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Six Sigma and Statistical Process Control: From theory to practice (Company Case *Abhishek export*)

Sanjay Agal[1] & Pooja Devija[2]
[1]Professor, Department of Computer Science and Engineering, Aravali Institute of Technical Studies, Udaipur, India
[2]Associate Professor, Pacific Business School, Udaipur, India
Email: sanjayagal@yahoo.com, poojadevija@gmail.com

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Abstract

This article is part of applied research; it aims to implement the Six Sigma methods. The main objective of Six Sigma is to increase profitability the company by reducing waste. It is also a statistical measure of the performance of the process to determine with great precision the quality of the products or services. The power of Six Sigma is the application of tools statistics in the context of a structured methodology and easy to implement. These tools are most commonly used in an operational environment of production. The aim of our research is to provide a vision operational, through the integration of the methodology Six Sigma based tools of statistical mastery of process such as the control board in order to improve the system production company "abhishek export".

Keywords: *Six Sigma, statistical mastery of process variability process control board*

1. Introduction

For several years, the context of globalization and increased competition has defined a new order Business and Industry for Production Company's property. Indeed, these companies are daily faced with the control and performance improvement of their overall process to ensure their sustainability and competitiveness. Whatever process production, that is to say irrespective of the level of its design, the maintenance of the raw materials used, qualification of manpower, method, etc. it will never be possible to create products or exactly the same characteristics. If the variability of production process is important, the supplier will difficulties or find too expensive to satisfy its customers because part of its production will have to be reworked, recycled, mixed or rejected [3].

In such situations, it is proposed to follow variability industrial waste recycling process within the Company "Abhishek Export" by integrating Six method Sigma and Statistical Process and mastery particularly the use of the control card to detect evidence of significant change in variability of the waste grinding process. Before taking action, it is considered necessary start with a theoretical recall.

2. Six Sigma Concepts and Statistical Control of Processes

2.1. Concepts of Six Sigma

2.1.1 History of Six Sigma

Six Sigma was launched in the US in the 1980s at Motorola. This approach was first consisted applying the concepts of Statistics Mastery Process (MSP) and is then extensively expanded in integrating all aspects of the control of variability. To As its dissemination in other companies (including General Electric), Six Sigma has also by associating more structured approach to its elements managerial and strategic [4]. Today it is a comprehensive approach to improving satisfaction customers, which is not quite the same thing as quality improvement. Based on this improved customer satisfaction, Six Sigma is a source to increased profitability for the company by combining the following effects:

- Reduced scrap, rework, and more generally non-quality costs
- An improvement in the availability of machinery and OEE

- Improved consecutive market share improving the quality of products [1].

2.1.2 Definition of Six Sigma

Six sigma is available in several ways, it is:

- a certain philosophy of the quality-oriented total customer satisfaction
- a performance indicator to know where is the company in terms of quality
- a problem solving method the full involvement of men to reduce variability on products and services
- a organization of skills and of responsibilities of the company's men
- a quality management method by which builds heavily on a project-management [2].

2.1.3 Meaning of Six Sigma

In statistics, the Greek letter sigma σ denotes the gap kind; Six Sigma therefore means six times the standard deviation. Any process of production, is unable to produce exactly the same result over time. One of major concerns of the production management is therefore controlling the production conditions or performance so that there is less waste, less dissatisfaction possible. To better manage the production process, it is suitable for First determine which nominal value is desirable to achieve and what are the limits of variation acceptable with respect to this value (range or tolerance). Then, provide the greatest number possible faultless products (that is to say fewer Parts out of tolerance). The ideal is thus the process is capable of providing an average value of the products or of equal or very close to the nominal value services desired.

2.1.4 The problem solving approach to Six Sigma

The method of resolution is divided into five stages:

- Set: This first step is to identify all problems and rank them in order of priority
- Measure: the next step is to search data relevant characterizing the process concerned and measure the existing results
- Analyze: Find the root cause, show the relations of cause and effect
- Improve: implementing improvement actions and prove that these actions have been effective
- Check: implement all actions necessary for the improvement is sustainable.

2.1.5 Six Sigma and sources of variability

The concept of quality is closely linked to that of variability. Some even define non-quality variability as compared to an expected reference. Gold the fight against the variability is one of the basic concepts of Six Sigma [4].

