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A Critical Analysis of a case study 'On the use of Quality tools'

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Abstract

This paper provides a critical analysis of a case study, which reports on the use of quality tools to reduce product defects in a manufacturing facility. The company analyzed is a new one with no experience in leather products. The production system consists of cutting, preparation, and assembly of leather components. Leather defects include leather tearing, leather getting stretched too thin, and leather not getting stretched enough. The case study analyses the quality tools used by the company to improve the quality of the product as well as to reduce the percentage of defective components in the plant. The authors claimed that all the tools implemented were found to be effective. Our review of the case indicates that, while some of the tools have been used successfully, others reported lack strength due to how or why they were used or lack of sufficient data for analyses. The paper also presents a framework for integrating quality and reliability in order to manage process innovation.

Keywords: *Quality Tools, Total Quality Management, Quality Improvement*

1. Introduction

The company identified priority areas for quality improvement, used quality tools to determine best strategies for improving the system, and implemented a continuous improvement cycle. The methodology they used consists of three steps as shown in Figure 1. First is assessment of quality management processes. The goal is to diagnose possible problems and limitations in the management processes which ultimately should lead to improvement opportunities. The second step is general production quality data analysis and determining which action (s) to take to resolve production quality problems. The last step is the application of PDCA cycle to solve a specific problem that would help to increase the effectiveness and efficiency of actions.

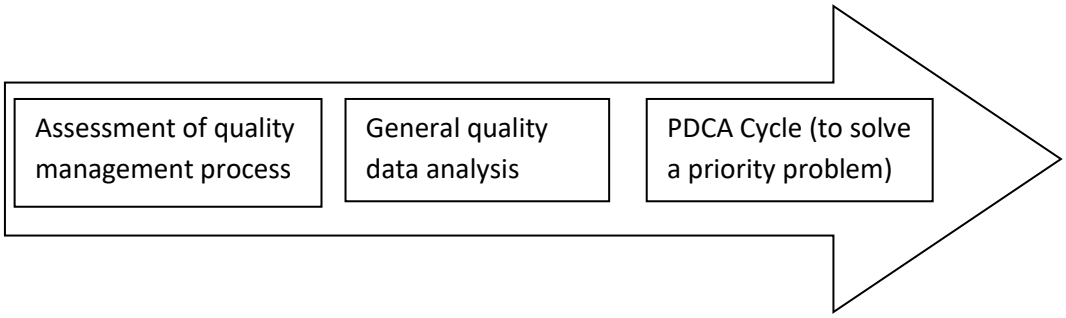

Figure 1: Implementation Methodology of Quality Tools

Literature review:

As a form of the function of the management, quality was approached first in the first half of the 20th century. After the work of Walter A. Shewhart on the process control and creation of control graphs, quality management achieved a scientific status [1]. Since then it expanded and in this area some other techniques and tools have been developed or incorporated in to it, for example Design of experiments (DOE). McQuarter et al. (1995) defined tools as a scheme which has a precise role (clear objective) to solve a given problem. For example, histogram, scatter diagram, affinity diagram, matrix diagram and control chart etc [2]. On the other hand technique is defined as a set of tools associated with a solution of a given problem. For example, SPC may need the use of tools such as control chart (XBar, R, CUSUM etc), histogram, box plot, stratifications and acceptance table. There are some other terms such as methods and methodology along with the terms technique and tools. The methods indicate what to do and which steps to follow in achieving the goals. PDCA cycle (Plan, Do, Check and Act) approved by ISO 9000:2000, TQM and DMAIC (define, measure, analyze, improve and control) cycle are some of the examples of quality methods. Where the main purpose of PDCA cycle is to improve the process. Studying the methods and the process of generation of such methods is called the methodology [3]. In all stages of the production process quality tools can be used from the starting of the development of the product up to the marketing of the product and customer support. A great number of quality assurance and quality management tools are available to quality experts and managers but it is not an easy task always to select the most appropriate one [4]. Implementation of quality management system is an advantage of the successful application of quality tools. However performance cannot always be improved by using TQM when the impact of TQM practices in the firm is weaker and not significant [5]. Though TQM has advantages, there are also some problems associated with its implementation [6]. Firstly, it is very important to develop a firms intangible resources to achieve a positive performance [7]. Secondly, firms needs to improve their operating performance in order to implement an effective TQM program [8]. Thirdly, While implementing TQM, some firms fail [9, 10] because use of appropriate quality management methods are necessary for the successful implementation of TQM [11, 12]. The principles of quality management are the starting point for the management of the company fighting for the improvement of the continuous efficiency

