IOSR Journal of Business and Management (IOSR-JBM)
e-ISSN:2278-487X, p-ISSN: 2319-7668. Volume 27, Issue 3. Ser. 8 (March. 2025), PP 01-10
www.iosrjournals.org

The Impact Of Infrastructure Bond Yields On Road Infrastructure Development: Evidence From Nairobi Metropolitan Region, Kenya

Roselyn Anyango Aoko
Dr. Fredrick W.S. Ndede
Dr. Jennifer G. Njaramba

Abstract
Infrastructure bonds are crucial for funding large-scale infrastructure initiatives, such as road construction, energy systems, and public transportation networks. Consequently, infrastructure bond yields represent the returns that investors receive for purchasing bonds issued by governments or corporations to finance infrastructure projects. They also represent the bond's risk and return profile. This study sought to find out the effect of the Infrastructure bond yields on the performance of road projects in Nairobi Metropolitan Area, Kenya. The research employed a longitudinal research design to effectively address its objectives. The study population encompassed 18 road construction projects conducted between 2014 and 2022 in the area. Panel data for the bonds and projects performance were compiled from the Central Bank of Kenya; National Treasury; Ministry of Transport and Infrastructure, as well as the Kenya Urban Roads Authority. Data was analysed using descriptive statistics and inferential statistics aided by STATA ver.14.0. The findings of this study reveal a significant relationship between infrastructure bond yields and the performance of road projects in the Nairobi Metropolitan Region. Higher bond yields are associated with delays in project completion, suggesting that increased borrowing costs may restrict infrastructure financing, ultimately hindering progress in road development. Government agencies should implement policies that stabilize infrastructure financing costs, such as tax incentives for infrastructure bonds, improved public-private partnerships, and innovative funding mechanisms to enhance road project completion rates.

Keywords: *Infrastructure Bonds, Yields, Road Projects, Nairobi Metropolitan Area*

Date of Submission: 06-03-2025 Date of Acceptance: 16-03-2025

I. Introduction

Infrastructure development is essential for driving a nation's economic growth and social progress. This encompasses the creation and maintenance of critical systems such as roads, railways, airports, and telecommunication networks, all of which contribute to lowering transportation costs and improving accessibility (World Bank, 2012). However, the implementation of these large-scale projects often faces significant challenges, particularly regarding resource scarcity and funding (Munyoki, 2018). Consequently, one of the most pressing issues in completing infrastructure projects is allocating limited financial resources (Theyel & Theyel, 2023). Therefore, effective project financing planning and seeking sustainable financing options becomes imperative. For infrastructure projects, a number of funding options are available, including grants, government budgets, corporate bank loans, equity financing, debt financing, bonds, and debt financing. (Brixiová, Kangoye & Yogo, 2020). Furthermore, recent surveys indicate a shifting perspective on infrastructure, considering it as an independent asset class with an anticipated significant increase in allocation (Gupta & Sharma, 2022). Consequently, alternative and innovative funding methods like infrastructure project bonds have gained prominence and are now being considered for implementation (Haasnoot et al., 2020).

There has been an increased emphasis on infrastructure project bonds due to the usual characteristics of physical infrastructure projects, which frequently require significant and long-term funding in a blend of local and foreign currencies. These bonds, often referred to as revenue bonds or specific-purpose bonds, have drawn interest as a viable financial product in local currency bond currency and as a way to finance private infrastructure (Ahwireng-Obeng & Ahwireng-Obeng, 2019). However, the performance of the infrastructure bonds depends on among other things, the bond yield. Infrastructure bond yields represent the returns that investors receive for purchasing bonds issued by governments or corporations to finance infrastructure projects (Kumar, 2022). These bonds are crucial for funding large-scale infrastructure initiatives, such as road construction, energy systems, and public transportation networks. The yields reflect the bond's risk and return profile, with higher yields generally indicating higher perceived risk or a greater financing need (Li, Abraham, & Cai, 2017). Understanding the impact

of infrastructure bond yields on road infrastructure projects is vital for evaluating their effectiveness in financing development globally.

In North America, particularly in the United States, infrastructure bonds have become an essential tool for financing transportation infrastructure. Bonds such as those issued by the Highway Trust Fund (HTF) have been a primary source for funding road projects. Yields on infrastructure bonds in the U.S. have fluctuated with economic conditions, often increasing during periods of uncertainty or financial instability (Mallett, 2019). For example, a higher yield on infrastructure bonds could be seen when the government or municipal entities are perceived to have a higher risk of default. However, the U.S. bond market, especially municipal bonds, has been stable due to the government's backing, with tax exemptions further enhancing the appeal of these bonds (Owusu-Manu et al., 2020). The challenge here lies in the rising infrastructure funding gap, with estimates indicating a need for over $1 trillion in the next decade to maintain and upgrade U.S. infrastructure (Yoshino & Stillman, 2018). While bonds offer an attractive financing option, the high cost of capital and the increasing reliance on state and local governments can limit the overall impact on road infrastructure development.

In the European Union (EU), infrastructure bonds have similarly supported large-scale road construction projects, particularly through Public-Private Partnerships (PPPs). The Project Bond Initiative (PBI), introduced by the European Commission in 2013, aimed to boost private investment in infrastructure by offering credit enhancements (Mosionek-Schweda, 2016). The yields on these bonds are closely tied to market conditions, but they have played a significant role in creating bond markets that rival those in Asia (Hyun et al., 2017). In countries like the UK, low-interest rates have made infrastructure bonds more attractive, encouraging private sector participation. However, challenges remain, such as the high administrative costs associated with bond issuance and the complexity of managing PPP agreements (Reinhardt, 2011). Moreover, while the EU has made progress in utilizing infrastructure bonds, there remains a gap in the coverage of projects, especially in Eastern European countries, where infrastructure deficits are more pronounced (Ribberink & Schubert, 2020).

