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BENEFIT USING STATISTICAL PROCESS CONTROL (SPC) FOR PROCESS CONTROL IN TEXTILE MANUFACTURING: A REVIEW

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ABSTRACT

The history of technological developments affects the way we can provide services to customers quickly. One of the methods of industrial Control Systems is the statistical process control method (SPC) for short-term production. This review aims to explain some of the advantages of the SPC method, namely in terms of monitoring multistage processes and fault diagnosis has become a necessity. by Entering process control. The SPC and hybrid approaches and their results help in building a sound understanding of process control with a sense of a different approach which helps in analyzing processes that further assist in making the right decisions.

Keywords: Statistical process control, industrial Control Systems, control charts, manufacturing, quality, hybrid systems.

1 INTRODUCTION

The main objective of quality improvement is not only to provide good quality products. but also to increase productivity and customer satisfaction. Increasing productivity and customer satisfaction must go hand in hand to provide companies with low costs in improving the quality[1]. SPC is a technique that enables quality controllers to monitor, analyze, predict, control, and improve the production process through control charts. Control charts are a tool for analyzing variations in the production process. Usually, control chart plots consist of lines showing Under Control Limit (UCL), Center Line (CL), Lower Control Limit (LCL), as well as sample means[2]. Customer expectations change rapidly, and the durability of parts and processes are some of the important factors facing manufacturing enterprises. Process control plays an important role in establishing recognition in a competitive marketplace [3].

Modern technology can simultaneously control many variables and collecting data can seem easy. However, process control also involves costs, for example:

1. Expenditure on an initial analysis of the process
2. Implementing and integrating expense.

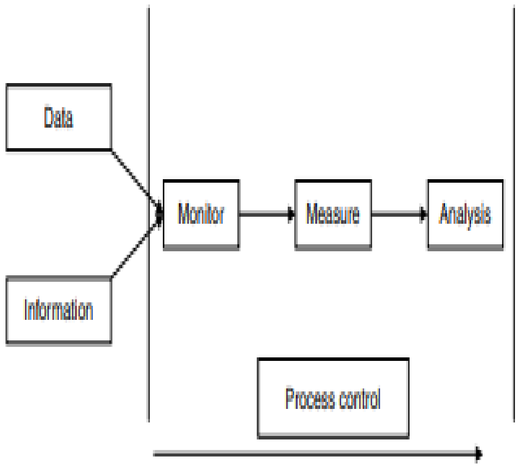

Figure 1 Process control

1.1 Some steps in process control

It is important to be aware of the goals and benefits of process control at the outset. Process control may add value if it is used effectively in decision making, for example, if the process is under control, the desired quality of the product will be achieved.

Basics of process control in textile manufacturing If process analysis shows technology is not serving its purpose, it can be

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modified or replaced to improve product quality, save costs or improve productivity. Some basic stages of process control are shown in the Figure. 1. Some of the tools in process analysis, measurement, and control are shown in Figure 2 These techniques are discussed later in the chapter.

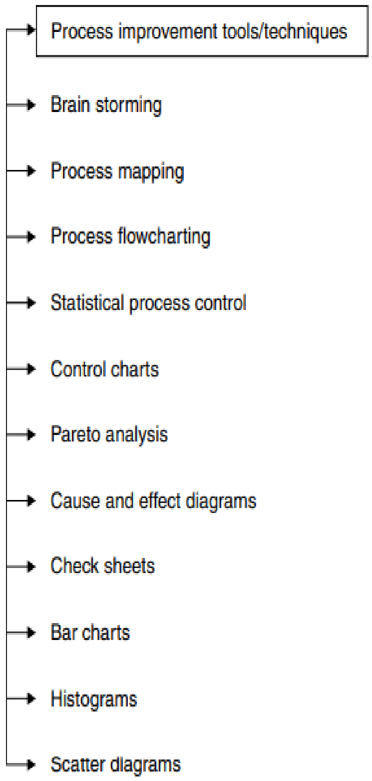

Figure 2 Some step-in process control

1.2 Process mapping, analysis, and control

Product quality is directly dependent upon the process quality. To achieve excellent quality and defect-free operations process mapping becomes very important. It starts with understanding the process, its approach, and the application level and presenting the information with graphical representation [4]. Once the process mapping is done, the control and analysis part comes into the picture. This allows us to determine whether the process is in control or not and to analyze if the quality improvement efforts have the desired effect [5].

