PRIORITIZE MEASURES TO ACHIEVE INTENDED RESULTS USING SPC (STATISTICAL PROCESS CONTROL) TOOLS: A REVIEW

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Abstract- SPC is the application of statistical method to monitor and control the process to ensure that it operates at its full potential to produce confirming products. In order to survive in a competitive market, improving quality and productivity of product or process is a must for any company. Hence quality improvement program should be an integral part of the overall business strategy. Some simple techniques like seven basic quality control(QC) tools to provide a very valuable and cost effective way to meet these objectives. The main tool of SPC are the 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 are special causes. Control charts are designed and evaluated under the assumption that the observations from the process are independent and identically distributed normal. However, the independence assumption in often violated in practice. Control charts are utilized by industrial units to augment quality of products and to minimize wastage but other aspects are equally important for the effective implementation of SPC in organizations. This paper depicts implementation of the Statistical Process Control techniques in various manufacturing units. In this research paper, various articles on the implementation of Statistical Process Control techniques in the manufacturing units are examined for the review.

Keywords-Statistical Process Control, Quality, Process effectiveness, 7QC Tools.

I. INTRODUCTION:

SPC is an analytical decision making tool which allows you to see whether a process is working effectively so that preventive measures can be taken at right time. In this era of strains on the resources and rising costs of manufacturing, it becomes apparent that decisions must be taken on the facts, not just opinions by gathering and analyzing data.

II. BASIC 7 QC TOOLS

The company had used some of the “seven basic quality control tools” in their problem solving technique. The seven quality tools are:

- **a.** Check Sheet
- **b.** Pareto Chart
- **c.** Histogram
- **d.** Scatter Diagram
- **e.** Process Flow Chart
- **f.** Cause and Effect Diagram or Fish Bone Diagram
- **g.** Control Chart

The control chart is perhaps the most widely used of the “seven basic quality control tools”. It is the key tool in statistical process control (SPC) because it displays process behavior graphically and it is used to monitor and control processes within the specified control limits. There are two basic types of control chart, depending on the type of data collected; namely variable control chart and attribute control chart. Variable control chart are designed to control product characteristics and process parameters which are measured in continuous scale. Examples of product characteristics are length, weight, and diameter and examples of process parameters are temperature, pressure, and PH value. The primary variable control chart used are the X-bar and R chart and moving range chart, while the other two, rarely used charts include X-bar and s chart and median chart. Attribute control charts are designed to control the process. Measurements used are in terms of good or bad, accept or reject, go/no-go, or pass or fail criteria (e.g. conforming or non-conforming) . The distinction between nonconforming or defective unit and nonconformities or defects is very important in attribute control chart because it will determine the selection in the type of attribute control chart used. Examples of nonconformities or defects in injection molded lenses are flow lines/marks, dirty dots and scratches. A nonconforming or defective unit, however, may fail to meet the assessment criteria because of one or more nonconformities or defects exist. For attribute data, there are: p chart, np chart, c chart and u chart. The p and np charts are the most widely used. They are primarily used to monitor the fraction of nonconforming unit, while, the c and u charts are used to monitor the number of nonconformities or defects.

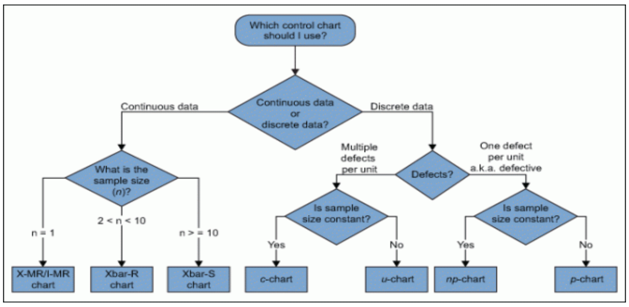

Fig-1: Shows the selection criteria of control charts on the basis of data available (variables or attributes) with sample size or subgroup size.

III LITERATURE REVIEW

Number of researchers has published research papers on the topic of SPC. The literature that deals on SPC for effectively optimizing a process is quite vast. Some of them are given below:

A.Coskun Dalgic, Hasan Vardin and K.Bulent Belibagli [1] has been investigated that the SPC techniques in food processing operations can play an important role of quality control and safety. A large number of managers have achieved the benefits from statistical process control (SPC) implementation. Use of these tools is discussed by considering traditional sucuk (sausage) process. Sucuk, is a term used for a fermented dry meat product, is a very popular meat product in Turkey and countries located in Balkans, Middle East and Caucasus. This meat product has been chosen because of its liability to deteriorate easily. Assuring HACCP (Hazard analyzes and critical control points is a system that identifies, evaluates and control hazards which are significant for food safety) effectiveness for food safety relies on application of many prerequisite programs. In addition, some processes (Documentation and record process, internal audit process, etc) applied with ISO 9000-Quality Management System (QMS) standard are used with the HACCP system. ISO 22000-Food Safety Management System (FSMS) standard is being introduced as organizing all of these requirements; moreover it is desired to be used as a single standard in the world. In this work, an effort was made for safety and quality parameter analyses (e.g. Failure mode and effect) of traditional sucuk production by describing and outlining the incoming hazards in every process stage, starting from raw materials to the final product. Hazard, cause and risk analyses for traditional sucuk production lead to have CCPs in every production steps. All production steps were also determined to be quality control points. A more efficient correction of the process is possible by use of these SPC tools.

A.De Vries and J.K.Reneau [2] has been investigated that an important SPC tool is the control chart can be used to detect changes in production processes, including animal production systems, with a statistical level of confidence. This paper introduces the philosophy and types of control charts, design and performance issues, and provides a review of control chart applications in animal production systems found in the literature from 1977 to 2009. Primarily Shewhart and cumulative sum control charts have been described in animal production systems, with examples found in poultry, swine, dairy, and beef production systems. Examples include monitoring of growth, disease incidence, water intake, milk production, and reproductive performance. Most applications describe charting outcome variables, but more examples of control charts applied to input variables are needed, such as compliance to protocols, feeding practice, diet composition, and environmental factors. Common challenges for applications in animal production systems are the identification of the best statistical model for the common cause variability, grouping of data, selection of type of control chart, the cost of false alarms and lack of signals, and difficulty identifying the special causes when a change is signaled. Nevertheless, carefully constructed control charts are powerful methods to monitor animal production systems. Control charts might also supplement randomized controlled trials. Control charts can be used to detect planned and unplanned changes in animal production systems.

Pankaj Chandna and Arunesh Chandra[3] depicted that with the help of Pareto diagram, which are mostly used to identify critical areas, the forging defects of the crankshaft have been prioritized by arranging them in decreasing order of importance. Then cause and effect diagram is being applied to explore possible causes of defects through brain storming session and to determine the causes which has the greatest effect. In this work the forging analysis of six cylinder crankshaft produced by hot forging with the help of quality tools is being made. The analysis shows that more than 80% of rejection and rework are due to forging defects like overlap, under filling, pitting, foreign body and shop scrap. Corrective measures are being suggested to overcome the forging defects of the 697 integral counter weight crankshafts. Finally, few remedial measures and suggestions have been made provided for the existing crankshaft production line in the forging shop and controlling vital few forging defects will reduce the present rejection rat from 2.43% to 0.21% and rework from 6.63% to 2.15%.

Jafri Mohd. Rohani and Chan Kok Teng[4] has been studied to reduce the defect rate of plastic injection molded lenses used in telecommunication devices from 13.49% to 7.4% through use of seven basic quality control (QC) tools. The company collected the data over a period of three months based on daily check sheet which include the quantity output of good parts and defective parts. Pareto chart was constructed to identify the most common defect. the chart revealed that flow lines/marks is the highest defect with average of 5.04% dirty dots with average of 3.96% and followed by scratches with average of 2.27%. All other minor defects are shown in the pareto chart. Only the top three defects are chosen for this case study. The root causes of these three defects can be grouped in to machine operator, work method, environment, material, and equipment. After implementation of SPC tools data collected showed that the average defect has improved to 7.4% from 13.49% initially. Thus the study has achieved its set goals. It is noted that simple QC tools can make significant improvement to the company.

Eleni Smeti, Demetrios Koronakis and Leonidas Kousouris [5] applied the typical SPC techniques and the time series method (Alwan-Roborts method) on toxicity data of water for human consumption from treated water tanks. This application shows the serious effects of autocorrelation when typical SPC control charts are applied on autocorrelated observations. Typical control charts (Shewhart, CUSUM, EWMA) are designed and evaluated under the assumption that the observations from the process are independent and identically distributed. However, the independence assumption is often violated in practice. Autocorrelation may be present in many processes, and may have significant effects on the properties of the control charts.

B.P.Mahesh and M.S. Prabhuswamy [6] illustrate the step by step procedure adopted at a soap manufacturing company to improve the quality by reducing process variability using statistical process control. To reduce the number of soaps falling outside the specification band, there are two types of strategies available. The first one is to reduce the variability in the system. The second one is to shift the target (process mean) towards the centre. But the first strategy of reducing the variability is preferred because the weight of the soap bar is to be kept just around 75g. Shifting the target will lead to increase in weight of the soap, which is not profitable for the organization. Finally remedies were given to reduce the number of defects being produced, so that the system can attain the state of statistical control. Span of one year, many easily executable remedies were implemented. Then the entire study was repeated again for the production lines. Post implementation study revealed that defects rate came down thus reducing the process variability.