In Asia, infrastructure bond markets have grown significantly, particularly in countries like China and India, where the need for infrastructure investment is urgent. The Asian Bond Markets Initiative (ABMI), established in 2003, has fostered the development of local currency bonds to finance long-term infrastructure projects (Ng & Tao, 2016). This initiative has allowed countries to reduce their dependence on foreign currency-denominated bonds, lowering the risk of exchange rate fluctuations. However, bond yields in Asia have varied significantly, influenced by global economic shifts and local political stability. In China, for instance, the yield on infrastructure bonds has been relatively low due to the state's strong backing of such projects, but concerns about local government debt and over-leveraging have raised questions about the sustainability of this financing model (Liu et al., 2022). While bond financing has expanded in Asia, a significant gap remains in the ability of local currency bonds to cover the growing infrastructure needs, particularly in developing countries like Indonesia and the Philippines, where infrastructure deficits are critical (Hyun et al., 2017).

In Africa and Kenya, the use of infrastructure bonds has been pivotal in financing road projects, though challenges persist. The African Development Bank (ADB) has projected a $360 billion funding requirement for infrastructure by 2040, with a significant portion of this figure relying on domestic financing (African Union Commission et al., 2021). The yields on African infrastructure bonds have been higher than those in more developed regions due to perceived risks, such as political instability and currency depreciation. For instance, Kenya's infrastructure bonds, which have been used to fund road networks and energy projects, have seen yields of around 12% (Mugwe, 2011). These bonds, while offering high returns for investors, have also created challenges, such as rising public debt and the slow pace of project completion. The Nairobi Metropolitan Region, for example, has seen numerous road projects delayed or abandoned due to insufficient funding and delays in bond issuance (Mbewa et al., 2007). Additionally, countries like South Africa and Nigeria have increasingly relied on sovereign bonds to finance infrastructure, but competition for capital between sovereign issuers and other organizations often creates challenges in maintaining sustainable financing levels (Mukoki et al., 2023). A critical gap in Africa is the underdeveloped local bond markets, which hinders access to long-term financing for infrastructure projects, ultimately limiting growth and development.

Infrastructure bond yields, therefore, play a significant role in financing road infrastructure projects worldwide, but the challenges and gaps in their utilization are apparent across various regions. North America and Europe have relatively mature markets, though funding gaps and inefficiencies remain. In Asia, China and India have made strides in utilizing local currency bonds, but more work is needed in emerging markets. Africa and Kenya, despite high yields on bonds, continue to face barriers such as insufficient local financing options and the risk of political instability.

Kenya has also turned to infrastructure bonds to support its development goals. The government issued its first infrastructure bond in 2009 to finance key projects, including roads and geothermal energy (Mugwe, 2011). In 2022, a seven-year infrastructure bond raised Sh220.5 billion, well exceeding its target, reflecting the growing investor confidence in such instruments. However, despite these efforts, Kenya faces significant infrastructure challenges, with large portions of its road network still unpaved and many projects delayed or

incomplete due to inadequate funding (Adeniran, 2019). The country has a financing shortfall of over $1.8 billion, with the World Bank estimating that Kenya will need to invest nearly $4 billion annually for the next decade to meet its infrastructure requirements (World Bank, 2023). The Kenyan government has increasingly relied on debt, including treasury and infrastructure bonds, to meet its financing needs. However, the sustainability of this approach is in question, with the country's credit rating at B and a negative outlook (Standard & Poor's, 2023). Several studies have explored infrastructure financing in Kenya, but few have specifically examined the impact of infrastructure bond yields on road project performance. This gap in the literature presents an opportunity to investigate how infrastructure bond yields affect the completion and efficiency of road infrastructure projects, particularly in the Nairobi Metropolitan Region.

II. Problem Statement

Infrastructure development is a fundamental driver of economic growth and social progress, contributing significantly to improving accessibility, reducing transportation costs, and enhancing overall connectivity (World Bank, 2012). However, the financing of large-scale infrastructure projects often faces significant challenges, particularly regarding resource scarcity and the availability of funding (Munyoki, 2018). These challenges are exacerbated by the increasing demand for infrastructure investment across both developed and developing countries. In Kenya, for instance, despite the issuance of infrastructure bonds, substantial road network portions remain unpaved, and many critical projects continue to face delays due to funding constraints (Adeniran, 2019). As of 2023, Kenya faces a $1.8 billion financing shortfall, with an estimated annual investment need of $4 billion to meet its infrastructure requirements (World Bank, 2023). Although infrastructure bonds have emerged as a key funding solution, the relationship between bond yields and the performance of road infrastructure projects remains underexplored, especially in the context of Kenya's Nairobi Metropolitan Area (NMA).

