DOI: 10.20472/IAC.2015.015.122

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STATISTICAL CONTROL OF THE PROCESS - SIX SIGMA TECHNIQUE TO IDENTIFY THE PROBLEMS

Abstract:

Initiating the Six Sigma system in the Motorola Company has led to a fundamental discovery, identifying that some of the problems could be solved by exploiting some opportunities using the tools that are accessible to any organization. In my opinion, one of these, and the most important, is the statistical control of the process and the control charts.
Throughout this article, I wanted to emphasize what “Statistical Process Control” means, where and how it can be used and the method of its application for designing, management and improvement the processes.
I’ll mention that if this power tool is not used carefully, it may be useless or totally ineffective.

Keywords:

corrective actions, deviations, limit of control, measuring, performance

JEL Classification: A20

Introduction

Statistical process control (SPC) involves both the measurement, and the evaluation of deviations in the process, accompanied by efforts for reducing or maintaining the control of these deviations. This tool is used especially when either organization or process manager wants to identify the potential problems or unusual incidents in order to undertake prompt actions aimed to solve them. In other words, this method contributes directly to monitoring the performance of the process.

Control charts are “the main way of monitoring the actual performance of a process” (Pande, P., Newman, P.R., Cavanagh, R.R., 2009). Through them, there can be estimated both the future performance, and necessary undertaken actions, in order to correct the performance. Also, these control charts are an effective communication tool because there are required a simple preliminary training, in order to be easily understood. Many companies have displayed key processes charts, in the visible places, which give greater transparency in daily activities, and a rapid assessment of trends and concerns related to the occurrence of any problems. Thus, in that process, there is allowed the active involvement of all members of the organization in solving and administration of the various problems that can occur in the company.

Statistical Process Control

Why and when do we use SPC?

In the Six Sigma system we can identify three situations in which control charts can demonstrate their usefulness:

- During the measurement phase, the team can identify the type and frequency of various problems occurrence, and a number of variables over which system operators have no control. Once they have been warned, the team members can use the most effective investigation or corrective actions;
- Using the control charts, the obtained results can be tracked throughout the testing activities, the implementation of solutions for improving or changing the process, if it is necessary. Following the results, we can highlight the effects recorded on the performance of the process, and the way of various parameters variation, suggesting us in which direction the efforts and future research should be targeted;
- The third situation, when the control charts demonstrates their usefulness acting as a good alarm system, is represented by alerting the observers when there are occurred different atypical events in the process, enabling

them to have recourse in a timely manner to so-called “reaction plans”, which aim to remove these malfunctions.

Modalities for performing the control in the SPC

Before highlighting the modality for performing the control, it should be noted that this control aims to keep the parameters fluctuations that are monitored in the process, in a well-established and predictable interval of deviation, which will maintain a high standard of the process performance.

So that, in order to be able to tell if a process is under the control, all we have to do is to follow various parameters of the process, and then to analyse and identify the variations in the obtained results.

This method is called statistical control, within which, after we have collected enough data, we can proceed to calculate a “comfortable limits” where must be the parameters of that process.

Charts

Warning indicators

Normally we expect the process parameters to vary randomly, so that, we need to identify the warning indicators, when the process gets out of control.

Thus, you should observe:

- any outlier value, or otherwise, any point on the chart that is outside of the control limits;
- trend of the process progress, so, the appearance of dots, which are either in continuing increasing or decreasing;
- sequences of points which are below the normal average for carrying out the process;
- “waves” of points that alternates either upside or downside of the control limits;
- Situations when the tendency of the points of the control charts are consistently near the midline, so the process is under the control, being on a normal trajectory.

Most often, we tend to say that if the process is under the control, as shown in the control charts, everything is in order. However, in this situation, the various problems may occur.

For example, if the times for each repair are measured in a home appliance repair workshop, it is possible that drawing up a control chart to reveal us that this process is perfectly under the control. But the delicate problem is that, although the average time of repair could be just three days, the customers are not willing to wait more than two days. Therefore, we discuss of two types of limits:

1. Control limits;
2. Specification limits.

While we receive the specification limits only from the customers and they will change only if the customer requirements are changed, the control limits are calculated based on obtained data by measuring the current performance of the process when there are intervened changes in time, every time when the process performance is changed.

