

A Study on Right Side Vehicle Paint Thickness Using SPC Method in an Automotive Company

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ABSTRACT

This paper investigates paint thickness on the right side (RS) vehicle in automotive manufacturing company. By using Statistical Process Control (SPC) method specifically the \bar{x} and S chart and process capability which is the C_p and C_{pk} indices in this particular study, variation due to assignable causes in the process has been identified. Data analysis has showed that the paint thickness process is in out-of-control.

INTRODUCTION

In general, companies compete on three main issues: quality, price, and delivery. This is true for all types of organizations, whether they are in manufacturing, services, or public sector [2]. As quality improves, costs fall through reduction in failure and detection costs. The absence of quality problems also removes the need for the "hidden operations" devoted to dealing with failure and waste, and delivery performance benefits from increased output and higher productivity [2].

The uniformity of paint deposition on the automobile surfaces is one of the important factors in consumer's approval. Therefore, today's car market demands uniform paint thickness on the auto bodies [3]. However, the paint distribution coming out of the spray gun has a complex form and ensuring uniform coverage is challenging even on the simplest of the target surfaces such as a planar sheet.

The \bar{x} and S charts are typically implemented together, as the two charts offer different, but closely related forms of information about a process. The \bar{x} chart relays information about the central tendency of the data, or the tendency of the measurements to accumulate in a normal distribution around an average value, or \bar{x} . While this is an important statistic to know and understand, it is also critical that the amount of variation around a particular average is also known. The S chart, recording the standard deviation from the average value in a given sample, is used for measuring and monitoring variation, and together \bar{x} and S charts can provide insight into the stability of a process or system.

Process capability refers to ability of a process to produce products or services capable of meeting the specifications set by the customer or designer. The main function of a capability analysis is to determine how good is the measurements are when compared to the specifications [1]. In recent years, C_p and C_{pk} indexes have become very popular as a measure of process capability in relation to the specification requirements.

Capability Index, C_p

$$C_p = \frac{\text{Tolerance}}{6s}$$

or=

$$C_p = \frac{USL - LSL}{6s}$$

A second capability index that is used in conjunction with C_p is the C_{pk} . The C_p value compares the whole tolerance with $6s$ and indicates how good the process could be. The C_{pk} compares the worst half of the distribution with $3s$. It shows the worst scenario when the distribution is off center.

Capability Index, C_{pk}

$$C_{pk} = \text{the minimum of } \frac{USL - \bar{x}}{3s} \text{ or } \frac{\bar{x} - LSL}{3s}$$

The minimum occurs with the specification limit that is closest to \bar{x} .

The C_p and C_{pk} indexes are always referred by recent industries in order to check whether their process is capable of meeting specification or always producing rejects.

METHODOLOGY

It starts with a detailed literature review relating to SPC, automotive industries especially in paint thickness, research methods, and similar research. For data collection, case study research has been implemented which paint testing check sheet data were collected. This is followed by the data analysis based on SPC implementation. After obtaining the needed data, MINITAB software was familiarized in order to verify the result. From SPC implementation and MINITAB analyzed data, result and discussions are made.

RESULTS AND DISCUSSION

Analysis on \bar{x} and S Chart

An analysis of the control chart in Figure 1 has shown a nonrandom pattern and reveals that the \bar{x} chart appears out of statistical control, the ideal action is to stop the process and eliminate the cause. There are 7 points beyond the control limits, and the patterns of the point not within the control limits and match of the trouble pattern that were illustrated. The S chart (standard deviation) has 8 points beyond the control limits, but a trend is evident. A trend is a gradual increase or decrease of the points on a control chart. There may be fluctuations within the gradual change, so there is no specified number of points to indicate the trend. The process is not in statistical control, and the cause for the out-of-control situation should be determined.

