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Assessment of the Relationship between Foreign Exchange Rate Movement and the Cost of Road Infrastructure in Ethiopia

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Abstract

This study investigates the association of foreign currency (USD) exchange rate movements with the cost of road construction in Ethiopia using historical data from 2013 to 2025, with forecasts extending to 2036. A regression-based predictive model was applied to analyze the relationship between exchange rate devaluation and rising construction costs, yielding strong associations (correlation coefficients of 0.91 for Design-Build (DB) and 0.98 for Design-Bid-Build (DBB) projects). Construction materials such as cement, fuel, bitumen, and reinforcement steel also showed significant sensitivity to exchange rate changes, with R^2 values of 0.82, 0.91, 0.93, and 0.94, respectively. Per kilometer costs for construction activities increased from 10.4 million ETB in 2013 to 138.8 million ETB in 2025, with projections reaching 181.4 million ETB by 2036. While the findings demonstrate a strong association between exchange rate increment and cost overrun, causality cannot be inferred due to potential omitted variables. These results emphasize the urgent need for financial risk mitigation strategies in currency-vulnerable economies.

Keywords: Construction cost, correlation, cost overrun, currency-vulnerable, exchange rate, financial risk

1. Introuction

Ethiopia's economic advancement is highly contingent upon the construction industry, with particular emphasis on road infrastructure [1], [2]. Nevertheless, the reliance of road construction on imported materials, equipment, and foreign capital renders it susceptible to movements in foreign currency exchange rates, which significantly affect overall costs. The relationship between currency exchange rates and the cost of infrastructure development, especially in road construction, is one of several key factors influencing economic growth. Considering that road construction is so dependent on imported resources and technology, variations in exchange rates can considerably influence both the financial outlay of projects and project delays that occur indirectly through increased construction costs and resource constraints. Over recent decades, the Ethiopian Birr (ETB) has experienced considerable devaluation against foreign currencies, such as the U.S. dollar (USD), driven by an array of macroeconomic factors directly or indirectly, including inflation, trade deficits, and monetary policies. This devaluation has profound implications, particularly regarding infrastructure development [3], [4], [5].

The currency exchange rate significantly influences the attraction of foreign direct investment (FDI), which is essential for infrastructure initiatives such as road construction in Ethiopia. A positive and effective exchange rate can enhance export performance and draw in foreign direct investment [6], thereby resulting in improved construction technologies and methodologies. This augmented investment has the potential to accelerate infrastructure development and increase efficiency in road construction projects. Thereby, a stable exchange rate mitigates the risks associated with currency fluctuations, facilitating a more attractive condition for international investment in road infrastructure [7]. Such stability is crucial for reducing costs linked to imported construction materials and equipment. The implication is that a conducive exchange rate environment may foster heightened investment in road construction, which is vital for enhancing Ethiopia's economic connectivity and overall development.

Conversely, an unstable exchange rate affects project budgeting and execution within the road construction sector negatively. Continual increment in exchange rates can escalate the costs of construction material costs, resulting in budget overruns and project delays [8], [9]. This increment complicates financial planning for construction initiatives, underscoring the importance of comprehending these dynamics for project managers and policymakers [8], [9]. Furthermore, assessment of the factors contributing to cost overruns in Ethiopian road projects has identified exchange rate volatility as a significant factor [10]. Comparable findings in Indonesia, supporting the case of Ethiopia, also showed that currency rate volatility can precipitate unanticipated expenditures in road development [11].

The broader economic consequences of exchange rate movements also exert influence on road construction. Exchange rates substantially impact international trade, thereby affecting the economic landscape that is conducive to infrastructure investment [4]. When the exchange rate is favorable, improvements in agricultural productivity may occur, accompanied by an increased demand for road infrastructure to facilitate the transportation of goods [12]. This

correlation highlights the necessity for positive currency exchange rates in Ethiopia's infrastructure development. Additionally, the management of exchange rates impacts the industrial sector, including the production of cement, steel, and oil, which is indirectly related to road construction [13]. Improved manufacturing capabilities can boost local demand for construction services, demonstrating the complex impact of currency rates on infrastructure development.

This paper explores how the continual foreign currency increment is associated with federally administered road construction, focusing on cost implications. The primary objectives of the study are to analyze the relationship between foreign exchange rate and the costs associated with road construction in Ethiopia, to develop a predictive model to forecast future costs based on historical data, to identify the challenges faced by local contractors related to currency devaluation, and to provide recommendations for mitigating the challenge of exchange rate increment on road construction. Additionally, predictive analysis was conducted to forecast future costs based on historical data.

2. Methodology

This study utilized only quantitative data analysis. Historical data on foreign exchange rates and federal road construction costs in Ethiopia were sourced from governmental and industry reports. Federal road project contract data were obtained from the Ethiopian Roads Administration Engineering Procurement Directorate and ERA Project Management Offices. A total of 212 asphalt concrete road project contracts (115 DBB and 97 DB projects) from 2013 to 2025 were analyzed in this research. This dataset, therefore, represents the complete set of federally administered asphalt concrete road projects undertaken between 2013 and 2025, and the study ensures that the analysis is wide-ranging and representative of the federal road sector. However, this study didn’t examine the cost dynamics in regional and private-sector road projects and other than asphalt concrete surfacing types of federal road projects. Accordingly, the findings should be generalized with caution.

Statistical methods were employed to analyze the quantitative data, revealing trends and correlations between exchange rate movements and construction costs. Additionally, predictive analysis was conducted to forecast future costs based on historical data. Regression analysis was employed to evaluate the association between the exchange rate co-moment with costs of federal road construction. A linear predictive model was used to forecast future costs, with assumptions including stable macroeconomic conditions and continued reliance on imported materials. Long-term projections should be interpreted with caution, as uncertainty increases with the forecasting horizon. Model validation was conducted using cross-validation techniques, with Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) reported to assess forecasting accuracy. Confidence intervals were generated to capture uncertainty in long-term projections. The forecasting horizon of 2036 was selected to align with Ethiopia’s 10-year road sector strategic plan, ensuring policy relevance and comparability with national infrastructure targets.

Factors influencing road construction costs included inflation, project type, length, width and scope, exchange rates, surfacing type, structure, project duration, location, bidding competition, contract signing dates, political

stability, and corruption [14], [15], [16], [17]. Other factors, such as terrain type, urbanisation, soil quality, and government regulations, are also crucial for road construction costs [18], [19], [20], [21]. Most of the Ethiopian federal road network comprises primarily two-lane roads [22], [23], [24], and in line with this, costs per kilometer for specific activities can be compared, affirming the feasibility of this research.

