ISSN 2456-8066
International Journal of Advanced Engineering and Management
Vol. 3, No. 4, pp. 127-133, 2018

Development of Quality Control System for Cement Manufacturing using Software Techniques

Murtada Elshiekh[1]*, Khalid Eltayeb[2] and Osama Mohammed Elmardi Suleiman[3]
[1,2]Department of Manufacturing Engineering, Faculty of Engineering and Technology- Nile Valley University – Atbara – Sudan
[3]Department of Mechanical Engineering, Faculty of Engineering and Technology- Nile Valley University – Atbara – Sudan
Corresponding author E-mail: murtada93.elshiekh@gmail.com

Abstract—**The cement material is considered to be of great importance in different aspects of building development projects and as a commodity for export and investment. Accordingly, the product should be compatible with the standard specifications within manufacturing stages to ensure acceptable quality. This research paper focuses on creating a system that monitors and records daily readings of cement physical tests at quality laboratories of cement factory and accordingly the control charts for each test were established. The importance of control charts for the variables lies in the expression of the system status (inside or outside the control limits); normally the points which are located outside the borders indicate that the system is out of control. But in some cases, the points are within the control limits but took an abnormal distribution. First, the system determines the style of pattern type, analyzes and then finds out the expected causes and suggests the solutions. The system was tested by inserting different records in different intervals of time; the results obtained were reasonable and had explained the effectiveness of the system.**

Keywords—**Quality control; Control charts; patterns; cement laboratory.**

I. Introduction

Recently, the River Nile State had witnessed a great leap in cement industry due to the fact that all production elements were available; raw materials (lime stone), which is available in most areas extending from Atbara to Abu Hammad[*1*]. Moreover, the availability of transport means (paved roads and railway tracks) linking production sites with national markets and ports of export, in addition to the availability of power sources and skilled labors [*2*]. Based on the above-mentioned reasons, the policy of supply and demand overshadows the local and regional market, making these companies at a big challenge to obtain the trust and the customer satisfaction[*3*]. Due to an increasing competition in products, consumers have become more critical in choosing products[*4*]. The quality of products has become more important. Statistical process control (SPC) is usually used to improve the quality of products and reduce rework and scrap so that the quality expectation can be attained.

II. Problem Statement

All the industries and institutions are keen to optimize the profit, and to be friendly with environment[*5*]. This will help these companies to keep its position and status within the market, such process will be maintained by developing and promoting the manufacturing systems as well as applying the total quality control principles[*6*][*7*].

Control charts are the most popular charts widely used in industry to detect abnormal process behavior[*8*]. The most typical form of control charts consists of a central line and two control limits representing the specifications of the product and the variant range limits[*9*]. This provides a useful method for monitoring variations in the product manufacturing process[*10*]. However, these control charts do not provide pattern-related information because they focus only on the latest plotted data points.

There are five cement factories in River Nile State; all these factories are highly recommending improving their quality control system (mainly the physics lab) to be within the present international market competition. The process is applied through monitoring and documenting the results of different trails, analysis and decision making.

III. The Objectives

The purpose of this research is to develop a quality control system of cement manufacturing using software technique, which is aiming to achieve the following objectives:-

- To record daily results for various physical tests.
- To draw control charts for variables (average, X), (range, R) for any period of time required.
- To find different patterns, then analyze and identify corrective action accordingly for each pattern.

To Display the results of all tests at any time and obtain respective reports.

IV. Methodology

- General information about the system, which includes machines, production stages, and sequence of operations etc, were gathered.
- Historical data of previous physical test results were collected, and the causes of poor quality were analyzed.

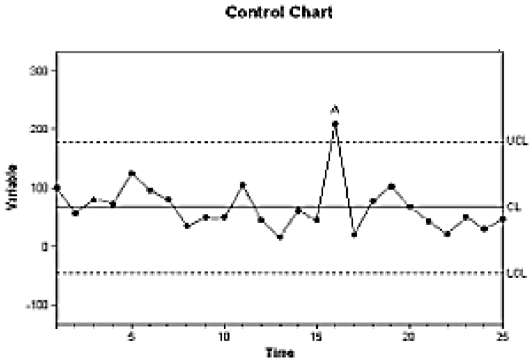
Computer program created by using Visual Basic language will be used to control the quality and to evaluate and indicate the subgroup pattern and its analysis.

