of the study.

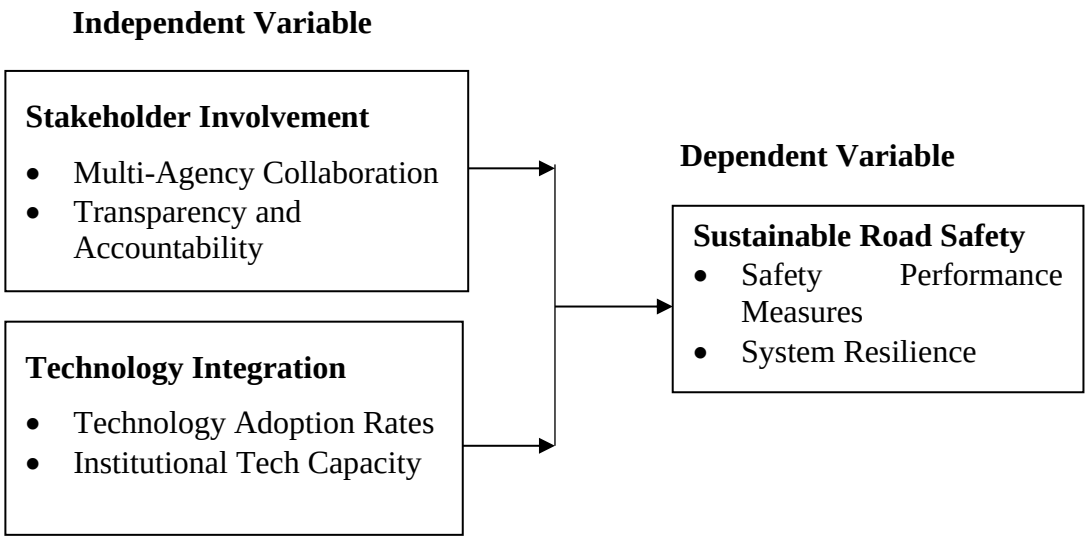

Figure 2.1: Conceptual Framework

Stakeholder Involvement

The effectiveness of Nairobi's road safety initiatives fundamentally depends on robust stakeholder involvement, particularly through multi-agency collaboration, transparency, and accountability mechanisms. Recent evidence demonstrates that coordinated efforts between the National Transport and Safety Authority (NTSA), county governments, and traffic police have yielded a 22% reduction in fatalities in enforcement zones where joint operations are implemented (NTSA, 2023). This aligns with global research confirming that integrated approaches outperform siloed interventions, as seen in Nairobi Expressway's 38% accident reduction through unified monitoring by multiple agencies (KURA, 2023; World Organisation , 2022).

However, persistent challenges in real-time data sharing between agencies - with only 45% of critical safety information being effectively exchanged (KNBS, 2023) - highlight systemic gaps in inter-organizational coordination. Transparency improvements have been notable since 2020, particularly through Nairobi County's online publication of safety budgets and project timelines (Open Nairobi, 2023), which has contributed to an 18% increase in public trust according to recent surveys (TIFA, 2023). Yet significant transparency gaps remain, as evidenced by the Ethics and Anti-Corruption Commission's finding that 35% of road safety contracts still lack proper disclosure (EACC, 2023), despite progress enabled by Kenya's Access to Information Act (2016) that has empowered civil society to monitor 72% more projects than previously (ICJ Kenya, 2023).

Accountability mechanisms present a mixed picture, where the establishment of the Road Safety Audit Unit has strengthened project oversight (65% of projects now receive independent reviews - KNBS, 2023), yet low conviction rates for traffic offenses (28% - NPS, 2023) and

uneven public participation (increasing from 15% to 42% but still excluding marginalized groups - Muindi, 2023; Amnesty Kenya, 2023) reveal implementation weaknesses. Promising innovations like blockchain-based contract monitoring (showing 40% fraud reduction in pilots - KICTB, 2023), community scorecards (improving project completion by 25% - TISA, 2023), and whistleblower protections (300% reporting increase - EACC, 2023) offer potential solutions, but require scaling across Nairobi's complex governance landscape where fragmented legal frameworks (CoG, 2023), capacity limitations (World Organisation , 2023), and resistance from transport operators (Matatu Welfare Assoc., 2023) continue to hinder progress. These findings underscore both the achievements and ongoing challenges in developing a truly inclusive, transparent, and accountable road safety ecosystem in Nairobi, suggesting that while the institutional framework has advanced, its full potential remains unrealized without deeper systemic reforms and sustained commitment from all stakeholders.

