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A Quality Control Analysis in a Production Company

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Abstract
Nigerians are very concerned about the growing rate of building collapses as well as the lack of strong roads and bridges in the country. The quality of cement in Nigeria has received a lot of attention; therefore, it is a significant concern in this study. To prevent such depressing incidents in Nigeria, cement production businesses must be properly supervised and counseled on the quantity of raw materials utilized in the production process and the appropriate quality level of cement production. This study examines the quality control of cement produced by Dangote Cement Plc. in Kogi State.The project's goal is to evaluate the cement manufactured by Dangote Cement Plc in order to determine if the recent collapse of a building was caused by poor-quality building materials or by incompetent contractors. Six samples were collected at each period (day) for 31 days with the use of cluster sampling procedure, and the density (kg.dm(-3)) of the samples was measured before being assessed using the chosen control chart (x bar chart and R chart) quality control tool. For the analysis, MINITAB 17.0 software was employed.The outcome indicated that the R chart's upper control limit (UCL) is 0.07250, its lower control limit (LCL), 0, and its average quality, 0.03618. The maximum control limit (UCL) for the X chart is 2.01472, the lower control limit (LCL) is 1.97975, and the average quality is 1.99723, according to the graph. The standard error chart's upper control limit (UCL) is 0.02676, lower control limit (LCL) is 0.00041, and average quality is 0.01358. It was found that the process was statistically under control during the research time because no figures showed any violations of the control rule, as represented by the red lines. Since all periods corresponded to the quality specification, the quality of Dangote cement is not a factor in Nigerian building collapses.
***Key Word**: Control Chart, Statistical Quality Control, Cluster Sampling,*

I. Introduction

Nigerian cement manufacture dates all the way back to 1957. The Northern, Eastern, and Mid-Western regional administrations initially ordered three cement facilities. Later, a number of other businesses were founded, including Ashaka Cement, Benue Cement Company (BCC), West African Portland Cement Company (WAPCO), Cement Company of Northern Nigeria (CCNN), and a number of others. However, there are now numerous cement producing firms/plants in Nigeria, with facilities spread out over the nation. The West African Portland Cement Company Plc (WAPCO), Ashaka Cement Company Plc, Benue Cement Company Plc (BCC), Cement Company of Northern Nigeria Plc (CCNN), Dangote Industries plc, Nigerian Cement Company Limited, Edo Cement Company Limited, and a number of other well-known businesses are just a few of the notable ones.

The issue of demand and supply discrepancy and poor quality, which has directly caused the collapse of multiple structures and the loss of life and property, is one of the primary challenges facing Nigeria's cement sector (Adetokun 2010). Since the beginning, the supply of cement has not been able to keep up with the demand. These supply gaps were still quite noticeable even in the 1980s, during the economic downturn that saw a fall in cement demand. Cement mills may expand local production as a result of Nigeria's economy's slow but steady growth.In order to fulfill the expanding demand, the cost of producing cement has increased, significantly lowering the quality of cement produced today. Recent building collapses in Nigeria have caused the loss of lives and property, while they may also have been caused by the contractors' incompetence or the inferior quality of the cement and other building materials used in their construction.Dangote Cement and associated goods are prepared, manufactured, controlled, researched, and distributed by Dangote Cement Plc. The corporation is the owner of the largest cement mill in sub-Saharan Africa, Obajana Cement Plant, as well as cement import terminals in Lagos, Port Harcourt, Ghana, and Lagos.

The quality of cement in Nigeria has received a lot of attention; therefore, it is a significant concern in this study. To prevent such depressing incidents in Nigeria, cement production businesses must be properly supervised and counseled on the quantity of raw materials utilized in the production process and the appropriate quality level of cement production.

Given that it comprises a complicated procedure, quality control is a crucial component of the cement production strategy. Any quality control policy will be successful once the administrative and technological aspects impacting performance are adequately controlled.

The best-planned procedure, however, can be rendered ineffectual and useless if it is inconsistent and erratic. The measures used to reduce divergences that could prevent the achievement of predetermined goals and objectives are known as quality tools and techniques.

The application of collaborative effort through TEAMWORK is the greatest approach.

The lack of reliable technological processes in Nigeria, according to Nwaroh (1991), is one of the obstacles to the adoption of total quality in Nigeria.

The use of quality control in the production process has been the subject of numerous studies. Beinmote (2018) worked on a project to install statistical quality control at Junac Multilink Limited (JML) in order to determine whether or not the company's production process is in check. Felix (2018) worked on a project analyzing quality control in paint production using Berger Paint Industry Limited in Port Harcourt as a case study.