ISSN 2456-8066
International Journal of Advanced Engineering and Management
Vol. 3, No. 4, pp. 127-133, 2018

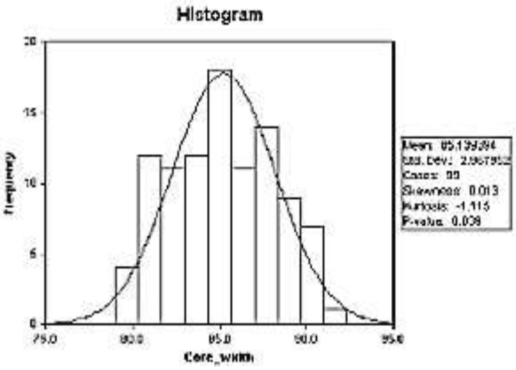
V. INTRODUCTION TO QUALITY

Quality control is the use of techniques and activities to achieve, sustain, and improve the quality of a product or service [*11*]. It involves integrating the related techniques and activities such as specifications of what is needed, design of the product or service to meet the specifications, production or installation to meet the full intent of the specifications, inspection to determine the conformance of specifications and review of usage to provide information for the revision of specifications if needed[*12*][*13*].

Control chart shown in Fig. 1 is an essential tool of continuous quality control; they monitor processes to show how they performing and how their capabilities are affected by changing in processes.



(a)



(b)

Fig 1. Control charts shows (a) Control charts show the variation in a measurement during the time period that the process is observed (b) In contrast, bell-curve type charts, such as histograms or process capability charts, show a summary or snapshot of the results

Utilization of these activities provides the customer with the best product or service at the lowest cost. The aim should be continued quality improvement.

This information is then used to make quality improvements, and they can help to identify random or assignable causes for factors that impede peak performance[*14*].

Control charts determine if a process is under control or out of control, also monitor the variance of output of a process over different intervals of times, by comparing this variance against upper and lower limits to see if it fits within the expected, specific, predictable and normal variation levels.

If so, the process is considered in control and the variance between measurements is considered normal random variation that is inherent in the process. If, however, the variance falls outside the limits, or has a run of non-natural points, the process is considered out of control.

When the variation between the points is large enough for the process to be out of control, the variation is determined to be due to non-natural or assignable (special) causes.

A. Average Charts (X-bar Chart)

Average charts, Fig. 2 are made by simply taking the averages of a number of subgroups and plotting the averages on the chart. The average chart is called the X-bar chart because in statistical notation, a bar or line over the variable (X) symbolizes the average of X. X-bar is a shorthand way of saying the average of X.

An X-bar chart is a variable control chart that displays the changes in the average output of a process. The chart reflects either change over time or changes associated with a categorical data variable. The chart shows how consistent and predictable a process is at achieving the mean.

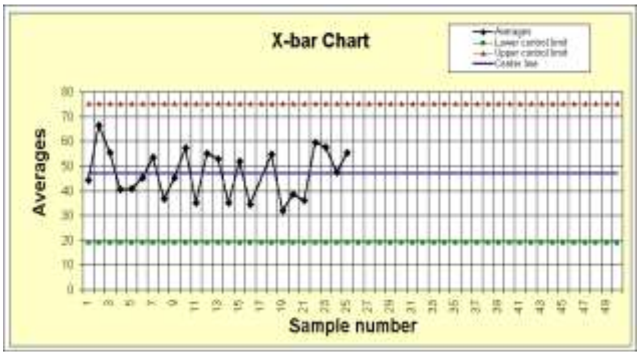


Fig 2. X-bar Chart the averages of a number of subgroups and plotting the averages on the chart.

$$\overline{\overline{X}} = \frac{\sum_{j=1}^{N} \overline{x_j}}{N}$$

$$UCL_{\bar{x}} = \overline{\overline{X}} + A_2 \overline{R}$$

$$LCL_{\bar{x}} = \overline{\overline{X}} - A_2 \overline{R}$$

B. Range Charts (R-Chart)

The Range chart, Fig. 3 can be combined with I charts and X-bar charts. The chart names combine the corresponding chart initials.