How do we use the control charts?

For a suitable implementation of the CSP, it is required the following steps:

- identify the critical parameters, which are expected to measure;
- establishing the way of data collection;
- graphical representation of the obtained data;
- viewing and analyzing the results;
- Development of the plan for the collective action.

It is formed a closed system with closed circuit within which the data representation and its analysis can be relieved by using some software specifically designed for the statistical operations. In this case, we only introduce the collected data in the program, to select the desire type of chart and thus, we shall obtain the control chart. But it must be paid more attention for choosing the type of the chart that we want to use it, because we are dealing with many factors involved that will lead us to choose the more suitable format of the chart, depending on the situation we face.

For efficaciousness of the statistical process control, and of the control charts, we must consider the following points:

- collection, representation and prompt review of data (to receive timely warnings about the potential problems or opportunities);
- choosing carefully the parameters that must be measured and ordering them according to the priorities (preferable to use more than three control charts to monitor the performance of the process, because if we use many such charts, after a certain period of time, we'll consider them unnecessary and we'll give up to look on them);

- determining and calculating carefully the alarm signals (the more promptly the corrective measures will act at the occurrence of an event, the more effective they will be);
- it is not recommended the frequent recalculation of the control limits for the process, because it would aggravate detection of the alarm signals; the recalculation is indicated only when the process itself supports significant changes;
- Also, it is dangerous to assume that sometime we have perfect data, because the alarm signals are triggered after the data collection, whose quality should be checked periodically.

It should be considered that the control charts are useful for monitoring and understanding the process, and not for solving any occurred problems, or to improve the performance of that process, because for it, there will be prepared the corrective action plans or will be used other methods of the Six Sigma improvement.

Case Study - Analysis of External PPM at SC Auto Romania SRL

PPM (parts per million) is the number of non-conforming products delivered to the customer, for which it has opened a formal complaint, reported to a million delivered products. In the automotive industry it is used this indicator because the impact of large numbers is more impressive than using some indicators, such as the percentage reporting.

Formula for calculating external PPM is:

$$External\ PPM = \frac{Number\ of\ claimed\ products\ by\ customer\ in\ the\ "x"\ month}{Number\ of\ the\ delivered\ products\ in\ the\ "x"\ month} * 1{,}000{,}000 \quad (1)$$

At SC AUTO ROMANIA SRL, this indicator is calculated:

- annually, at the organization level, in order to know which is the organization's overall performance, useful in relation to the potential customers, because it defines the level of organization quality as a whole;
- Monthly, quarterly and annually, at the sector level, to define the performance of the level of quality, in a direct relation to each customer, as a requested indicator both by the customer and by the top management. Its level indicates us the performance of each activity.

A low level of the external quality, that is an external PPM > 100, indicates the major risks for the customer. It seems paradoxical, but the customers do not want any zero external PPM, because this could mean an over quality that means higher costs for the product, which the customer is unwilling to pay. Therefore, in practice, in dealing with automobile factories, there are used a level of the external PPM between 5 and 80, depending on the type of the products that are delivered.
In practice, to calculate the PPM, is used an indicator called PPM sliding. Depending on auto Assembly Company, this indicator is sliding per semester or annually, but most of the companies work with such a sliding indicator per year.

PPM sliding uses the following formula for calculating:

$$Sliding\ external\ PPM = \frac{Number\ of\ claimed\ products\ by\ customer\ in\ the\ last\ 12\ months}{Number\ of\ the\ delivered\ products\ in\ the\ last\ 12\ months} * 1.000.000 \quad (2)$$

In addition of highlighting the performance, this indicator provides us data on the trend. Using the control charts, it can be traced its trend at a moment and can be taken preventive measures, if the trend is contrary to the expectations of the customer and of the top management. It is noted that there is a small gap between the delivery of the parts and their assembly on the automobile, which should be taken into account when there is conducted an analysis.

