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SURVIVAL STRATEGIES OF SMES: AN APPROACH OF STATISTICAL QUALITY CONTROL METHODS

Kazeem, Kolawole R., Olufemi, Olugbenga P. and *Nofiu, Tunji N.,

National Board for Technology Incubation, Abuja, Nigeria.

*Corresponding authors' email: tunjinofiu@gmail.com

ABSTRACT

A wealth of literature exists on benefits of SMEs to an economy. These include: creation of jobs, reducing income disparities, the development of skilled and semi-skilled workers for future industrial expansion and excellent breeding ground for entrepreneurial and managerial talents. The critical shortage of these benefits is often a barrier to economic development. To stimulate processes of qualitative growth in SMEs, this study investigated the application and effective use of Statistical Quality Control (SQC) tools in entrepreneur firms. The results showed that most managers are still experiencing low levels of quality control implementation and they do not recognize the need to compete in the pursuit of modern technologies. This could be due to the major problems of SMEs such as knowledge loss, human and financial resource limitation, product design and development incapability, lack of training infrastructure and networking. There is a growing need for advanced and codified quality control practices.

Keywords: SMEs, Statistical Quality Control, Total Quality Management, Control Charts

INTRODUCTION

Until the mid-seventies, SMEs had a minor role in economic development due to the dominance of the mass production paradigm in the industry. After this period, this paradigm was increasingly challenged, leading to large firms' fragmentation, unemployment growth and creation of new SMEs (Acs, 1992; cited in Fathian et al., 2008). When in the early 1980s unemployment rose in many of the nations' economies, the interest in SMEs development and self-employment (through micro businesses) intensified. Many studies were undertaken during that period and a vision for SMEs based economic growth was developed.

Many nations, particularly developing countries, have acknowledged the value of small and medium enterprises, which are seen as the engine of growth for any economy (Okpara, 2009). However, recent global changes have forced manufacturing organizations across the globe to reconsider their management techniques and tools.

SMEs are found in every sector of the economy and play a vital role. They are crucial for sustained, long-term growth, dynamism and employment (Thassanabanjong et al., 2009). SMEs are regarded as one of the main driving forces of economic development, stimulating private ownership and entrepreneurial skills (Gadenne and Sharma, 2009). For developing economies SMEs often offer the only realistic prospects for increases in employment and value added services or products (Mirbatrgkar, 2009). They generally employ the largest percentage of the workforce and are responsible for income generation opportunities (Singh, 2010). Small and medium enterprises are critical to the economies of all countries (Akhavan and Jafari, 2008), and especially the developing ones (Fathian et al., 2008; Gadenne and Sharma, 2009) as Okpara (2009) believed that they were the engine of growth for any economy. As noted by Singh et al. (2008) and Mirbargkar (2009), SMEs are considered as the backbone of economic growth in all countries and they contribute in providing job opportunities, act as supplier of goods and services to large organizations (Singh et al., 2008; Garengo et al., 2005; McAdam et al., 2000). The importance of the small and medium industries will become more significant as the country expands its industrial base in meeting the challenges of the new millennium (Sohail and Boon Hoong, 2003).

The pressure from globalisation has made manufacturing organisations moving towards three major competitive arenas: quality, cost, and responsiveness. Quality is a universal value and has become a global issue. In order to survive and be able to provide customers with good products, manufacturing organisations are required to ensure that their processes are continuously monitored and product quality are improved.

Manufacturing organisation applies various quality control techniques to improve the quality of the process by reducing its variability. A range of techniques are available to control product or process quality. These include seven statistical process control (SPC) tools, acceptance sampling, quality function deployment (QFD), failure mode and effects analysis (FMEA), six sigmas, and design of experiments (DoE).

The purpose of this paper is to present the implementation of quality control in manufacturing company and identify the factors that influence the selection of quality control techniques in the company. The paper discusses the reasons for applying quality control techniques, the techniques used, and problems faced by them during the implementation. The paper begins with an overview of quality control and its implementation in organisations. This is followed by the description of a selected company and application of quality control in the company is then presented.

Quality Control

Quality can be defined as fulfilling specification or customer requirement, without any defect. A product is said to be high in quality if it is functioning as expected and reliable. Quality control refers to activities to ensure that produced items are fulfilling the highest possible quality. Most of tools and techniques to control quality are statistical techniques. Quality control techniques can be classified into basic, intermediate, and advance level, but there is no consensus among researchers in the classification. For example, Xie and Goh (1999) consider DoE as an intermediate level technique whereas Antony et al (1998) classified the technique as advanced. Nevertheless, the content is more important than the classification.