ISSN 2456-8066
International Journal of Advanced Engineering and Management
Vol. 3, No. 4, pp. 127-133, 2018

Range charts measure the variation in the data. An example is the weather report in the newspaper that gives the high and low temperatures each day. The difference between the high and the low is the range for that day.

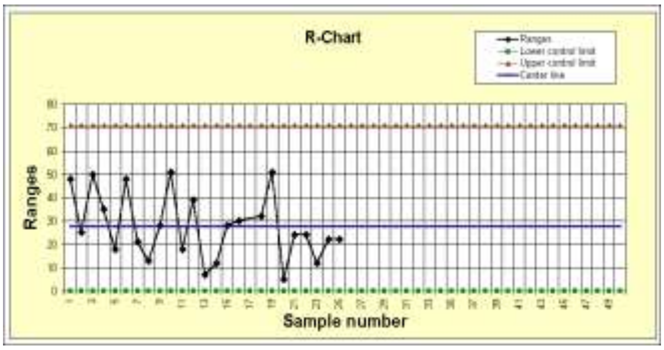


Fig 3. R-Chart combined with I charts and X-bar charts. The chart names combine the corresponding chart initials.

$$\overline{R} = \frac{\sum_{J=1}^{N} \overline{R_j}}{N}$$

$$UCL_R = D_4 \overline{R}$$

$$LCL_R = D_3 \overline{R}$$

C. Quality Control Chart Patterns

To date, quality control methods remain underutilized in a number of applications due to the knowledge and experience required for their selection and implementation. Pattern interpretation is the one of the important efforts that did in this area. Control charts patterns have great impact on the process control decisions; industry has developed much effort toward their identification.

In the literature, classified pattern recognition techniques into four categories, Expert System (ES), statistical analysis, feature-based method, and neural network technique. He discussed the merits of each category[*15*]. Papers that discuss pattern recognition concentrate on six patterns only, i.e. systematic, trends (increasing and decreasing), stratification, cyclic, and natural pattern. Eight tests to interpret the X-bar chart patterns. These tests are applicable for variable charts and some can also apply to attributes charts discuss the development and use of (ES) to detect and analyze various patterns of variation that can occur in manufacturing environment based on quality control charts. Statistical significance tests, as interpretative rules, are used to determine the pattern variation.

E. Control Charts Pattern Recognition Methodology

The natural trend for control chart pattern has no evidence of unnaturalness over a long run of samples as described in Fig. 4. In this case, the system appears to be in balance and the process is in control. The characteristics of this trend are most of points are close to the centerline, a few are close to the control limits and no points above or below the control limits.

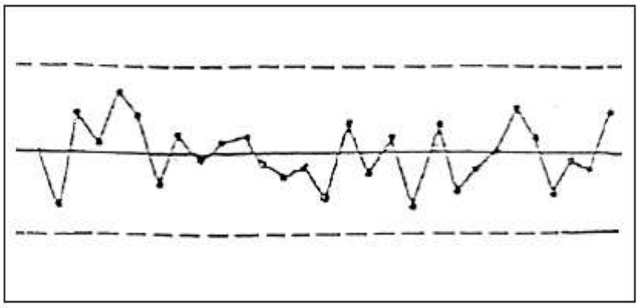


Fig 4. The natural trend for control chart pattern has no evidence of unnaturalness over a long run of samples

Fig. 5 also shows an increasing trend. The decreasing trend is the same trend but the slope takes the opposite direction.

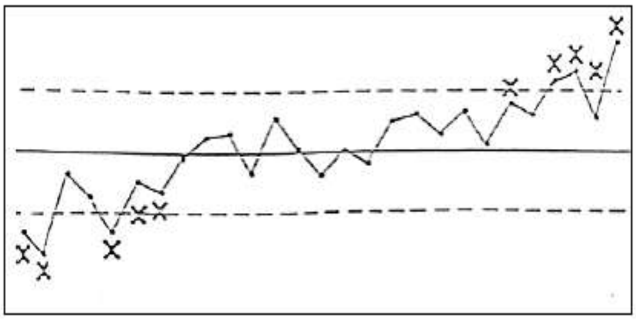


Fig. 5 Trend pattern slope takes the opposite direction

The trend may be a result of any causes that work on the process gradually. Fig. 6 depicts a systematic trend.