Note that there is a small gap between delivery of parts and their assembly in car

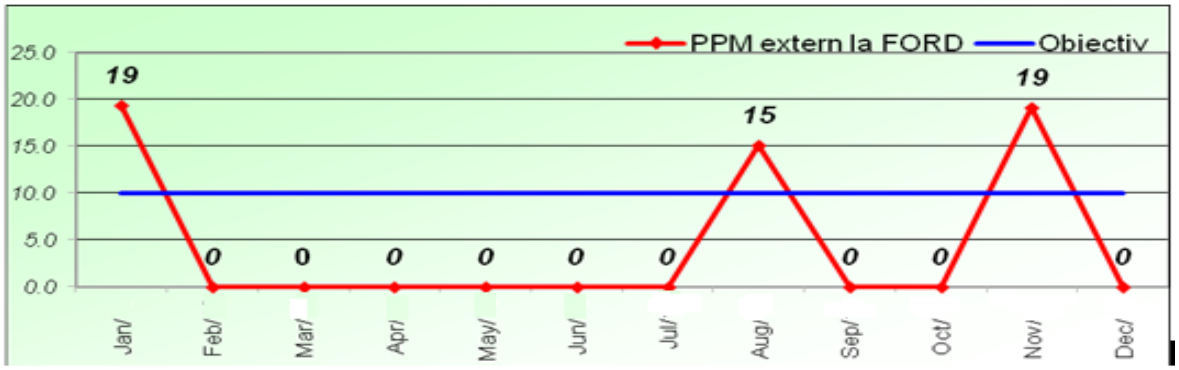
To calculate the indicator, data are derived from the following sources:

- portal of the customer or their mails, for the number of non-conforming products, claimed by them;
- Internal logistics provides information on the quantity of products delivered monthly.

At S.C. AUTO ROMANIA S.R.L. this indicator was monitored both in the monthly value and sliding for 6 months, for each section.

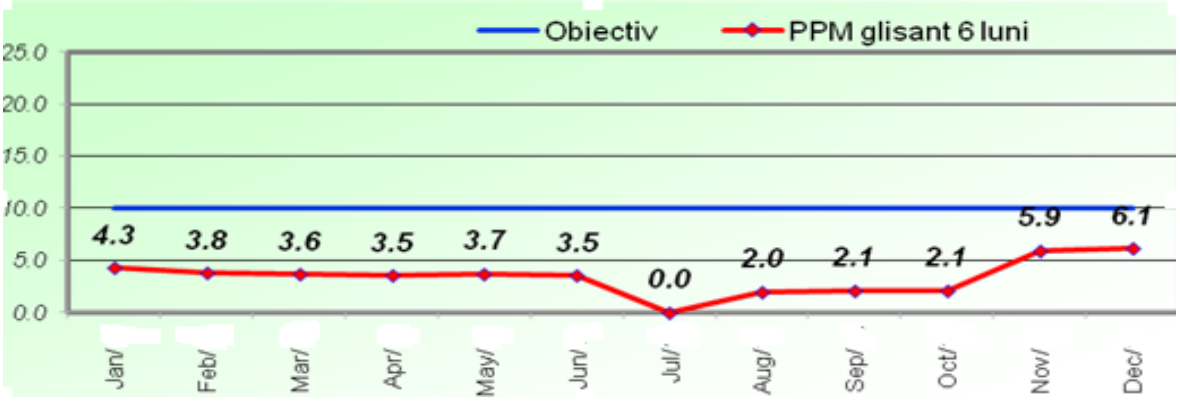
Following the developments in 2013 and 2014 in Section A, we can note a very good level of quality of the products at customer. In 2013 there were reclaimed products only in January, August and November. The obtained external PPM in 2013 was below the target required by the customer of 10 PPM per month.