However, this study was conducted solely to examine the relationship between the construction costs of two-lane asphalt roads and foreign currency exchange rates, highlighting a potential omitted-variable bias as a limitation. Both Design–Bid–Build (DBB) and Design–Build (DB) projects were included to evaluate costs per kilometer. DBB projects were specifically used to analyse trends in construction material costs, as the DBB bids include a unit rate for construction materials, whereas DB projects are typically lump-sum by nature. Consequently, the study focuses exclusively on asphalt concrete road construction projects to ensure comparability among similar activities. Unit costs, both per kilometer and for materials, were utilized in comparisons against the USD exchange rate to assess the co-movement of exchange rates and construction prices. Tables 1 and 2 summarize the per-kilometer costs of asphalt concrete projects from 2013 to 2025, categorized by costs in ETB per km for DBB and DB projects. Table 3 also presents a summary of the cost per kilometer versus the exchange rate, illustrating their correlation.

Table 1: Summary of road construction project works (DBB) cost in ETB per km

Year	N	Cost Parameters in ETB				
		Mean	Median	sd	Min	Max
2013	4	10,367,899	11,159,788	4,191,563	5,192,127	13,959,893
2014	2	14,420,264	14,420,264	4,799,154	11,026,750	17,813,778
2015	6	14,412,254	14,594,223	4,186,088	8,979,761	20,076,535
2016	4	10,890,102	10,470,818	5,449,432	6,119,398	16,499,378
2017	24	19,573,201	17,111,976	11,845,519	7,439,171	69,171,888
2018	18	26,502,842	18,547,053	27,131,301	8,296,549	130,525,803
2019	8	21,984,729	18,440,071	9,966,787	13,051,249	40,588,126
2020	20	28,667,826	27,243,668	13,384,394	13,512,354	76,063,630
2021	11	30,107,571	31,007,048	8,670,748	15,810,761	41,596,258
2022	6	41,756,127	35,818,771	23,470,990	14,566,471	84,845,745
2023	3	35,200,957.76	35,365,993.53	616,382.33	34,518,857.05	35,718,022.71
2024	6	75,832,083.09	70,549,246.58	19,861,783.68	53,645,173.49	107,954,742.63
2025	3	138,819,673.08	106,013,552.74	86,252,187.7	73,784,052.42	236,661,414.08

Table 2: Summary for design and build road project works cost (DB) in ETB per km

Year	N	Cost Parameters in ETB				
		Mean	Median	sd	Min	Max
2013	2	12,998,620	12,998,620	6,503,941	8,399,639	17,597,601
2014	6	24,335,302	21,936,017	8,754,653	16,365,443	40,496,292
2015	3	10,327,335	11,237,393	2,028,977	8,002,656	11,741,957
2016	1	26,623,373	26,623,373	_	26,623,373	26,623,373
2017	23	25,929,099	17,181,805	20,192,243	11,797,599	93,410,785
2018	8	29,104,194	26,776,651	12,566,843	13,796,754	57,519,018
2019	11	33,592,919	22,438,235	37,510,433	13,626,000	145,143,939
2020	23	31,971,889	27,690,699	16,290,565	17,191,011	94,050,000
2021	17	30,782,656	28,589,100	24,477,744	1,666,851	111,474,276
2022	2	47,573,836	47,573,836	22,039,187	31,989,778	63,157,895
2024	1	71,899,340.92	71,899,340.92	_	71,899,340.92	71,899,340.92

3. Results and Discussion

3.1. Introduction

The majority of asphalt concrete road projects, investigated in this study (54.25%), were DBB, while DB projects constituted 45.75%. Rising construction costs in recent years have caused significant challenges for both project owners and contractors. According to the Global Competitiveness Report, international costs of construction projects have increased over time [25]. This issue is particularly pressing in developing countries and is common across African nations. Costs have shown erratic increases, especially in asphalt road construction [26]. This rise is primarily attributed to foreign exchange rate effects, compounded by inflation and various macroeconomic factors, including supply and demand, energy costs, raw material price hikes, and import duties [15], [16], [17], [27]. As the primary focus of this research is to investigate the association between incessant rises in foreign exchange rates and domestic road construction expenses, the following section presents the association between exchange rates and per kilometer costs and material input costs from 2013 to 2025, as well as the expected per kilometer costs for the next decade.

3.2. Correlation between the exchange rate and per Km road construction cost

The unit cost of road construction per kilometer is derived from the aggregate of subunit costs for constructing 1 kilometer road. Per kilometer construction cost of each project was calculated from the total construction cost submitted by the bid-winning contractor, by dividing the total cost by the total length coverage of the project and then taking the average for multiple project contracts signed in the same year. Tables 3 illustrates average unit costs for road construction from 2013 to 2025, categorized by costs in ETB per km for DBB and DB projects. Notably, there is a significant rise in per Km costs from 10.4 million ETB in 2013 to 138.8 million ETB in 2025 for construction activities.

Table 3: Cost per Km for DB and DBB projects vs exchange rate

Year	Exchange rate (ETB/USD) [28]	Per Km DB Project cost (x10^6 ETB)	Per Km DBB Project cost (x10^6 ETB)
2013	18.71	13.00	10.37
2014	19.67	24.34	14.42
2015	20.69	10.33	14.41
2016	21.84	26.62	10.89
2017	23.97	25.93	19.57
2018	27.67	29.10	26.50
2019	29.21	33.59	21.98
2020	34.95	31.97	28.67
2021	44.32	30.78	30.11
2022	51.94	47.57	41.76
2023	54.74	N.A	35.20
2024	82.41	71.90	75.83
2025	138.93	N.A	138.82

As depicted in Figure 1, the cost trends for DB and DBB projects demonstrate an association with the exchange rate. The strong correlation between the exchange rate and road construction costs per Km indicates that the exchange rate is significantly associated with the increase in construction expenses. The forecast of project costs for DB and DBB projects, relying on the exchange rate, shows a robust linear interdependence with correlation coefficients of 0.91 and 0.98, respectively. The regression equation is presented in Equations 1 and 2 for DBB and DB projects, respectively. Hence, the cost of road construction per kilometer in Ethiopia has risen steadily over the last decade in parallel with currency devaluation. Table 4 below shows the summary of statistical regression analysis results and interpretation for per-kilometer projects cost.