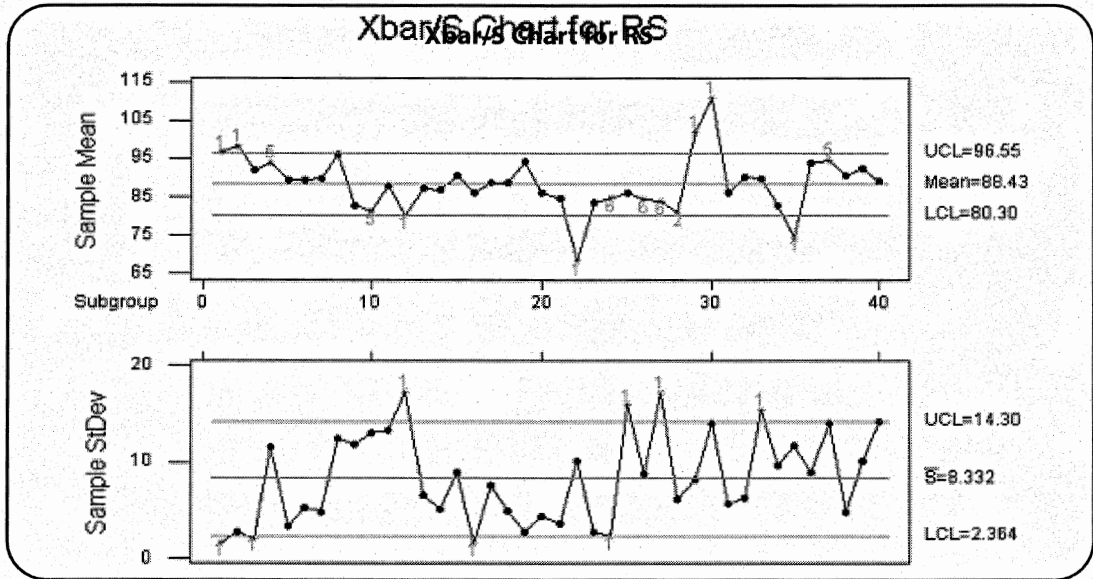


Figure 1. Analysis on \bar{x} and S Charts for RS Data

Figure 1 shows two separate occasions in which freaks and shift occur. Test number 1, 5 and 6 indicate the freaks pattern and test number 2 indicate the shifts pattern on both control charts. It signifies that something changed dramatically in the process for a short time or that a mistake was made. The most common process cause of freaks is an operator's error, poor technique, defectives parts and sudden change in material. If the raw material is subject to occasional inconsistencies or if the control of the mix of material is affected by either human error or flow gauge irregularity, freaks will result. These processes problem indicated by freaks should be tracked because they can be seriously affected the quality of the product. A freak can also falsely signal process trouble when a mistake is made in measurement, recording, arithmetic, or plotting. When a freak occurs, always check for error of this type first [4].

Shifts pattern are usually temporary because something has been introduced to the process that changed the whole process. The points on control charts change different level for a while, and then change back again. When diagnosing a shift, look for something that affects the whole process. Any special cause of the shift in the process is generally in one of six major categories; operator, method, machine, material, tooling or environment. A change in one of those categories can affect the entire process and shift the point on the control chart. The common process cause for \bar{x} chart indicate the careless or poorly trained operator, maintenance problems, fixtures not holding the work in place and change the material. Meanwhile, the S chart indicate the change machine setting or speed, new operator, change method, new lot of material and use of a different gauge.

Process Capability Analysis

Process capability refers to ability of a process to produce products or services capable of meeting the specifications set by the customer or designer [1]. The main function of a capability analysis is to determine how good is the measurements are when compared to

the specifications. Indicator Cp and Cpk indexes have become very popular as a measure of process capability in relation to the specification requirements.

