



Prediction of the Price of Cement in South Western Part of Nigeria: A Machine Learning Approach

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Abstract

Cement is one of the essential products that is needed in various construction works. It has been found very useful in the construction of houses, roads, bridges etc. In Nigeria the price of cement was quite stable in 1970's and 1980's. Recent market survey indicated that the price is on a very high side to the extent that it is almost becoming impossible for average Nigerians to have their own apartments where they can lay their heads after the daily activities. To the best of our knowledge, literature reveals that no attempt has been made to predict the price of cement in Nigeria, using Machine Learning (ML) models. Those that attempted it, mostly focused on statistical approach. In this research work, a machine learning model was used to predict the price using exponential regression model. Our method was compared with the existing ones and the performance is better. It produced the least Mean Squared Error (MSE) of 1.5455 and the percentage errors during the training were quite minimum. It was finally predicted that by the 2050, the price of 50kg bag of cement will be about ₦50,000 if government do not take necessary actions. This research work will be an eye opener to the government and other stakeholders.

Keywords: Machine Learning, Statistical Model, Linear Regression, Multiple Regression, Mean Squared Error

1. Introduction

Nigeria as a country is blessed with abundant mineral resources. One of those resources is cement. Cement is a natural gift which is made up of various compound that include lime (CaO), Iron oxide (Fe₂O₃), Alumina (Al₂O₃). It is made up of those substances that resist attack by chemicals after setting. After setting, it hardens and adheres to other materials, to bind them together. They all react together to form various layers of cement as noted in Kenneth (2019). The cement industry in Nigeria is recognized as manufacturing sector. In some years back, this really boost the economy of the country to the extent of overtaking South Africa and becoming the best nation in Africa. Hence, Nigeria as a country was described then as a giant of Africa.

Cement is used in various ways. It could be used to mould blocks to erect buildings, for construction of pavements, bridges etc. So, it will not be an over statement to say that without cement life would have proved much more difficult for man. The demand for cement is always on a high side because of its relative importance. Around nineteen seventies, a 50kg bag of cement would not cost more than five naira. Later it was

ten naira until today when a 50kg bag of cement will cost about ₦4, 000. Cement market like other products in Nigeria is currently witnessing galloping inflation. In spite of the fact that there are so many cement industries currently producing at high capacity in Nigeria, the galloping inflation still persist. Some of the cement companies producing cement in Nigeria includes Dangote cement, Asaka cement, OCN and Lafarge Cement. They are the four largest in the country with over 85% of the total combined cement capacity. Nigeria now produced 28.95 million metric tonnes, Dunn (2014). Hence it is described as cement exporting country rather than importing country, Man are said to be intelligent because they possess natural intelligence which made them to act appropriately in an attempt to solve real life problems Olanloye (2014)

Machines of course do not possess natural intelligence and yet can be made to solve real life problems in a humanlike manner. This is possible if the machines can be trained with various machine learning algorithms which will eventually create a set of artificial intelligence in the machines. Artificial Intelligence was defined by John McCarthy as the science and engineering of making intelligence machines. Tutorial points (2022) defined

AI as a way of making a computer, a computer controlled robot or a software that think intelligently in a similar manner the intelligent human think. Boucher (2020) refers to Artificial Intelligent(AI) system as a system that display intelligent behaviour by analyzing their environment and take action with some degree of autonomy to achieve some specific goal. So, Artificial intelligence is nothing but just an aspect of computer Science that attempts to create a sort of intelligence(Artificial) in machine to enable the machine to solve real life problems in a humanlike manner.

With the current technological development going on the world, data are being collected from time to time using various methods and approaches. Hence, the prevailing technological development made data available from time to time. Such data will have to be put into use so that the efforts used in collecting such data will not be fruitless one. Machine learning as one of the subset of AI make use of appropriate learning algorithm to train large amount of data such that the knowledge acquired can be used to solve the target problem without human intervention. ML provide the machine with adequate knowledge to solve targeted problems. It is an aspect of AI which uses large amount of data to train computer machine to acquire enough skill to solve future problems. ML makes it possible for machines to acquire knowledge from massive amount of data which is very heavy and sometimes impossible for man to analyze, Youness and Muhammed (2018).