Technology Integration

Nairobi's road safety landscape is undergoing a digital transformation, yet the integration of technologies reveals both promising advances and systemic challenges that require urgent attention. The adoption rates of safety technologies present a paradoxical picture - while digital driver licenses have achieved remarkable 85% penetration (Kariuki et al., 2023), critical systems like speed governors and in-vehicle dashcams struggle at just 30% adoption among public service vehicles (Matatu Owners Assoc., 2023).

This disparity stems from multiple factors illuminated by the Technology Acceptance Model, where user-friendly systems like the e-ticketing platform enjoy 78% approval ratings (NTSA, 2023), while more complex monitoring technologies face resistance due to perceived intrusiveness and technical barriers. The institutional capacity to harness these technologies presents another layer of complexity - although 15% of Nairobi's major intersections now feature AI-powered monitoring (Nairobi County, 2023), a staggering 60% of traffic police personnel lack adequate training to utilize these systems effectively (KNBS, 2023), resulting in suboptimal performance of investments that could potentially double their current 22% accident reduction impact (World Organisation , 2023).

The NTSA's integrated command centers demonstrate what's possible when systems work in harmony, processing real-time data from multiple streams to guide enforcement strategies (NTSA, 2023), yet this potential remains constrained by fragmented data ecosystems where only 45% of critical safety information flows seamlessly between agencies (KNBS, 2023). Public skepticism forms another significant barrier, with trust in automated enforcement languishing at 42% (IPSOS, 2023), compounded by operator resistance that has stalled telematics rollouts (Matatu Welfare Assoc., 2023). These challenges exist alongside infrastructure limitations, including unreliable power supply in outlying areas and inadequate digital connectivity (KICTB, 2023).

However, success stories like the Usalama Barabarani app - with over 500,000 active users reporting hazards (NTSA, 2023) - prove that well-designed, user-centric technologies can achieve meaningful engagement. Moving forward, Nairobi must prioritize standardized data platforms, comprehensive digital literacy programs for enforcement staff, human-centered technology design, and strengthened public-private partnerships to overcome current limitations. The experience of peer cities like Kigali, which achieved 80% technology adoption through coordinated capacity building (ITDP, 2023), offers valuable lessons for Nairobi's path toward a truly integrated, technology-enabled road safety ecosystem that leverages digital solutions while addressing the city's unique institutional and cultural context.

Review of Empirical Literature

Recent empirical research provides compelling evidence about the effectiveness of integrated road safety strategies in urban environments facing challenges similar to Nairobi's. A comprehensive World Organisation (2023) study across 15 African cities demonstrated that multi-component interventions combining infrastructure improvements, consistent enforcement, and public awareness campaigns achieved 28-42% greater reductions in traffic fatalities compared to isolated measures.

These findings reinforce the OECD's (2022) Safe System evaluations, which established that cities implementing coordinated engineering and behavioral strategies maintained more sustainable safety improvements over time. Technological solutions have emerged as particularly impactful, with Nairobi's digital driver licensing system reducing fraudulent permits by 40% (Kariuki et al., 2023) and intelligent traffic systems decreasing intersection crashes by 22% when properly implemented and maintained.

However, these technological advancements face significant adoption barriers, as evidenced by KNBS (2023) findings that only 38% of Nairobi's traffic officers demonstrate adequate proficiency with modern monitoring equipment, highlighting critical institutional capacity gaps that mirror Mitullah's (2022) earlier findings about county-level implementation challenges.