Infrastructure bonds, particularly those issued for road projects, have garnered attention for their potential to address funding gaps by offering long-term investment opportunities. However, these bonds' yields, which reflect the associated risks, play a crucial role in determining the success of financing strategies. Higher yields typically signal higher financial risks, which may discourage investment or inflate borrowing costs, potentially hindering the completion and efficiency of infrastructure projects (Ahwireng-Obeng & Ahwireng-Obeng, 2019). While several studies have examined infrastructure financing in Kenya, the specific impact of bond yields on the performance of road infrastructure projects, especially in the Nairobi Metropolitan Area (NMA), remains a gap in the literature. Research on this topic is crucial as Kenya continues to rely on bond issuance to finance its infrastructure goals, such as the development of 5,681 kilometers of critical road improvements under Vision 2030.

The NMA, home to many of Kenya's most important infrastructure projects, faces severe challenges related to delayed payments, budget constraints, and fluctuating bond yields, leading to cost overruns and stalled projects. Out of the 939.6 kilometers of road construction projects valued at 162.4 billion shillings, only 10.6% were completed in 2021, with several projects either abandoned or stalled (Mugwe, 2011). These issues raise questions about how bond yields influence the timely completion and efficiency of road infrastructure projects in Kenya. Understanding this relationship can provide valuable insights for policymakers and infrastructure planners, enabling them to develop more effective financing strategies and enhance the sustainability of infrastructure development. Thus, the research aimed to explore how infrastructure bond yields affect the performance of road infrastructure projects in the NMA, addressing the gaps in both policy and academic research.

Objectives

To find out the effect of the Infrastructure bond yields on the performance of road projects in Nairobi Metropolitan Region, Kenya.

Hypothesis

H_{02}: Infrastructure bond yields has no significant effect on the performance of road projects in Nairobi Metropolitan Region, Kenya.

III. Literature Review

This literature review explores the role of infrastructure bonds in financing infrastructure projects. It examines trends, challenges, and gaps in infrastructure bond yields, particularly their impact on project performance and sustainability from both theoretical and empirical perspectives.

Theoretical Framework

Debt Overhang Theory

Debt Overhang Theory, developed by Myers (1977), asserts that a country or firm with excessive debt may struggle to attract further investment, even if new investments would yield positive returns. This is because

the value of any new investment primarily benefits existing creditors rather than equity holders. The theory suggests that when a government or corporation has accumulated significant debt, it is less able to raise additional funds for new projects due to the risks associated with high debt levels, which may lower the expected return on investment. In the context of infrastructure, this theory implies that excessive borrowing for infrastructure projects may deter future investment, leading to underinvestment in critical infrastructure such as roads.

The theory operates under several key assumptions. First, it assumes that debt levels are high enough to hinder future borrowing. Second, investors, particularly in highly indebted environments, are generally risk-averse, demanding higher returns to compensate for the increased risk. Lastly, the theory assumes economic uncertainty, where the ability to generate returns from new investments is reduced due to the existing debt burden. In the bond market, Debt Overhang Theory suggests that countries or corporations with high debt may face elevated borrowing costs, as investors demand higher yields to compensate for the perceived risks associated with lending. This can be particularly problematic for infrastructure projects, where long-term funding is essential. High debt levels may push up bond yields, making it more expensive for governments to finance infrastructure projects.

However, the theory has been critiqued for oversimplifying the relationship between debt and investment. Some scholars, such as Krugman (1988), argue that debt overhang may not always impede investment, especially when institutional frameworks are strong or when there is a clear path to debt reduction. Furthermore, the theory assumes that all creditors have an equal claim on future revenues, which may not always be the case in practice. In the Kenyan context, Debt Overhang Theory can be applied to evaluate how rising debt levels and the resulting bond yields impact the financing of road infrastructure projects. The government's increasing debt burden, particularly in the face of critical infrastructure needs, may hinder the ability to secure affordable financing for road development. This could lead to delays, cost overruns, and ultimately, suboptimal infrastructure outcomes. By applying Debt Overhang Theory, policymakers can gain insights into how to balance debt levels with investment in infrastructure, ensuring that road projects can be financed without exacerbating the national debt crisis.

Efficient Market Hypothesis (EMH)

The Efficient Market Hypothesis (EMH), introduced by Fama (1965), posits that financial markets are informationally efficient, meaning that asset prices always fully reflect all available information. According to EMH, it is impossible for investors to consistently outperform the market because any new information is rapidly incorporated into asset prices, ensuring that they always reflect the true value of the underlying assets. In the context of infrastructure bonds, EMH suggests that bond yields are determined by the prevailing market conditions, including economic indicators, government policies, and investor sentiment, and that these yields reflect the full spectrum of available information.

EMH operates under several key assumptions. It assumes that markets are competitive and that all relevant information is available to all participants. Additionally, it assumes that investors are rational, making decisions based on the best available information. Lastly, it assumes that asset prices adjust quickly to new information, eliminating any opportunity for investors to achieve superior returns by using publicly available information. In the bond market, EMH implies that bond yields are always reflective of the current economic and financial environment. For example, if a government issues infrastructure bonds, the yields will adjust according to the available information about the country's fiscal health, economic growth prospects, and other relevant factors. Bond investors, in this framework, cannot expect to outperform the market consistently because the yields reflect all the relevant data.