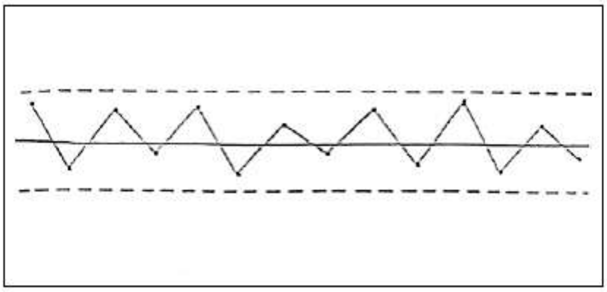


Fig. 6 Systematic Variable Pattern

These trends are defined as continuous movement up or down at the same direction of the control chart. A systematic pattern is present when any kind of systematic variable exists in either the process or the data. The characteristic of this pattern is

ISSN 2456-8066
International Journal of Advanced Engineering and Management
Vol. 3, No. 4, pp. 127-133, 2018

always predictable.

The mixture pattern is shown in Fig. 7. In this pattern, all points fall close to the high and low control limits of the control chart with an absence of the normal fluctuations close to the centerline of the control chart. In this pattern, very few points are close to the centerline.

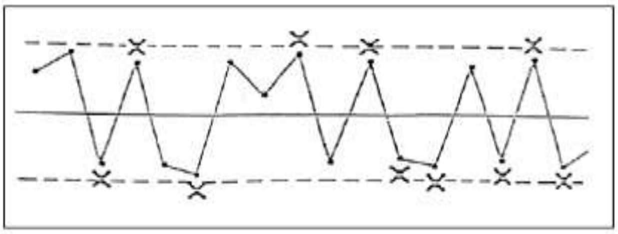


Fig 7. Mixture Pattern very few points are close to the centerline.

A stratification pattern which is depicted in Fig. 8 appears to hug the centerline with few deviations or excursions at any distance from the centerline. This means that many points are close to the centerline. In other words, unnaturally small fluctuations, with no points close to the control limits describe stratification.

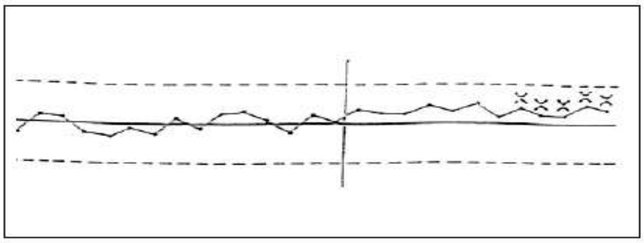


Fig 8. Stratification Pattern unnaturally small fluctuations, with no points close to the control limits.

In Fig. 9 the freaks pattern is presented where freaks result from the presence of one or more samples greatly different from the others. Freaks are among the easiest of the patterns to identify.

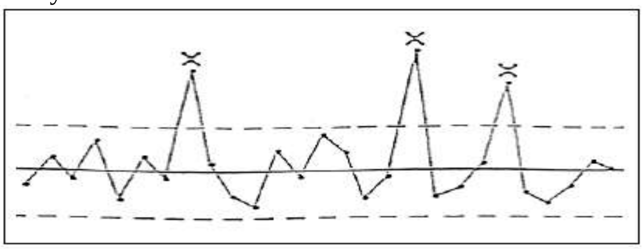
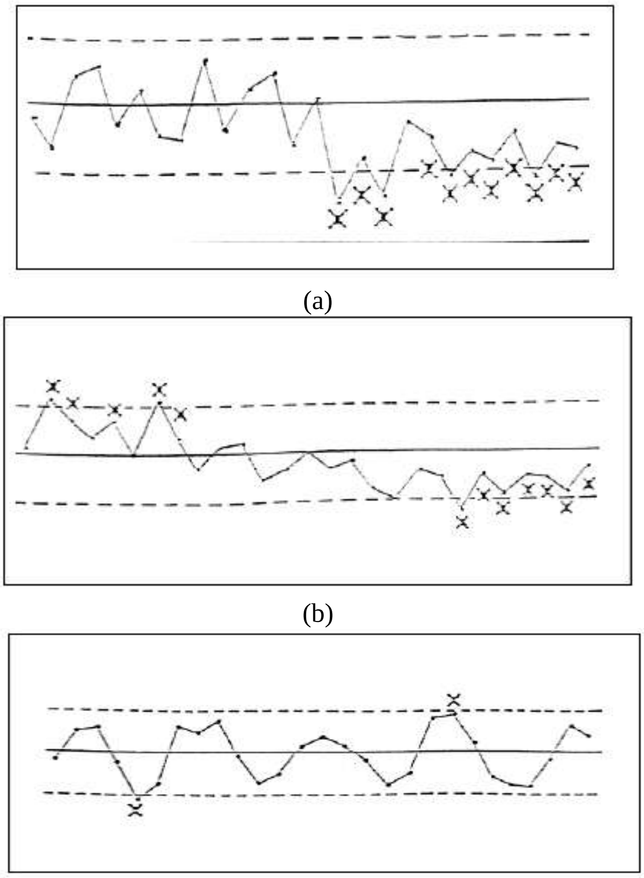