2 METHODOLOGY

2.1 Process mapping

One of the fundamental steps in understanding or improving a process is process mapping. Information about the activities/steps that take place in a process is gathered and mapped to create a model representing the complete process. Complex interactions may be represented in a simplified manner [6]. Activities can be grouped into several sub-processes. By the use of process maps, improvement teams are better able to understand the process and become more efficient in ensuring effective control and finding opportunities for improvement [7].

To ensure process control is effective, the correct product attributes need to be identified first. Data or information about the product is collected. The specific characteristics of the product are identified as the critical attributes and determine the type of measure [8]. Not all attributes will be critical for the customer. Some may be very important while others may add little value to the product. It is necessary to use appropriate tools to determine a ranking procedure. Among these may be failure mode and effect analysis (FMEA), which analyses how failure is observed, the causes of the failure, and the effect of failure on the product and other operations. A process flowchart is an important tool in the construction of a process and provides a snapshot of the complete process [9]. Standard symbols are used for drawing the flowchart. Through process flowcharting, a conclusion may be drawn as to why any redundant operations are being carried out, the final objective is to seek opportunities for process improvement.

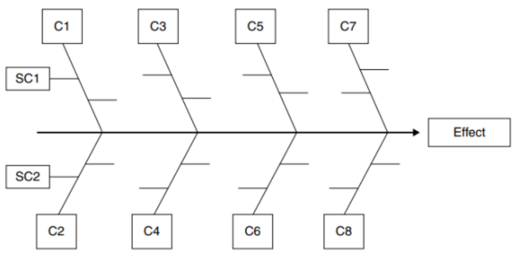

Figure 3 Cause-effect diagram

A cause-and-effect diagram is also known as the Fishbone or Ishikawa diagram. It is an effective way of mapping the inputs that affect quality. It is also a very effective tool in problem-solving [10]. In this approach, as shown in Figure 3, the possible causes of the problem are written as C1 to C8. Then the sub-causes (SC1, SC2, etc.) that are relevant to the principal causes are identified [11]. This method is very useful for identifying the causes of a problem. Brainstorming sessions may also be useful in understanding the possible causes of a problem.

2.2 Process analysis and control

Once a process has been mapped, its performance can be measured and assessed. It is important to be aware of the relationship between a manufacturing control system and a statistical process control (SPC) system. In a manufacturing control system, the processes to be carried out are carefully planned and executed according to the initial plan. A processing run of the chosen products is processed in a manufacturing facility as defined by the manufacturing model. An SPC analysis is then carried out on the processed units to identify and analyze the process. The manufacturing facility is then modified according to the SPC analysis. These tools and techniques help the production manager adjust a process and avoid it becoming out of control. An uncontrolled process may cause considerable wastage of resources and time. Organizations alert to this will invest in creating and upgrading the process control systems in their manufacturing facilities.