Among the basic techniques are SPC. SPC is a statistical approach for assisting operators, supervisors and managers to manage quality and to eliminate special causes of variability in a process (Oakland, 2003). The initial role of SPC is to prevent rather than identify product or process deterioration, but Xie and Goh (1999) suggest for its new role to actively identifying opportunities for process improvement. The main tools in SPC are control charts. The basic idea of control charts is to test the hypothesis that there are only common causes of variability versus the alternative that there are special causes by continuously monitoring the process, the manufacturing organisation could prevent defect items to be processed in the next stage and to take immediate corrective action once a process is found to be out of control (Hairulliza et al., 2005).

DoE and Taguchi methods are powerful tools for product and process development. Taguchi methods, for instance, aim at making product or process that robust to undesirable disturbances such as environmental and manufacturing variations. However, the application of these two methods by industries is limited (Antony and Kaye, 1995). Antony et al (1998) explore the difficulties in the application including improper understanding and fear of statistical concepts in the methods, thus propose a methodology for the implementation.

Process capability study is an efficient method to examine the capability of a process to produce items that meet specifications. The method gains rapid growing interest due to increased use of quality system QS9000, where use of process capability studies is requested (Deleryd et al, 1999). The findings from capability study might require adjustment of process using other statistical technique such as SPC or DoE. Capability studies conducted by Motorcu and Gullu (2004) and Srikaeo et al (2005) show that the machine tool and process capability and production stability was evaluated and necessary steps to reduce poor quality production was carried out using other statistical techniques.

FMEA is a powerful method to detect where exactly problems can occur and to prioritise possible problems in the order of their severity (Dale et al., 2003). The tool is useful to identify problems in product, i.e. design FMEA, as well as to trouble shoot problems in process, i.e. process FMEA (Xie and Goh, 1999). Six sigma is also a statistical tool for ensuring defect free products through process continuous improvement. The term six sigma originated at Motorola and many inspired worldwide organizations have set goal towards a six sigma level of performance (Breyfogle and Cupello, 2001). The application of six-sigma has been mainly used in manufacturing industry. An example of the use of six-sigma in non-manufacturing industry is in software development (Mahanti and Antony, 2005).

Acceptance sampling is another statistical technique to make a decision whether to accept or reject a lot based on the information from sample. The application of acceptance sampling allows industries to minimise product destruction during inspection and testing, and to increase the inspection quantity and effectiveness. The application of acceptance sampling has been mainly used in manufacturing industry. Similarly, its application in nonmanufacturing industry is widely reported such as Thorpe et al. (1994), Gardiner and Mitra (1994) Bathika (2003) and Slattery (2005).

Ways of Controlling Qualities (Xie and Goh, 1999)

i. ***Setting Standard***: - Determine the require cost, quality, performance quality, safety quality and reliable quality standard for a product.
ii. ***Appraising Conformance***: - Comparison of the conformance of your product or services to the set standard.
iii. ***Acting When Necessary***: - If after appraisal the process is out of control then an appropriate action is taken.
iv. ***Planning for Improvement***: - Developing a continuous improvement in cost, safety, performance and reliability standard.

Benefits of Quality Control in Industry

i. Improving the quality of products.
ii. Increasing the productivity of manufacturing processes.
iii. Reducing manufacturing and corporate costs.
iv. Determining and improving the marketability of products.
v. Reducing consumer prices of products.
vi. Improving and/or assuring on-time deliveries and availability.

Statistical Quality Control

The Statistical Control of Quality is application of statistical principles and techniques in all stages of design, production, maintenance and service, directed toward the economic satisfaction of demand. This definition was given by Deming (1971) emphasizes the statistical applications, and it also makes explicit the economic objectives of quality control.

Statistical process control (SPC) can be considered as statistical quality control applied to a process or to a product resulting from a process. The DuPont Co. definition of SPC is: SPC is the totality of all process activities directed at improving process consistency through detecting changes in measured characteristics, identifying causes of changes, and Preventing, recurrence of those causes.

Statistical Quality Control Method is analytical tools used to evaluate men, materials, machine, method, measurements and process. Evaluation obtained by this method assist in maintaining the desired results by using past history to predict probability and trend such analytical method are management tools which furnish data to all level of supervision for appropriate action.

The following are some of the advantages of the use of statistics technique in interpreting data and controlling management:

i. Improves design tolerance.
ii. Improved inspection by better plan.
iii. Better plan relationship through co-ordinated effort.
iv. More uniform quality at higher level.

The above uses advantages mentioned are not applicable to production sectors only it is also applicable to where services were render.