The sources of variability can be grouped into two families' assignable causes and random causes.

The causes assignable: Including in these cases, all sources of variability which can be identified and on which one has the means to eliminate them. The assignable causes are also known special causes of variation.

Random causes: this second group includes all other unidentifiable sources of variability or on which there is no means for the eliminate

2.2. Concepts of Statistical mastery of process

2.2.1 Definition of Statistical Process mastery

Statistic mastery of processes (MSP) is according to NFX06030 standard, "a set of actions to assess, set and maintain a production process capable of delivering all of its products comply with the specifications selected [3]. The MSP is a preventive strategy that aims to bring the manufacturing process at the required quality and there hold [3].

2.2.2 The techniques

The MSP techniques can be divided into two groups:

- Methods "off-line" for determining and optimization influential parameters (analysis Pareto, fault tree, causes- chart Indeed, experimental design, etc.).
- Methods "on-line" monitoring of production (measures to control charts, control charts to attributes, etc.) [3].

2.2.3 The principles

It involves gathering information on the product and its manufacturing process and use this information to effectively act on the process, on the one hand, to reduce, eliminate and prevent nonconformities on quality and secondly, to improve ongoing basis to performance.

2.2.4 Control charts

a) Control Board Definition

The control board is one of the basic tools used to the statistical process control. It is a representation graphic image composed of a result of the production. It allows visualizing the process variability in distinguishing random causes of assignable causes [3].

A control chart is a graph showing successive images of manufacture, taken at a certain "Sampling frequency" from samples on production are plotted on the

charts or map the different calculations on samples (mean, standard deviation, range, number, percentage, etc.).

The control board has three lines: a line Central and two control limits:

- The center line (LC): represents the mean of the followed statistics.
- The upper control limit (LSC) and the limit lower control (LIC) are established so in normal operation, virtually all Statistics sample values fall within control limits.

As the points representing the value of Statistics are used within the control limits, the process is assumed to be stable or mastered .By against when Points falling outside the control limits, this indicates that the process is not mastered or out of control, that is to say, the assignable causes of variability are present in the process.

b) The types of control chart

Depending on the nature of the monitored characteristic, card Control can be classified into two main branches: control cards for measurement and control cards to attributes. When the feature is followed by a measurable variable (e.g., weight, diameter, length, pressure, etc.). Mastery and control of the processes are performed using control charts measures. The attribute control is used when the controlled characteristic is qualitative, that is to say, the data is classified as "compliant" or "non-compliant. In our study, the average control card was used She what, that is to say that the control limits are coated 3 gaps subtypes either side of central tendency. The average control board characteristics are given by the following formulas:

$$LSC = \overline{\overline{X}} + A_2\overline{R}$$

$$LC = \overline{\overline{X}}$$

$$LIC = \overline{\overline{X}} - A_2\overline{R}$$

With: n = sample size

and m = number of selected samples

$$\overline{\overline{X}} = \frac{\overline{X}_1 + \overline{X}_2 + ... + \overline{X}_m}{m}$$

is the average of the average of m selected samples.

$$\overline{X} = \frac{X_1 + X_2 + ... + X_m}{m}$$

is the average of the sample i.

$$\overline{R} = \frac{R_1 + R_2 + ... + R_m}{m}$$

is the average of the ranges of m selected samples.

$$R_i = X_{max} - X_{min}$$

is the extent of the sample i.

The coefficient A_2 only depends on the size n collected samples. It is tabulated as a function of n.

To plot the average control chart Shewhart it traces the point X_i (i = 1 ... m).

3. Industrial Application

A. Company Description the Company "Abhishek Exports" is an industrial company small, located on the industrial area of Udaipur. She has the form of a limited liability company. It specializes in the collection and transportation plastic waste. The company's activity summarizes the supply of plastic waste, and sells them as products intermediates for the production of other end products.

The supply of raw materials is done with many mining agency and companies. Once the raw materials are stored and packed in company, they are transferred to the sorting workshop then workshop recycling which represents the output sequence the company's business. In triage workshop material sorting is done according to the existing plastic colors in stock.