Fig. 9 Freaks Pattern from the presence of one or more samples greatly different from the others.

In addition to the preceding, Figures 10, show sudden shifts in level, gradual change in the level and cyclic patterns, respectively. Sudden shift in level is characterized by a positive change in one direction.



(a)

(b)

(c)

Fig 10. Different sudden level pattern (a) Sudden-shift in level Pattern, (b) Gradual-change in level Pattern, (c) Cyclic Pattern

A number of points appear only on one side of the control chart. This pattern generally indicates a change in the system or the process. Gradual change in the level indicates that there are some elements in the processes that are capably affecting a few units at the beginning, and then affecting more and more as time goes on. Generally, this pattern is sensitive to the shift in the process average. Cyclic pattern has characteristics short trends in the data that occur in repeated patterns, where a series of high peaks is followed with low peaks at the same period length.

VI. SOFTWARE DESIGN

To create quality control software for cement laboratory, several things should be determined as follows:

A. Inputs

The software inputs include:

1. Physical tests types.

ISSN 2456-8066
International Journal of Advanced Engineering and Management
Vol. 3, No. 4, pp. 127-133, 2018

2. The daily results of experiments.
3. Patterns type, which regarded as out of control patterns.
4. The corrective action for each pattern.

B. Processing

1. Calculate the average results for every test in any period of time.
2. Calculate the upper and lower control limit for any experiment at any period of time.
3. Compare the status that the pattern will be out of control, with samples distribution in the chart for any period of time.

C. Outputs

1. Establish multiple functions at the database such as adding or deleting records.
2. Viewing the contents of the database table for any period of time.
3. Construct quality control chart for any physical test at any period of time required, then determine pattern classification and express the suitable treatment if it needs.
4. Printing all outputs as reports.

D. Robust pro-active scheduling

The software was written in Visual Basic 6, which is a programming language, and development environment created by Microsoft. It is an extension of the BASIC programming language that combines BASIC functions and commands with visual controls. Visual Basic provides a graphical user interface GUI that allows the developer to drag and drop objects into the program as well as manually write program code.

E. User interface

The software contains three forms which could be explained as follows:

1. The Main Form

When starting the program, this form will display first. The title of this form is Quality Control Program; as shown in Fig. 11, the anymore forms will carry out from the main form.

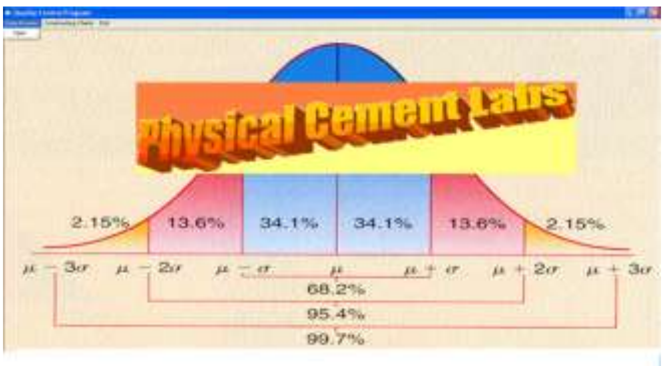


Fig 11. Main Form

2. The ProcessingScreen

The purpose of this screen is to display the database, so the user can easy add and save the daily results. In this screen there are about eight commands help users in displaying, adding, saving, deleting and canceling as shown in Fig. 12.

