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Understanding and Implementation of some Aspects of SQC Tools and Reduced Rejection in Manufacturing Industry: A Case Study

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Abstract: In today global economy, the survival of companies depends on their ability to rapidly innovate and improve. As a result, an increasing search is on for the methods and processes that drive improvements in quality, costs and productivity. In this paper, we used some important quality tools (Statistical Quality Control Tools) and examine the change in result after considering and find out the factors which are responsible for maximum rejection. For completeness, some better alternatives to previously proposed procedures are also provided for the case where the process parameters are assumed known in advance of production. In the light of the above mentioned facts problem solving techniques gain an increased importance in context of Indian industries. Method has become an important approach in order to produce quality products and reduced rejection ration This method is very important tool by rejection in operation of a system may be eliminated. Various techniques may be applied to reduce or eliminate rejection and error in manufacturing process.

Keywords: Control charts, SQC, Quality Management, Quality Control.

1. QUALITY CONTROL TECHNIQUES: AN INTRODUCTION

1.1 Introduction

In preparing to introduce a quality improvement initiative, managers must create a supportive environment for this initiative, form and train a team to implement the initiative, and work with the team to focus on the needs and priorities defined by users of their health services One way to start to improve quality is to solve existing problems. To begin the process for the first time, think about a small but important problem that is likely to be resolved with some thought and work. Start by envisioning that problem as having the six distinct steps illustrated in the graph above. A small project in the beginning serves as a tool for learning about quality improvement and as a catalyst for change. Choose a problem that is both important and manageable. If the problem is important, its resolution will also be visible, and the perceived improvements will invite increased interest in the quality improvement efforts. If the scope of the problem is manageable, resolution is more likely and learning is more focused. It is essential that the first problem solving cycle be a success. [14]

1.2 Quality

A sample is a collection of numbers (measurements or counts) on the quality characteristic(QC) of process variable (PV) of units drawn from a process. A sample unit is a part of the process on which the QC or PV is measured. The units may be patients, incidents, time (day of week), a form, an incoming shipment of material—all of which are integrally related to process.

Table: 1 Definition of Quality

1.Customer – Based	Fitness for use , meeting customer expectations.
2. Manufacturing –Based	Conforming to design, specifications, or requirements. Having no defects.
3. Product- Based	The product has something that other similar products do not adds value
4. Value- Based	The product is the best combination of price and features
5. Transcendent	It is not clear what it is, but it is something good…

1.3 Total Quality Control

Total Quality Control defined as an effective system for intergrating the quality development, quality maintenance and quality improvement efforts of the various groups in an organisation so as to enable production and service at the most economical level which allow for full customer satisfaction. It may be classified as a ‘‘Management Tool’’ for many industries outstanding improvement in product quality design and reduction in operating costs and losses. Product quality is defined as ‘‘the composite product of engineering and manufacture that determine the degree to which the product in use will meet the expectations of the customer’’. ‘‘Control’’ represents a tool with four steps:

i. Setting up of quality standards.
ii. Appraising conformance to these standards
iii. Acting when these standards are exceeded.
iv. Planning for improvements in these standards.

1.4 Statistical Quality Control

A Quality control system performs inspection, testing and analysis to conclude whether the quality of each product is as per laid quality standard or not. It’s called‘‘Statistical Quality Control’’ when statistical techniques are employed to control quality orto solve quality control problem. SQC makes inspection more reliable and at the same time less costly. It controls the quality levels of the outgoing products. SQC should be viewed as a kit of tools which may influence related to the function of specification, production or inspection.

Controlling the quality of products so as to maintain it at a given level is a major problem in production. Production has been trying to use some men, machine and raw materials in the hope of turning out of uniform quality. But neither men nor machine are infallible and cause of irregularity often creeps in inadvertently. As a result, rejection in finished materials are rarely eliminated and inspection and screening because necessary for varied extents depending on the nature of the products.