However, EMH has been subject to criticism. Behavioral economists, such as Shiller (2000), argue that markets are not always rational and that investor behavior, including overreactions and underreactions, can lead to inefficiencies. Additionally, EMH assumes that all market participants have access to the same information, which is not always the case in practice. Information asymmetries can exist, with some investors having access to more or better information than others, undermining the hypothesis's validity. In Kenya, the application of EMH can be used to assess how infrastructure bond yields are determined by available information about the country's fiscal policies, economic growth, and other relevant factors. If the Kenyan bond market operates efficiently, the yields on infrastructure bonds will reflect these factors accurately, and investors will make informed decisions based on the available data. However, if the market is inefficient, bond yields may not fully reflect the true cost of financing infrastructure projects, leading to either excessive borrowing costs or underpricing of bonds. This could have significant implications for the financing of road infrastructure projects, as inaccurate bond yields could lead to misallocation of resources, delays, or cost overruns.

Infrastructure bond yields and performance of projects

Infrastructure bond yields represent the effective annual return earned by an investor who holds an infrastructure bond until maturity (Humphrey, 2020). These yields are influenced by various factors, including

the bond's interest rate, current market price, and maturity date. When individuals invest in infrastructure bonds, they provide funding to the issuer—typically a government or corporation—in return for the principal amount and periodic interest payments upon maturity. The relationship between financing costs and project outcomes highlights how crucial bond yields are in determining the success of infrastructure projects, particularly road projects. Higher bond yields may increase the cost of borrowing, affecting the financial viability of road projects (Smith et al., 2020; Johnson & Lee, 2018). As bond rates rise, bond prices fall, making capital more expensive for issuers and potentially delaying or diminishing the quality of road projects. Conversely, lower bond yields make borrowing more affordable, enabling projects to secure financing at more favorable terms. Therefore, the yield of infrastructure bonds plays a pivotal role in managing the costs and performance of road projects, influencing their overall outcomes.

A study by Anderson and Sundaresan (2020) explored the link between a nation's environmental, social, and governance (ESG) performance and its sovereign cost of borrowing on global capital markets. Their research found that countries with better ESG performance tend to have smaller sovereign bond yield spreads and lower default risks. Specifically, the social and governance components of ESG were strongly negatively correlated with bond yield spreads. This suggests that nations with stronger ESG credentials are able to borrow at lower costs, reflecting the market's confidence in their long-term sustainability. Research on corporate bonds, such as that by Altman (2019), also emphasizes the importance of bond yields. His study, focused on measuring corporate bond mortality and performance, found that riskier bonds—such as BB-rated securities—can offer better returns over time, despite higher default risks. This demonstrates that bond performance can vary widely based on risk levels and market conditions, underlining the complexity of using bonds as a funding mechanism for infrastructure.

Silva, Cortez, and Armada (2023) analyzed European bond funds to determine the factors predicting bond returns. Their study found that while bond funds did not outperform passive strategies, adding more risk factors could improve performance evaluations. This suggests that infrastructure bonds' performance, like other bond markets, can benefit from a more comprehensive approach to risk analysis and financial modeling. The role of social capital in bond performance was explored by Amiraslani et al. (2023), who examined the relationship between firms' social capital and bond spreads. Their findings revealed that during times of financial instability, firms with high social capital—measured through strong environmental and social performance—were able to issue more debt with lower spreads. This indicates that firms with positive reputations in social and environmental matters can potentially access cheaper financing, which is crucial for infrastructure projects that rely on bond issuance.

In a different context, Partridge and Medda (2020) compared the performance of U.S. green municipal bonds with traditional municipal bonds. Their study found that green bonds, representing environmentally friendly infrastructure projects, outperformed traditional bonds between 2014 and 2018. By 2018, a "green premium" emerged, indicating that investors were willing to accept slightly lower returns for the benefit of supporting sustainable infrastructure. This highlights how bond yields can be influenced by market preferences for sustainability, which may become a more significant factor in infrastructure bond performance. Choi and Kronlund (2018) explored how the "reaching for yield" strategy affects U.S. corporate bond mutual funds. Funds that seek bonds with higher yields typically perform better in terms of returns, especially in low interest rate environments. However, this strategy also leads to greater risks, including lower liquidity and poor risk-adjusted returns. This behavior is relevant to infrastructure bonds, as issuers may opt for higher-yielding bonds, potentially increasing the financial burden of infrastructure projects if not carefully managed.

These studies collectively show that infrastructure bond yields are influenced by a range of factors, including market conditions, investor preferences, and the broader economic environment. Understanding these dynamics is crucial for evaluating the financial sustainability and performance of road projects, particularly in regions like Kenya, where infrastructure bonds play a central role in financing development. In the Kenyan context, there is a research gap in understanding how infrastructure bond yields specifically impact road project performance, given the unique financing challenges the country faces. Exploring this gap using panel regression analysis could shed light on the relationship between bond yields, the financial viability of road projects, and their timely completion across different regions. Additionally, investigating the influence of factors such as government policies, macroeconomic conditions, and project management efficiency on bond performance in Kenya's infrastructure sector remains underexplored. These insights could help policymakers optimize financing strategies for sustainable infrastructure development in the country.

IV. Materials And Methods

A positivist research philosophy was chosen for this study because it primarily relied on empirical knowledge derived from objective observation. Positivism emphasizes the use of data collected and interpreted in an unbiased and objective manner (Saunders,Lewis &Thornhill, 2012).

Research Design

This study employed a longitudinal panel research design, chosen for its capability to assess relationships between variables over time. The panel regression model is the chosen approach, given its suitability for handling panel data, which aligns with the data structure envisioned for this research. Employing this research design facilitated the formulation of hypotheses, which in turn enhanced the comprehension of the relationship between the variables under investigation.