Table 4: Summary of statistical analysis results for per-kilometer project cost

Statistic	Value (Projects)		Interpretation
	DB	DBB	
R^2	0.9125	0.9794	97.94% of DBB projects, and 91.25% of DB projects cost variation is explained by the exchange rate
Standard Error (RMSE)	5.22	5.31	Typical prediction error is about ±5.31 ×10^6 ETB for DBB Projects and ±5.22 ×10^6 ETB for DB Projects
F-statistic	93.87	523.17	The overall regression model is highly significant
P-value	4.65× 10^{-6}	1.26 × 10^{-10}	Reject the null hypothesis; the model is statistically significant
Slope (β_1)	0.84	1.03	Each 1-unit increase in exchange rate is associated with an average cost increase of about 1.03 ×10^6 ETB for DBB projects and 0.84 ×10^6 ETB for DB projects
95% CI for Slope	0.65 to 1.04	0.93 to 1.13	The true slope is very likely positive and different from zero

$$y = 1.03x - 9.0459 \ldots\ldots \text{Equation 1}$$

$$y = 0.8436x + 3.0747 \ldots\ldots \text{Equation 2}$$

Where:
x represents the exchange rate (ETB/USD)
y represents the project cost (million ETB)

Supporting evidence from a prior study indicates that a 20% devaluation in the exchange rate was associated with a rise in construction costs by an average of 14%, with asphalt and bitumen prices increasing by 32% over five years [29]. Another research finding concluded that Ethiopia's parallel exchange rate system inflated construction costs, with a 10% disparity in exchange rates linked with project costs by 6%. Imported materials constitute 45–60% of total road project expenditures, making currency devaluation associated with cost increments [30].

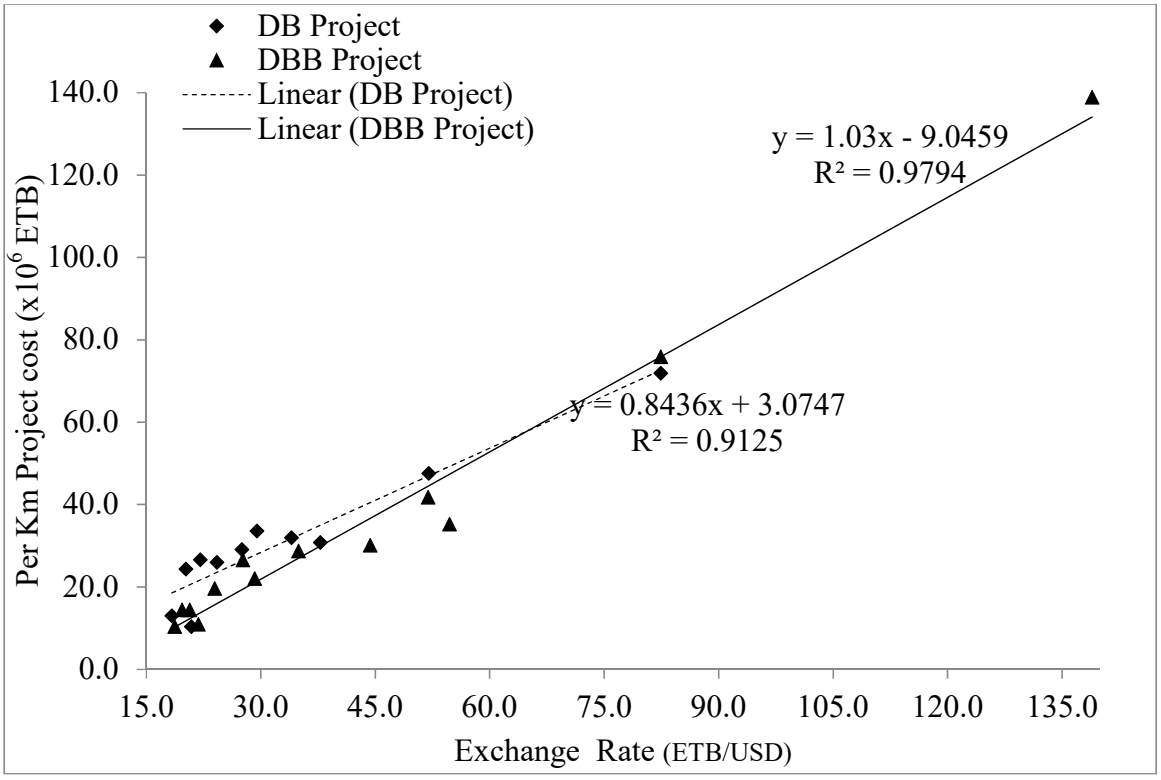


Figure 1: Regression analysis for Per km projects Cost vs Exchange rate

A 38% inflation-adjusted increase in road construction costs per km from 2010 to 2020 in relation to currency devaluation was reported. Regression analysis yielded an R^2 value of 0.87, underscoring a significant relationship between foreign exchange and road project cost overruns [31]. Berta & Tesfaye (2025) illustrated a 47% increase in road construction costs in Ethiopia over the past decade, which was largely correlated to currency devaluation. A strong positive correlation (R^2 = 0.79) was identified between the exchange rate and material costs [32]. Collectively, these prior studies consistently affirm that the foreign exchange rate is significantly correlated with road construction costs in Ethiopia, corroborating the findings of this investigation.

Furthermore, historical per kilometer cost data have been used to predict the expected cost per kilometer for the next decade. Future project costs were forecasted using

the Exponential Triple Smoothing (ETS) time series forecasting method implemented in Microsoft Excel, within 95% confidence interval (CI). The forecasted per kilometer project cost is presented in Table 5. As shown in Table 1, there was an increase in per km costs from 10.4 million ETB in 2013 to 138.8 million ETB in 2025 for construction activities. As illustrated in Table 5 and Figure 2, this cost, 138.8 million ETB per kilometer in 2025, is projected to rise to 181.4 million ETB in 2036 for DBB projects. Similarly, for DB projects, the per kilometer cost is anticipated to increase from 71.9 million ETB in 2024 to 112.3 million ETB in 2036, as shown in Table 5 and Figure 3. Table 6 showcases the forecast Accuracy Statistics, evaluating how well the forecasting model fits the historical data and indicates the optimal smoothing parameters selected by the model.

Table 5: Future project costs forecast using the ETS time series forecasting method

Project type		Year											
		2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Per Km DBB Project cost (in million ETB)	Lower Confidence Bound	138.8	67.7	69.6	72.0	74.7	77.7	81.0	84.4	88.0	91.8	95.6	99.6
	Forecast	138.8	111.1	118.1	125.2	132.2	139.2	146.3	153.3	160.3	167.4	174.4	181.4
	Upper Confidence Bound	138.8	154.5	166.7	178.4	189.7	200.8	211.6	222.2	232.7	243.0	253.2	263.3
Per Km DB Project cost (in million ETB)	Lower Confidence Bound	47.3	51.6	55.9	60.2	64.4	68.7	73.0	77.3	81.6	85.9	90.2	94.4
	Forecast	63.6	68.0	72.5	76.9	81.3	85.7	90.2	94.6	99.0	103.4	107.8	112.3
	Upper Confidence Bound	79.9	84.5	89.1	93.6	98.2	102.7	107.3	111.8	116.4	121.0	125.5	130.1