in long period of time and satisfaction of the customer [13-16]. The authors Crosby 1979; Deming 1982; Ishikawa 1985; Juran 1988;Feignbaum 1991; have great influence on the quality management theory. The research of these authors represents both strengths and weaknesses but they do not give all the solutions to the problems confronted by the firms [17]. In spite of the fact some common issues are generally observable, for example, leadership of the management, training, involvement of the employees, process management, quality planning and quality measures for continuous improvement [18]. The constituents of TQM can be arranged in two dimensions-one is the management system and the other is the technical system [19] or in to the 'hard' and 'soft' parts [20]. Tools and techniques are very important in order to support and develop the quality improvement process [21, 22].

1.1Analysis of the Assessment of Quality Management Process

The company created quality department in the early start up phase since this process involves diagnosing possible problems and limitations, which helps to determine improvement opportunities. The first stage of applying quality tools involved evaluation of the processes and sub processes, which include quality planning, quality control and quality improvement. Table 1. represents all the measures that were taken into consideration and implementation.

Table 1: Processes and sub-processes for quality management

Quality Function	Process
A. Quality Planning	A.1.Suppliers qualification A.2.Definition and communication of the raw materials/components or subcontracted services requirements to the supplier A.3.Definition of the specifications/acceptance criteria and critical features of the product A.4.Customer requirements survey and product features validation to meet customer requirements A.5.Survey and verification of the compliance with the statutory and regulatory requirements applicable to the product A.6. Preliminary studies on the processes capability (products) or skill (services) and operating conditions A.7. Ensure that who is involved in the processes have the necessary capabilities and knowledge to the products realization A.8. Identification of potential problems (that may arise in the product realization) and solutions
B. Quality Control	B.1.Planning of inspection and testing in the production B.2.Inspection and testing of raw materials/components and control of subcontracted services B.3.Calibration/verification of measurement, inspection and testing equipment (MITEs) B.4. Identification and treatment of nonconforming product B.5. Corrective actions to sporadic problems B.6. Verification of the process capability
C. Quality Improvement	C.1.Identification of improvement opportunities C.2.Priorities definition C.3.Analysis of opportunities for improvement C.4.Definition and planning of improvement actions C.5. Verification/monitoring of the effectiveness of improvement actions

After implementing the above tools the company determined the following:

1. Some quality planning procedures were not documented during quality planning. This was not consistent with A1, A2, A3, A4, A5, A6, A7 and A8 as stipulated in Table1.

2. In order to control the quality of the product, in various stages of the production process, 100% inspections was conducted. This is neither consistent with the best and cost effective sampling practices, nor it is consistent with some of the techniques reported in the case including Taguchi method which requires limited sampling. Moreover since the defects rate was found to be relatively small (less than 3%), Variable control charts should have been adopted and not attribute control charts.

3. Regarding quality improvement of the product there were no use of quality approach and tools. This finding is inconsistent with what is reported in Table 1. The authors then concluded that the main problem the company is dealing with is the poor production process. ”poor” is not quantifiable. The company should report other statistics and be specific.

1.2 Examination of the General Quality Data Analysis

The authors analyzed the historical records of the occurrence of the nonconformities in the entire production process. Those are necessary prioritize a problem and action and to resolve the problem. In order to find improvement opportunity in the production process a variety of quality tools were used including Histograms, Pareto chart, Attribute control chart, Repeatability and Reproducibility analysis, Taguchi method , Ishikawa diagram, Deming cycle (PDCA cycle).

1.2.1 Histograms

Three histograms were used in this case study; one to show the percent of defective components in the assembly section of the process daily, one to show the percent of defective components in the preparation sections of the process daily, and one to show any differences between the day shift and night shift defective components during the preparation section.