At the recycling workshop, the sorted material is passed to the grinder machine. In the end, bags of crushed materials will be controlled quantitatively and qualitatively to store the distribution. The crushed plastic according to three types of color gives recycled end products, namely:

- PET (polyethylene terephthalate) recycled plastic the blue color used in the production Packing water bottles and bottle soft drinks.
- HDPE (High Density Polyethylene) plastic white color, usable in the production green bottles of milk packaging.
- Movie: Plastic in different colors form waste used for the production of bags, crates and tarpaulins.

B. Problem solving methodology according six sigma approaches

Step 1: Define the problem The Company's goal "Abhishek Export" is to minimize the lost amount of material recycled after obtaining PET product. The target for the company is to have a rate of waste material in the order of 22%. To achieve this goal, the company will seek relevant solutions to monetize its business.

Step 2: Measure: Before embarking on the stage of the search for causes assignable to the problem, we used the control board Shewhart-average extent as steering tool grinding process. To do this, we carried out the data collection as follows:

Before the recycling operation was selected 10 bags of material PET plastic product for 10 hours such as sampling frequency is one bag per hour. Each bag a weight of 200Kg. Thereafter, the 200 Kg was left to plastic bags 5 under weight 40Kg. After the operation of recycling, the amount of was calculated recycled plastic unusable. The following table shows the amount of non-recycled material usable expressed in kg.

Table 1. Summary of Sample Collected

Sample	X_1	X_2	X_3	X_4	X_5
1	8,5	8,8	8,9	8,6	8,5
2	9,6	9,8	9,7	9,3	9,9
3	8,4	8,6	8,5	8,7	8,9
4	8,3	8,2	7,5	7,9	7,7
5	9,1	9,2	9,5	9,2	9,8
6	8,3	8,9	8,4	8,7	8,3
7	9,1	9,6	9,5	9,3	9,7
8	8,9	8,3	8,4	8,5	8,7
9	7,7	7,9	7,5	7,6	7,8
10	9,1	9,4	9,3	9,3	9,6

Study of normality: Test Shapiro -Wilks

Before tracing the Shewhart control card, you must verify the observations of normality assumption. In this study we used the Shapiro-Wilks test. The Shapiro-Wilks test is a mechanism which allows decide between two hypotheses:

H0: The quality characteristic is normally distributed

H1: The quality characteristic does not follow a law par given a sample of results.

In the Shapiro-Wilks test, the statistical test comparing the form of the sample to the normal distribution. After this comparison in the software outputs a number called p-value is calculated. The decision is p-value comparing the test value with the risk of first species α: if p-value α, the hypothesis H is kept 0 otherwise we rejects H0.

In our study, the Mintab16 software gives output a value of p value 0.1 (**Figure 1**). So it accepts submissions of normality.