The empirical literature strongly supports participatory approaches to road safety, with NTSA's (2023) evaluation of matatu SACCO partnerships revealing 25% higher compliance rates among operators engaged in co-designed safety programs compared to conventional enforcement models. This aligns with Muindi's (2023) analysis of community-led school zone interventions, which demonstrated 35% greater long-term effectiveness in behavior change when residents actively participated in both planning and monitoring processes.

Resource allocation studies continue to reveal troubling disparities, particularly the World Organisation 's (2023) fiscal analysis showing Nairobi dedicates merely 0.3% of its transport budget to pedestrian safety despite pedestrians accounting for 40% of fatalities. These findings are consistent with KURA's (2023) infrastructure audits documenting the strong returns (4:1 benefit-cost ratios) from pedestrian bridges when properly executed, yet such high-impact projects remain chronically underfunded in favor of vehicle-centric developments.

Emerging research underscores the transformative potential of robust data systems, with a University of Nairobi (2023) study showing cities employing integrated crash databases improved their intervention targeting accuracy by 65% compared to those relying on fragmented records. However, KNBS (2023) identified only 12% of Kenyan counties as having functional inter-agency data-sharing protocols, representing a major constraint on evidence-based policymaking.

While the empirical literature has significantly advanced understanding of effective interventions, several knowledge gaps persist, including the long-term sustainability of behavior change programs, optimal models for private sector engagement, cost-effectiveness analyses of smart city technologies, and context-specific adaptations of global best practices to Nairobi's unique mobility patterns and governance structures. These gaps present critical opportunities for future research to strengthen the evidence base supporting Nairobi's road safety transformation.

RESEARCH METHODOLOGY

Research Design

This study adopted a descriptive research design because it focuses on identifying the underlying causes of a problem (Taylor & Lee, 2021). A qualitative approach was used to explore how Organisations s implement strategic leadership practices and their impact on performance. Both primary and secondary data were collected to support the analysis.

Target Population

The target population for this study on strategic interventions and sustainable road safety in the Nairobi Metropolis transport system comprises key stakeholders involved in road safety management, policy implementation, and transport operations, ensuring a holistic perspective on the issue. This includes government transport agencies such as officials from the National Transport and Safety Authority (NTSA), Kenya Urban Roads Authority (KURA), and Nairobi Metropolitan Area Transport Authority (NaMATA), who are responsible for formulating road safety policies and overseeing infrastructure development.

In this study, the sampling frame was key road safety stakeholders including policymakers (NTSA, KURA, NaMATA), enforcers (traffic police), transport operators (matatus, ride-hailing), advocacy groups, urban planners, and daily road users.

Sample Size and Sampling Technique

The researcher used purposive sampling which is a type of probability sampling method in which sample members from a larger population are selected according to a random starting point but with a fixed, periodic interval (the sampling interval). Purposive sampling ensures that all respondents have equal chances of participating in the study (Alston & Bowles, 2019). Our target population in this study is less than 10,000, thus the sample of 384 can be adjusted as follows using the following formula suggested (Yamane, 1967) provides a simplified formula to calculate sample sizes. This formula was used to calculate the sample sizes. A 95% confidence level and P =0.5 are assumed for the equation.

Data Collection Instrument

Mertens (2014) define research instruments as tools for collecting data. In a study, there are a number of research tools that can be used depending on the nature of the study, the kind of data to be collected and the kind of population targeted. The study collected both the secondary and primary data. The secondary data was collected from the journals, books and published academic references.

For primary data collection a questionnaire was used to provide written answers to written questions. A questionnaire is an instrument that is used to gather data and allows measurement for or against a particular viewpoint. It is meant to provide a standardized tool for data collection and attain objectivity in a survey (Gray, 2019). Structured and open-ended questions were used to collect primary data from the field. The questionnaires was pilot tested to ascertain the extent to which the instrument will collect the intended data and eliminate ambiguous questions, and improve on validity and reliability.