It is reported that the histograms indicate that the number of defective components were higher mainly in the preparation section (with an average of 3.5%) compared to the assembly section (with an average of 2.1%). Then they identified the preparation section as the most problematic and decided to find the most troublesome component in this section. The authors then concluded that the results from the histograms show component FL (which is not defined in the case study) had the largest impact on the number of defects (9.6%). Also, there were no notable differences between the day and night shifts.

The authors do not explain why 3.5% is significantly higher than 2.1%. They do not provide any explanation of the relevance of these percentages in relation to the size of batch samples during either preparation or assembly. The authors do not explain how they arrived at 9.6% of defects.

Figure 2. shows a histogram of the percentage of defective components in the preparation section by day.

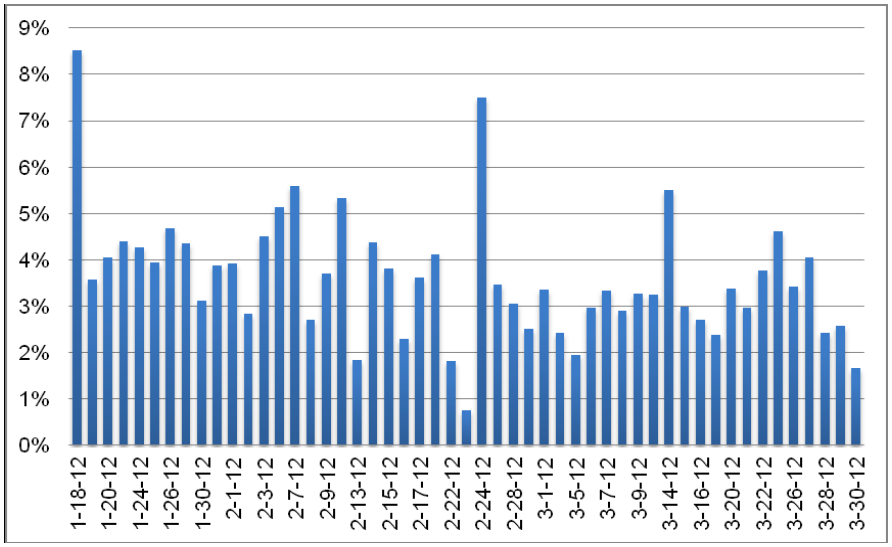

Figure 2: Histogram of Nonconforming Components in Preparation

1.2.2 Pareto Chart

Pareto Chart were used to categorize the nonconformities in order to develop a more focused approach for improvements. Since the source of the problems and their size were not known though, the preparation section was recognized as the most complicated. It is reported that three out of twelve categories represented about 70% of the total defects. These three are: IG Station (Equalization) (represented 20.7% of total defective component in the preparation section) and the downstream IG station, the Folding station (VC), the Raw Material (MP). No statistics were reported about the last two categories mentioned.

1.2.3 Attribute Control Chart

An Attribute Control Chart was developed and analyzed by the company to determine if the current preparation process was in control. The results show that the majority of the points were above the upper control limit and thus the preparation process was found not to be in control. This led the team to create the histogram broken down by shifts to narrow down the source of the defects. Since there were no differences among the shifts, the team then decided to create an Ishikawa Diagram to determine the root cause for the defects.

Since the data is not reported, it is not possible to determine whether the results are reproducible or not. It is also not possible to report on the reliability of the control chart data results as the samples sizes analyzed are not reported.

1.3 Analysis of the Application of PDCA Cycle

It involves solving a particular problem diagnosed as a priority in the previous step. This is a repetitive four stage model for continuous improvement (CI) in business process management. This last tool includes several stages such as Plan, Do, Check, Act. It is also called Deming Cycle.

1.3.1 Taguchi Method

It is reported that a series of steps were followed to set the optimum combination of parameters. These involve setting the response characteristic, identification of factors (control and noise), choosing factor levels, selection of orthogonal matrix, performing the experiment, interpretation of results and confirmation test. Then it is concluded that the optimal combination was found to reduce the variation in the FL components using this method. But sufficient data is not available to understand how the experiment has been performed. Again, there is a lack of information in reproducing the results of the experiment or the results in this case.