Amadi (2018) applied statistical quality control in the plastic manufacturing business using PVC pipes from AVI Global Resource Ltd. as a case study to.

To determine the quality of cement produced by Dangote Cement Plc and to determine whether the recent collapse of buildings was caused by the quality of the cement and other building materials used or by the incompetence of contractors, researchers in this work plan to conduct a quality control analysis on Dangote Cement Plc using the Dangote Cement industrial plant in Obajana, Kogi state as a case study.

II. History Of Dangote Cement Plc

Cement and associated goods are prepared, manufactured, controlled, researched, and distributed by Dangote Cement Plc. It conducts business in Zambia, South Africa, Benin, Ghana, and Senegal. The company imports and bags bulk cement through its ownership of cement import facilities in Lagos, Port Harcourt, and Ghana. On November 4, 1992, Dangote Cement was established, and its headquarters are in Lagos, Nigeria..

It was founded in May 1981 as a trading company with a primary concentration on cement. Over time, the Group evolved into a conglomerate that traded fish, sugar, flour, salt, and cement. The Group had become one of the biggest trading conglomerates operating in the nation by the early 1990s.

The Group made the strategic choice to transform from a trading-based company into a fully fledged manufacturing operation in 1999, following the change to civilian authority and following an inspiring trip to Brazil to examine the expanding manufacturing sector. A manufacturing operation that could satisfy the "basic necessities" of a huge and rapidly expanding population was clearly needed in a nation where imports make up the vast majority of consumed commodities.

The Group started an extensive construction project with the intended goal of building wheat mills, a sugar refinery, and a pasta factory. The Group purchased the Benue Cement Company Plc from the Nigerian government in 2000, and in 2003 it opened the largest cement facility in sub-Saharan Africa, the Obajana Cement Plant.

The Group, which is already among the biggest manufacturers in sub-Saharan Africa, is pursuing more backward integration in addition to an expansion program in both current and emerging markets.

III. Research Methodology

An objective scientific approach to analyzing production data is statistical quality control. On the basis of the analysis, steps are done to preserve the manufactured products' high quality. These actions include; Statistical process control and acceptance sampling

Acceptance By choosing a specific number of products for testing, sampling is a statistical tool used in quality control that enables a business to assess the quality of a batch of products. The technique takes into account the sample size, batch size, and the allowable number of flaws per batch. A t-test statistic is typically used to assess the sample's statistical reliability.Statistical sampling is used in statistical process control to identify and address production-related errors. Its goals are to produce products that fulfill design specifications in the most practical and cost-effective way possible and to identify process changes that could indicate that next products won't be up to par.

So, employing a statistical instrument or technique, quality control is accomplished. The most popular quality control tool in use today is referred to as a control chart

3.1 Control Chart

The control chart concept was created by Walter.A. Shewhart in 1924 to help distinguish between assignable variation and chance variation in a system.

Utilizing a control chart, one may determine whether a process is under control or has become unmanageable. Control charts are graphs that represent the process measurement received from samples over time along with standards for a manufacturer, also known as control limits.The control limit (upper and lower control limits) are usually set at $\pm 3\sigma$ where σ is the sample standard deviation.

The average attribute that is being measured is shown by the chart's control line. When a state of control is present, the lower control limit represents the smallest allowable random variation and the higher control limit shows the largest allowable random variation.

3.2.1 Types Of Control Charts

Control charts can be divided into two categories: control charts for variables and control charts for characteristics.

Two charts, the X chart and the R chart, make up the control chart for the variable.

X Chart

Thus, variances in average samples are evident. Based on the samples that were taken from the process at a particular period, they are used to monitor the mean of a process. A subgroup is the measurement of a sample at a certain moment. The control limit for the mean of each subgroup is created using the mean and standard deviations. The control shows whether a process is under control or not.

The i^{th} subgroup mean is calculated using

$\bar{X} = \frac{\sum_{i=1}^{n} x_i}{n} = \frac{x_1 + x_2 + \cdots + x_n}{n}$

Where $\bar{X}$= mean of the sample, and X_i= i^{th} data with sample size n.

$$\bar{\bar{X}} = \frac{\sum_{i=1}^{n} \bar{x}_i}{n} =$$

$\bar{\bar{X}}$ = Grand mean, and Upper control limit (UCL) = $\bar{\bar{X}}$ +3σ or $\bar{\bar{X}}$ +A_2R

Lower control limit (LCL) = $\bar{\bar{X}}$ -3σ or $\bar{\bar{X}}$ -A_2R

R chart

The spread between the highest and lowest value in the frequency distribution is monitored using the range chart (R chart), a control chart.