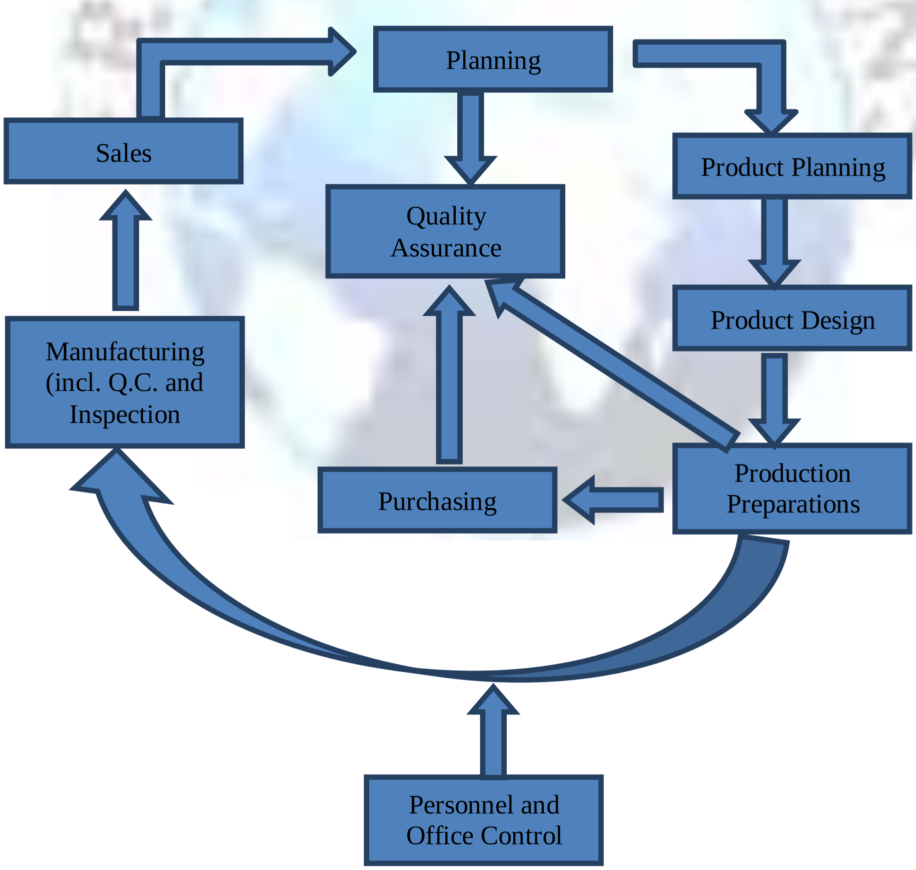

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Fig. No. 1.1: Concept of Gross Functions for Quality Management

1.4.1 Statistical Quality Control (SQC)

SQC is the term used to describe the set of statistical tools used by quality professionals. Statistical quality control can be divided into three broad categories:

i. Descriptive statistics are used to describe quality characteristics and relationships. Included are statistics such as the mean, standard deviation, the range, and a measure of the distribution of data.
ii. Statistical process control (SPC) involves inspecting a random sample of the output from a process and deciding whether the process is producing products with characteristics that fall within a predetermined range. SPC answers the question of whether the process is functioning properly or not.
iii. Acceptance sampling is the process of randomly inspecting a sample of goods and deciding whether to accept the entire lot based on the results. Acceptance sampling determines whether a batch of goods should be accepted or rejected. The tools in each of these categories provide different types of information for use analysing quality.

1.4.2 Principles of Statistical Quality Control

The principles that govern the control of quality in manufacturing are:

i. Control of quality increases output of saleable goods, decreases costs of production and distribution, and makes economic mass production possible.
ii. The quality of manufactured goods is variable with an upward trend under conditions of competitive manufacturing.
iii. The conformance of finished product to its design specifications and standards should be accomplished by avoiding the making of non-conforming materials rather than by storing the good from the bad after manufacturing is completed.

1.4.2.1 Vision SQC

To be the leading changing agent in industry enhancing its competitive edge to achieve the sustainable growth through learning organization.

1.4.2.2 Mission SQC

To support the society and industry through strategic partnership in total business management solution.

1.4.3 Objectives

To solve the problems using various quality tools.

1. **Identifying the problem—**which problem should I address? If there are several, how do I choose the most important one?
2. **Describing the problem—**how do I accurately and completely describe the problem?
3. **Analyzing the problem—**what are the different causes of the problem, and which causes are most important to solve right away?
4. **Planning the solutions—**what are the different alternative solutions for solving the problem?
5. **Implementing the solutions—**how do I make sure the solutions are implemented correctly and effectively?[6]
6. **Monitoring/evaluating the solution--**How did the solutions work? What needs to be changed?