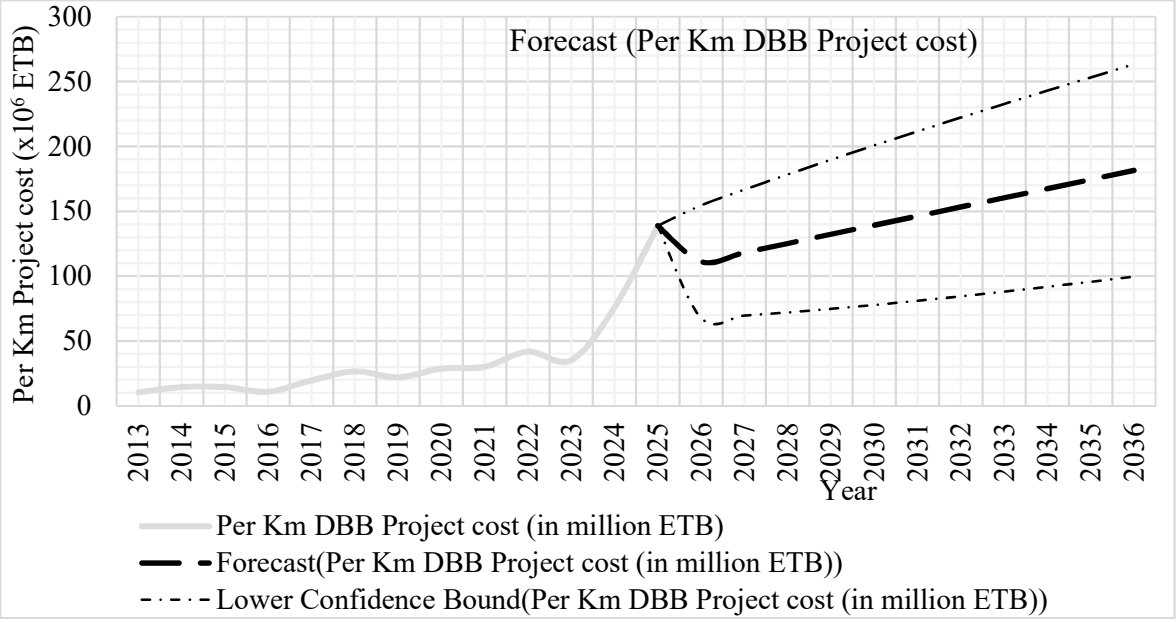


Figure 2: Forecast for per km cost of the DBB project from 2026 to 2036

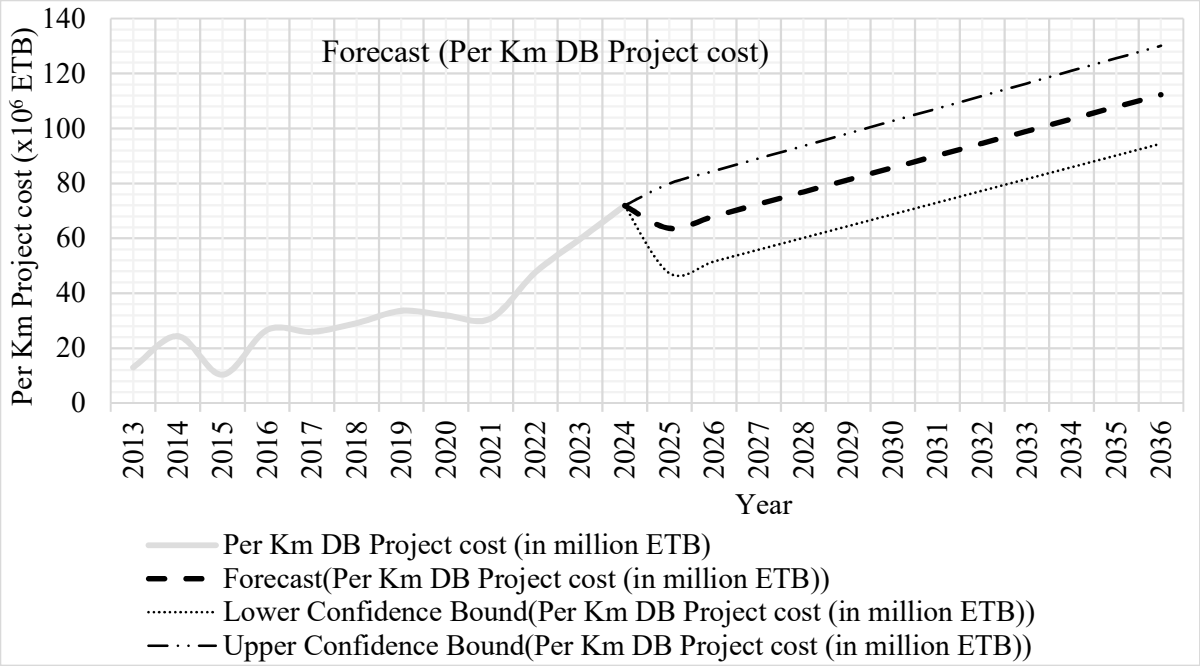


Figure 3: Forecast for per km cost of the DB project from 2026 to 2036

Table 6: Forecast accuracy statistics and interpretation

Statistic	DBB Projects	DB Projects	Interpretation
Alpha (α) Level Smoothing Parameter	0.500	0.126	The DBB Projects model gives equal weight to the latest observation and previous estimates, resulting in moderate responsiveness to recent changes. In contrast, the DB Projects model places much greater emphasis on past observations, producing smoother and more stable forecasts.
Beta (β) Trend Smoothing Parameter	0.001	0.001	The trend is almost fixed over time for both types of projects, suggesting that long-term project cost growth is relatively stable.
Gamma (γ) Seasonality Smoothing Parameter	2.22×10^{-16}	2.22×10^{-16}	The value of γ is essentially zero for both types of projects, confirming the absence of meaningful seasonality in DB project costs.
Mean Absolute Scaled Error (MASE)	4.85	1.24	Both forecasting models perform worse than a simple naive forecast, with the DB Projects model being considerably closer to acceptable performance.
Symmetric Mean Absolute Percentage Error (sMAPE)	33.68%	18.46%	On average, forecasted costs differ from actual costs by approximately 33.68% and 18.5% for DBB and DB projects, respectively, indicating moderate and good forecasting accuracy, respectively.
Mean Absolute Error (MAE)	23.81	9.12	The average absolute forecasting error is about 23.81 and 9.12 units for DBB and DB projects, respectively, demonstrating substantially more accurate forecasts in the DB model.