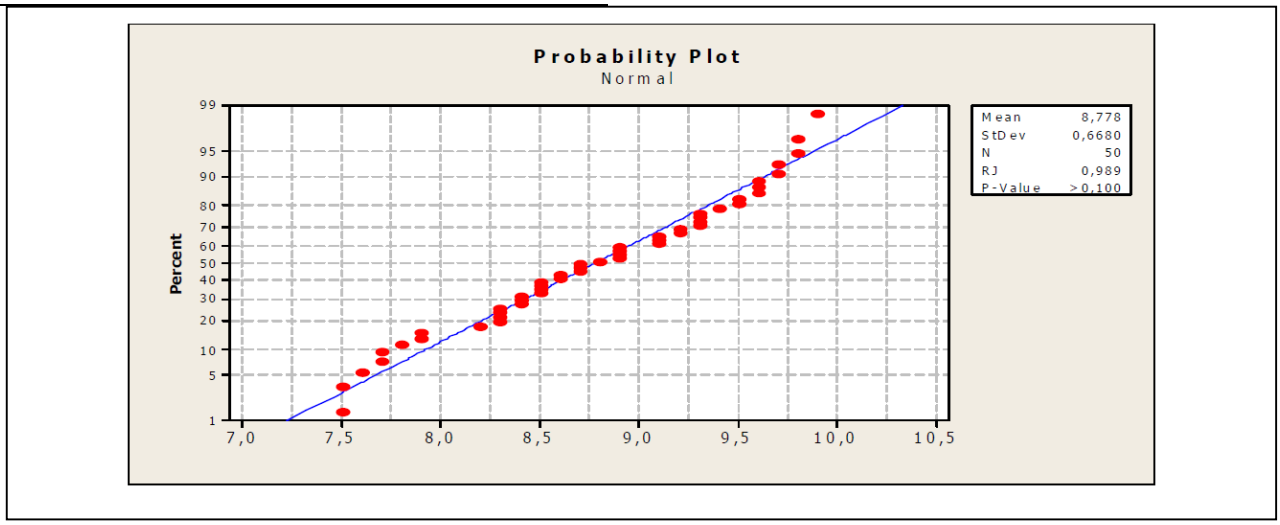

Figure 1: Normality

The average control board is given by the output Minitab in **Figure 2**.

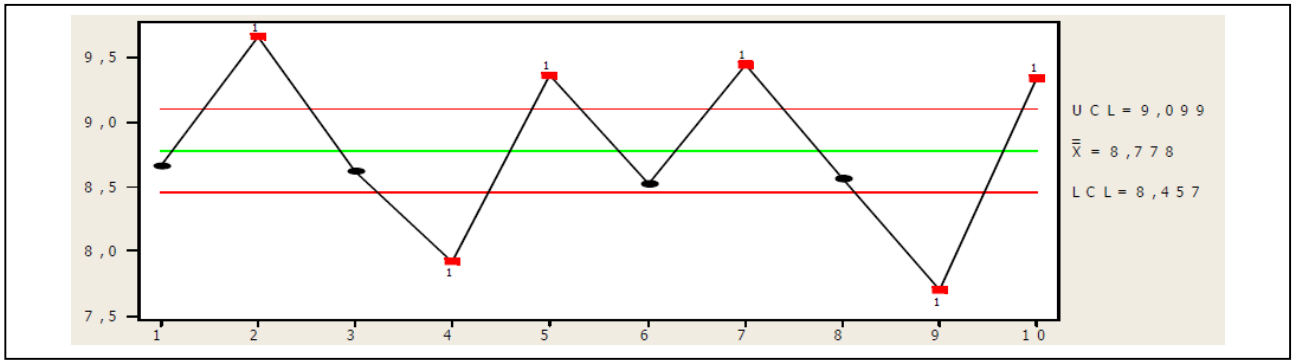

Figure 2: Average Control board

The map control limits are:

LIC = 8.457
LC = 8.778
LSC = 9.099

From the graph, six points are observed outside control limits, one concludes that the milling process is not stable. This variability is due to assignable causes will be the third stage of the six methods Sigma.

Step 3: Analyze: It aims to increase our knowledge of process to discover the causes "roots" of the variability and insufficient performance. An analytical tool among the most used is the fishbone diagram also called diagram Ishikawa. Five root causes were identified variability, namely:

- Labor: Workers no Qualified (without degree), lack of accountability, lack of training
- Means: traditional machine, machine failure, mal adjustment, lack of maintenance, limited capacity machine;
- Methods: archaic working methods, simplicity the sorting operation, lack of means of cotrol;
- Materials: poor quality, non-compliance material provided by the supplier;
- Environment: humidity, lack of security means.

Step 4: will focus on the proposed solutions their implementation. Following the brainstorming, the one developed solutions to the problems identified, which are:

• Improved working condition;
• Increase the level of employees and their yield;
• Improved quality of raw material;
• Application of best working methods
• Use of new technologies;
• Make training assignments;
• Recruitment of qualified employee

4. Conclusion

The objective of this paper is to implement the Six sigma method to master the grinding process Waste within the company "Abhishek Export" .The methodology problem solving in Six Sigma helped us drive the recycling process .This philosophy contributed to waste reduction rate, it becomes very close to the target. In this work, we focused on practicality and this by model experimentation Six sigma in company located in Udaipur specializing in small size recycling of industrial waste to improve its production process and in particular the process of grinding. Knowing that this study was done over a period of six months. Finally, this article has the ambition to create a starting reflection to build projects using both approaches (six sigma statistical mastery of the process). Evidence of benefits to take a joint approach will be more formally established as and as companies stop choose one or the other of these two approaches to yield their change projects.

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