Chart 1 – FORD – monthly external PPM in 2013



Source: Mirea G. (2015) Doctoral Thesis

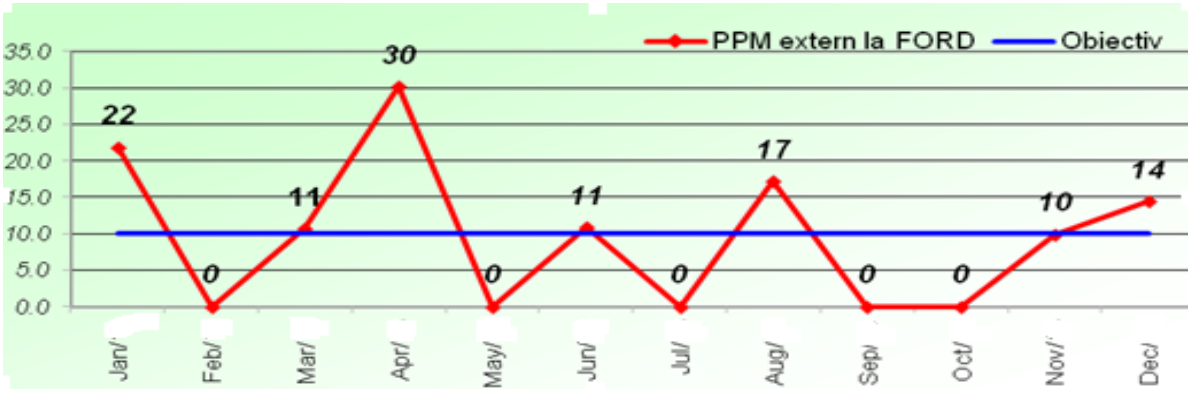
Chart 2 - FORD – sliding external PPM for 6 months, in 2013



Source: Mirea G. (2015) Doctoral Thesis

In 2014, in Section A, a change process has been taken, which has impacted the quality of the delivered product. Thus, following the evolution presented in the control chart no. 3 it is noted that in seven of the 12 months there have been recorded complaints from the customer.

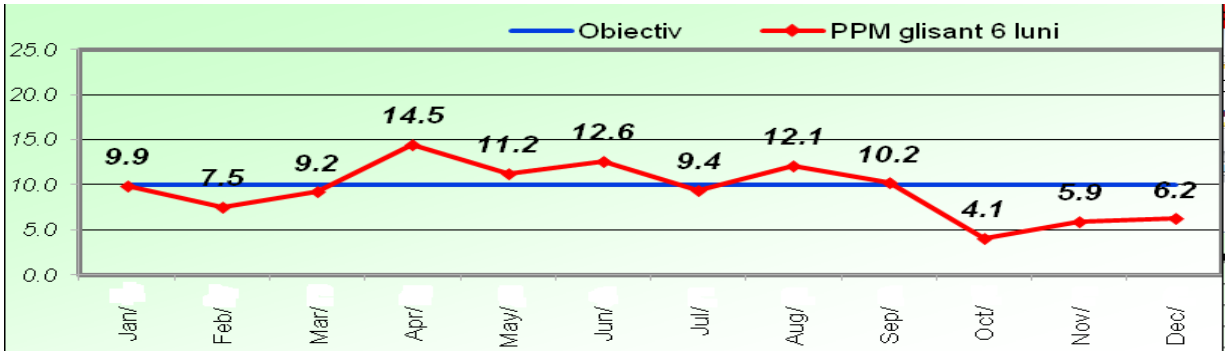
Chart 3 - FORD - monthly external PPM in 2014



Source: Mirea G. (2015) Doctoral Thesis

However, the control chart no. 4 - sliding external PPM for 6 months at FORD shows us that after a slight upward trend in early 2014, which peaked in April, the situation began to regulate, so that by the end of the year it was succeeded to achieve the imposed objective by the customer.

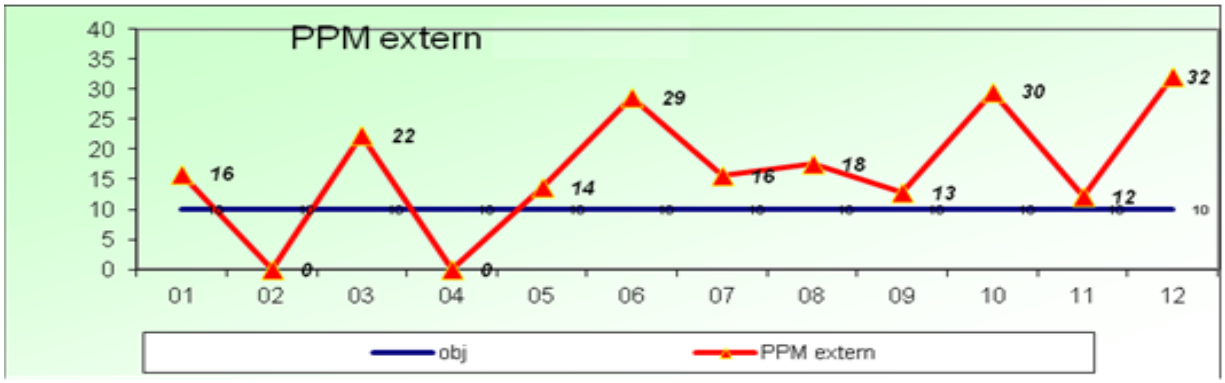
Chart 4 - FORD - sliding external PPM for 6 months, in 2014