3.3. Correlation of the exchange rate with construction material cost

Several factors contribute to the increase in construction costs. The study aiming to establish unit costs for infrastructure development projects in Sub-Saharan African Countries pointed out that a range of factors account for cost increases in infrastructure development projects in Africa, particularly road projects [33]. These include the escalation in the price of oil and oil-related inputs determining the construction cost, such as bitumen, cement, and steel reinforcement, tight market conditions in the construction sector, and inadequate tender competition. Other project-specific factors, such as geographic considerations, quantity considerations, and item availability, influence unit bid prices of road construction [34], [35]. Figures 4 and 5 present the correlation of the exchange rate with construction input materials, with the input data summarized in Table 8. The linear regression equation is presented in Equations 3, 4, 5 and 6 for materials fuel, cement, reinforcement, and bitumen cost correlation, respectively. Moreover, Table 7 presents the summary of statistical regression analysis results and interpretation for the road construction material cost in relation to the exchange rate.

$$y = 0.7001x + 0.0882 \quad \text{……Equation 3}$$

$$y = 0.1344x - 0.479 \quad \text{……Equation 4}$$

$$y = 2.0832x - 28.135 \quad \text{……..Equation 5}$$

$$y = 1.6035x - 26.841 \quad \text{.....Equation 6}$$

Where;

x represents the exchange rate (ETB/USD)

y represents material cost (ETB per unit measure)

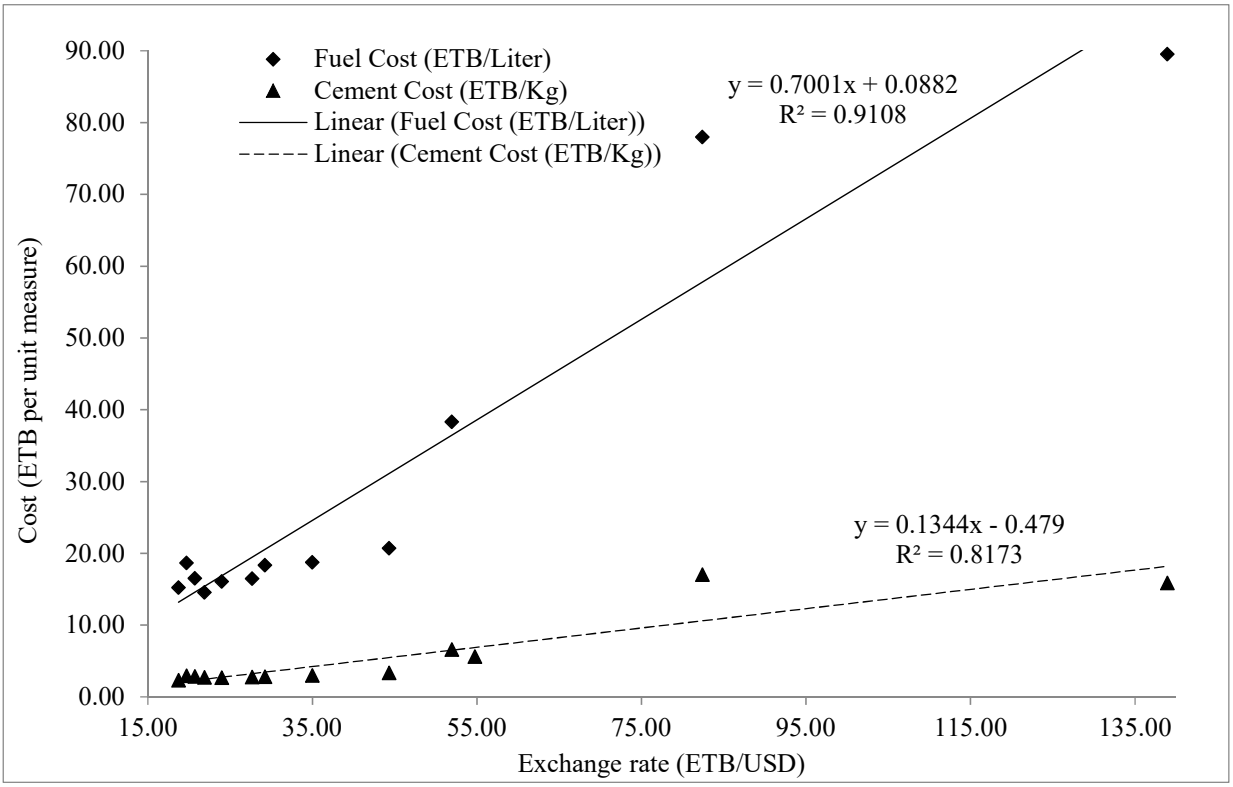


Figure 4: Regression analysis for cement and fuel cost vs exchange rate

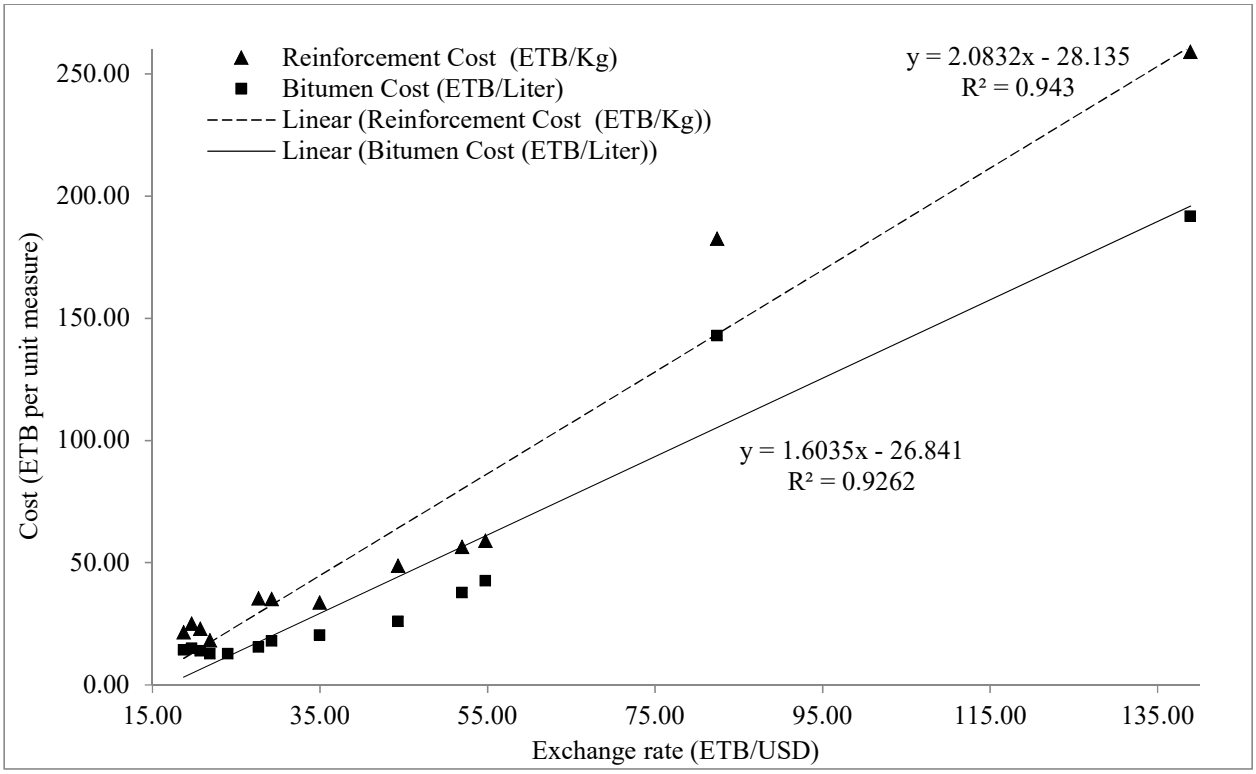


Figure 5: Regression analysis for bitumen and reinforcement cost vs exchange rate