R_i=$Xmax_i$ - $Xmin_i$

R_i = range of the sample

$$\bar{R} = \frac{\sum_{i=1}^{n} R_i}{K}$$

Upper control limit UCL = R+3σ or $D_4\bar{R}$ and Lower control limit LCLR = R-3σ or $D_3\bar{R}$

3.3. DATA collection/presentation

The 50kg cement bags are produced and filled at the Dangote cement manufacturing facility in Obajana, Kogi state. Cement of sufficient quality is estimated to be produced at 2,000 kg/dm (-3).

Three additional important elements, namely a quality assurance system, quality tools and procedures, and teamwork, support the management's efforts and dedication.

Six samples were taken daily for 31 days as part of the data sample, which was chosen via cluster sampling It was assessed utilizing a statistical quality control technique, an x bar chart, and a range chart after being measured in density (kg.dm(-3)). They were monitored for any unusual causes and their mean quality was utilized to determine The researcher will be able to accurately and clearly depict real data properties and conclusions thanks to these charts. Items in tables used for this study will also be described using interpretation and data analysis.The period as used in the table is the number of days and sample is measured in density ($kg.dm^{-3}$). The data used for this study is secondary data.

To determine the strength and quality of the cement used in building, quality tests are performed on the material. Based on its performance and durability, which are discussed below, cement can be used for a variety of purposes.

Fineness test: The pace of hydration, the rate of heat development, and the rate of strength gain are all governed by the fineness of the cement. The surface area of the cement particles per unit mass is measured by a fineness test, which is used to verify that the cement is being ground properly.

Consistency test: This test is carried out to determine the cement's setting times utilizing a vicats device for standard consistency testing of cement.

Strength test: On the cement, the strength cannot be directly determined. Instead, cement mortar with a 1:3 ratio is used to indirectly quantify the strength of cement. The strength of the cement at a particular time is the compressive strength of the mortar.

Soundness test: This test is carried out using Le Chateller's apparatus to find out whether cement contains uncombined lime and magnesia.

Period	Sample1	Sample2	Sample3	Sample4	Sample5	Sample 6	Subtotal	Samplemean($\bar{X}$)	Sample range (r)
Period1	1.988	2.005	1.994	1.991	1.975	1.972	11.925	1.9875	0.033
Period2	1.988	1.984	1.978	2.000	2.003	1.983	11.983	1.9893	0.025
Period3	1.983	2.009	2.019	2.016	2.006	1.989	12.022	2.004	0.036
Period4	1.989	2.022	1.976	1.994	1.997	2.018	11.996	1.999	0.046
Period5	2.018	1.969	1.990	1.997	1.999	1.971	11.994	1.991	0.049
Period6	1.974	1.990	1.991	2.008	2.002	1.982	11.947	1.991	0.035
Period7	1.983	1.991	2.019	2.011	2.006	1.998	12.008	2.001	0.036
Period8	1.989	2.020	1.976	2.010	1.997	1.994	11.986	1.998	0.044
Period9	2.018	1.991	1.990	2.013	1.999	1.989	12.000	2.000	0.025
Period10	1.972	2.000	1.991	1.984	2.002	1.980	11.929	1.988	0.030
Period11	1.982	2.016	2.020	1.987	1.995	1.991	11.991	1.999	0.038
Period12	1.998	1.994	1.991	1.994	2.011	2.020	12.008	2.001	0.03
Period13	1.994	1.997	2.000	1.997	2.020	1.991	11.999	2.000	0.03
Period14	1.989	2.008	2.016	2.008	2.000	2.000	12.021	2.004	0.027
Period15	1.980	1.976	1.994	1.982	1.998	2.016	11.946	1.991	0.04
Period16	1.991	2.003	1.997	1.998	2.004	1.994	11.907	1.985	0.013
Period17	2.005	1.997	2.008	1.994	1.996	1.997	11.997	2.000	0.011
Period18	1.984	1.988	2.011	1.989	1.988	2.008	11.968	1.995	0.027
Period19	2.009	2.023	2.010	1.980	2.020	1.998	12.04	2.010	0.043