1.4.4 Benefits/Advantages of Statistical Quality Control:

Benefits & advantages of statistical quality control are as follows:

1. It provides a means of detecting error at inspection.
2. It leads to more uniform quality of production.
3. It improves the relationship with the customer.
4. It reduces inspection costs. It reduces the number of rejects and saves the cost of material.
5. It provides a basis for attainable specifications.

1.5 Seven Basic Tools of Quality

The Seven Basic Tools of Quality is a designation given to a fixed set of graphical techniques identified as being most helpful in troubleshooting issues related to quality.They are called basic because they are suitable for people with little formal training in statistics and because they can be used to solve the vast majority of quality-related issues. Seven Management and Planning tools are given below.

The seven tools are:

i. Check sheet
ii. Stratification (alternately, flow chart or run chart)
iii. Histogram
iv. Cause-and-effect diagram (also known as the "fishbone" or Ishikawa diagram)
v. Pareto chart
vi. Control chart
vii. Scatter diagram

1.5.1 Check Sheet

1.5.1.1Definition
A simple data collection form consisting of multiple categories with definitions. Data are entered on the form with a simple tally mark each time one of the categories occurs.

1.5.1.2Purpose

To facilitate the collection and analysis of data
A check sheet is a simple means of data collection. The most straightforward check sheet is simply is simply to make a list of items that you expect will appear in a process and to mark a check beside each item when it does appear. This type of data collection can be used for almost anything, from checking off the occurrence of particular types of defects to the counting of expected items (e.g. the number of times the telephone rings before being answered).

i. Clearly define the objective of the data collection.
ii. Determine other information about the source of the data that should be recorded, such as shift, date, or machine.
iii. Determine and define all categories of data to be collected and who will collect the data.
iv. Determine how instructions will be given to those involved in data collection.
v. Design a check sheet by listing categories to be counted.
vi. Pilot the check sheet to determine ease of use and reliability of results.
vii. Modify the check sheet based on results of the pilot.

1.5.2 Stratification

1.5.2.1 Definition
Knowledge of the process allows you to group things so that you get the most information from your data collection for the effort expended. This called stratification. Creative thinking is usually required to select possible groupings, or strata, within which sample units will be taken. Examples of possible strata are

Acuity Day of Week
Zip code
Sex
Age
Weight

1.5.2.2 Purpose
Allows you have to better understand the variation in your QC or PV by aligning data with known groups in the process.

1.5.2.3 Guidelines
i. The sample units must be in sequence and serially numbered.
ii. The grouping variable must be selected based on process knowledge.

1.5.2.4 Types of Stratification

1.5.2.4.1 Pre-stratification:

This occurs when the team breaks the data collection into smaller groups prior to collecting data, because they know the grouping. In pre-stratified samples, you plan to collect enough data in the strata to establish a run chart for those strata.

1.5.2.4.2 Post-Stratification:

This occurs when the team collects additional information during data collection such as triage level. They then separate the data into groups based on this additional information after data collection is complete. In post-stratified samples, there is usually not enough data in the strata to establish a run chart and, hence, further data collection may be necessary. In both types of stratification, the data are analyzed within the strata or groupings. Prior to data collection, stratify to the maximum extent that you can based on your knowledge of the process (pre-stratification).If you are unsure of the impact of some potential stratifying factor, plan to collect the data necessary to post-stratify on it.

1.5.3 Histogram

Overview: This histogram tutorial will provide information on how to construct and interpret histograms for use in quality process control (Q.C.). The main areas explained are:

a) Histogram Background
b) Creating a Histogram
c) Interpreting Histogram
d) Recommended Additional Q.C. Topics and Software

Purpose: The purpose of the tutorial is to let you become familiar with graphical histogram, which is used widely in quality control (Q.C.). Histograms are effective Q.C. tools, which are used in the analysis of data. They are used as a check a specific process parameters to determine where the greatest amount of variation occurs in the process, or to determine if process specifications are exceeded. This statistical method does not prove that a process is in a state of control. Nonetheless, histograms alone have been used to solve many problems in quality control. This histogram evolved to meet the need for evaluating data that occurs at a certain frequency. This is possible because the histogram allows for a concise portrayal of information in a bar graph format. The histogram is a powerful engineering tool when routinely and intelligently used. The histogram clearly portrays information on location, spread, and shape that enables the user to perceive subtleties regarding the functioning of the physical process that is generating the data. It can also help suggest both the nature of, and possible improvements for, the physical mechanisms at work in the process.