In ML, machines are made to acquire enough experience from historical data and apply such experience to solve the future problems. The performance of ML algorithm will depend on the quality and quantity of historical data. A lot of research work are being carried out making use of the ML as a tool.

The galloping inflation in the price of cement is becoming economically embarrassing and call for serious attention. A lot of research works have been done and are still being carried out by different authors in this research area but yet, enough is yet to be done in the area of ML. Therefore, this research is out to look into the aspect of using ML models in predicting the price of cement in the south western part of Nigeria. The research made use of historical data from 2011 to date. It was finally predicted that in the 2050, a 50kg bag of cement will cost about fifty thousand naira, if all other things remain equal. The research work was implemented using MatLab ML Predictive tool.

2. Review of Related Studies

There are so many published articles in the area of prediction using either statistical or machine learning approach. Kenneth M.Oba (2019) presented a research work using multiple linear regression to predict the price of cement in Nigeria. He was able to develop a statistical model which was used to predict the price of cement in Nigeria between 2020 and 2025. The model was tested at 15% confidence level using a two tail T-test and F-test. Various tests carried out by the author on the model confirm the accuracy and efficiency of the model. Finally, the model predicted that by 2025, the cost of a bag of 50kg of cement will be N3750. This research work made use of the statistical model and again the prediction range is within 2020 to 2025; Unlike in the proposed research work where a ML Model will be used and it will be able to have more coverage; from 2021 to 2050.

Bipin pal et al (2018) presented a cost estimate model of buildings using Artificial Neural Network (ANN). It was a review of various models which were built earlier. So, no new method or technique was presented by the author. Though the author still used ANN model for prediction, but not the price of cement but rather the cost of buildings. The result of the trained models gave the impression that ANN reasonably succeeded in estimating building project. The method used is statistical method and has nothing to do with ML.

Mohd Ajmal (2015) also published a research article on evaluation of financial performance of cement cooperation in India. The author assessed the performance of cement cooperation in India using statistical principles,

Also M. Bediako, E.O Amankwah and D. Adobor (2016) also presented a research work on the impact of macro-economic indicator on cement prices in Ghana. This is based on the principle of economics.

Also Bassioni Elmastry, Ragheb and Abeer (2021) presented a time series analysis for prediction of Rc material component prices in Egypt and Gardashara. Huseyna (2016) also carried out a research on cement industries overview and transact price forecasting in Azerbaijan

Saranya. S.(2017). He was able to present an article titled Comparative Financial Analysis of Ultra Tech Cement Limited ,Shree Cement Limited and Ambuja Cement limited companies between 2012 and 2016

Olanloye, Olasunkanmi and Oduntan (2018) also published a research article on prediction of Population of Nigeria using ML approach.

Going through literature, it was observed that though authors have been publishing various research articles on price prediction but, none has made an attempt to predict the price of cement in the south western part of Nigeria. But the galloping inflation in the price of cement calls for attention. Hence there is a need for this type of research at this point in time.

2.1 Artificial intelligence and machine learning

Artificial Intelligence (AI) is a branch of computer science which is concerned with development of computer programs that is capable of accomplishing tasks which would have demanded for human intelligence. AI basically addresses some fundamental problems and therefore provides answers to some questions such as: What is the knowledge required in an attempt to solve some real life problems? What techniques or methods do we use to represent such knowledge and how can such knowledge be beneficially applied to solve the problem (Ziyad, 2019)?

AI is subdivided into many areas which includes ML, Expert System, Natural Language Processing, speech recognition, computer vision and so on. It is a category of algorithm that enables software applications to predict responses more accurately without being explicitly programmed. ziyad (2019)

Machine Learning is a subset of AI and therefore used in solving AI Problems. It has to do with making machines to take decisions without being especially programmed. Data is being fed into the computer system to learn and apply the experience

Prediction of the Price of Cement in South Western Part of Nigeria.... or knowledge acquired to solve future problem. ML has become very popular nowadays because it is a good and useful tool for the purpose of prediction or forecasting. Hence series of forecastings and predictions can be made with ML. Once ML will need a large data then it encourages generation of large data from time to time. It is useful for the purpose of extracting useful information from data. It also recognize pattern in a given set of data.