Source: Mirea G. (2015) Doctoral Thesis

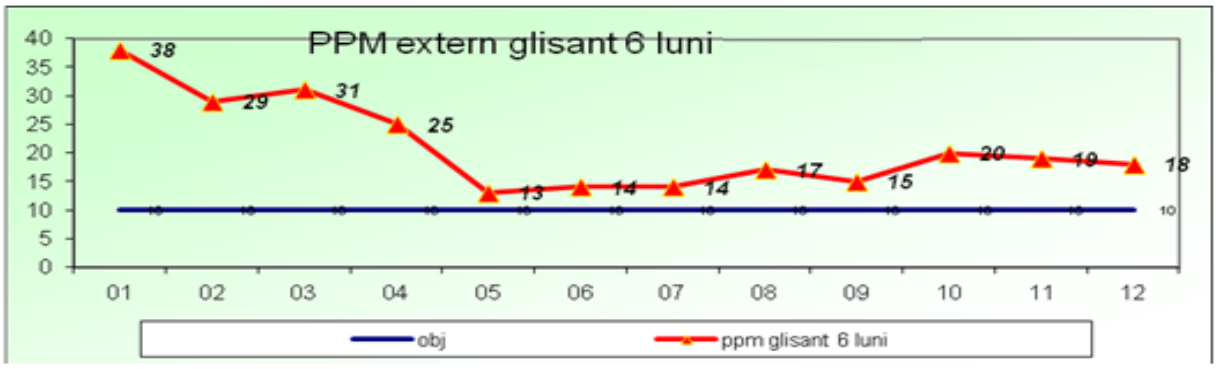
I'll present the obtained result in monitoring of this indicator, in Section B, in 2013 and 2014.

Chart 5 - monthly external PPM at the customers, in 2013



Source: Mirea G. (2015) Doctoral Thesis

Chart 6 - sliding external PPM at the customers for 6 months, in 2013



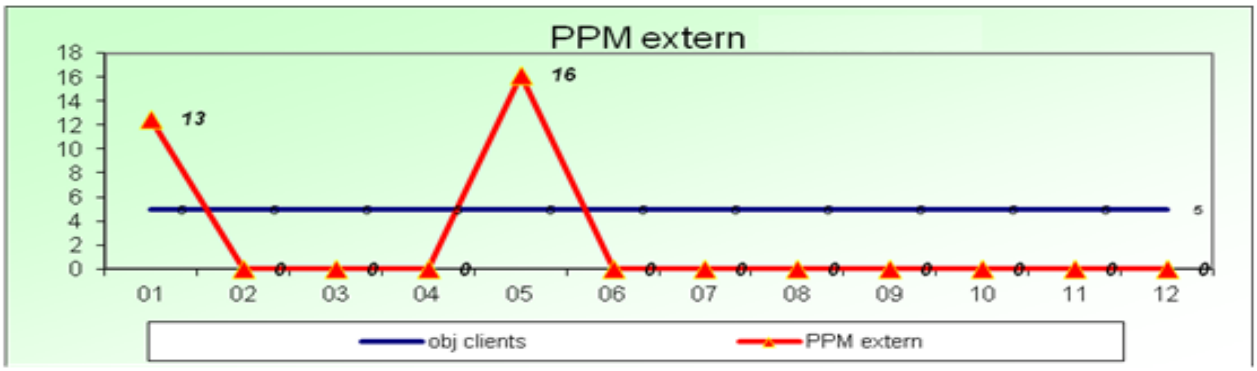
Source: Mirea G. (2015) Doctoral Thesis

Analysis of the charts show us that in early 2013, until May, the trend was decreasing, which can be seen very well in the control chart no. 6. The control chart no. 5 shows us that in February and April there weren't complaints. Then, because there were complaints each month, the trend has become increasing. Towards the end of the year (November-December), the trend is slightly decreasing. Another aspect that can be observed is that the evolution was not appropriate beside the objective, so that, there were imposed the corrective and preventive actions, from the owner of the process.