Process Capability Analysis for RS

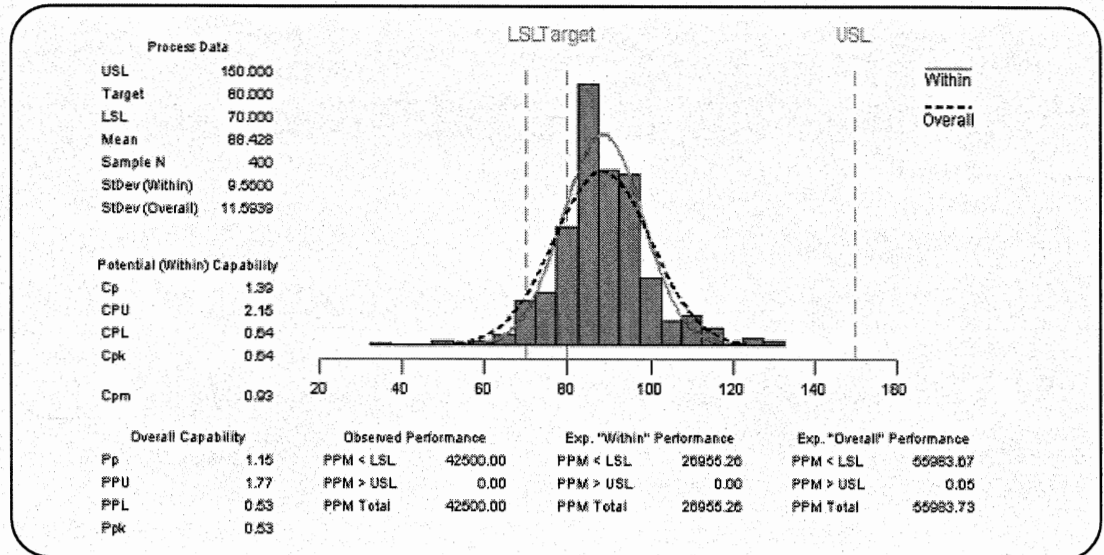


Figure 2. Process Capability Analysis for RS Data

Interpreting the process capability statistics, there data approximately follow a normal distribution. This requirement appears to have been fulfilled, as shown by the histogram overlaid with a normal curve.

But, as one can see that the process means (88.428) rise short of the target (80.00). And the left tail of the distribution falls outside the lower specification limits. This means, there will sometimes see RS paint thickness does not meet the lower specification of 70.00 μm.

The Cpk index indicates whether the process will produce units within the tolerance limits. The Cpk index for RS is only 0.64, indicating that there need to improve their process by reducing variability and centering the process on the target.

CONCLUSION

This project has successfully revealed how the SPC method has been implemented at the case company. The quality of paint thickness study using SPC methods has been assessed through the control chart and process capability to identify the weaknesses of the quality works at the paint shop.

Using quality tools which are the Statistical Process Control (SPC) methods, the study has arrived at the following findings:

- (i) SPC methods at the case company encompass control chart and process capability to investigate the quality paint thickness. SPC, it's the application of statistical techniques to control a process, reducing variation so that performance

remains within boundaries or specification limits. Therefore, SPC is the best tool to use and can be implemented to almost all product inspection stage in all manufacturing process.

- (ii) Control chart for \bar{x} and S chart regarding to $n \geq 10$ samples, process capability based on Cp and Cpk indicator able to show any contingency that occurred in on-going process whether the process able of meeting specification or always producing rejects. Earlier detection might reduce overall production cost and decreases wastes. Meanwhile latest detection might lead to a lot of material wastage due to increasing number of rejects.
- (iii) When the process is out-of-control and not capable of meeting the product specification, therefore there will be changes or causes by men machines, materials and methods. Some actions are require must be taken in order to adjust the process to meet the specification. All causes or intervention to production process capability should not be ignored.
- (iv) The level of SPC implementation at the case company are measured according to:
 - (a) Control chart especially and S chart is used to visualizing the variations that occur in the central tendency and dispersion of a set observation is present in a process.
 - (b) Process capability its ability of a process to produce products or services capable of meeting the specifications set by the customer.

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