Various factors are important in controlling the different stages of a process. These are presented in Figure 4. Defects are examined with the help of quality tools. Problems that are solvable online are taken care of by line staff. More complex issues are discussed at quality clinics. The aim of these is to ensure that durable, mistake-proof corrective actions are taken. Among the tools used in quality, clinics are Root Cause Analysis. The processes that have the most impact on quality is identified and studied in detail to assess how they can be enhanced. Once implemented, the revised process is tested. The quality team will then carry out a final inspection by selecting samples according to a standard plan. A check sheet is a tool to help in collecting the data in an efficient and organized way. Data is categorized to simplify the task of analysis. The data is collected and ordered by adding checkmarks. A simple example is given in Table 1. Control charts are used to monitor processes with the help of measures such as arithmetic means and other ranges. Control charts measure limits above and below the mean. These are called the upper and lower control limits. These control charts provide real-time information on the process and are very useful in detecting and predicting variations when used with SSC. A typical control chart consists of a centerline and two control limits (upper and lower). The control limits are normally located at $\pm 3\,\sigma$ of this statistic and the centerline refers to the average level of the statistically controlled process. The X bar and R (Range) charts are the most commonly used charts for monitoring variations and measuring variable quality characteristics. If a particular variation is observed in the process, it is necessary to identify an assignable cause for this variation. If observations show fluctuations outside the control limits, the process is defined as going out of control and the assignable causes must be eliminated to bring it back under control. However, a process may be defined as uncontrollable even if all observed points are within the control limits. [12]. It occurs when an unnatural pattern is displayed. Clues from this pattern of observation provide the user with information about the process and assist in eliminating the causes of variation.

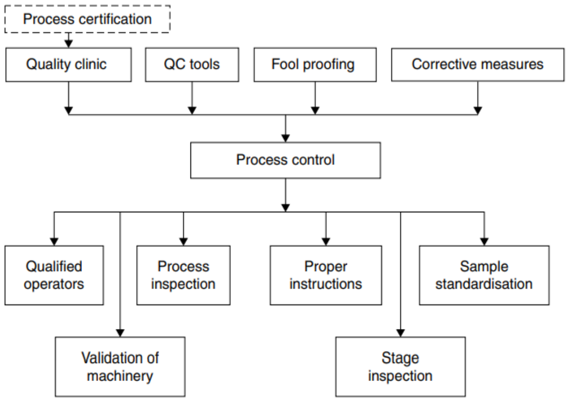

Figure 4 Control stages of a process.

Table 1 Check sheet for data collection

Check sheet category	Sub-category	Check marks	Total
Failure	Run outs	IIII IIII III	11
	Wears	IIII IIII IIII	12
Appearance	Finish	IIII I	5

In Fig. 5, the X bar and R chart show the observations recorded at different time intervals for the solder heights. The central limit (CL), the upper (UCL), and lower (LCL) control limits are set according to the process requirements. In the R chart, all observations are within the control limits, whereas in the X chart, the observations marked with (*) are below the LCL, representing an out-of-control process. it shows that the average of the process is influenced by certain external factors and that corrective measures are necessary to eliminate the causes. A bar graph is a visual display device in which the relative sizes of the measured data are displayed by the height of the bars. The bars are separated to show where data are not continuous. The bar chart helps in comparing different types of data. A scatter diagram gives a graphical representation of the data. It shows the changes in a variable between one state and another. These variables are plotted at right angles to each other and the scatter marks are made accordingly. This tool shows how two variables are related, how one variable changes if another is changed, and if there is a relationship between them. These predictions are numerous. depending on the range of data available. A histogram shows the probability of a particular value occurring. Here, the data are grouped in cells, and the relative frequency is represented in bars. Figure 6 illustrates a histogram taking frequency (f) and time (t) (or any other parameter) into consideration on the vertical and horizontal axes respectively. It is used to assess large amounts of data with a wide range.

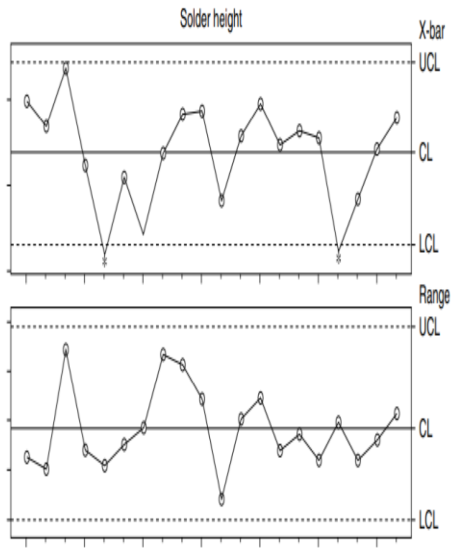

Figure 5 X bar and range (R) chart.

