ADVANTAGES AND LIMITATIONS OF STATISTICAL PROCESS CONTROL FOR ONE PIECE FLOW PRODUCTION

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ABSTRACT
Globalization and freedom of markets, supported by international agreements, lead to a serious competition among companies. The control is one important issue when it comes to quality. This paper presents the evolution of control methods by examining their advantages and limitations and presents the alternatives by which these limitations can be overcome. These alternatives are represented by organizational innovations (participation stimulation) and/or advanced technical means.

KEYWORDS: *inspection, self control, statistical quality control, source control, fool proof*

Introduction

The last years enhanced a great interest for the principles and practices of Japanese management. Its success and different approach generated a lot of research studies in the field. In the context of such a strong competition, more and more researchers, businesspeople and students turn their eyes towards what is behind the Japanese success; towards what is different and what can be implemented in their geographical areas in such a way to provide strategies that sustain long term success.

"People have been and will always remain the pillars".[3] People in their position of customers, of employees, of stakeholders, are crowding around a big word: quality. Quality is defined by customers but is the responsibility of everyone. When the customer is making a purchasing decision, it is probably that he considers quality, cost and on-time delivery. Thus, quality improvement has become the goal of many corporations.

Quality improvements

In any field of activity, the market is the one that imposes the majority of regulations and the one that, through competition obliges the organizations to seek for ways to improve the performances.[6] One such reliable way today is quality.

The approach of quality improvements today should not be established

based on a philosophy, but rather based on the quality problems faced. One of the common known problems is variability. A process is a mechanism that transforms inputs in products or services. But the inputs vary, so the process will vary itself, and a combined variation will also be present in the products. The basic idea is to isolate the common cause variation and to try to eliminate the other causes of variation. The most effective approach of this problem is represented by a individual combination of statistical methods and knowledge of process details. Research has proven that solving the problem of process capability means eliminating some percentages of internal failure.

Another common problem known is related to reducing the time necessary to detect errors, meaning moving the production from batches to one piece flow. *One piece flow* is moving one piece at a time between operations of a production process. This type of production is preferred because it maintains the WIP low while balancing work; other benefits are related to quality and other internal improvements. Of course that one piece flow is not the solution for all production system, but where applicable it is an ideal for which engineers must tend to.

The consequences of using one piece flow for quality are:

- The lead time through the operations is far shorter than for batches. If the parts are found to be not acceptable after coming out, the results can be fed back to the line before the error can become a real damage.
- Due to the movement of parts FIFO, when a part is found to be unacceptable it can be traced immediately
- Any defect introduced in one step that prevent the execution with success of the next step is detected immediately and thus is prevented the production of further defective products.

It is evident that the above mentioned solutions cannot help a business reducing defects to zero, which is the most important target of the day. The reason why these are not sufficient is that people are involved in processes. People always make mistakes, mistakes that we accept as being natural but in the same time we try to find the responsible person. If companies maintain this attitude, the defects can be discovered very late, and sometimes by the customer. But, the great idea is that errors can be reduced and even eliminated. If people are trained and the production system is designed according to the idea that errors can be eliminated, then they make fewer mistakes.

Process control methods

There are several methods for detecting errors. The first one is inspection, with two types: sampling inspection and 100% inspection.

Sampling inspection, as the name reveals, means inspecting a relatively small number of items from a batch and then using the results of this sample to accept or to reject the entire lot. The accept/reject criteria represents the number of defectives in the sample. Sampling relies on statistical probability and there is the possibility that a good batch to be rejected in a wrong way and also that a bad batch

to be accepted in a wrong way. Thus, with sampling, there is a chance that one error goes undetected, and the customer experiencing that error will be 100% dissatisfied, with all the consequences leading from this. But from the manufacture's point of view sampling inspection makes sense because it is inspection, it detects part of the errors, and it is cheap.

On the other hand, there is *100% inspection*. The best managers are aware of the fact that even one defective product can destroy the customer's confidence in the company; thus, the attitude is not to tolerate a single defect. But, with the increasing competition, the good products must be provided on a large scale, so how to do 100% inspection? On paper, things are very clear: if every piece is inspected, it means that no defect product will go on the market, so the customer will know exactly what to expect from the company. But in reality, things are not so simple.

If for sampling inspection is clear that the quality control responsible takes samples, analyzes them and after a period comes with the result, independent of the production activity, for 100% inspection is the need that everyone inspects or at least that are many inspectors in place, ready to accept or reject a part.

Even if 100% inspection seems closer to our target, it has its disadvantages. Firs would be that it costs too much inspecting all products, and in case of a capable process that functions at a level of 4 to 5 sigma, 100% inspection represents not a sustained increase of costs. Another bad aspect is the mobilization of human resources and time in this area, which besides the money aspect it could represent a delay in the activity.

Inspection is now left behind because if it is not too expensive, then it is not reliable.

Another step of quality control is *self control*. It is obvious that no one intends to make mistakes; but working, errors can appear without the employee noticing. But if that part doesn't do what it has to do, or does not correspond for any other reasons, the error is discovered. The worker is the best at discovering the error because it works directly with the part. In case of a flow production, defects are found before they go in another process step and increase the damage.

Then there is *statistical process control (SPC)*. SPC is an important tool because it eliminates variation. Initially developed by Dr. Walter Shewhart and later expanded by Dr. D. Edwards Deming, SPC was an innovation because it made the distinction between common cause and special cause variation.