1.5.4 Cause & Effect Diagram

1.5.4.1 Introduction

When utilizing a team approach to problem solving there are often many opinions as to the problems root cause. One way to capture these different ideas and stimulate the teams brainstorming on root causes is the cause and effect diagram, commonly called a fishbone. The fishbone will help to visually display the many potential cause for a specific problem or effect. It is particularly useful in a group setting and for situations in which little quantitative data is available for analysis. he fishbone has an ancillary benefit as well. Because people by nature often like to get right to determining what to do about a problem, this can help bring out a more thorough exploration of the issues behind the problem- which will lead to a more robust solution. Cause and effect diagram graphically illustrates the relationship between a given outcome and all the factors that influence this outcome. Sometimes called an Ishikawa or “fishbone” diagram, it helps show the relationship of the parts (and subparts) to the whole by:

i. Determining the factors that cause a positive or negative outcome (or effect).
ii. Focusing on a specific issue without resorting to complaints and irrelevant discussion.
iii. Determining the root causes of a given effect.
iv. Identifying areas where there is a lack of data.

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Table. No. 1.2: Different Industries cause and effect table

Service Industries (The 4 Ps)	**Manufacturing Industries**	**Process Steps (The 4 Ps)**
❑ Policies ❑ Procedures ❑ People ❑ Plant/Technology	❑ Machines ❑ Methods ❑ Materials ❑ Measurements ❑ Mother Nature (Environment) ❑ Manpower (People)	❑ Determine Customers ❑ Advertise Product ❑ Incent Purchase ❑ Sell Product ❑ Provide Upgrade

1.5.4.2 Use the Cause /Effect Diagram to:

i. Focus attention on one specific issue or problem.
ii. Organize and display graphically the various theories about what the Root Causes of a problem may be.
iii. Show the relationship of various factors influencing a problem.
iv. Cause-and –effect diagrams do not have a statistical basis, but are excellent aids for problem solving.
v. Reveal important relationships among various variables and possible causes.

1.5.4.3Construction of a Cause-Effect Diagram

i. Clearly identify and define the problem, symptom, or effect for which the causes must be identified.
ii. Place the problem or symptom being explored at the right, enclosed in a box.
iii. Draw the central spine as a thick line pointing to it from the left.
iv. Brainstorm potential causes of the problem. It is acceptable to list a possible cause under more than one major cause category. (or construct an Affinity Diagram) to identify the "major categories' of possible causes (not less than 2 and normally not more than 6 or 7). If other applicable data such as check sheets are present, incorporate them as well. Then the final diagram will be like :