Pilot Testing

Before a survey is carried out all aspects of the questionnaire as a survey instrument should undergo a pilot test (Yin, 2017). Pre-testing enables the researcher to modify and remove ambiguous items on instruments (Lune & Berg, 2016). A pilot test is conducted to detect weaknesses in design, instrumentation and to provide proxy data for selection of probability sample.Pilot test enables the researcher to identify and eliminate any problems that may exist

in a questionnaire (Best & Kahn, 2016) and examine the reliability and validity for measures used in the questionnaire (Yin, 2017). A pilot study is conducted with 4% - 10% of the sample population (Creswell & Clark, 2017).

Data Processing and Analysis

The generated quantitative data from the structured questionnaire. Descriptive and inferential statistics were used to analyze quantitative data after appropriate data coding. Descriptive statistics describe patterns and general trends in a data set. Descriptive statistics were used to examine or explore one variable at a time. Descriptive statistics included frequencies, percentages, mean and standard deviation. Mean is a measure of central tendency used to describe the most typical value in a set of values. Standard deviation shows how far the distribution is from the mean.

Inferential statistics were used to test the research hypotheses as they were trying to establish the associations and relationships between the independent variable) and the dependent variable. The relationship between level of the independent and dependent variables was measured using Pearson Correlation and regression analysis. This informed whether the independent variables significantly matter in influencing project success at a significance level of 0.05 thereby test the research hypotheses. Regression analysis was used to predict the value of the dependent variable on the basis of the independent variables using R square. This was also used to get regression model coefficients. Linear regression was used to test relationship between variables due to linear relationship between the variables. The following regression model was used for quantitative procedures examining the relationship between independent and dependent variables.

RESEARCH FINDINGS AND DISCUSSIONS

Descriptive Analysis

In this section Likert scale questions are presented by the study where research participants were required to tell their opinion on a number of statements concerning strategic leadership practices relates to Sustainable Road Safety in Nairobi Metropolis Transport System. The research utilized a five-point Likert scale ranked as follows, 1-strongly disagree, 2-disagree, 3-moderate, 4-agree, 5-strongly agree.

Stakeholder Involvement

To obtain information about the first independent variable Stakeholder Involvement, several statements were asked and the respondents required to provide feedback on a likert scale of one (1) to five (5), for 1 being strongly disagree, 2 being disagree, 3 being neither agree nor disagree, 4 being agree and 5 being strongly agree to the statements. On the statement "To what extent are stakeholders aware of Nairobi's road safety objectives and future plans?" 5.6% of the respondents disagreed to the statement, 23.5% of the respondents neither agreed nor disagreed to the statement, 33.78% of the respondents agreed to the statement whereas 13.1% of the respondents strongly agreed to the statement, with a mean of 3.78 and standard deviation 0.739. On the second statement "How strongly do stakeholders feel inspired by and aligned with Nairobi's road safety vision??" 19.1% of the respondents neither agreed nor disagreed to the statement, 41.0% of the respondents agreed to the statement while 38.9% of the respondents strongly agreed to the statement, with a mean of 4.21 and standard deviation 0.741. On the statement "Do stakeholders perceive a sense of belonging or ownership in achieving road safety goals?, 2.8% disagreed with the statement, 38.6% of the respondents neither agreed nor disagreed to the statement, 32.3% of the respondents agreed to the statement whereas 26.3% of the respondents strongly agreed to the statement, with a mean of 3.82 and standard deviation 0.885. Regarding the statement "The purpose of existence creates a sense of belonging amongst

Stakeholders", 13.1% strongly disagreed to the statement, 10.4% of the respondents disagreed to the statement, 23.9% of the respondents neither agreed nor disagreed to the statement, 35.5% of the respondents agreed to the statement whereas 17.1% of the respondents strongly agreed to the statement, with a mean of 3.33 and standard deviation 1.337.