Some Basic Tools

In statistical process control numbers and information will form the basis for decisions and actions, and a thorough data recording system is essential. In addition to the basic elements of a management system, which will provide a framework for recording data, there exists a set of 'tools' which may be applied to interpret fully and derive maximum use of the data. The simple methods listed below will offer any organization a means of collecting, presenting and analysing most of its data:

i. Process flowcharting –Helps to determine what variations to focus upon?
ii. Check sheets/tally charts – how often a problem occurs?
iii. Histograms – what does the variation look like?
iv. Graphs – can the variation be represented in a time series?
v. Pareto analysis – helps to identify the big problems.
vi. Cause and effect analysis and brainstorming – what causes the problems?

vii. Scatter diagrams – what are the relationships between factors?
viii. Control charts – which variations to control and how?

Control Charts

The control chart is a graph used to study how a process changes over time. Data are plotted in time order. Control charts are tools used to determine if a manufacturing or business process is in a state of statistical control. If analysis of the control chart indicates that the process is currently under control, then no correction or process are needed or desired. Data from such process can be used to predict the future performance of the process. If the chart indicates that the monitored process is not in control, analysis of the chart helps to determine the sources of the variation. To effectively use control charts, you must understand the information in variation.

What is Variation

If you understand variation, you will realize that most of the problems you face are not due to individual people, but to the process that is, the way it was designed and the way it is managed on a day-to-day basis. Variation comes from two sources, common and special causes. Think about how long it will take you to get to work in the morning. Maybe it takes you 30 minutes on average. Some days it may take a little longer or lesser, the range may be between 25-30 minutes, this variation represent common variation. And this type of variation is consistent and predictable. Now, suppose you have a flat tire when driving to work. How long will it take you to get to work? Definitely longer than the 25-30 minutes in your 'normal' variation. Maybe it will take you an hour longer. This is a special variation. Special variations are not predictable and are sporadic in nature.

Control Charts for Process Location

The type of charts is often classified according to the type of quality characteristic that they are supposed to monitor: there are quality control charts for variable and control charts for attributes. Specifically, the following are commonly constructed for controlling variables:

i. X-bar Control Chart
ii. R-chart
iii. C-chart
iv. S-chart
v. U-chart
vi. P-chart
vii. NP-chart etc.

The purpose of statistical process control using control charts is to monitor so that any changes can be detected and corrected quickly. This is economical method of maintaining good product quality.

Total Quality Management (TQM)

Total Quality Control also called Total Quality Management (TQM), is an approach that extend beyond ordinary statistical quality control techniques and quality improvement methods. Total Quality Management refers to management methods used to enhance quality and productivity in business organization. Total Quality Management (TQM) practise are primarily found in large and multinational organizations but little has been written on how TQM has been applied in SMEs.

Numerous definitions have been given on Total Quality Management (TQM) by quality gurus, practitioners and academician. Besterfield (1995) defined TQM as both a philosophy and a set of guiding principles that represents the foundation of a continuously improving organization. It integrates fundamental management techniques, existing improvement efforts and technical tools under a disciplined approach. Using a three-word definition, Wilkinson & Wither (1990) and (Ho, 1999) defines TQM as:

Total: Every person is involved (its customers and suppliers)
Quality: Customer requirements are met exactly
Management: Senior executives are fully committed.

MATERIALS AND METHODS

The survey methodology was used to obtain general overall information on application and effectiveness of quality control tools and techniques among entrepreneurs in Technology Incubation Centre, Abeokuta, Ogun State, Nigeria. The monthly/weekly sales data of an entrepreneur called Glober Academy for Creativity and Innovation (GACI) was collected and that of the Engineer whose task is to monitor a specific process. All the data collected had been constructed in table to make it more systematically. The main data analysis is statistical process control and process capability analysis. Both the two types of analysis were solved by using MINITAB which is a powerful Quality Control tool aided in data analysis. From the X-bar to R-chart, the information that has been provided could be used for quality improvement.

RESULTS AND DISCUSSION

The sales data have been collected within twenty-four (24) months. Also, an engineer in same company who's his first day in office was required to collect data for the process of a specific machine in hours and each hour we take four reading so as to be consistent with this baseline data. In this study, there have two processes that can be categorized as variable data and analysed by using X-bar and R chart. The Figure 1. Shows the X-bar of weekly sales data. Among the data for Xbar chart, all subgroups are in limit. The mean is 182.12, upper control limit (UCL) is 192.10 and lower control limit (LCL) is 172.11. There are two points that fall outside the control limit, so the process is not is state of control. The Figure 2. shows the X-bar of monthly sales data. For the forging section, the mean is 528.89, UCL is 570.01 and LCL is 485.79. There is no point beyond central limit; therefore, the process is in a state of control. Figure 3 and 4 shows the X-bar and R- chart of the hours reading by the engineer are UCL is 7.0982, LCL is 6.9251 and 7.01, for the R-chart is LCL is 0, UCL is 0.2710 and mean is 0.12. None of the points both the X-bar and R- charts fall beyond the central limit; so, this shows that the reading taking by the engineer in his first day in office is in control.

