

A Multiple Linear Regression Model to Predict the Price of Cement in Nigeria

Kenneth M. Oba

Abstract—This study investigated factors affecting the price of cement in Nigeria, and developed a mathematical model that can predict future cement prices. Cement is key in the Nigerian construction industry. The changes in price caused by certain factors could affect economic and infrastructural development; hence there is need for proper proactive planning. Secondary data were collected from published information on cement between 2014 and 2019. In addition, questionnaires were sent to some domestic cement retailers in Port Harcourt in Nigeria, to obtain the actual prices of cement between the same periods. The study revealed that the most critical factors affecting the price of cement in Nigeria are inflation rate, population growth rate, and Gross Domestic Product (GDP) growth rate. With the use of data from United Nations, International Monetary Fund, and Central Bank of Nigeria databases, amongst others, a Multiple Linear Regression model was formulated. The model was used to predict the price of cement for 2020-2025. The model was then tested with 95% confidence level, using a two-tailed t-test and an F-test, resulting in an R^2 of 0.8428 and R^2 (adj.) of 0.6069. The results of the tests and the correlation factors confirm the model to be fit and adequate. This study will equip researchers and stakeholders in the construction industry with information for planning, monitoring, and management of present and future construction projects that involve the use of cement.

Keywords—Cement price, multiple linear regression model, Nigerian Construction Industry, price prediction.

I. INTRODUCTION

CEMENT has remained a key material in the construction industries of most countries [1]. In Nigeria, cement is the most utilised construction material. In some instances it is used with different other materials to produce concrete, while in other instances, it is used with other materials for blockwork, finishes, and repairs. It is also used in some instances, with other materials for modification and stabilisation of soils for pavement construction. Cement consumption in Nigeria is about 149 kg/person [2]. As a result of these, cement has a critical impact on Nigeria's economy, as it affects several sectors of the economy such as the construction, oil and gas, and education sectors [3], [4]. It is therefore important to place serious attention on cement prices, considering the way they fluctuate (change), the factors that cause those changes, and the effects of those changes. The growing population, inflation rate, energy, exchange rate, GDP, and transportation cost among others have always been serious issues for engineers, contractors, private and government developers to contend with when it comes to procurement of construction materials, especially that of

cement [1]. Therefore there is a dire need for one to be equipped and be proactive in the planning of future construction projects that would utilise cement.

In Nigeria, there had been several cement producing companies in the past. However, some have left the scene, while some new ones have emerged. Some of the past and present cement companies in Nigeria include Dangote cement, West African Portland Cement Company (WAPCO) now called Lafarge cement, Unicem, Ashaka cement, Cement Company of Northern Nigeria (CCNN), Eagle Cement, Rock Cement, Ibeto Cement, Niger Cement, Benue Cement Company (BCC), Eastern Bulk Cement, Purecem, and Bua Cement.

During the post-civil war, Nigeria was completely dependent on importation of cement [5] because of rapid infrastructural and residential development. However, despite the massive volume of local manufacture of cement in Nigeria today, there is still a significant trace of importation of either cement or some of its raw materials, which still has a huge effect on the economy. This study looks at investigation of prices of grade 42.5 cement of 50 kg bags between 2014 and 2019; factors affecting changes in cement prices; and predictions from 2020 to 2025 using Multiple Linear Regression (MLR) model.

II. LITERATURE REVIEW

Cement is an integral part of concrete, while concrete contributes the most quota in the construction industry [6]. The rising price of cement has however been a major constraint to the development of the Nigerian construction industry [3]. Several studies and attempts have been made to address, monitor, or predict the prices of cement. This is not peculiar to Nigeria, as several researchers such as [7]-[9] have also carried out similar studies on cement prices in India; while those of Ghana, Egypt, Bangladesh, Azerbaijan, and Turkey have been carried out by [10]-[15] respectively.

A. Dangote Cement

Dangote Cement is the biggest cement producing company in Africa with a production capacity of 29 million metric tonnes per annum [16] with profit margin of 62% [1], [16] and market share price of 43.8% [17], making it the largest company of all the companies in the Nigerian Stock Exchange (NSE) [1], [16], [17]. Dangote Cement is also the largest cement company in Nigeria with a 65% market share [2]. However, in the first quarter of 2019, [18] reported that Dangote Cement profit margin dropped to 60.9% with a capacity of 46 million metric tonnes per annum across Africa,

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of which Nigeria alone had about 29.25 million metric tonnes per annum.