Target Population of the study

The study's population consisted of all 61 road construction projects conducted in the Nairobi Metropolitan Area between 2014 and 2022. The research concentrated on 18 (30%) out of the 61 road construction projects that have been financed through infrastructure bonds. This time frame was considered appropriate for the study as it spans a significant duration and encompasses key events that could influence bond prices, such as political instability. The study identified a total of 61 road construction projects that were executed within the Nairobi Metropolitan Region during this specified period. Data was collected using a data collection sheet.

Data Analysis and Presentation

Since endogeneity is a concern in this context (e.g., potential reverse causality or omitted variable bias), the System Generalized Method of Moments (GMM) can be used to provide consistent estimates. GMM can address potential endogeneity by using lagged values as instruments for endogenous variables. Thus, the panel GMM specification was specified as:

$$Y_{18,8} = \alpha + \beta_1 X_{18,8} + \gamma_8 + \lambda_{18} + \varepsilon_{18,8}$$

Where:

Y_{it} is the dependent variable representing road project performance (e.g., completion rate, cost efficiency, etc.) for road project *i* at time *t*.

X_{it} is the independent variable of interest, which is the infrastructure bond yield for road project *i* at time *t*.

γ_t is the time-specific effect, capturing unobserved factors that vary across time but are constant for all projects (e.g., macroeconomic conditions).

λ_i is the individual (project) specific effect, capturing unobserved factors that vary across road projects but are constant over time (e.g., institutional factors specific to each project).

ϵ_{it} is the error term.

Where lagged values of X_{it} (infrastructure bond yields) may serve as instruments to address potential endogeneity.

V. Results

Descriptive Statistical Analysis

This study analyzed the relationship between infrastructure bond yields and road project performance in the Nairobi Metropolitan Region (NMR) over an eight-year period (2014 to 2022). The analysis focused on 18 completed road construction projects, representing 30% of the total projects in the NMR, with an additional focus on the mediation effect of economic uncertainty on this relationship. To ensure adequate degrees of freedom for the model estimations, annual data covering the entire study period was collected. However, four road construction projects exhibited unbalanced panels, leading to their exclusion from the final analysis. As a result, the study included 14 completed road projects, accounting for 23% of the total, in the final analysis.

Table 1: Descriptive Statistics Results

Variable	Mean	Max	Min	Std.Dev.	Skew	Kurt	Sum	Jarque-Bera	Prob.
BY (%)	12.1129	13.938	10.2	0.972522	-0.11045	-0.55042	254.371		
KC	182.4378	250.8	100.5	55.25772	-0.28862	-1.82055	1641.94		
Ln_BY	2.494271	-0.02786	2.6346	2.322388	-0.59262	-0.10262	-0.40919	4.860292	0.086210
Ln_KC	5.154556	5.52466	4.6102	0.331848	-0.51461	-0.11461	-1.00419	5.362026	0.061146

The descriptive statistics for infrastructure bond yield (BY) and kilometers of road completed (KC) in Table 1 reveal key distributional characteristics that may influence their relationship. The average BY stood at 12.11%, with a moderate deviation (0.97) and a range of 10.2% to 13.94%. The distribution was slightly left-skewed (-0.11045) and platykurtic (-0.55042), indicating a flatter shape than normal. Similarly, KC had an average of 182.44 kilometers, with a standard deviation of 55.26, ranging between 100.5 and 250.8 kilometers. The distribution of KC was more left-skewed (-0.28862) and significantly platykurtic (-1.82055), suggesting the presence of fewer extreme values. These results imply that while bond yields have shown relative stability, road completion has exhibited wider variability, which may be linked to funding availability, project timelines, and external factors such as regulatory approvals and construction efficiency.

Applying the natural logarithm transformation (Ln_BY and Ln_KC) improved normality, as indicated by the Jarque-Bera (JB) tests. The p-values of 0.0862 for Ln_BY and 0.0611 for Ln_KC suggest that the transformed variables are approximately normal, making them suitable for regression analysis. The potential implication of bond yields on road completion can be analyzed from a financial perspective—higher yields may indicate increased borrowing costs, which could slow project completion due to rising debt servicing obligations. Conversely, moderate and stable yields may encourage infrastructure investment by ensuring favorable financing conditions. The variability in KC suggests that road completion may not solely depend on bond yields but also on budgetary allocations, government policy, and project execution efficiency. This highlights the need for sustainable financing mechanisms to ensure consistent infrastructure development without excessive reliance on fluctuating bond yields.

Inferential Analysis

Diagnostic Tests

For regression analysis it is necessary to carry out diagnostic tests. The test carried out include: Test of Normality and Test for Stationarity -Unit Root Test. The Jarque-Bera test was conducted to assess the normality of Ln_BY and Ln_KC and the results are shown in Table 1. The test statistics for Ln_BY (JB = 4.8603, p = 0.0862) and Ln_KC (JB = 5.3620, p = 0.0611) were both below the critical value of 5.991 at the 5% significance level. As a result, we failed to reject the null hypothesis of normality for both variables, indicating that their distributions do not significantly deviate from normality. Therefore, from the results, it is evident that all the variables were normally distributed and further interpretation of the data was not expected to be affected by lack of normality.

To assess the stationarity of the variables, the Levin, Lin, and Chu (LLC) panel unit root test was conducted. The results for the two key variables, "Road Kilometers Completed" and "Bond Yields," are presented in Table 2.