On the statement "How freely do stakeholders identify with and support current road safety policies?." 8.4% strongly disagreed to the statement, 23.9% disagreed to the statement, 23.5% of the respondents neither agreed nor disagreed to the statement, 31.1% of the respondents agreed to the statement whereas 13.1% of the respondents strongly agreed to the statement, with a mean of 3.17 and standard deviation 1.178. On the statement "Is there shared commitment among stakeholders to uphold and enforce road safety measures?." 8.0% strongly disagreed to the statement, 23.9% disagreed to the statement, 26.3% of the respondents neither agreed nor disagreed to the statement, 33.5% of the respondents agreed to the statement whereas 8.4% of the respondents strongly agreed to the statement, with a mean of 3.10 and standard deviation 1.105.

Table 1: Stakeholder Involvement Frequencies

Stakeholder Involvement	**Strongly Disagree**	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**	**Mean**	**Std. Dev.**
To what extent are stakeholders aware of Nairobi's road safety objectives and future plans?	-	5.6	23.5	337.8	13.1	3.78	.739
How strongly do stakeholders feel inspired by and aligned with Nairobi's road safety vision?	-	-	19.1	41.0	38.9	4.21	0.741
Do stakeholders perceive a sense of belonging or ownership in achieving road safety goals?.	-	2.8	38.6	32.3	26.3	3.82	.885
The purpose of existence creates a sense of belonging amongst Stakeholders.	13.1	10.4	23.9	35.5	17.1	3.33	1.337
How freely do stakeholders identify with and support current road safety policies?.	8.4	23.9	23.5	31.1	13.1	3.17	1.178
Is there shared commitment among stakeholders to uphold and enforce road safety measures?.	8.0	23.9	26.3	33.5	8.4	3.10	1.105

Technology Integration

To obtain information about the first independent variable Technology Integration, numerous statements were asked and the respondents required to provide feedback on a likert scale of one (1) to five (5), for 1 being strongly disagree, 2 being disagree, 3 being neither agree nor disagree, 4 being agree and 5 being strongly agree to the statements. On the statement "To what extent are stakeholders' technical skills aligned with their roles in road safety technology implementation?" 2.0% strongly disagreed to the statement, 2.8% of the respondents disagreed

to the statement, 11.6% of the respondents neither agreed nor disagreed to the statement, 30.7% of the respondents agreed to the statement whereas 53.0% of the respondents strongly agreed to the statement, with a mean of 4.30 and standard deviation 0.922.

On the statement "How well are Nairobi's road safety technologies (e.g., surveillance systems, AI) aligned with strategic objectives?" 5.6% strongly disagreed to the statement, 7.2% of the respondents disagreed to the statement, 5.6% of the respondents neither agreed nor disagreed to the statement, 53.8% of the respondents agreed to the statement whereas 27.9% of the respondents strongly agreed to the statement, with a mean of 3.91 and standard deviation 1.058. On the statement "Are technology implementation plans (e.g., smart traffic lights, e-policing) developed collaboratively with stakeholders?, 5.6% strongly disagreed to the statement, 27.1% of the respondents disagreed to the statement, 19.1% of the respondents neither agreed nor disagreed to the statement, 27.5% of the respondents agreed to the statement whereas 20.7% of the respondents strongly agreed to the statement, with a mean of 3.31 and standard deviation 1.229.

Regarding the statement "Resource allocation is matched with the Organisation s objective.", 10.4% strongly disagreed to the statement, 2.8% of the respondents disagreed to the statement, 19.1% of the respondents neither agreed nor disagreed to the statement, 41.8% of the respondents agreed to the statement whereas 25.9% of the respondents strongly agreed to the statement, with a mean of 3.70 and standard deviation 1.188. On the statement "Are adequate resources (funding, expertise) allocated for maintaining and upgrading road safety technologies?" 21.9% strongly disagreed to the statement, 29.1% of the respondents neither agreed nor disagreed to the statement, 39.0% of the respondents agreed to the statement whereas 10.0% of the respondents strongly agreed to the statement, with a mean of 3.15 and standard deviation 1.284.