B. Other Cement Companies and the Nigerian Cement Industry

The cement industry in Nigeria is classified under the manufacturing sector [19], [20]. The country's economic activities have gradually improved, making it the largest economy in Africa, overtaking South Africa [20]. Nigeria has several cement companies, but Dangote cement, Ashaka cement, Lafarge cement, and CCNN are the four largest in the country with over 85% of the total combined cement capacity [2]. The overall cement capacity in Nigeria has increased to 28.95 million metric tonnes [4] as Nigeria is now more of a cement exporting country, than an importing one (see Fig. 1).

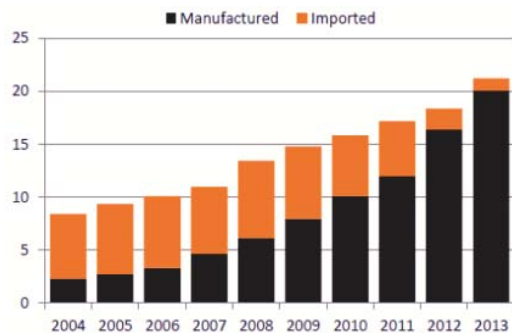


Fig. 1 Growth in Nigeria cement sales in million tonnes [16]

Nigeria is currently the leading cement producing country in sub-Saharan Africa, overtaking South Africa [4] in 2012. However, Lafarge cement which has a profit margin of about 35% [21] has consolidated with Dangote cement in a bid to increase Nigeria's cement production capacity to place Nigeria in the world's top 15 cement producing countries by 2025 [4].

C. Cement Prices in Nigeria and Factors Affecting Them

Cement prices have evolved over the years in Nigeria. For fewer years there was decrease in the prices, while for the most years, there was increase. Cement is either sold in retail or wholesale. The former is considered on a per 50 kg bag basis. The cement retailers in Nigeria sold a bag of cement at prices with which they could make reasonable profit, after deduction of transportation, and other minor expenses. Table I shows the cement price changes between 2014 and 2019. These changes were as a result of certain factors such as production cost, prices of raw materials, energy cost, industry related factors, and macro-economic variables [11]. The macro-economic factors according to [10] are inflation rate, exchange rate, and monetary policy rates. Studies carried out by [5] also show that GDP, importation of cement, and local manufacture of cement are important factors that affect the price of cement. Similarly, [4] categorised the internal macro-economic factors as GDP growth, inflation, population growth, interest rates, and government expenditure, while the external factors are crude oil prices and exchange rate. However, according to [3], the most critical factors affecting

the prices of construction materials are; inflation rate, import, exchange rate, money supply, and interest rate. Some of the above mentioned factors increase the price of cement, while others decrease it.

D. Cost of Raw Materials

Cement is made of raw materials such as lime (CaO), silica (SiO₂), alumina (Al₂O₃) and ferrite or iron oxide (Fe₂O₃) which react together to form four main complex compounds [6]. Limestone and clay have high amounts of lime [22], and limestone is in a large abundance in Nigeria [5]. This makes it less expensive [4]. However, the only raw material that is imported is gypsum, which constitutes less than 8% of the total raw materials for cement production [4]; hence importation of raw materials does not have much negative impact on cement price.

E. Cost of Energy

Energy is required to power the production plants and other equipment required for the manufacture of cement. In Nigeria, electricity supply is minimal, hence there is need to resort to the use of large volumes of fossil fuels to generate power for the plants. About 39% of the cost of production of cement in Nigeria is spent on energy, as compared to 10% in China, and 27% globally [4]. As a result of this, coupled with the rising demand for cement in Nigeria, there is a high influence of energy cost on the increase in the price of cement.

F. Inflation Rate

Reference [4] showed that Nigeria's high inflation rate has affected domestic cement consumption negatively. According to [19] inflation rates in Nigeria have increased between 2013 and 2017, but decreased in 2018 and first half of 2019. This means that there is a tendency for it to increase in the near future looking at the trend, which can force up the price of cement.