Period20	2.022	2.035	2.013	1.991	2.000	1.994	12.055	2.001	0.044
Period21	1.969	2.017	1.984	2.005	2.018	1.989	11.982	1.997	0.049
Period22	2.030	1.973	1.987	1.984	1.978	1.980	11.932	1.989	0.057
Period23	1.980	1.998	1.994	2.009	1.998	1.991	11.97	1.995	0.029
Period24	1.991	2.003	1.996	2.020	2.006	1.997	12.013	2.002	0.029
Period25	2.005	1.996	2.008	1.976	1.996	2.00	11.981	1.997	0.032
Period26	1.984	1.988	2.011	1.990	1.983	1.982	11.938	2.000	0.029
Period27	2.000	2.021	2.010	1.991	2.001	1.998	12.021	2.004	0.03
Period28	2.000	2.025	2.013	2.019	2.00	1.994	12.051	2.009	0.031
Period29	1.969	2.019	1.984	1.976	2.018	1.980	11.946	1.991	0.05
Period30	2.031	1.978	1.987	1.980	1.978	1.980	11.934	1.989	0.053
Period31	1.977	1.999	2.024	1.991	1.998	2.023	12.012	2.002	0.046
TOTAL								**61.910**	**1.0943**

TABLE 1: Sample quality of Dangote cement plc.
Source: Obajana cement plant kogi

IV. Results From The Analyses Using MINITAB 17.0

Descriptive Statistics: mean of mean

```
               Total
Variable       Count   N  N*  CumN    Mean  SE Mean    StDev  Variance
Minimum
mean of mean      31  31   0    31  1.9971  0.00116  0.00647   0.00004
1.9850


Variable          Q1  Median      Q3  Maximum
mean of mean  1.9910  1.9990  2.0010   2.0100
```

Descriptive Statistics: RANGE

```
          Total
Variable  Count   N  N*  CumN     Mean  SE Mean    StDev  Variance  Minimum
RANGE        31  31   0    31  0.03539  0.00195  0.01088   0.00012  0.01100


Variable       Q1   Median       Q3  Maximum
RANGE     0.02900  0.03300  0.04400  0.05700
```

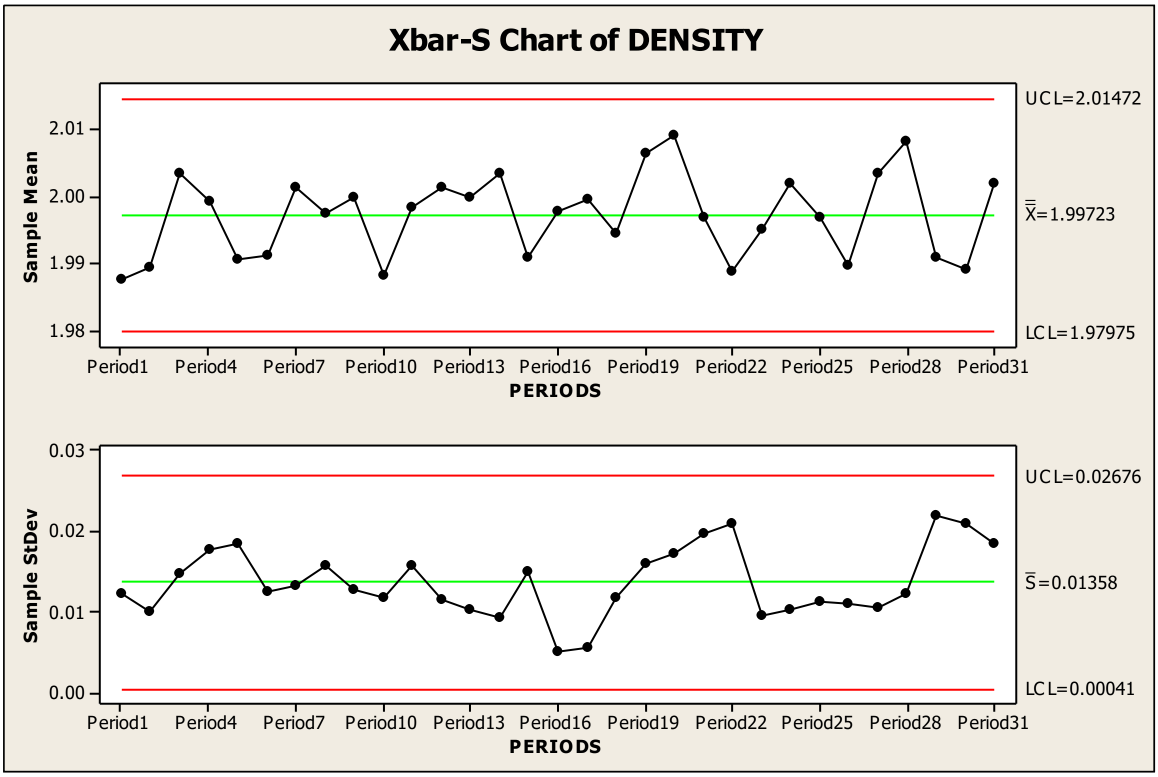

Fig 1: X **Chart and s-chart For The Quality Of Cement Produced At The Obajana Plant Kogi for the subgroups**