Table 7: Summary of statistical analysis results for material cost

Statistic	Value				Interpretation
	Fuel	Cement	Bitumen	Reinforcement	
R^2	0.9108	0.8173	0.9262	0.9430	91.08% of fuel cost, 81.73% of cement cost, 92.62% of bitumen cost, and 94.30% of reinforcement cost variation is explained by the exchange rate
Standard Error (RMSE)	8.13	2.26	16.10	18.80	Typical prediction error is about ±8.13, ±2.26, ±16.91, and ±18.80 ETB per unit measure for fuel, cement, bitumen, and reinforcement cost
F-statistic	102.07	49.20	138.04	165.42	The overall regression model is highly significant
P-value	1.45×10^{-6}	2.23×10^{-5}	1.45×10^{-7}	1.52×10^{-7}	Reject the null hypothesis; the model is statistically significant
Slope (β_1)	0.70	0.13	1.60	2.08	Each 1-unit increase in exchange rate is associated with an average cost increase of about β_1 ETB per unit measure of materials
95% CI for Slope	0.546 to 0.855	0.092 to 0.177	1.303 to 1.904	1.722 to 2.444	The true slope is very likely positive and different from zero

Oil is a crucial component in road construction, especially for producing bitumen and asphalt. Studies indicate that a depreciating local currency leads to higher oil prices, increasing overall road construction costs. Oil price volatility, in relation to exchange rates, has been shown to significantly impact macroeconomic stability in developing countries, often leading to inflation in the construction sector [36]. Oil price variations will have a greater effect on items that are equipment-oriented, such as excavation. A 30 to 40% fuel price increase will increase the total cost of construction by about 2 to 5% [37].

Bitumen, derived from crude oil, is essential for road paving. The price of polymer-modified bitumen (PMB) is particularly sensitive to currency movement since it is often imported. Cement, a key binding material, is also vulnerable to exchange rates. Currency depreciation leads to increased cement costs due to higher import prices for furnace fuel and/or clinker [38]. Similarly, reinforcement steel, often imported, experiences price volatility in relation to currency fluctuations, making it difficult for contractors to predict project costs accurately [39].

Table 8: Summarized cost of Fuel, Cement, Steel, and Bitumen

Year	Exchange rate (ETB/USD)	Fuel price (ETB/Liter)	Cement price (ETB/Kg)	Bitumen price (ETB/Liter)	Reinforcement price (ETB/Kg)
2013	18.71	15.21	2.28	14.28	21.50
2014	19.67	18.66	2.90	15.03	25.00
2015	20.69	16.54	2.81	13.92	23.00
2016	21.84	14.57	2.71	12.70	18.20
2017	23.97	16.06	2.67	12.79	N.A
2018	27.67	16.46	2.74	15.54	35.42
2019	29.21	18.34	2.79	18.02	35.20
2020	34.95	18.76	2.98	20.35	33.66
2021	44.32	20.72	3.31	25.99	48.79
2022	51.94	38.30	6.58	37.76	56.52
2023	54.74	N.A	5.60	42.55	59.00
2024	82.41	78.00	17.01	142.90	182.59
2025	138.93	89.53	15.86	191.72	259.03

Research conducted by Dinsa (2015) in Ethiopia scrutinized the phenomenon of price escalation in road construction projects in relation to exchange rate devaluation. The results elucidated that these devaluations were related with 68% of the variance (R^2 = 0.68) in the costs of cement and rebar. The most substantial relations were noted in bitumen and fuel, which exhibited correlation coefficients exceeding 0.75 owing to their direct reliance on imports [40]. In a similar vein, Shiha (2019) devised a neural network model aimed at forecasting construction costs predicated on macroeconomic indicators in Egypt. The outcomes indicated that association in exchange rates yielded an R^2 of 0.72 for cement and 0.85 for rebar, while the correlation on fuel was also noteworthy (R^2 =

0.61) due to the increase in transportation costs [41]. A study undertaken in Nigeria by Alintah-Abel et al. (2025) explored the repercussions of subsidy elimination and exchange rate depreciation on the pricing of construction materials. Their findings indicated that volatility in exchange rates related with 63% ($R^2 = 0.63$) of the variations in costs pertaining to essential construction materials. Among the materials most associated with the exchange rate, bitumen and rebar exhibited the highest sensitivity, with R^2 values recorded at 0.78 and 0.74, respectively [42].

Furthermore, Aigbavboa & Thwala (2024) examined road construction projects within the context of currency depreciation scenarios and discovered that the prices of fuel and bitumen escalated at a rate 1.5 times greater than that of other materials, under a 10% currency depreciation scenario. Their research also reported a substantial correlation ($R^2 = 0.81$) for bitumen, signifying its significant association with the exchange rate [43]. Muhit et al. (2024) analyzed the cost dependencies associated with imported construction materials, revealing that cement exhibited an exchange rate sensitivity ($R^2 = 0.75$), whilst rebar demonstrated an even greater correlation ($R^2 = 0.79$) due to influences from global steel pricing [44]. Comprehensive macroeconomic analyses further substantiate these findings. Liu et al. (2024) investigated the volatility of material costs in nations with a high dependency on imports, concluding that exchange rates accounted for 69% ($R^2 = 0.69$) of the variability in costs [45]. Their research further accentuated that currency instability in developing economies engenders intensified construction cost inflation, in relation to project budgeting and feasibility.

The extant literature thus substantiates the findings of this study, indicating that the costs of construction materials exhibit a prominent sensitivity to the movement of exchange rates. Analyzing a thirteen-years' worth of data, the costs of construction materials, namely cement, fuel, bitumen, and reinforcement bars, demonstrated a significant correlation with the USD exchange rate movement, yielding R^2 values of 0.82, 0.91, 0.93, and 0.94, respectively, as depicted in Figures 4 and 5. As the phenomenon of currency devaluation continues to be associated with global market prices, developing nations confront escalating challenges in stabilizing the costs of infrastructure, thereby necessitating the implementation of financial risk mitigation strategies to protect the co-movement of construction budgets with the exchange rate.