1.3.2 Ishikawa Diagram

Before the Ishikawa diagram was created, the team (the coordinator of the Quality sub-department, the responsible for maintenance, the Head of production and IG station operators) brainstormed to develop the main branches of the diagram which were machine, measurement, manpower, material, method, and environment. From here, they expanded on how each branch can result in creating more defective products. The main causes of the problem of nonconformity that the authors pointed were experimental procedure, control methods, measurement method, parameterization of the machine, devices and equipment. This analysis was completely reliable because there is sufficient explanation of the activities that were performed along with the cause effect diagram

The Ishikawa diagram is shown below:

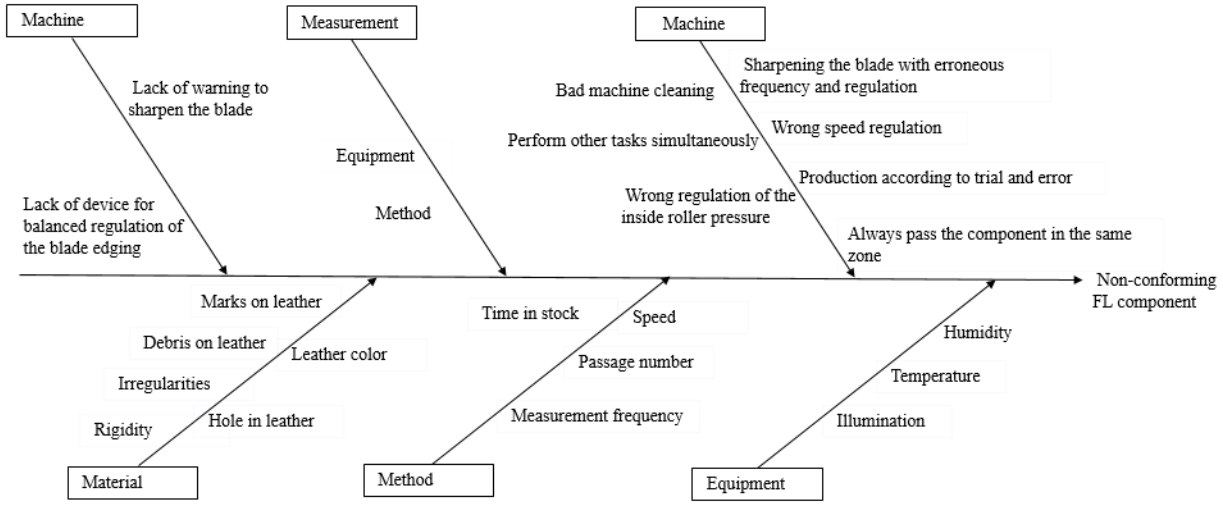

Figure 3: Cause-Effect diagram of nonconforming FL components

1.3.3 Repeatability and Reproducibility

The repeatability is defined as the ability of the measuring instrument to provide the similar results repeatedly and the reproducibility is defined as the ability of the measuring instrument to provide the similar results repeatedly if one of the factor changes.

Once the Ishikawa diagram was completed, the team decided to use R&R analysis to ensure that if the measurement system is dependable and if it has a high enough capability factor. Thirty samples were measured twice by two operators. They measured the same component repeatedly without knowing about it that they are the same and using the same measuring instrument. It is reported that the process capability was determined to be not acceptable since the ratio of precision to tolerance was greater than 10%. The estimated value of the standard deviation for reproducibility was three times lower than the estimated standard deviation of repeatability. It is then concluded that the measurement instrument is responsible for the main source of variation that affects the system precision. This study is reliable and reproducible since there is complete explanation of the tasks that have been performed along with the end results.

Conclusion

In conclusion, the case study team determined four primary planned actions. The first is to implement the best combination of parameters (from the Taguchi method) in order to reduce the product variation. The second is the replacement of the measuring instruments in the FL section (due to R&R results) in order to improve capability. This change allowed the process to satisfy the capability requirements. The third planned action is the change the operation modes and control. This involved implementing a formal process for trained operators in order to make sure each operation is conducted the same way each time. The last planned action is to add mistake-proofing devices into the machine. This involved the development and design of poka-yokes which were not originally used in the plant.

It is not possible from the case study as reported to determine whether the primary planned actions are viable or not as some of the techniques used for analysis are inadequate, while others are not supported by accompanying data that is reproducible.

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