In ML, data has to be trained with algorithm through a learning process, There are different aspects of learning e.g. Supervised, Unsupervised and Reinforcement learning

In supervised Learning, the model are trained using label data set. Every data input we are feeding the system are labelled. The Supervised Learning algorithm contains a dependent variable which is predicted from any giving set of independent variable. This gave birth to a function that maps each input value (independent variables) to a particular output (dependent variable). This process will continue until the model attains satisfactory level of performance in term of its accuracy.

Supervised learning is one of the aspect of machine leaning and has become so popular because of its wide application. In its application, the teacher (algorithm) measure the error involved during the learning process at the end of every iteration with the utmost intension to reduce the error to the barest minimum as the learning continues. Hence, the teacher continues to adjust the parameter until the error is reduced to the acceptable level. If there is an input variable X and an output variable Y , the algorithm learns the mapping function from input to output. $Y = f(x)$ and this function is provided by dataset which is a collection of labelled examples $\{(X_i, Y_i)\}_{i=1}^N$. Each element X_i among N is called feature vector. Examples of supervised learning algorithm includes: Regression, Decision Tree, KNN, Random Forest, Logistic Regression. e.t.c

Unsupervised Learning: Here, there is no target variable. unlabelled data set is given as input for the model to study on its own without any supervision, divide them into various groups (clusters) such that set of data in one group differ from set of data in another group. So, there is no target variable to predict but rather the algorithm train the model to group set of unlabelled data into clusters. Examples of unsupervised learning algorithm includes: K-nearest neighborhood, KSOM, C-Clustery .

Reinforcement learning. The algorithm train the model to make free decision without being supervised. The algorithm can make its own decision based on the past experience and use it to train itself using trial method to adapt to a particular situation.

3. Statement of the Problem

Nigeria in recent years continues to battle with economic hardship brought about by the galloping inflation in prices of goods and services. Hence the price of cement has continued to be on a very high side and gradually becoming unaffordable to the average Nigerians especially the less privileged ones. Millions of naira will be required to build a simple apartment for a family to leave because of the hike in price of cement.

The cost of renting an apartment is also on a very high side. Buildings, roads, drainages and quarters are poorly maintained by individuals and government for the same reasons. Government is also finding it extremely difficult to embark on meaningful construction works for the benefit of the masses.

This calls for attention of the researchers. Literature reveals that most of the researches carried out in this area are not really from AI or M principle. Few works that have been done in this particular area made use of statistical principles. Researchers in the area of Artificial Intelligence or Machine Learning have not made enough attempts to address this unbearable situation. Therefore, in this research work, an attempt is being made to predict the price of this essential commodity. The result of such prediction will go a long way to assist the government to plan and decide on how to curb this galloping inflation. The novelty of this research work lies on the fact that ML exponential regression models will be applied to characterize the behavior of cement price and predict the price till 2050. The decision to be made by the stakeholders based on the result obtained in this research work will go a long way to reshape the economy of this country.

Methodology and Implementation

Exponential Regression Analysis and trending were used to carry out this research work. The visualization shows an exponential trend hence we used exponential trend to characterize the historical data. The function is of the form $y = ax + be^{cx} + \mu$. where y is the dependent variable that represent the price of cement and x is the independent variable that represent the year, a is the coefficient of the linear function $y = ax$ and b is the coefficient of the exponential function $y = be^{cx}$, c is the exponential factor and μ is the error. Different exponential models were developed and tested before the the most accurate was selected for prediction.

Historical data has always been unstable since 1990 to date. In this research work, an attempt is made to collect prices of cement (historical price) from 2011 to date. Different ML models are formulated to characterize the behavior of the changes (increase) in price from time to time especially in the last ten years. The best of these models was chosen to predict the future price of the commodity from now till 2050 .MatLab Machine Learning Linear Regression tool was used for implementation.

4.1 Tables and figures

Fig 1 shows the line graph of the actual price of cement per 50kg from year 2011 to 2021. There was a government intervention at the beginning of 2015 that reduce the price drastically to 1,500 naira until 2016 when the price skyrocketed again to its previous level at over 2000 naira

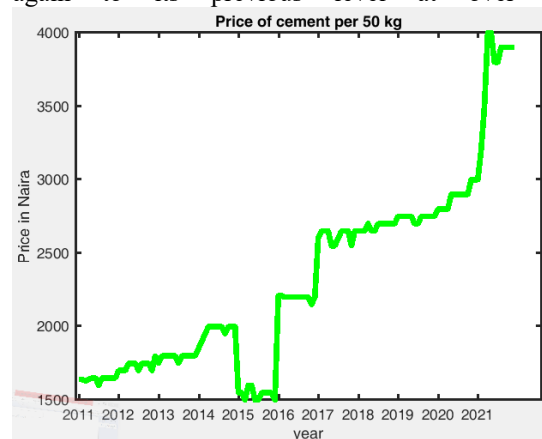


Fig. 1: Price of cement per 50 kg from 2011 to 2021

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Fig 2 shows the bar chart for each monthly price of cement from 2011 to 2021. At the top of each bar, it was observed that the prices dropped slightly due to raining season.