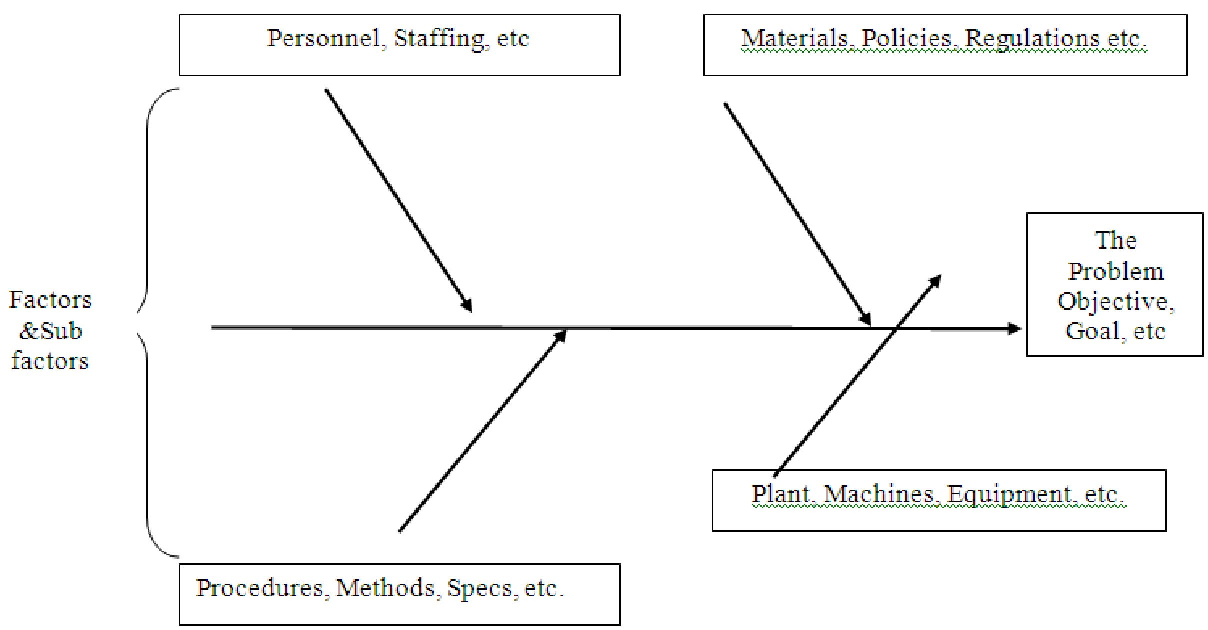

Fig. No.1.2: Cause-Effect Diagram

1.5.5 Pareto Chart

1.5.5.1 Introduction

It is a bar graph used to arrange information in such a way that priorities for process improvement can be established. Pareto analysis is way of organizing data to show what major factors (s) are significantly contributing to the effect being analyzed (i.e., how much each cause contributed to the problem at hand). Such analysis can help you:

i. choose a starting point for problem solving
ii. identify the Root Cause of a problem
iii. monitor success in a process improvement program

A Pareto Chart is a type of histogram in which the height of each bar represents the relative contribution of that element to the overall problem. Consistent with the “80-20” rule (“80% of the results are produced by 20% of the causes”), Pareto Charts usually reveal that a majority of the problematic results of process can be traced to only a few specific causes. Having identified the Root Causes with a Pareto Chart, you can then make changes to the process, confident that you are working with the “vital few” sources of problems rather than the “trivial many”.

1.5.6 Control charts

Control charts, also known as Shewhart charts (after Walter A. Shewhart) or process-behaviour charts, in statistical process control 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 (i.e., is stable, with variation only coming from sources common to the process), then no corrections or changes to process control parameters are needed or desired. In addition, data from the 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 can help determine the sources of variation, as this will result in degraded process performance. A process that is stable but operating outside of desired (specification) limits (e.g., scrap rates may be in statistical control but above desired limits) needs to be improved through a deliberate effort to understand the causes of current performance and fundamentally improve the process. The control chart is one of the seven basic tools of quality control. Typically control charts are used for time-series data, though they can be used for data that have logical comparability (i.e. you want to compare samples that were taken all at the same time, or the performance of different individuals), however the type of chart used to do this requires consideration.

1.5.7 Scatter Diagram

A scatter plot is used when a variable exists that is under the control of the experimenter. If a parameter exists that is systematically incremented and/or decremented by the other, it is called the control parameter or independent variable and is customarily plotted along the horizontal axis. The measured or dependent variable is customarily plotted along the vertical axis. If no dependent variable exists, either type of variable can be plotted on either axis or a scatter plot will illustrate only the degree of correlation (not causation) between two variables.

A scatter plot can suggest various kinds of correlations between variables with a certain confidence interval. For example, weight and height, weight would be on x axis and height would be on the y axis. Correlations may be positive (rising), negative (falling), or null (uncorrelated). If the pattern of dots slopes from lower left to upper right, it suggests a positive correlation between the variables being studied. If the pattern of dots slopes from upper left to lower right, it suggests a negative correlation. A line of best fit (alternatively called 'trend line') can be drawn in order to study the correlation between the variables. An equation for the correlation between the variables can be determined by established best-fit procedures.