Common cause variation is inherent in the process. A stable process exhibits only common cause variation, and its behavior is constant and predictable, following a normal distribution. Special cause variation is not part of the process. It can be traced to the source, identified and eliminated. A process exhibiting special cause variation is unpredictable and inconsistent, and the process is said to be out of statistical control, in comparison with the stable process which is in control.

SPC uses simple statistical tools to control, monitor and improve processes. But this was 70 years ago in an environment where measurements were collected manually and recorded on paper, the calculations being made based on

permissive rules. Since then, different statisticians developed, with the help of new technologies, different tools adapted for different industries, like Coordinate measurement machines and Supervisory control and data acquisition systems. Now, even the e-spreadsheets have an analysis package that supports them, more powerful than the traditional SPC. Furthermore, there are different specialized statistical software that supports data analysis and design of experiments, which are inexpensive, reliable and fast.

Except for the special industries, the power of these tools is unknown. Why? The answer is the lack of skills. There are very few people who have a good understanding of both statistical methods and process details.

Limitations of control methods

The control methods presented below were developed decades ago, and even if they still are at the basis of quality improvements, today they are not sufficient.

As we stated above, inspection is either to expensive, either not reliable. Self control is good because represents people empowerment, a missing feature in companies today that weights in the journey of quality improvements, but is not enough. SPC is a good tool, but for batch production. And anyhow it is time consuming, it is expensive, and the results come too late and are not enough.

Today, the business environment sustains only those companies that know how to fight and where to invest with respect to quality. Thus, some solution must be found as an answer to the current issue, because "incapable and inconsistent processes render the best design impotent and make supplier quality assurance irrelevant".[5]

Zero defects

Research has proved that only a zero defects policy can help businesses survive. There are two strategies behind the zero defects quality. The first strategy is not to make what is not necessary, using just in time principle. It is well known the phrase, at least in Romania: "only who doesn't work doesn't make errors". The second strategy is to build safeguards.

As stated above, the employee is an expert in finding errors. Thus, the safeguards must be built in the process. Quality can be built in the products by implementing poka yoke and jidoka. These two can be related to source inspection.

Source inspection is the inspection of 100% products at the source, the place where errors can be found before being transformed into defects. By checking the factors that cause that error, not only that error is eliminated from the system, but also the cause is eliminated, preventing the reoccurrence of the error, which is in fact the most effective measure; another important consequence is that it reduces the time until the corrective action is in place.

Shingo (1986) was stating that "for reducing defects within production activities, the most fundamental concept is to recognize that defects are generated by work" [1].

Above is written that human errors are inadvertent, but the poka yoke devices help eliminate the defects related to human errors. Poka yoke is a term originated in Japan. At first, it was baka yoke, which means fool proof, but because the purpose was not to insult the employees, nor to punish them by implementing this devices, it changed to the form we know today. In fact, poka yoke means literally avoiding inadvertent errors or more common mistake proofing. In theory, poka yokes ensure that the process is run in the proper conditions before it actually starts, preventing thus the occurrence of defects. In reality, where this is not possible, poka yokes detect the errors as early as possible, before being converted in a defect.

The methodology is very simple: first is identify the process based on a pareto; then analyze and understand the process; decide the poka yoke type and determine its form, try it and if it is good train the operator and measure success. The types of poka yokes are: control approach – shut down the process when detecting an error and isolate it – and warning approach – signalizing the operator about the occurrence of an error -. Common examples of poka yoke devices are: alarms, checklists, go/no go gauge, photo sensors, switches, and so on.

We can summarize that poka yoke helps people and processes work right the first time, sustaining quality improvements and reliability.

Related to poka yoke is also jidoka, a term referring to a quality control method that endows machines with the ability to detect something is wrong and to stop in order to solve the problem. Jidoca mechanisms stop the machine in three situations: a quality problem occurs, a machine problem occurs, or the process ended. Thus, jidoka is also called "automation with a human touch" suggesting that the machines have a human sense for detecting wrong situations. [4] The idea behind jidoka is that it distinguishes between the work of the machine and the work of the operator. While it helps the machine, the poka yoke devices help the operator to make fewer mistakes, so thus the defects have a much lower rate of occurrence.

Conclusion

The business environment now days faces different factors with multiple advantages and disadvantages like globalization, technology, CSR, economic crises, demands, and so on. The competition is stronger and stronger, and only those companies that can easily adapt are going to survive. The need for quality and continuous improvements has rise from this battle. Quality has evolved, and so the methods for improving it. It was proved that control is one most important method when it comes to quality. Control can be dome through inspection, under its different aspects, or through statistical control.

There were times when inspection was enough, but now, if it is cheap like sampling inspection, it is neither useful nor reliable; but if it's expensive, like

100% inspection, it is also not a solution. Thus, it developed SPC as a solution to other conditions. But SPC, even if it is at the basis of quality improvements, and even if it is good, it is not enough. Even the modern approach of SPC it is not what managers need in order to survive. The results of SPC come too late and do not reflect the whole reality. It is good to identify the defects before they reach the customer, but the corrective actions cost the company too much money. So the question was what can be done now, to maintain the advantages accumulated with SPC, but also to move forward? The answer was in the Japanese management. The goal is to identify errors and eliminate them before becoming defects.

Mistake proofing requires efforts, and jidoka mechanisms require additional improvements of the processes, but only used together ensures that the company in on the path to zero defects. Each time possible the organization must implement these in order to ensure that no costumer will have a defect product, and each customer will have a 100% satisfactory experience. And if too all these we add the ideal one piece flow, we will have the most effective and low cost alternative of all methods for improving quality.

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