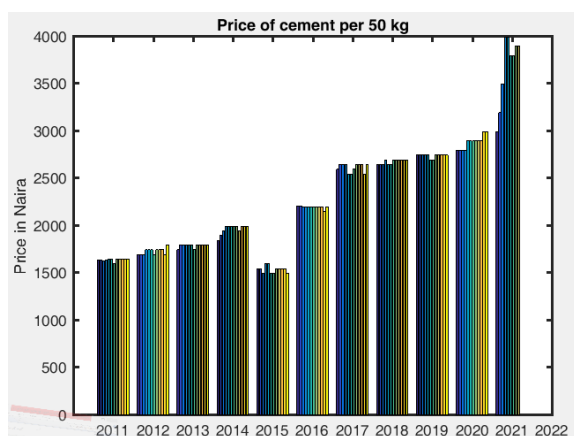


Fig. 2: Monthly average price of cement per 50 kg from 2011 to 2021

Fig 3 shows the 3-D bar chart of the price of cement from 2011 to 2021. This is meant to show further visualization of the data.

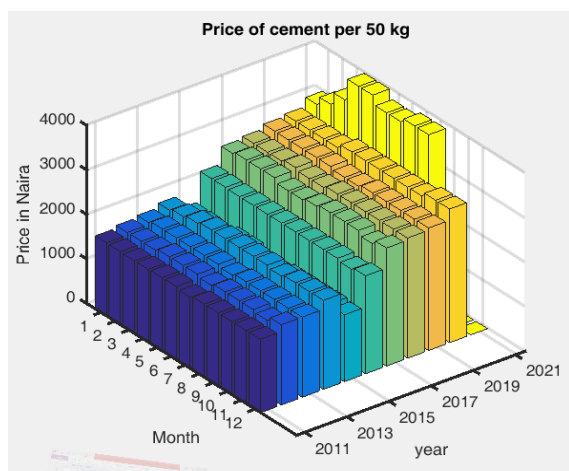


Fig.3:3D Bar chart of monthly average price of cement from 2011 to 2021

Fig4. shows the actual price of cement and the fitted curve of the trended model. Further extrapolation of the trended model into the future is shown in fig 5 and based on this, the predicted price of cement by the year 2050 will be 50000 naira per 50kg. if the current trend continues. Fig 6 explains more.