G. Population Growth Rate

With the growing population in Nigeria, local cement consumption has a high tendency of increase. The demand for cement is growing. The United Nations population data [23] show that Nigeria, with a population growth rate of 2.6 in 2019, is the 7th most populated country in the world, with a population of about 200,963.6 persons, with 50.67% and 49.33% male and female respectively (see Table II). According to [4], the increasing population of Nigeria portends a boost in infrastructural and housing developments which are currently on a lower level. This, based on the law of demand, can decrease the price of cement.

H. Exchange Rate

Nigeria's overdependence on cement importation in the past resulted in low exchange rates for the Naira against some foreign currencies, as well as high interest rates, making funding a bit more difficult [5]. This, according to [4] is because Nigeria, had relied on importation of cement for about 43 years, and as a result, had issues whenever the foreign currencies rise against the Naira. However, given that Nigeria

is now more of a cement exporting country than an importing one, the exchange rate has a positive effect on the price and consumption of cement in Nigeria. A study carried out by [24] indicates that exchange rate is highly correlated with price of cement, with a 0.99 correlation factor.

I. Cost of Transportation

Transportation of cement to depots, and to retail outlets has proven over the years to be very important to local cement consumers. Construction sites all over the country require movement of cement from the point of sale to the sites. This has been seriously affected by the fact that the main means of transportation in Nigeria is the road. The trucks and other vehicles that transport the cement are all dependent on fossil fuels, whose prices are recently on a rise. Also, the roads in most parts of Nigeria are in a deplorable state, making it difficult for transporting cement to certain parts of the country. These have, and can continually cause an increase in cement prices.

J. GDP Growth Rate

The manufacturing sector of the Nigerian economy comprises 13 activities which are cement; oil refining; food, beverages, and tobacco; wood and wood products; non-metallic products; plastic, and metallic products; textile, apparel, and footwear; pulp paper and paper products; electrical and electronic; basic metal, and iron & steel; motor vehicles and assembly; chemical and pharmaceutical products; and other manufacturing [25]. The cement aspect of the Nigerian manufacturing sector has recorded significant contribution to the entire GDP of the country. In 2010 and 2016, Nigeria recorded the highest and lowest GDP growth rates of 11.3% and -1.61% respectively [26]. GDP was one of the variables used in the determination of the regression model in [4] which shows how important the GDP of Nigeria is on locally manufactured and imported cement.

K. The MLR Model

The multiple linear regression is a regression model that is used to predict a dependent variable given more than one

independent variable in a straight line form. Several authors [4], [5], [7], [8], [10], [13] have used it in research for one form of prediction or another.

III. RESEARCH METHODOLOGY

The study is centred on collection of secondary data from published articles on the subject matter. On this note, data were collected from CBN, UN, and IMF website, as well as other published literature. However, primary data of prices of cement were also collected with the aid of questionnaires distributed to some cement retail outlets in some parts of Port Harcourt. From the available data and literature review, it was found that the most critical factors to be considered in this study are: Inflation rate, population growth rate, and GDP growth rate.

The governing equation of the study is:

$$P = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \quad (1)$$

This is a MLR to degree one where: P is the Price of cement in Naira, and X_1 , X_2 , and X_3 are the inflation, population growth, and GDP growth rates respectively. Also, β_0 , β_1 , β_2 , and β_3 are model constant coefficients.

The inflation rates between 2014 and 2018 were collected from the website of the Central Bank of Nigeria (CBN). The population growth rates between 2010 and 2025 were obtained from the United Nations (UN) website. Finally, the GDP growth rates were obtained from the International Monetary Fund (IMF) website. The Multiple Regression Analysis was carried out using Minitab 16, and the regression model equation generated.

RESULTS AND DISCUSSIONS

The prices of grade 42.5 per 50 kg bag of cement between 2014 and 2019 are shown in Table I (in Naira).

By interpolation, the growth rates for 2014, 2020, 2021, 2022, 2023, and 2024 are 2.70, 2.58, 2.57, 2.55, 2.54, and 2.52 respectively.