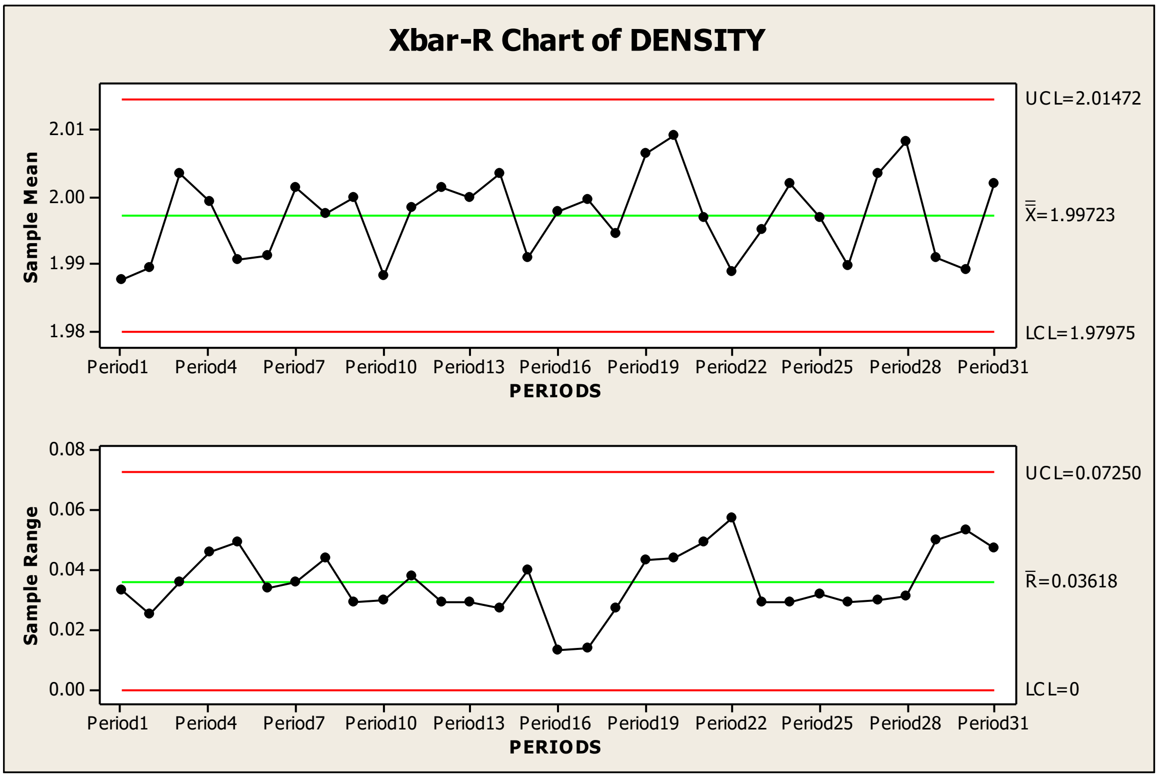

Fig 2: Fig 1: **RChart For The Quality Of Cement Produced At The Obajana Plant Kogi in the subgroups**