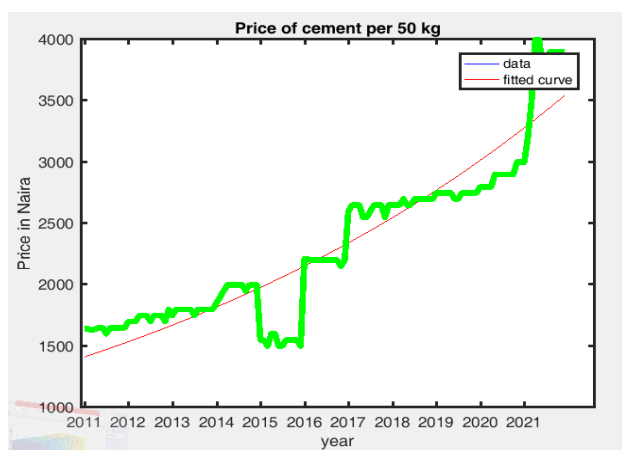


Fig. 4: Actual and trended price of cement per 50 kg

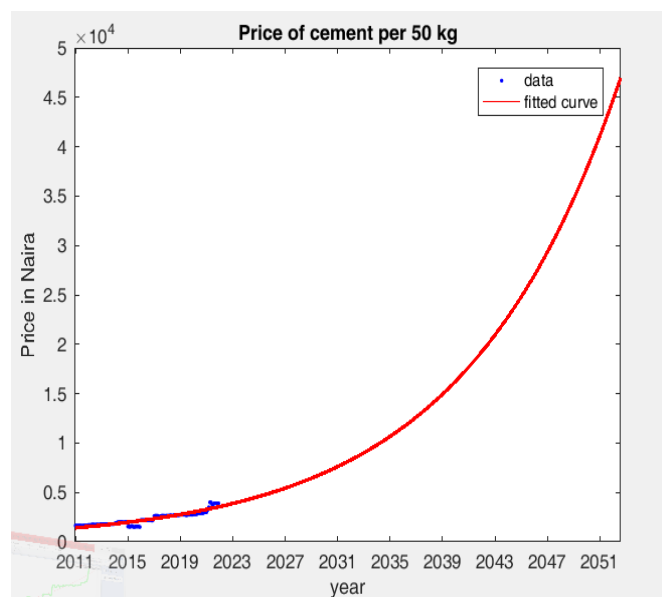


Fig. 5: Actual and extrapolated price of cement per 50 kg

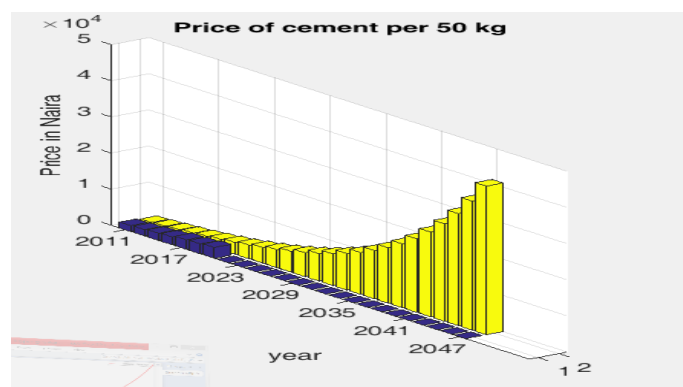


Fig. 6: 3D Bar chart of actual and extrapolated Price of cement per 50 kg.

Table 1: Percentage Mean Square Error of the New Model

YEAR	ACTUAL PRICE X1	PREDICTED PRICE X2	D= X1 - X2	D ²	%ERROR	ABSOLUTE %ERROR
2011	1642	1640	2	4	0.1218	0.1218
2012	1733	1732	1	1	0.0577	0.0577
2013	1792	1790	2	4	0.1116	0.1116
2014	1971	1972	-1	1	-0.0507	0.0507
2015	1542	1543	-1	1	-0.0649	0.0649
2016	2198	2199	-1	1	-0.0455	0.0455
2017	2617	2618	-1	1	-0.0382	0.0382
2018	2679	2680	-1	1	-0.0373	0.0373
2019	2742	2741	1	1	0.0365	0.0365
2020	2883	2882	1	1	0.0347	0.0347
2021	3678	3679	-1	1	-0.0272	0.0272
SUM				17	0.0985	0.4964

$$MSE = \frac{1}{n} \sum_{i=1}^n (X1 - X2)^2$$

$$= \frac{17}{11}$$

$$= 1.5455$$

$$= \frac{143026.043}{6}$$

$$= 23837.6738$$

Table 2: Percentage / Mean Square Error of the Existing System
I. Data Source: Velumoni and Nampoothiri (2018)

ACTUAL PRICE X1	PREDICTED PRICE X2	D= X1 - X2	D ²	%ERROR	ABSOLUTE %ERROR
160	154.01	5.99	35.8801	3.7438	3.7438
155	153.94	1.06	1.1236	0.6839	0.6839
155	152.21	2.79	7.7841	1.8000	1.8000
315	339.1	-24.1	580.8100	-7.6508	7.6508
302	337.35	-35.35	1249.6225	-11.7053	11.7053
295	334.16	-39.16	1533.5056	-13.2746	13.2746
254	240.53	13.47	181.4409	5.3031	5.3031
254	240.83	13.17	173.4489	5.1850	5.1850
255	243.06	11.94	142.5636	4.6824	4.6824
261	246.93	14.07	197.9649	5.3908	5.3908
290	332.66	-42.66	1819.8756	-14.7103	14.7103
290	332.66	-42.66	1819.8756	-14.7103	14.7103
280	351.64	-71.64	5132.2896	-25.5857	25.5857
285	353.78	-68.78	4730.6884	-24.1333	24.1333
SUM			17606.8734	-84.9814	138.5594

$$MSE = \frac{1}{n} \sum_{i=1}^n (X1 - X2)^2$$

$$= \frac{17606.8734}{14}$$

$$= 1257.6338$$

Table 3: Percentage/ Mean square error of the Existing Model
2; Data Source: Kenneth (2019)