TABLE I
CEMENT PRICES IN NIGERIA (SOURCE: RESEARCHER'S SURVEY IN PARTS OF PORT HARCOURT)

Month/Year	2014	2015	2016	2017	2018	2019
January	1,550.00	1,800.00	1,400.00	2,350.00	2,550.00	2,500.00
February	1,550.00	1,800.00	1,400.00	2,350.00	2,550.00	2,500.00
March	1,850.00	1,850.00	1,550.00	2,350.00	2,550.00	2,500.00
April	1,750.00	1,900.00	1,600.00	2,350.00	2,550.00	2,500.00
May	1,700.00	1,900.00	1,600.00	2,350.00	2,550.00	2,500.00
June	1,700.00	1,900.00	1,600.00	2,350.00	2,550.00	2,500.00
July	1,700.00	1,800.00	1,600.00	2,650.00	2,500.00	2,500.00
August	1,700.00	1,800.00	1,650.00	2,650.00	2,500.00	2,500.00
September	1,650.00	1,850.00	2,300.00	2,650.00	2,500.00	2,500.00
October	1,650.00	1,500.00	2,300.00	2,650.00	2,500.00	2,500.00
November	1,600.00	1,500.00	2,300.00	2,650.00	2,500.00	2,500.00
December	1,400.00	1,400.00	2,300.00	2,650.00	2,500.00	2,500.00
AVERAGE	1,650.00	1,750.00	1,800.00	2,500.00	2,525.00	2,500.00

TABLE II
NIGERIA'S POPULATION DATA [23]

Year	Total Population	% Male	% Female	Pop. Density (kM ²)	Population Rank	Growth Rate
2010	158,503.20	50.57%	49.43%	171.58	7	2.68%
2015	181,137.45	50.64%	49.36%	196.09	7	2.71%
2016	185,960.24	50.65%	49.35%	201.31	7	2.66%
2017	190,873.24	50.66%	49.34%	206.62	7	2.64%
2018	195,874.68	50.66%	49.34%	212.04	7	2.62%
2019	200,963.60	50.67%	49.33%	217.55	7	2.60%
2020	206,139.59	50.68%	49.32%	223.15	7	
2025	233,343.11	50.71%	49.29%	252.6	6	2.51%

TABLE III
NIGERIA'S REAL GDP GROWTH RATE [26]

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Real GDP Growth Rate (%)	6.7	7.3	7.2	8.4	11.3	4.887	4.279	5.394	6.31	2.653	-1.617	0.806	1.937	2.147	2.536	2.441	2.743	2.551	2.569

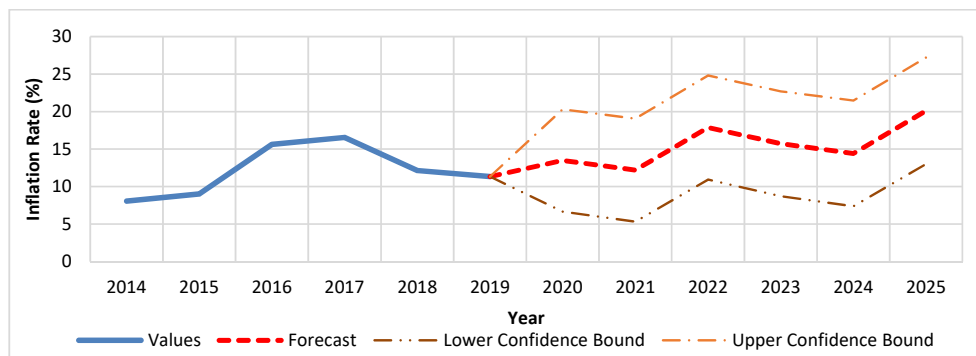


Fig. 2 Inflation Rate Forecast Using MS Excel exponential trend forecast tool

TABLE IV
NIGERIA'S INFLATION RATES [19]

Year	Inflation Rate (%)
2014	8.06
2015	9.01
2016	15.63
2017	16.55
2018	12.15
2019	11.32

The forecast in Table III was done by [26] up to 2024. A linear extrapolation yields 2.587 for 2025.

Using exponential trend forecasting tool in MS Excel, Fig. 2 represents both the previous and forecast inflation rates. Hence 2020, 2021, 2022, 2023, 2024, and 2025 will be 13.48, 12.19, 17.88, 15.71, 14.42, and 20.11 respectively.

From the data in Tables I-IV, and using (1), the model was formulated from Minitab 16 as

$$P = 24296.1 + 42.06X_1 + 8589.59X_2 + 58.82X_3 \quad (2)$$

The above model was used to predict the prices as shown in Table V.

The model prediction is represented graphically in Fig. 3.