1.6 Pie Chart

A pie chart (or a circle chart) is a circular statistical graphic, which is divided into slices to illustrate numerical proportion. In a pie chart, the arc length of each slice (and consequently its central angle and area), is proportional to the quantity it represents. While it is named for its resemblance to a pie which has been sliced, there are variations on the way it can be presented. Pie charts are very widely used in the business world and the mass media.However, they have been criticized, and many experts recommend avoiding them, pointing out that research has shown it is difficult to compare different sections of a given pie chart, or to compare data across different pie charts. Pie charts can be replaced in most cases by other plots such as the bar chart.

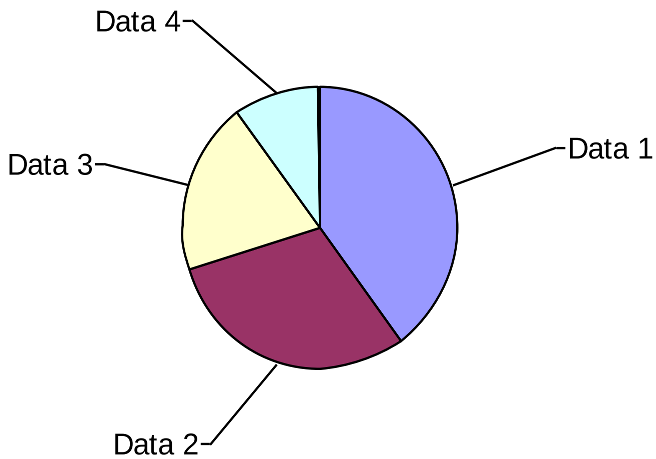

Fig. No. 1.3: Bar Chart

1.7 Brainstorming

Brainstorming helps a group create as many ideas as possible in as short a time as possible. Typically, brainstorming should only take about 5 to 10 minutes to generate 25 or 30 ideas. This rapid pace helps creative thinking. Ideas are written down on a flip chart. Discussion and criticism are not allowed. Brainstorming is a group or individual creativity technique by which efforts are made to find a conclusion for a specific problem by gathering a list of ideas spontaneously contributed by its member(s). Osborn claimed that brainstorming was more effective than individuals working alone in generating ideas, although more recent research has questioned this conclusion. Today, the term is used as a catch all for all group ideation sessions. Brainstorming activity conducting

i. **Focus on quantity**: This rule is a means of enhancing divergent production, aiming to facilitate problem solving through the maxim *quantity breeds quality*.
ii. **Withhold criticism**: In brainstorming, criticism of ideas generated should be put 'on hold'. Instead, participants should focus on extending or adding to ideas, reserving criticism for a later 'critical stage' of the process. By suspending judgment, participants will feel free to generate unusual ideas.
iii. **Welcome unusual ideas**: To get a good and long list of ideas, unusual ideas are welcomed. They can be generated by looking from new perspectives and suspending assumptions.

2. LITERATURE REVIEW

The Harvard Business Review published a thought-provoking article ‘‘Successful Change Programs Begin with Results” (Schaffer and Thomson 1992). Schaffer and Thomson report that quality programs are easily derailed when the focus is on activity-centred quality programs, and they describe the basic flaws and solutions for such failed efforts. Too often the focus of change programs is centred on activities rather than results, and the end becomes confused with the means—processes with outcomes. Deming (1986) alludes to this concept when discussing his “Do Something!” theory in his book Out of the Crisis. In the late 1988s, one of the largest U.S. financial institutions was committed to a TQM program to improve operational performance. The company trained hundreds of employees. At the end of a 2-year costly effort, the company reported the results of their TQM program, as summarized in the following: 48 quality improvement teams are up and running; two quality improvement stories are completed; morale of employees regarding TQM is very positive. Nowhere did the report show any bottom-line performance improvements because there were none.

A large mineral-extracting firm stated their TQM program accomplishments as 50% of the training and employee participation goals were met but only about 5% bottom-line improvement. Another company's success consisted of getting 100% of each division's employees to attend a quality training program, but n0n mention of quality improvements within the company. In a 1991 survey of electronic companies, it was found that 73% of the companies reported had a TQM program, but of these, 63% had failed to reduce quality defects by even as much as 10%. [22]The field of quality has its roots in agriculture. Early this century in Brita in, R.A Fisher conducted statistical research to assist farmers in understanding how to optimally plant and rotate crops. This work subsequently inspired Walter Shewart at Bell Laboratories, whose work subsequently Motivated W. Edward Deming to devote his life to the teaching and Improvement of quality methods. Arguably, Deming have become the best-known ‘guru’ of quality. Both Deming and Juran could find no interest in quality methodologies in the U.S. before the World War II. However, both statisticians were invited to Japan as consultants to ‘spread the word ‘about quality .In Japan, they found a receptive audience for their ideas.