On the statement "How effectively does technology help analyze external factors (urbanization, traffic patterns) for safety planning?" 9.6% of the respondents neither agreed nor disagreed to the statement, 41.0% of the respondents agreed to the statement whereas 49.4% of the respondents strongly agreed to the statement, with a mean of 4.40 and standard deviation 0.658. On the statement "The information gathered is analyzed for the purpose of making decision" 2.8% strongly disagreed to the statement, 5.6% of the respondents disagreed to the statement, 47.8% of the respondents neither agreed nor disagreed to the statement, 29.5% of the respondents agreed to the statement whereas 14.3% of the respondents strongly agreed to the statement, with a mean of 3.47 and standard deviation 0.904. Finally, on the statement "Stakeholders are sensitive to wastage when using of available resources" 7.6% strongly disagreed to the statement, 5.6% disagreed to the statement, 17.9% of the respondents neither agreed nor disagreed to the statement, 52.6% of the respondents agreed to the statement whereas 16.3% of the respondents strongly agreed to the statement, with a mean of 3.65 and standard deviation 1.061.

Table 2: Technology Integration Frequencies

Technology Integration	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Mean	Std. Dev.
Stakeholder's skills are matched with their responsibilities.	2.0	2.8	11.6	30.7	53.0	4.30	0.922
The Organisation s systems are aligned with objectives, strategies and plans of the Organisation .	5.6	7.2	5.6	53.8	27.9	3.91	1.058
Are technology implementation plans (e.g., smart traffic lights, e-policing) developed collaboratively with stakeholders?.	5.6	27.1	19.1	27.5	20.7	3.31	1.229
Is resource allocation for road safety technology (e.g., sensors, data platforms) matched with Nairobi's safety priorities?.	10.4	2.8	19.1	41.8	25.9	3.70	1.188
Are adequate resources (funding, expertise) allocated for maintaining and upgrading road safety technologies?	21.9	-	29.1	39.0	10.0	3.15	1.284
How effectively does technology help analyze external factors (urbanization, traffic patterns) for safety planning?.	-	-	9.6	41.0	49.4	4.40	0.658
Is collected road safety data (e.g., accident reports, traffic flow) systematically analyzed using technology?	2.8	5.6	47.8	29.5	14.3	3.47	0.904
Do stakeholders demonstrate efficient use of technological resources to minimize wastage?	7.6	5.6	17.9	52.6	16.3	3.65	1.061

Correlation Analysis

Correlation analysis identified the existence or otherwise of relationship between Sustainable Road Safety in Nairobi Metropolis Transport System and all the other variables. Pearson Product Moment Correlation coefficient was used, the correlation coefficient (r) was used to establish whether there was linear relationship between the variables of interest in the study. The coefficient of determination (r^2) was used to check for goodness - of - fit. The value of r ranges between -1 and +1, r = 0 implies no correlation, r = 1 means perfect correlation.

Table 3: Correlation matrix for all variables

		Y	X_1	X_2
Y	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	337		
X_1	Pearson Correlation	.653**	1	
	Sig. (2-tailed)	0		
	N	337	337	
X_2	Pearson Correlation	.763**	.598**	1
	Sig. (2-tailed)	0	0	
	N	337	337	337

From table 3, there is a positive significant relationship between Sustainable Road Safety in Nairobi Metropolis Transport System and Stakeholder Involvement. The Pearson's correlation coefficient was 0.653, p-value <0.001. This implied that 65.3% of Sustainable Road Safety in Nairobi Metropolis Transport System in Kenya is explained by Stakeholder Involvement.

Likewise, there was a strong positive significant relationship between Sustainable Road Safety in Nairobi Metropolis Transport System and Technology Integration, with a Pearson's correlation coefficient of 0.763 and a p-value<0.001, implying that 76.3% of Sustainable Road Safety in Nairobi Metropolis Transport System in Kenya is explained by Technology Integration.

Regression Analysis

To determine how strategic leadership practices affects Sustainable Road Safety in Nairobi Metropolis Transport System, the study computed multiple regression analysis. The results were placed on three tables presented and discussed in coming subsections.