Table 2. Panel Unit Root Test

Variable	Statistic	Prob.**	Cross Sections	Obs
Road Kilometers Completed	-8.93338	0.0000	12	56
Bond Yields	-3.41253	0.0005	13	56

Road Kilometers Completed: The LLC test statistic is -8.93338, with a corresponding p-value of **0.000**. This result strongly rejects the null hypothesis of a unit root, indicating that the series for road kilometers completed is stationary at the 1% significance level.

Bond Yields: The LLC test statistic is -3.41253, with a p-value of 0.0005. This also leads to the rejection of the null hypothesis of a unit root, suggesting that bond yields are stationary at the 5% significance level.
Both variables were found to be stationary, as evidenced by the highly significant test statistics and p-values.

Panel Data Model Selection and Suitability Tests

This study aimed to assess the impact of infrastructure bond yields on the performance of road projects in the Nairobi Metropolitan Area, Kenya, using a panel regression approach. The analysis was conducted over an eight-year period (2014 to 2022), utilizing Ordinary Least Squares (OLS) methodology with panel data to capture both cross-sectional and time-series variations. To ensure robust statistical inference, annual data for the full study period was collected, providing sufficient degrees of freedom for the model estimations. Given the potential for endogeneity concerns, the study employed panel data estimators based on the System Generalized Method of Moments (GMM), which allows for more accurate inferences in the absence of natural experiments or external instruments.

The Common Effects model was excluded from the analysis due to theoretical considerations regarding the bond market. To determine the most appropriate model between fixed effects and random effects, the Hausman specification test was used. Based on the results of this test, the study selected the random effects model, which was deemed the most efficient for the data at hand. This approach ensures a comprehensive understanding of the relationship between bond yields and infrastructure project performance.

Hypotheses testing of Infrastructure Bond Interest Rates

The null hypothesis of this study (H01) posited that Infrastructure Bond Yields has no significant impact on the on completion of roads in kilometer in the NMR. Consequently, the H1 suggested that infrastructure bond yields exert a significant impact on the number of kilometers of road completed in the NMR. To the test this hypothesis, a regression analysis was carried out and the results presented in the Table 3.

Table 3 Panel Regression Equation

Variable	Coefficients	Std.Error	t-statistic	Prob.
Ln_BY	-0.212	0.066	-3.21212	0.000337
C	-3.785	1.443	-2.62301	0.004790
	Effects Specification			
			SD	Rho
Cross-section random			0.512902	0.6290
Idiosyncratic random			0.403361	0.3301
	Weighted Statistics			
R-Squared	0.20413	Mean dependent var.		-0.51722
Adjusted R-Squared	0.17576	SD dependent Var.		0.423446
SE of Regression	0.4114	Sum squared redid		10.1714
F-statistic	6.250459	Durbin-Watson stat.		2.416
Prob.(F-statistic)	0.015372			

The regression results examine the relationship between infrastructure bond yields (Ln_BY) and kilometers of road completed (Ln_KC) using a random effects panel model. The coefficient of Ln_BY (-0.212) indicates a negative relationship, suggesting that an increase in bond yields is associated with a decline in road completion. This result aligns with economic theory—higher borrowing costs can reduce infrastructure investment by making debt financing more expensive for governments and project developers. The coefficient is highly statistically significant ($p = 0.000337$, $p < 0.01$), meaning the impact of bond yields on road completion is unlikely to be due to chance. The intercept ($C = -3.785$, $p = 0.00479$) is also significant, representing the baseline level of road completion when bond yields are minimal or absent.

Despite the strong significance of bond yields, the model's R-squared value (0.20413) suggests that only 20.4% of the variation in road completion is explained by bond yields alone, implying that other factors—such as budget allocations, policy frameworks, efficiency of project execution, and external economic conditions—also play a critical role. The F-statistic (6.25, $p = 0.0154$) confirms that the model is statistically valid overall. Additionally, the Durbin-Watson statistic (2.416) suggests minimal autocorrelation, strengthening the reliability of the estimates. The random effects specification reveals that cross-sectional differences (SD = 0.5129, Rho = 0.6290) account for more variance than idiosyncratic factors (SD = 0.4034, Rho = 0.3301), indicating that regional or time-specific effects significantly influence road completion rates. The results highlight the negative impact of rising bond yields on road infrastructure development. The findings suggest that while bond yields impact road project completion, a multi-faceted approach involving stable financing, efficient fund allocation, and improved governance is essential to ensure sustainable infrastructure development. Policymakers should ensure stable financing conditions to minimize borrowing costs and enhance road project completion.

The hypothesis test examined the impact of infrastructure bond yields on road project performance in Nairobi Metropolitan Region, Kenya. The regression results indicated a negative and statistically significant relationship between bond yields (Ln_BY) and road completion, with a coefficient of -0.212 and a p-value of 0.000337. At a 5% significance level, the null hypothesis (H_0), which stated that infrastructure bond yields have no significant effect on road project performance, was rejected in favor of the alternative hypothesis (H_1). The highly significant t-statistic (-3.21212) further confirmed this finding, indicating that as bond yields increase, the kilometers of roads completed decline, likely due to rising borrowing costs constraining infrastructure investment. These results underscore the importance of stable and affordable financing mechanisms to support sustainable road development in the region.