The term quality means different things to different people. For example, A quality automobile may be one which has no defects and works exactly as we except. Such a definition would fit with an oft-repeated definition by J.M Juran (1988[3]): “Quality is fitness for use.” However, there are other definitions widely discussed. Quality as “conformance to specifications” is a position that people in the manufacturing industry often promote. Why? Presumably because manufacturing can do nothing to change the design, hence this definition others promote wider views (Gitlow et al., 1989[6] or Ozeki and Asaka, 1993[18]), At that time, companies that had set about training their workforces in statistical quality control found that the complexity of the subject intimidated the vast majority of their workers and scaled back training to focus primarily on simpler methods which suffice for most quality-related issues.[8]Results-driven efforts bypass lengthy preparations and aim at quick, measurable gains within a few months rather than years. Investment is less, and improvement goals are short term.

Top management takes action steps because they lead directly toward improved results, not promises of a someday hopeful gain (Schaffer and Thomson 1992[10]).Implement the solution and follow-up (monitor and report results).The Memory Jogger (1988[3]) also describes where and how to use many of the quality improvement tools.Pareto analysis is a simple bar graph that shows the relative importance of all problems or causes to one another. This helps to make a decision on where to start solving problems or to identify basic causes of a problem. Pareto analysis summarizes information from a check sheet (discussed previously) or other forms of data from records. Department of the Navy (San Diego, September 1993[16]).Cause and effect diagrams (also called fish bone diagrams) are used to identify, explore, and display possible causes of a specific problem. Possible causes of a problem are grouped into major categories, such as people, machines, methods, materials, and environment. Each category is further broken down into possible causes (Brassard, M. (1988[5])). These causes can be further broken down into detailed causes. A detailed cause and effect diagram looks like fish bones. Causes of a problem are developed from brainstorming or information collected on check sheets. From the cause and effect diagram, the most likely cause of the problem is selected for further analysis (San Diego, 1992[11]).

3. Implementation of this study

This case study employed SQC techniques methodology to improve equipment effectiveness as well as the technical skills, morale of members participated in SQC implementation. This was not the first attempt that the company in this study implemented SQC techniques but, ultimately, the company succeeded to do so in the front-end process. It is foreseeable that once a particular process Statistical Quality Control techniques adapts to the new philosophy, others processes can also be reengineered to achieve the aims of SQC techniques. When all the labor force or employees or work force learn and Statistical Quality Control techniques are implemented, then there is a lesser need for a Statistical Quality Control team.

Traditional Statistical Quality Control techniques such as hit and trial or thumb rule are not guided by scientific principle or rules but follow an unsystematic approach leading to wastage of time, improper utilization of resources and ineffective solutions. These techniques do not provide optimum solutions but only provide a shortcut whose effectiveness is not guaranteed. Quality Problem Solving Analysis using various quality tools such as Histograms, Frequency Sheets, check sheets, Pareto Chart and Cause and Effect Diagram, it can be concluded that these scientific problem solving techniques are far better and efficient as well as provide systematic approach towards problem solving as compared to traditional quality control techniques used in Indian Industries leading to overall improvement in productivity.

4. Scope For Future Work

In addition to Statistical Quality Control techniques used by us in the given context such as Histograms, Frequency Sheets, Check Sheets, Pareto chart and Cause and Effect Diagram we can also apply other quality tools such as Kaizen, Sampling, Control Charts, Affinity Diagram, Brainstorming and Pie Chart, 3G, 5W2H & Hypothesis testing etc. The problems occurring in the industries are vast and require a mix of various quality tools to help us in effectively solving them. Standardization of the tools according to a specific problem can be done so that specific sets of the quality tools in a proper sequence can be made to be used again in the future on the occurrence of the problem in a different context.

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