In 2014, the situation was presented as follows:

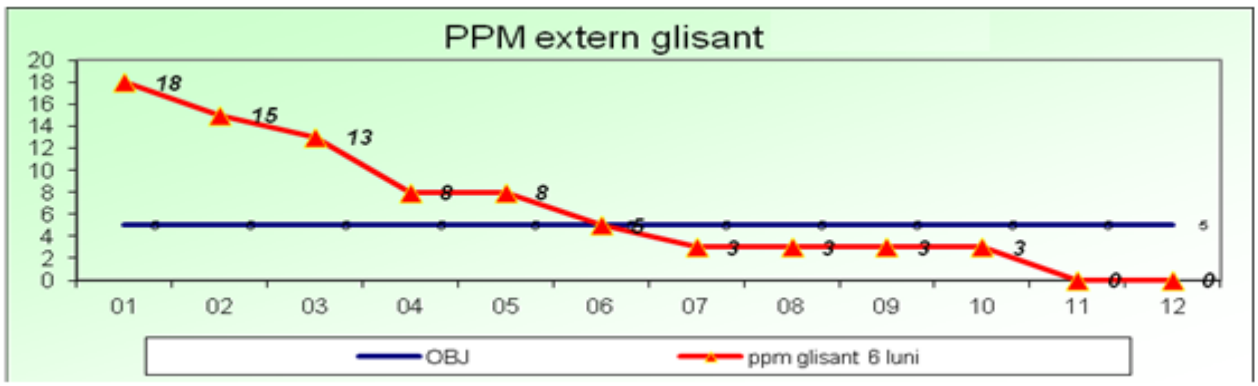
- there were complaints in January and May, which it is observed in the control chart no. 7;
- As regards the sliding PPM, the trend was in continued decreasing, so that, in the second half of the year, the sliding PPM for 6 months was zero.

Chart 7 - monthly external PPM at the customers, in 2014



Source: Mirea G. (2015) Doctoral Thesis

Chart 8 - sliding external PPM to customers for 6 months, in 2014



Source: Mirea G. (2015) Doctoral Thesis

Conclusion

Control charts are a way of monitoring the actual performance of a process, acting as a well organized alarm system, and through them, there could be estimated the future performance and the necessary actions, in order to correct the performance.

Through them, there can be identified the type and frequency of the appearance of the various problems and can be traced the obtained results, on whose basis it can be highlighted the recorded effects on the performance of the process.

Through the control it is aimed to keep the parameters fluctuations that are monitored in the process, in a well-established and predictable interval of deviation, which will maintain a high standard of the process performance.

For efficaciousness of the statistical process control, we must consider the type of collection, representation and review of data, and choosing the parameters that must be measured by ordering them according to the priorities.

It must be mentioned that it is dangerous to assume that sometime we have perfect data, because the alarm signals are triggered after the data collection, whose quality should be checked periodically.

The control charts are useful for monitoring and understanding the process, and not for solving any occurred problems, or to improve the performance of that process,

Referring to the case study, the chosen indicators for the control charts, the external PPM or sliding external PPM, in addition of highlighted the performance of the process, provided us the real data on the tendency to fit in the imposed parameters.

Using the control charts, we monitored the trend of the process at a moment and there was taken the preventive measures, if the trend was contrary to the expectations, so that, overall the year it was succeeded to achieve the imposed objective by the customer.

In addition of highlighting the performance, this indicator provides us data on the trend. Using the control charts, it can be traced its trend at a moment and can be taken preventive measures, if the trend is contrary to the expectations of the customer and of the top management. It is noted that there is a small gap between the delivery of the parts and their assembly on the automobile, which should be taken into account when there is conducted an analysis.

NOTE: *„This paper was co-financed from the European Social Fund, through the Sectorial Operational Programme Human Resources Development 2007-2013, project number POSDRU/159/1.5/S/138907 "Excellence in scientific interdisciplinary research, doctoral and postdoctoral, in the economic, social and medical fields -EXCELIS", coordinator The Bucharest University of Economic Studies”.*

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