YEAR	ACTUAL PRICE X1	PREDICTED PRICE X2	D= X1 - X2	D ²	%ERROR	ABSOLUTE %ERROR
2014	1650	1813.99	-164	26892.7201	-9.9388	9.9388
2015	1750	1555.87	194	37686.4569	11.0931	11.0931
2016	1800	2010.12	-210	44150.4144	-11.6733	11.6733
2017	2500	2365.12	135	18192.6144	5.3952	5.3952
2018	2525	2416.37	109	11800.4769	4.3022	4.3022
2019	2500	2565.6	-66	4303.36	-2.6240	2.6240
			-2	143026.043	-3.4456	45.0266

$$MSE = \frac{1}{n} \sum_{i=1}^n (X1 - X2)^2$$

Considering the values of MSE (Mean squared error) obtained in tables 1, 2 and 3, a useful conclusion could be drawn. From table 1, the Mean Square Error of 1.54 55 was obtained. This is the lowest when compared with other existing models that were used in the previous presentations as shown in tables 2 and 3. The lower the value of MSE, the better the predictive model. Hence, our model is better than the existing ones. This is proved further by the percentage error values generated by our model.

Looking at the column for percentage errors obtained in tables 1, 2 and 3, it is evident that the values recorded in table 1 are of lower values compared to others. This also proves that the newly presented model are better than the existing ones. Table 4 presents the historical data used for the development of the new model.

Table 4: Price of Cement/50kg 2011:2021 (Data Source for the new model)

MONTH	YEAR	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	SUM	AVERAGE
JANUARY		1,640	1,700	1,750	1,850	1,550	2,210	2,600	2,650	2,750	2,800	3,000	24,500	2,227.3
FEBRUARY		1,640	1,700	1,800	1,900	1,550	2,210	2,650	2,650	2,750	2,800	3,200	24,850	2,239.1
MARCH		1,650	1,700	1,800	1,950	1,500	2,200	2,650	2,650	2,750	2,800	3,500	25,150	2,284.5
APRIL		1,640	1,750	1,800	2,000	1,600	2,200	2,650	2,700	2,750	2,800	4,000	25,890	2,353.6
MAY		1,650	1,750	1,800	2,000	1,600	2,200	2,550	2,650	2,750	2,900	4,000	25,850	2,350.0
JUNE		1,650	1,750	1,800	2,000	1,500	2,200	2,550	2,650	2,700	2,900	3,800	25,500	2,318.2
JULY		1,600	1,700	1,750	2,000	1,500	2,200	2,600	2,700	2,700	2,900	3,800	25,450	2,313.6
AUGUST		1,650	1,750	1,800	2,000	1,550	2,200	2,650	2,700	2,750	2,900	3,900	25,850	2,350.0
SEPTEMBER		1,650	1,750	1,800	1,950	1,550	2,200	2,650	2,700	2,750	2,900	3,900	25,800	2,345.5
OCTOBER		1,650	1,750	1,800	2,000	1,550	2,200	2,650	2,700	2,750	2,900		21,950	1,995.5
NOVEMBER		1,650	1,700	1,800	2,000	1,550	2,150	2,550	2,700	2,750	3,000		21,850	1,986.4
DECEMBER		1,650	1,800	1,800	2,000	1,500	2,200	2,650	2,700	2,750	3,000		22,050	2,004.5
SUM		19,700	20,800	21,500	23,650	18,500	26,370	31,400	32,150	32,900	34,600	33,100	294,670	26788.18182
AVERAGE		1,642	1,733	1,792	1,971	1,542	2,198	2,617	2,679	2,742	2,883	3,678	24555.83333	2232.348485

4. Conclusion

The new model performs better than the existing ones. It was predicted that the price of 50kg bag of cement by 2050 will be 50,000 naira and hence government should take quick action to arrest the bad situation.

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