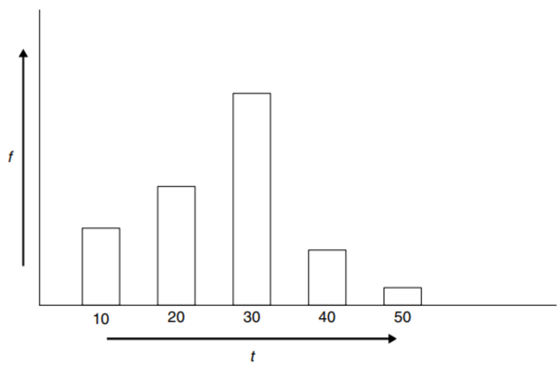

Figure 6 Histogram as a tool for process analysis.

3 RESULTS AND DISCUSSIONS

3.1 Statistical process control (SPC) and improving processes

SPC is a toolkit for managing processes. It is a method of controlling manufacturing processes to ensure that the outputs conform to specifications. 10 20 30 40 50 t f 1.6. Histogram as a tool for process analysis 10 Process control in textile manufacturing [13]. A process may go out of control for various reasons, which may include variability in materials and machinery, variability in the process parameters, or maybe due to some chance variations [14]. A process running out of control is a cause of concern and immediate steps must be taken to identify the causes. SPC provides the means of analyzing such a process. SPC was first developed in the USA during the 1940s. Initially, it was largely ignored until Japan launched a national effort to improve the quality and productivity of manufacturing. In SPC, decisions are taken based on information for a particular process in a data recording system. SSC integrates a variety of tools such as control charts, histograms, and control sheets, which are used for data recording and analysis [15].

SPC attempts to understand the critical variables in each sequence of a manufacturing process and their inter correlation. Through statistical sampling and experimentation, these interrelations may be understood and thus rendered controllable. In Japanese factories, workers sample parts as they move through the manufacturing processes using control charts. If any deviation from the specifications is found, it is readjusted. Therefore all finished products meet the specifications. Discovering the location of deviations improves process tolerances and capabilities and continuously improves product quality and efficiency. There can be various cultural issues in understanding and implementing SPC successfully in the workplace. As an example, factories tend to be highly segmented in their technical, structural, cultural, and political dimensions. Work is also highly segmented and there is a tendency to deal with each problem in isolation. However, SPC takes a holistic approach and requires multivariate thinking and working. Artificial intelligence (AI) has great potential in an automated SPC system. In this system, control and diagnosis are done by neural networks and expert systems respectively. The neural networks are used for control-chart pattern recognition and the expert systems are used for monitoring variations in the process. The expert system contains process-specific knowledge, enabling it to diagnose an uncontrollable process and suggest corrective actions. By incorporating quality–cost simulation technology, expert systems such as Intelli SPC have been able to monitor and predict costs over time [16]. Consistency in quality and machine utilization is very important in the Flexible Manufacturing System (FMS). FMS can be modeled with Petri nets. However, these models lack the functionality of SPC and therefore do not make possible a complete FMS. To resolve this problem: The Petri net-based SPC model is applied when using measurement data from inspection machines and sensor data from devices. The cause/effect of the products.

4 CONCLUSIONS

The results of the review are using Petri net-based SPC model and the diagnosis can easily be integrated into the model.

1. SPC has become one of the most used tools for maintaining acceptable and stable levels of quality in modern manufacturing.
2. The modern manufacturing environment is focused on computer integrated manufacturing and the challenges lie in developing advanced computer algorithms and process controls to implement the SPC tasks automatically.
3. The modern manufacturing world is demanding more precise and accurate methods for meeting industrial expectations. Advanced process control methods are always necessary across a variety of applications. More sophisticated methods of fault diagnosis are therefore being developed by researchers. Sensor implementation and integration with numerically controlled machines are developing rapidly.

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