Bimal Mishra and G.S. Dangayach [7] found on their research that Statistical Process Control (SPC) is an effective statistical tool used to prevent defects on a cigarette-manufacturing company in Nepal. The research was carried out on three cigarette-making machines, i.e., 01, 02 (plain makers) and 09 (filter cigarettes with premium brands), which have high variability in circumference. The initial data were taken on all three machines, and then special causes were eliminated. After eliminating special causes, the CP (process capability indices) was increased for Maker-02 from 0.343 to 0.709 and for Maker-09 from 0.521 to 1.044. Thereafter, several common causes were identified and eliminated, which resulted in an increase in CP (process capability indices) for Maker-02 up to 1.0567 from 0.343 and for Maker-01, up to

1.0372 from 0.717. Other recommendations and suggestions for preventive as well as corrective action were also made based on Failure Mode and Effect Analysis (FMEA).

Farzana Sultana, Nahid Islam Razive and Abdullahil Azeem[8] intend to combine the Hourly Data System (HDS) and Statistical Process Control (SPC) practices to improve manufacturing performances in manufacturing companies. The focus of the work is to find out the frequencies and time duration of machine breakdowns affecting productivity. Total quality management (TQM) was introduced to improve continually the products or services to increase the customer satisfaction level. The volume of cigarette packing department (CPD) has been taken for analyzing the performance of the machines. A detailed analysis has been done to find out the frequencies and time duration of cigarette machine breakdowns as well as major causes of those breakdowns. The obtained results show that any breakdown can cause a huge cost and the beast approach to address any breakdown is the preventive measures. If one can get any single of probable breakdown in the coming operation time, he/she can take the preventive actions and can save a huge amount of money avoiding the consequent breakdown or stoppage time. This only can be done by analyzing the recent and past breakdowns and the causes of those breakdowns. Moreover some prodand solving of the breakdown causes. But this is not the right way to minimize the causes of breakdowns. Long term corrective/ preventive actions are also needed to minimize or reduce these issues. Although SPC is primarily used as a quality control tool, it can also be used to improve the manufacturing performance of a factory.

Dr. D. R. Prajapati [9] has been investigated SPC techniques offering its customers the widest and latest range of sealing solutions for various applications in the automotive industry. Out of 7 QC techniques cause and effect diagram and Control chart are implemented in this industry. A study was conducted on defects in shocker seals of an automotive industry which resulted in reduction of rejection from 9.1% to 5% and process capability of 0.953 is achieved. The essential Tools for the discovery process are check sheet, cause and effect sheet, pareto chart, scattered diagram, histogram and control chart. Through SPC analysis efficiency of the manufacturing process can be improve by minimizing number of defective products, thus saving a lot of rework cost and valuable time after implementing the suggestive measures for shocker seals process capability got improved which was greater than required. 400 observations were made of outer diameter of shocker seals and found that no any observation is falling outside of control limits on both X bar and R charts.

Dr. R Satya Prasad, Bandla Sreenivasa Rao and Dr. R. L Kantham [10] consider an MMLE (Modified Likelihood Estimation) based scheme to estimate software reliability using exponential distribution. The MMLE is one of the generalized frameworks of software reliability models of Non Homogeneous Poisson Processes (NHPPs). The MMLE gives analytical estimators rather than an iterative approximation to estimate the parameters. In this paper researchers proposed SPC charts mechanism to determine the software quality using inter failure times data. The control charts can be used to measure the software process is statistically under control or not. The MMLE is one of such NHPP based software reliability model. The software reliability models can be used quantities management of quality. This is achieved by employing SPC techniques to the quality control activities that determines whether a process is stable or not. The objective of SPC is to establish and maintain statistical control over a random process. To achieve this objective, it is necessary to detect assignable causes of variation that contaminate the random process. The SPC had proven useful for detecting assignable causes.

IV. CONCLUSION

Conclusion can be drawn from the above study that quality has become one of the most important customer decision factors in the selection among the competing product and services. Consequently, understanding and improving quality is a key factor leading to business success, growth and an enhanced competitive position. Hence quality improvement program should be an integral part of the overall business strategy. By using the quality tools and statistical techniques quality of the products can be achieved and wastage can be minimized up to great extent these tools and techniques are easy to implement and it needs the involvement and support of top management, manager employees and workers. In this paper it has found that the SPC tools can be applied to different Industrial units for reducing the defects. Thus SPC tools can help managers, process improvement practitioners and researchers to use objective data and statistical thinking to make appropriate decisions.

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