In general, this study contributes to the literature by analyzing one of the largest datasets of Ethiopian federal road projects to date, encompassing 212 contracts between 2013 and 2025. This extensive dataset provides a more representative picture of cost dynamics than previous studies, which often relied on smaller samples or shorter time horizons. By incorporating both DB and DBB asphalt concrete projects, the analysis captures variation in delivery methods and strengthens the generalizability of the findings. Additionally, this study advances existing knowledge by extending the analysis through 2025 and introducing long-term forecasts to 2036, providing forward-looking insights directly relevant to Ethiopia's 10-year road sector strategic plan. This long-term perspective is particularly valuable for policymakers and contractors who have to anticipate future cost escalations under continued exchange-rate movement.

Furthermore, the findings of this study have broader relevance to other import-dependent economies that rely heavily on foreign-sourced materials and equipment for

infrastructure development. Countries across Sub-Saharan Africa face similar challenges, as exchange-rate volatility directly allied with import-dependent economic activities [46]. By demonstrating a strong association between currency devaluation and cost escalation, this study provides insights that can be cautiously generalized to comparable economies with high import reliance.

4. Conclusion

The findings of this study demonstrate a strong association between foreign exchange rate movements and rising road construction costs, supported by a large dataset of 212 projects and long-term forecasts to 2036. While causality cannot be inferred due to omitted variables, the results highlight the significant role of currency devaluation in cost escalation. A strong positive correlation was found between currency devaluation and the increase in cost per kilometer of road construction, with predictive models for DB and DBB projects demonstrating high correlations of R^2 value 0.91 and 0.98, respectively. The costs of core construction materials like cement, fuel, bitumen, and reinforcement bar exhibited high R^2 values of 0.82, 0.91, 0.93, and 0.94, respectively, further implying that the costs of imported inputs are strongly associated with currency rates.

This strong correlation reflects substantial empirical evidence that devaluing exchange rates transcends mere macroeconomic implications and contributes significantly to the growing financial burden on infrastructure development. Importantly, the implications extend beyond Ethiopia; many import-dependent economies face similar vulnerabilities in infrastructure financing. By adopting measures such as exchange-rate hedging, contingency budgeting, contract price-adjustment clauses, and increased local sourcing, governmental bodies and infrastructure stakeholders can better manage financial risks in volatile currency environments. The combination of empirical depth and forward-looking analysis makes this study a valuable reference for infrastructure planning in Ethiopia and other developing economies. Furthermore, future research in the area should address the current limitations by incorporating normalisation for terrain classification, urbanisation, soil nature, pavement structure, and typical road sections to improve the validity of project cost comparisons.

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References

[1] S. Alder, K. Croke, A. Duhaut, R. Marty, and A. Vaisey, *The Impact of Ethiopia's Road Investment Program on Economic Development and Land Use: Evidence from Satellite Data*. Washington, DC: World Bank, 2022. doi: 10.1596/1813-9450-10000.

[2] S. Bekele and T. Ferede, "Economy-wide Impact of Investment in Road Infrastructure in Ethiopia: A Recursive Dynamic CGE Approach," *Ethiop. J. Bus. Econ.*, vol. 5, no. 2, pp. 187–213, 2015.

[3] A. A. Mekonnen, A. D. Beza, and T. Sipos, "Estimating the Value of Statistical Life in a Road Safety Context Based on the Contingent Valuation Method," *J. Adv. Transp.*, vol. 2022, pp. 1–15, Nov. 2022, doi: 10.1155/2022/3047794.

[4] F. Haile, *The Exchange Rate: Why it Matters for Structural Transformation and Growth in Ethiopia*. World Bank, Washington, DC, 2019. doi: 10.1596/1813-9450-8868.

[5] K. Megersa and D. Cassimon, "Assessing Indicators of Currency Crisis in Ethiopia: Signals Approach," *Afr. Dev. Rev.*, vol. 27, no. 3, pp. 315–330, Sep. 2015, doi: 10.1111/1467-8268.12148.

[6] T. K. Gebremariam and S. Ying, "The foreign direct investment-Export performance nexus: An ARDL based empirical evidence from Ethiopia," *Cogent Econ. Finance*, vol. 10, no. 1, p. 2009089, Dec. 2022, doi: 10.1080/23322039.2021.2009089.

[7] D. M. Bekana, "Determinants of foreign direct investment in Ethiopia; time series evidence from 1991-2013," *J. Dev. Areas*, vol. 50, no. 1, pp. 141–155, Dec. 2016, doi: 10.1353/jda.2016.0002.

[8] T. Nguse, B. Oshora, M. Fekete-Farkas, A. Tangl, and G. Desalegn, "Does the Exchange Rate and Its Volatility Matter for International Trade in Ethiopia?," *J. Risk Financ. Manag.*, vol. 14, no. 12, p. 591, Dec. 2021, doi: 10.3390/jrfm14120591.

[9] S. M. Belay, S. Tilahun, M. Yehualaw, J. Matos, H. Sousa, and E. T. Workneh, "Analysis of Cost Overrun and Schedule Delays of Infrastructure Projects in Low Income Economies: Case Studies in Ethiopia," *Adv. Civ. Eng.*, vol. 2021, no. 1, p. 4991204, Jan. 2021, doi: 10.1155/2021/4991204.

[10] A. Shiferaw Belachew, "Causes of Cost Overrun in Federal Road Projects of Ethiopia in Case of Southern District," *Am. J. Civ. Eng.*, vol. 5, no. 1, p. 27, 2017, doi: 10.11648/j.ajce.20170501.15.

[11] I. Yuliadi, "Determinants of Regional Economic Growth in Indonesia," *J. Ekon. Studi Pembang.*, vol. 21, no. 1, 2020, doi: 10.18196/jesp.21.1.5035.

[12] D. Deme, "Road Traffic Accident in Ethiopia from 2007/08-2017/18," *Am. Int. J. Sci. Eng. Res.*, vol. 2, no. 2, pp. 49–59, Jun. 2019, doi: 10.46545/aijser.v2i2.90.

[13] Dr. C. Ehinomen, "Exchange Rate Management and the Manufacturing Sector Performance in the Nigerian Economy," *IOSR J. Humanit. Soc. Sci.*, vol. 5, no. 5, pp. 1–12, 2012, doi: 10.9790/0837-0550112.

[14] B. B. Sisay, G. M. Meseret, and Girmay, "Development of a mathematical model to predict the cost of Ethiopian Roads Authority Road projects: the case of Ethiopia," *Cogent Eng.*, vol. 11, no. 1, p. 2297492, Dec. 2024, doi: 10.1080/23311916.2023.2297492.

[15] J. S. Shane, K. R. Molenaar, S. Anderson, and C. Schexnayder, "Construction Project Cost Escalation Factors," *J. Manag. Eng.*, vol. 25, no. 4, pp. 221–229, 2009, doi: 10.1061/(asce)0742-597x(2009)25:4(221).

[16] P. Collier, M. Kirchberger, and M. SÖDERBOM, "The cost of road infrastructure in low and middle income countries," pp. 1–56, 2015.