Fig 12. Processing Screen

Also from the processing screen, the user able to move directly to the third screen by clicking the command Go to Chart.

3. Constructing Chart and Analysis Screen

This screen named SSTab, which includes four tabs:

The first tab Fig. 13 called Causes of out of control status which display the feasible causes of out of control. The second tab in Fig. 14 called Patterns Types which contains all patterns that take unmoral distribution.

Fig 13. Causes of out of control

Fig 14. Patterns Types

- The third tab called Data in Periods Fig. 15, this tab display data for any certain period of time determined by user. In this tab all data are just for displaying.

Fig 15. Data in Periods

- The last tab called Construct Chart as shown in Fig. 17 and Fig. 18, the main function of this tab to display the data as quality control chart.

Fig 16. Construct Chart

Fig 17. Chart Presentation

VII. Conclusion

With regard to the previous reports of cement quality control laboratory, the outcomes of the results show that all samples within control limits and the process under control. This belief is wrong since it disregards how many samples were distributed within the limits of control chart. According to the basis of the statistical quality control standard, there are several cases that the sample distribution within control limits, although they do not reflect normal distribution. Therefore, it is considered to be out of control.

Applying this concept to the results of the physical tests during certain periods of time, it became clear that there are a number of cases took an abnormal distribution, and not commensurate with preceding outcomes was previously thought to be within control.

Acknowledgement

The author would like to acknowledge with deep thanks and profound gratitude Mr. Osama Mahmoud Mohammed Ali of Daniya Center for Publishing and Printing Services, Atbara, who spent many hours in editing, re – editing of the manuscript in compliance with the standard format of international journal of advanced engineering and management (IJOAEM).

References

[1] Tignor, R. L. (2011). Egypt: A short history. Princeton University Press.

[2] Srinivasu, B., & Rao, P. S. (2013). Infrastructure development and economic growth: Prospects and perspective. Journal of Business Management and Social Sciences Research, 2(1), 81-91.

[3] Torfing, J. (1999). Workfare with welfare: recent reforms of the Danish welfare state. Journal of European social policy, 9(1), 5-28.

[4] Katz, M. L., & Shapiro, C. (1985). Network externalities, competition, and compatibility. The American economic review, 75(3), 424-440.

[5] Mukherjee, K. (2016). The psychology of the successful entrepreneur. International Journal of Advanced Engineering and Management, 1(1), 25-32.

[6] Kumar, M., Kabir, F., & Roy, S. (2017). Low Cost Smart Stick for Blind and Partially Sighted People. International Journal of Advanced Engineering and Management, 2(3), 65-68.

[7] Besterfield, D. H. (2004). Quality control. Pearson Education India.

[8] MacGregor, J. F., & Kourti, T. (1995). Statistical process control of multivariate processes. Control Engineering Practice, 3(3), 403-414.

[9] Momin Mukherjee, Entrepreneurial Judgment and Analysis for Successful Strategy Implementation, International Journal of Advanced Engineering and Management, Vol. 2, No. 1, pp.1-8, 2017.

[10] Rahman, A., Rasul, M. G., Khan, M. M. K., & Sharma, S. (2015). Recent development on the uses of alternative fuels in cement manufacturing process. Fuel, 145, 84-99.

[11] Dean Jr, J. W., & Bowen, D. E. (1994). Management theory and total quality: improving research and practice through theory development. Academy of management review, 19(3), 392-418.

[12] Morris, P. (2013). Reconstructing project management reprised: A knowledge perspective. Project Management Journal, 44(5), 6-23.

[13] Grover, V., Cheon, M. J., & Teng, J. T. (1996). The effect of service quality and partnership on the outsourcing of information systems functions. Journal of Management Information Systems, 12(4), 89-116.

[14] Raz, T., Shenhar, A. J., & Dvir, D. (2002). Risk management, project success, and technological uncertainty. R&D Management, 32(2), 101-109.

[15] Zorriassatine, F., Wykes, C., Parkin, R., & Gindy, N. (2003). A survey of virtual prototyping techniques for mechanical product development. Proceedings of the institution of mechanical engineers, Part B: Journal of engineering manufacture, 217(4), 513-53.