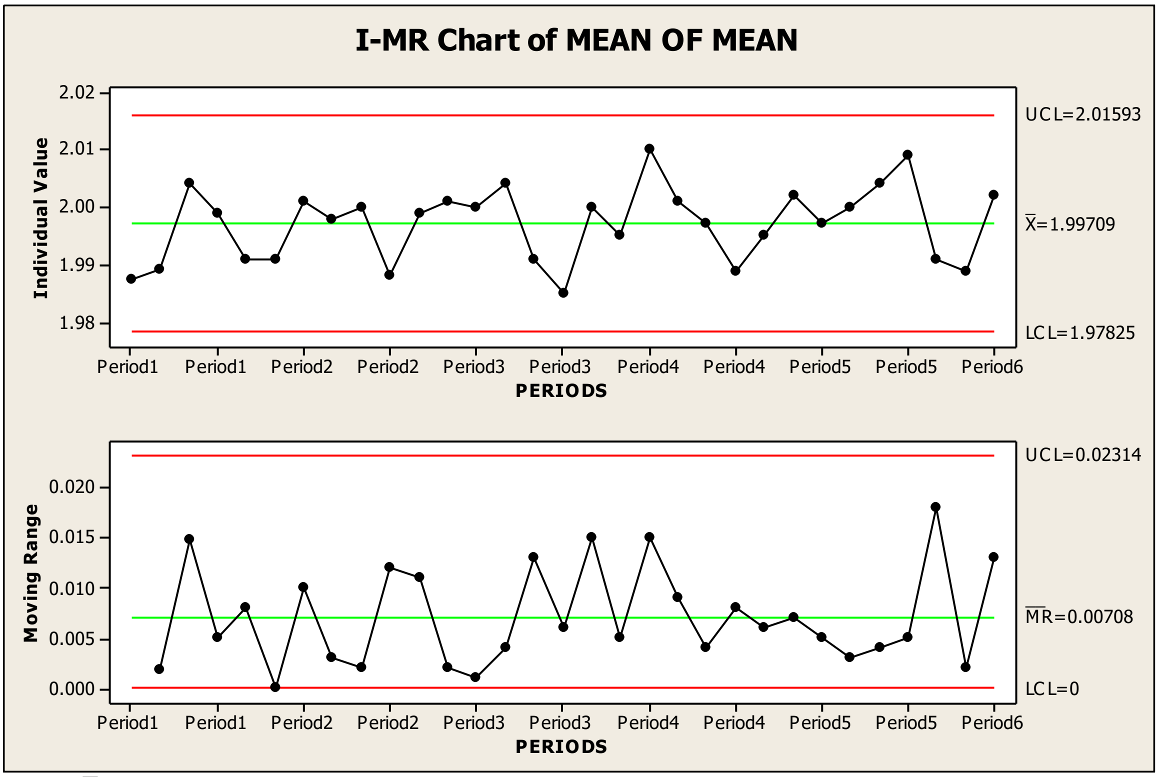

Fig 2:$\bar{\bar{X}}$ **Chart and** $\bar{R}$**chart For The Quality Of Cement Produced At The Obajana Plant Kogi in the subgroups**

V. Interpretation Of Results In The Control Chart

Upper control limit (UCL) = 2.018041

The Obajana cement plant in Kogi's upper control limit for cement production is set at 2.01804. Any quality that exceeds this requirement is referred to as being out of control. Raw materials will be wasted if the grade of cement is consistently higher than 2.018041. As a result, the cost of manufacture would rise, pushing up the price of cement.

Lower control limit (LCL) =1.97975

Any quality of cement below the specification set at the Obajana cement plant in Kogi is considered to be out of control. The lower control limit for cement produced there is set at 1.97975. Cements that are not of sufficient quality would be produced if the quality of cement was consistently below 1.97975

.Average quality = 1.99723

The Obajana cement mill produced an average of 1.99723 grade cement throughout the time the check was conducted.

VI. Summary And Conclusion

To determine the quality of cement produced by Dangote Cement Plc is one of the objectives of this study's quality control analysis of Dangote Cement Plc. to determine if the recent collapse of buildings was caused by poor-quality cement and other building materials, or by contractors' negligence. (i.e. whether it is random or out of our control).

The study's conclusions showed the following: The cement manufactured by Dangote Cement Plc is of acceptable grade. The cement plant is in fine functioning order because the level of cement production was never out of control.

According to the investigation, Dangote Cement Plc in Obajana, Kogi produces cement of a satisfactory level and cannot be the cause of the recent collapse of structures in Nigeria. Buildings fail primarily as a result of ignorance, carelessness, and greed. When inept employees are in control of design, construction, or inspection, that is ignorance. One of the main instances of ignorance is the adoption of a previous project's specification without first reviewing for any areas that could use modification, addition, or omission.

Greed on the part of building contractors, such as stealing building supplies, such as cement, intended for production on the client's site and using them on their own, or using cheap materials in order to make a lot of money. Making a distinction between buildings that fail during construction or throughout their service life, which is typically 25 years, and those that fail after this time is necessary when discussing the problem of building collapse. It can be inferred that the collapses that result in the greatest loss are those that happen soon after a building is constructed or when it has been in operation for a long time.

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