[17] ARCADIS, "The Year of Inflation, International Construction Costs 2022," 2022.

[18] C. Han, T. Han, T. Ma, Z. Tong, and S. Wang, "A BIM-based framework for road construction quality control and quality assurance," *Int. J. Pavement Eng.*, vol. 24, no. 1, p. 2209903, Dec. 2023, doi: 10.1080/10298436.2023.2209903.

[19] N. Simić, N. Ivanišević, Đ. Nedeljković, A. Senić, Z. Stojadinović, and M. Ivanović, "Early Highway Construction Cost Estimation: Selection of Key Cost Drivers," *Sustainability*, vol. 15, no. 6, p. 5584, Mar. 2023, doi: 10.3390/su15065584.

[20] A. Jaafari, I. Pazhouhan, and P. Bettinger, "Machine Learning Modelling of Forest Road Construction Costs," *Forests*, vol. 12, no. 9, p. 1169, Aug. 2021, doi: 10.3390/f12091169.

[21] P. Segui, A. E. M. Safhi, M. Amrani, and M. Benzaazoua, "Mining Wastes as Road Construction Material: A Review," *Minerals*,

vol. 13, no. 1, p. 90, Jan. 2023, doi: 10.3390/min13010090.

[22] Ethiopian Roads Administration. 2013 Geometric Design Manual.

[23] Ethiopian Urban Street Design Manual 2023.

[24] S. M. Gemechu and G. S. Tulu, "Safety Effects of Geometric Design Consistency on Two-lane Rural Highways: The Case of Ethiopia," *Am. J. Traffic Transp. Eng.*, vol. 6, no. 4, p. 107, 2021, doi: 10.11648/j.ajtte.20210604.11.

[25] K. Schwab and S. Zahidi, "The global competitiveness report: How countries are performing on the road to recovery," 2020.

[26] Y. Dinsa, "Assessment of the causes and effects of price escalation of federal road contracts in Ethiopia," 2015.

[27] E. B. E. Mohamed and S. Y. M. Mahmoud, "An Assessment of the Impact of Inflation on the Prices of Selected Construction Materials in Sudan," *Int. J. Multidiscip. Res. Publ. IJMRAP*, vol. 2, no. 12, pp. 41–44, 2020.

[28] "US Dollar to Ethiopian Birr History: 2025." Accessed: Apr. 29, 2026. [Online]. Available: https://www.exchangerates.org.uk/USD-ETB-spot-exchange-rates-history-2025.html

[29] H. Asrat, "Assessment of time and cost performance evaluation of Ethiopian construction: a case study of Addis Ababa city road authority," 2020.

[30] D. Degefa, "The parallel foreign exchange market and macroeconomic performance in Ethiopia," 2001.

[31] Z. T. Zewdu and G. T. Aregaw, "Causes of Contractor Cost Overrun in Construction Projects: The Case of Ethiopian Construction Sector," *Int. J. Bus. Econ. Res.*, vol. 4, no. 4, p. 180, 2015, doi: 10.11648/j.ijber.20150404.11.

[32] K. K. Berta and M. Tesfaye, "Determinants of road construction project delay in the case of Woliso–Ambo road construction," *Sci. Rep.*, vol. 15, no. 1, p. 5405, Feb. 2025, doi: 10.1038/s41598-025-86852-9.

[33] J. S. Arthur, "The impact of the 2008 global economic recession on Engineering Education in Africa – A case study from the AFRICON international conferences," *Adv. Comput. Technol. Educ.*, pp. 66–71, 2008.

[34] WSDT, "Cost Estimating Manual for WSDOT Projects," *Wash. State Dep. Transp.*, 2008.

[35] W. Wu, M. C. Cavalli, W. Jiang, and N. Kringos, "Differing perspectives on the use of high-content SBS polymer-modified bitumen," *Constr. Build. Mater.*, 2024, [Online]. Available: https://api.semanticscholar.org/CorpusID:266417371

[36] X. Xiuzhen, W. Zheng, and M. Umair, "Testing the Fluctuations of Oil Resource Price Volatility: A Hurdle for Economic Recovery," *SSRN Electron. J.*, 2022, doi: 10.2139/ssrn.4123875.

[37] USDAFSNRE, "Cost Estimating Guide for Road Construction USDA FOREST SERVICE NORTHERN REGION ENGINEERING," 2020.

[38] D. Cheng *et al.*, "Projecting future carbon emissions from cement production in developing countries," *Nat. Commun.*, vol. 14, no. 1, p. 8213, Dec. 2023, doi: 10.1038/s41467-023-43660-x.

[39] J. Puci, A. Demi, and A. Kadiu, "Impact of macroeconomic variables on the construction sector," *Corp. Bus. Strategy Rev.*, vol. 4, no. 1, pp. 22–30, 2023, doi: 10.22495/cbsrv4i1art2.

[40] Y. Dinsa, “Assessment of the Causes and Effects of Price Escalation of Federal Road Contracts in Ethiopia,” Master's, Addis Ababa University, 2015. Accessed: Mar. 21, 2025. [Online]. Available: http://thesisbank.jhia.ac.ke/6569/

[41] A. Shiha, “Prediction of construction material prices using macroeconomic indicators: A neural networks model”.

[42] U. V. Alintah-Abel, F. N. Okeke, and E. C. Enebe, “Assessing the Effect of Subsidy Removal on Cost- Significant Material and Labour within Anambra State Construction Economy,” *Br. J. Multidiscip. Adv. Stud.*, vol. 6, no. 2, pp. 1–23, Mar. 2025, doi: 10.37745/bjmas.2022.04253.

[43] A. Ebekozien, C. O. Aigbavboa, W. D. Thwala, M. A. Hafez, and M. S. Samsurijan, “Sustainable development goals under threat: the impact of inflation on construction projects,” *Eng. Constr. Archit. Manag.*, vol. 31, no. 13, pp. 323–341, Dec. 2024, doi: 10.1108/ECAM-03-2024-0357.

[44] I. B. Muhit, E. L. Omairey, and V. G. Pashakolaie, “A holistic sustainability overview of hemp as building and highway construction materials,” *Build. Environ.*, vol. 256, p. 111470, May 2024, doi: 10.1016/j.buildenv.2024.111470.

[45] Q. Liu, P. He, S. Peng, T. Wang, and J. Ma, “A Survey of Data-Driven Construction Materials Price Forecasting,” *Buildings*, vol. 14, no. 10, p. 3156, Oct. 2024, doi: 10.3390/buildings14103156.

[46] N. B. Nambie and P. Dadzie, “Trade Realignments, Exchange Rate Volatility, and Financial Stability in Sub-Saharan Africa,” *J. Econ. Finance Account. Stud.*, vol. 8, no. 2, pp. 26–40, Jan. 2026, doi: 10.32996/jefas.2026.8.2.3.