Discussions

The findings can be linked to the Efficient Market Hypothesis (EMH) by Fama (1960) and the Debt Overhang Theory by Myers (1977). According to EMH, financial markets reflect all available information, meaning that bond yields adjust to macroeconomic conditions, investor expectations, and government creditworthiness. If markets are efficient, rising bond yields could signal increased sovereign risk or inflation expectations, leading to higher borrowing costs for infrastructure projects. This aligns with the study's findings, where higher bond yields negatively impacted road completion, likely due to costlier debt financing. On the other hand, Myers' Debt Overhang Theory suggests that excessive debt burdens limit new investment because potential returns primarily benefit existing creditors rather than project initiators. In this context, if rising bond yields indicate higher debt burdens, governments may face reduced fiscal space, discouraging further infrastructure investments. The results support this theory, showing that increased bond yields hinder road completion, suggesting that high debt servicing costs constrain public infrastructure expansion. This underscores the need for prudent debt management and innovative financing models to sustain infrastructure development.

The study's results align with existing literature on the relationship between bond yields, macroeconomic stability, and infrastructure financing. Ahwireng-Obeng and Ahwireng-Obeng (2019) found that macroeconomic stability and investor confidence significantly influence sovereign bond markets in African emerging economies,

affecting infrastructure financing. Their findings suggest that when bond yields rise due to economic instability, governments face higher borrowing costs, reducing available funds for public infrastructure projects. This is consistent with the negative relationship observed in this study, where rising infrastructure bond yields constrained road project completion.

Additionally, Altig et al. (2020) highlighted how economic uncertainty, especially during crises like the COVID-19 pandemic, led to increased risk premiums and higher bond yields. This aligns with the study's findings, as uncertain economic conditions could drive up borrowing costs, making it more difficult to complete road projects. Altman (2019) further emphasized that corporate bond mortality rates rise when yields increase, reflecting higher default risks. Similarly, Anderson and Sundaresan (2020) noted that variations in bond yields impact investment decisions, reinforcing the idea that high infrastructure bond yields limit government investment in capital-intensive projects like roads.

From a policy and financing perspective, Bosire (2015) explored the role of public-private partnerships (PPPs) in infrastructure financing in Kenya. The findings suggested that alternative funding mechanisms could help mitigate the negative effects of high bond yields, a potential strategy for improving road project completion. Similarly, Choi and Kronlund (2018) found that investors often "reach for yield" in bond markets, meaning that lower yields could attract more investment into infrastructure financing. Finally, Partridge and Medda (2020) analyzed green municipal bonds, showing that structured financial instruments can provide cost-effective funding alternatives. This suggests that Kenya could explore alternative bond structures to mitigate the adverse effects of high yields on infrastructure development.

The combined evidence from these studies and the current findings suggests that governments should focus on stabilizing macroeconomic conditions to maintain manageable bond yields. Additionally, diversifying financing strategies through PPPs, green bonds, and structured financial instruments could provide alternative funding sources for infrastructure projects. Ensuring investor confidence and minimizing sovereign risk would also help keep borrowing costs lower, facilitating more sustainable road infrastructure development.

VI. Conclusions

The findings of this study reveal a significant relationship between infrastructure bond yields and the performance of road projects in the Nairobi Metropolitan Region. Higher bond yields are associated with delays in project completion, suggesting that increased borrowing costs may restrict infrastructure financing, ultimately hindering progress in road development. This relationship underscores the sensitivity of infrastructure projects to broader macroeconomic conditions, particularly interest rates and government borrowing policies, which can directly affect the cost and availability of capital. While bond yields play an essential role in shaping infrastructure outcomes, the model's relatively moderate explanatory power indicates that other factors—such as budgetary allocations, policy consistency, and the effectiveness of project management—also contribute to the successful completion of road projects. Moreover, the presence of cross-sectional variations highlights that regional and institutional differences can impact infrastructure development, signaling the need for targeted financing strategies and policy interventions. Tailoring financial mechanisms and policies to the specific conditions of each region and project may improve outcomes and help address local challenges. Ultimately, the study emphasizes that stable and affordable financing mechanisms are crucial for ensuring the timely, efficient completion of road projects, which is vital for supporting broader economic development objectives and improving infrastructure within the Nairobi Metropolitan Region.

VII. Recommendations

1. **For Investors:** Given the inverse relationship between bond yields and road project completion, investors should consider long-term infrastructure bonds with favorable interest rates to enhance project viability and minimize financing constraints.
2. **For Project Managers:** Efficient financial planning and cost management strategies should be adopted to mitigate the impact of fluctuating bond yields, ensuring that road projects remain on schedule despite changes in financing conditions.
3. **For Policymakers:** Government agencies should implement policies that stabilize infrastructure financing costs, such as tax incentives for infrastructure bonds, improved public-private partnerships, and innovative funding mechanisms to enhance road project completion rates.

References

[1] Adeniran, D. (2019). Challenges In Infrastructure Development And Financing In Kenya: A Study On The Road Sector. Nairobi Journal Of Infrastructure, 9(1), 32-49.
[2] African Union Commission, African Development Bank, & NEPAD. (2021). Programme For Infrastructure Development In Africa (PIDA) 2020-2040. African Union Commission.
[3] Ahwireng-Obeng, F., & Ahwireng-Obeng, C. (2019). Infrastructure Project Bonds As An Alternative Financing Model: A Review Of Global Trends. Journal Of Infrastructure Development, 21(3), 145-167.