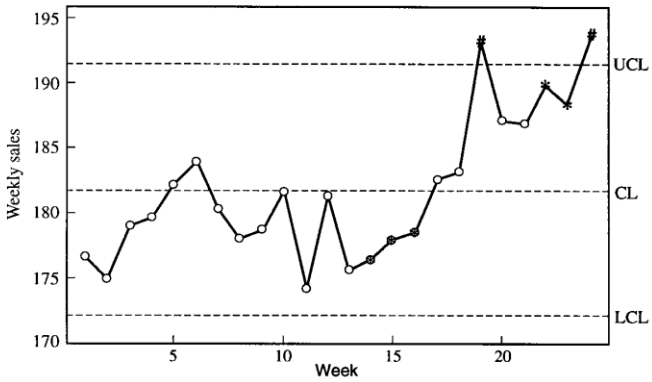

Figure 1: Weekly Sales Data

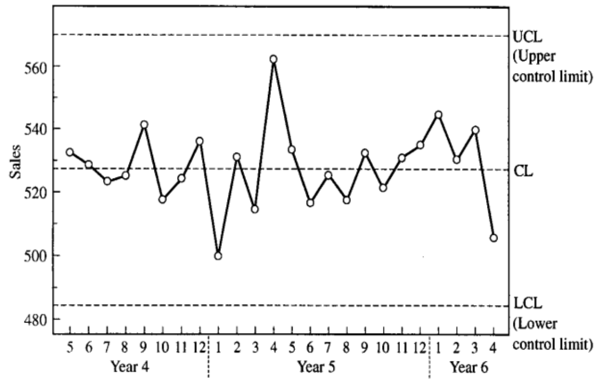

Figure 2: Monthly Sales Data

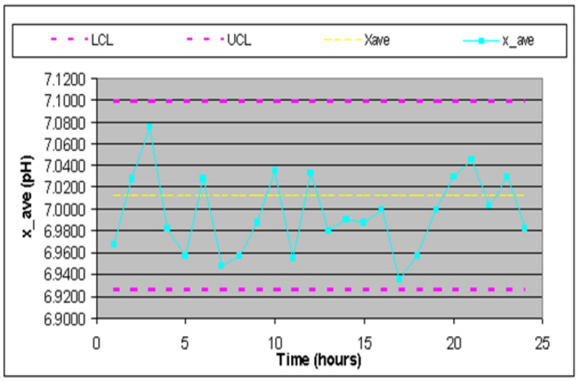

Figure 3: X-Bar Chart of the Engineer Reading

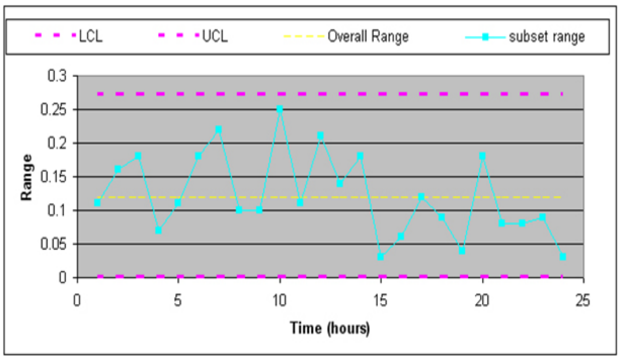

Figure 4: R-Chart of The Engineer Reading

CONCLUSION

A wealth of literature exists on benefits of SMEs to an economy. These include: creation of jobs, reducing income disparities, the development of skilled and semi-skilled workers for future industrial expansion and excellent breeding ground for entrepreneurial and managerial talents, the critical shortage of which is often a barrier to economic development. To stimulate the survival strategies processes growth in

SMEs, this study investigated the application and effectiveness use of statistical quality control tools entrepreneur firm. The results highlighted that most managers still are experiencing low levels of quality management implementation and they do not recognize the need to compete in the pursuit of modern technologies. This could be due to major problems to SMEs such as knowledge loss, human and financial resource limitation, product design and development capability, lack of training infrastructure and networking.

It is clear from both these charts that the weekly sales data process is completely out of control due to proper booking keeping and others factor unnoticed while in the monthly sales data and the Engineer reading process is completely in the control as all the rules of stability are been met. It is critically important that both of these charts should be used for a given set of data as there is a possibility that a point in the Range Chart can be beyond the control band even if nothing goes out of control in the XBar chart. Another important issue to be looked after is that if the control charts for given pH data show any points beyond the UCL or the LCL, it does not at all mean necessarily that the process is out of control completely. May be it simple means that the pH sensor is required to be calibrated again.

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