A. Test of Adequacy of the Model

A Fisher test and a two-tailed student t-test were carried out

at 95% confidence level using Microsoft Excel 2016 software. The correlation factor (R^2) and adjusted correlation factor [R^2 (adj.)] were also determined using Minitab 16 software. These are shown in Table VI.

The results in Table VI show that the model is both fit and adequate.

IV. CONCLUSION

Cement prices were predicted using a MLR model. The derived model shows that the average price of a 50 kg bag of cement will increase continuously from ₦2500 in 2019 to ₦3306.07 in 2022. It will later decrease in 2023 to ₦3289.40 after which it will increase continuously in 2024 and 2025 to ₦3407.99 and ₦3734.28 respectively. The model is based on the following three factors: inflation rates, population growth rate, and GDP growth rate. The model was tested statistically with a 95% confidence level using the two-tailed t-test and the Fisher test. The R^2 value was found to be 84.28%, which was adjusted to 60.69%. The both tests and R^2 values confirmed the model fit and adequate.

Construction project owners, civil engineers, and other stakeholders in the construction industry will now have a tool to plan for current and future projects as well as monitor the prices of construction materials, especially cement. It is hereby recommended that adequate attention should be paid to

the predicted prices for the next six years, assuming that the three factors considered will remain fairly close to those forecasted in this study. However, 2023 will be an election year in Nigeria. This means that there might be slight or major

changes in either the three factors, or the prices of cement, as a result of the elections. Hence, further studies should be carried out to address other factors that may arise before or after 2025 that were not considered in this study.

TABLE V
MODEL PREDICTION DATA

Period	Actual Prices, P_a (₦)	Inflation Rates, X_1 (%)	Population growth Rates, X_2 (%)	Real GDP growth Rates, X_3 (%)	Predicted Prices, P_p (₦)
Past/Current	2014	1650	8.05	2.70	1813.99
	2015	1750	9.07	2.71	1555.87
	2016	1800	15.63	2.66	2010.10
	2017	2500	16.55	2.64	2363.12
	2018	2525	12.15	2.62	2416.37
	2019	2500	11.32	2.60	2565.60
Future	2020		13.48	2.58	2851.13
	2021		12.19	2.57	2877.18
	2022		17.88	2.55	3306.07
	2023		15.71	2.54	3289.40
	2024		14.42	2.52	3407.99
	2025		20.11	2.51	3734.28

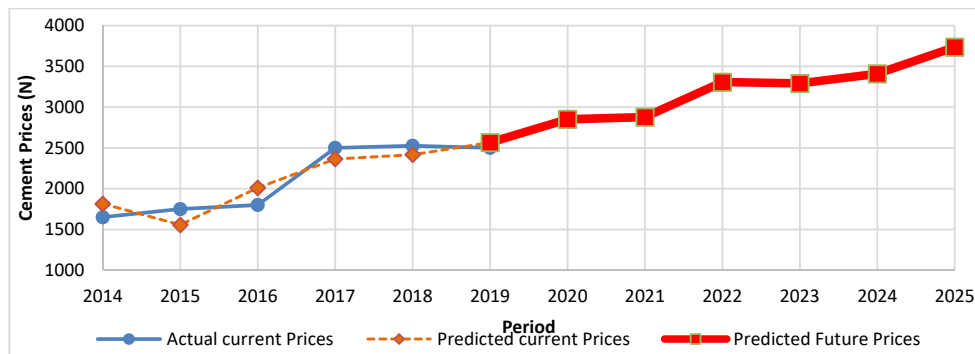


Fig. 3 Graphical Representation of Model Predicted Data

TABLE VI
MODEL STATISTICAL TESTING

t-Test: Paired Two Sample for Means			F-Test Two-Sample for Variances		
	Y_{actual}	$Y_{predicted}$		Y_{actual}	$Y_{predicted}$
Mean	2120.8333	2120.8417	Mean	2120.8333	2120.8417
Variance	182604.17	153892.08	Variance	182604.17	153892.08
Observations	6	6	Observations	6	6
Hypothesized Mean Difference		0	df	5	5
df		5	F	1.186573	
t Stat		-0.00012	P(F<=f) one-tail	0.427836	
P(T<=t) one-tail		0.49995	F Critical one-tail	5.050329	
t Critical one-tail		2.01505			
P(T<=t) two-tail		0.99991	Correlation	R^2	R^2 (adj.)
t Critical two-tail		2.57058		0.8428	0.6070

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