[4] Amiraslani, H., Lins, K. V., Servaes, H., & Tamayo, A. (2023). Trust, Social Capital, And The Bond Market Benefits Of ESG Performance. Review Of Accounting Studies, 28(2), 421-462.
[5] Anderson, R., & Sundaresan, S. (2020). A Comparative Study Of Structural Models Of Corporate Bond Yields: An Exploratory Investigation. Journal Of Banking & Finance, 24(1-2), 255-269.
[6] Brixiová, Z., Kangoye, T., & Yogo, F. (2020). Alternative Financing Mechanisms For Infrastructure In Africa: Trends And Challenges. African Development Review, 31(4), 538-554.
[7] Choi, J., & Kronlund, M. (2018). Reaching For Yield In Corporate Bond Mutual Funds. The Review Of Financial Studies, 31(5), 1930-1965.
[8] Fama, E. F. (1965). The Behavior Of Stock-Market Prices. Journal Of Business, 38(1), 34-105. Https://Doi.Org/10.1086/294743
[9] Gupta, P., & Sharma, S. (2022). Infrastructure Financing And Investment Trends: A Global Overview. International Journal Of Financial Research, 34(2), 221-237.
[10] Humphrey, C. (2020). From Drawing Board To Reality: The First Four Years Of Operations At The Asian Infrastructure Investment Bank And New Development Bank.
[11] Hyun, J., Li, C., & Wan, H. (2017). The Rise Of Infrastructure Bonds In Asia. Asian Development Review, 34(2), 29-50.
[12] Johnson, M., & Lee, K. (2018). The Impact Of Interest Rates On Government Project Delivery. Journal Of Infrastructure Systems, 24(1), 04017015.
[13] Krugman, P. (1988). Financing Vs. Funding: The Role Of Debt In The Funding Of Infrastructure Projects. Journal Of Economic Perspectives, 2(3), 49-64. Https://Doi.Org/10.1257/Jep.2.3.49
[14] Kumar, B. R. (2022). Infrastructure Financing Instruments. In Project Finance: Structuring, Valuation And Risk Management For Major Projects (Pp. 31-54). Cham: Springer International Publishing.
[15] Li, S., Abraham, D., & Cai, H. (2017). Infrastructure Financing With Project Bond And Credit Default Swap Under Public-Private Partnerships. International Journal Of Project Management, 35(3), 406-419.
[16] Liu, Z., Qi, Y., & Wan, Y. (2022). Local Currency Bond Markets In Asia: Challenges And Opportunities. Journal Of Asian Economics, 50, 85-99.
[17] Mallett, W. J. (2019). Highway Trust Fund And Its Role In Transportation Infrastructure. U.S. Congressional Research Service.
[18] Mosionek-Schweda, M. (2016). The Project Bond Initiative In The European Union. European Investment Bank.
[19] Mugwe, R. (2011). Infrastructure Bonds And Their Impact On The Kenyan Economy: A Case Study Of Road Projects. Journal Of Kenyan Economics, 5(4), 74-89.
[20] Mugwe, R. (2011). Infrastructure Bonds In Kenya: Trends And Impact. Kenya National Treasury.
[21] Mukoki, D., Ojah, K., & Kodongo, O. (2023). Sovereign Bonds And Infrastructure Financing In Sub-Saharan Africa. African Economic Review, 32(1), 14-28.
[22] Munyoki, M. (2018). Financing Road Infrastructure Projects In Kenya: Challenges And Opportunities. Journal Of African Development Finance, 12(3), 210-228.
[23] Myers, S. C. (1977). The Determinants Of Corporate Borrowing. Journal Of Financial Economics, 5(2), 147-175. Https://Doi.Org/10.1016/0304-405X(77)90015-1
[24] Ng, C., & Tao, S. (2016). Asia's Bond Markets: Financing Infrastructure Development. Asian Development Bank.
[25] Owusu-Manu, D., Dainty, A. R. J., & Wilkinson, S. (2020). Infrastructure Financing And The Role Of Bonds In Europe And North America. Journal Of Construction Management, 45(2), 88-102.
[26] Partridge, C., & Medda, F. R. (2020). The Evolution Of Pricing Performance Of Green Municipal Bonds. Journal Of Sustainable Finance & Investment, 10(1), 44-64.
[27] Ribberink, J., & Schubert, C. (2020). Public-Private Partnerships In The European Union. Public Finance Review, 48(6), 827-848.
[28] Saunders, M., Lewis, P., & Thornhill, A. (2009). Research Methods For Business Students. Pearson Education.
[29] Shiller, R. J. (2000). Irrational Exuberance. Princeton University Press.
[30] Silva, F., Cortez, M. D. C., & Armada, M. R. (2023). Conditioning Information And European Bond Fund Performance. European Financial Management, 9(2), 201-230.
[31] Smith, J., Brown, R. S., & Jones, A. L. (2020). Infrastructure Bonds And Project Performance: An Empirical Analysis. Transportation Research Record, 2674(5), 182-193.
[32] Standard & Poor's. (2023). Kenya's Credit Rating And Outlook Analysis. S&P Global.
[33] Theyel, G., & Theyel, R. (2023). Innovative Financing Strategies For Infrastructure Projects: A Global Perspective. International Journal Of Project Finance, 29(1), 93-109.
[34] World Bank. (2012). The Role Of Infrastructure In Development: A Global Perspective. The World Bank Group.
[35] World Bank. (2023). Kenya's Infrastructure Needs And Financing Requirements. The World Bank Group.
[36] Yoshino, N., & Stillman, J. (2018). Infrastructure Financing In The United States: Opportunities And Challenges. Asian Infrastructure Investment Bank.