Table 4: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.936[a]	.877	.868	.033767

a. Predictors: (Constant), stakeholder involvement and technology integration

According to the results presented in Table 4, the value of R square is 0.877. This shows that 87.7% difference in financial performance can be credited to these changes in stakeholder involvement and technology integration. The remaining 12.3% suggests other factors exist that are helpful in explaining variation in Sustainable Road Safety in Nairobi Metropolis Transport System excluded in this study.

Table 5: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1.233	2	.617	617	.000[b]
	Residual	.173	334	.001		
	Total	1.406	336			

a. Dependent Variable: Sustainable Road Safety in Nairobi Metropolis Transport System
b. Predictors: (Constant), stakeholder involvement and technology integration

From the findings in Table 5, the significance of 0.000 is below the chosen significance level of 0.05, meaning it can be considered significant. These results prove that the F-calculated value (617) was above the F-critical value ($F_{2,335}$= 3.022); this insinuates that the variables, stakeholder involvement and technology integration can be used to predict Sustainable Road Safety in Nairobi Metropolis Transport System.

Table 6: Beta Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.347	0.258		5.221	.000
	Stakeholder Involvement	0.347	0.103	0.439	3.369	.001
	Technology Integration	0.338	0.138	0.402	2.449	.018

a. Dependent Variable: Sustainable Road Safety in Nairobi Metropolis Transport System

This regression equation model was used to fit the regression coefficient.

$Y = 1.347 + 0.347 X_1 + 0.338 X_2 +$ v

Observing the equations, it can be noted that when all the other variables (stakeholder involvement and technology integration s) remain at constant zero, a constant value of 1.347 was held by the Sustainable Road Safety in Nairobi Metropolis Transport System.

The results depict strategic leadership practices significantly impacting Sustainable Road Safety in Nairobi Metropolis Transport System (β=0.347, p=0.001). These results insinuate that Stakeholder Involvement is significantly influences Sustainable Road Safety in Nairobi Metropolis Transport System in a positive way. Meaning, a unit rise in strategic leadership practices leads to a rise in Sustainable Road Safety in Nairobi Metropolis Transport System, by 0.347 units.

Technology Integration has an influence on Sustainable Road Safety in Nairobi Metropolis Transport System (β=0.338, p=0.018). The studies also revealed that decision-making procedures on investment had a desirable impact on Sustainable Road Safety in Nairobi Metropolis Transport System. These findings imply that investing decision-making procedures exhibit a favourable impact on Sustainable Road Safety in Nairobi Metropolis Transport System. As a result, a unit increase in Technology Integration processes leads to a 0.338 unit rise in the Sustainable Road Safety in Nairobi Metropolis Transport System. The study's findings accord with Mweresa (2018) that investment in manufacturing has a huge effect on a company's Sustainable Road Safety in Nairobi Metropolis Transport System.

Conclusion

The study concludes that stakeholder involvement has a positive and significant influence on Sustainable Road Safety in Nairobi Metropolis Transport System. Findings revealed that multi-agency collaboration and transparency and accountability influence Sustainable Road Safety in Nairobi Metropolis Transport System.

Further, the study concludes that technology integration has a positive and significant influence on Sustainable Road Safety in Nairobi Metropolis Transport System. Findings revealed that technology adoption rates and institutional tech capacity influences Sustainable Road Safety in Nairobi Metropolis Transport System.

Recommendations

The study recommends that the managements of sustainable road safety in Kenya should establish multi-stakeholder road safety committees at both county and metropolitan levels. These committees should include representatives from government agencies, traffic police, public transport operators, civil society organizations, urban planners, and local communities.

In addition, the study recommends that the managements of sustainable road safety in Kenya should deploy Intelligent Transport Systems (ITS), particularly through real-time traffic monitoring and automated enforcement tools. Installing smart traffic cameras, speed detectors,

and traffic signal control systems at major intersections and accident-prone areas can help monitor driver behavior, enforce traffic laws more consistently, and manage traffic flow efficiently.

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