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Implementation of Poka-Yoke System in an Automotive Company

Bruno Diego de Souza Silva[1], Nilo Antonio de Sousa Sampaio[1,2], José Wilson de Jesus Silva[2,3], Bernardo Bastos da Fonseca[1]

[1]*Universidade do Estado do Rio de Janeiro, DMFC UERJ FAT, Resende, RJ, Brazil*
[2]*Associação Educacional Dom Bosco, AEDB, Resende, RJ, Brazil*
[3]*Centro Universitário Teresa D'Ávila, UNIFATEA, Lorena, SP, Brazil*

***Corresponding Author:** *Bruno Diego de Souza Silva, 1Universidade do Estado do Rio de Janeiro, DMFC UERJ FAT, Resende, RJ, Brazil*

ABSTRACT

This article aims to present the Poka-Yoke error-proof system, aimed at the automotive sector, presenting and defining what will become the Poka-Yoke methodology and how it can be used in order to bring benefits to a company by means of its implementation in a case study. Quality problems are part of everyday business and the way in which they are treated/detected is what defines the level of Final Quality that a product or service is delivered to the customer. The use of quality tools or technologies such as Poka-Yoke is necessary to maintain a quality level that meets or exceeds the customer's expectations, besides avoiding high costs with rework, waste of productive material, recall among others and dirty the image of company.

Keywords: *Error-proofing (Poka-Yoke); Quality problems; Operational failures.*

INTRODUCTION

The quality problems encountered in products are generated by several factors during transportation, storage, raw material suppliers, equipment failures, operational errors, among others. It is clearly understandable that these quality problems affect the company's profits and, depending on the problem size, can be a determining factor for such a company to remain in the market by means of competitors. For a company to perform its activity in a market in order to be competitive before competitors, four basic guidelines must be observed: the financial, customer perspective, internal processes and the perspective of learning and growth [1].

Throughout history, one can observe alternative ways of organizing the work process that have arisen in response to specific contexts, conditioned by economic, social, cultural and institutional factors. Nowadays, the globalized economy demands from the organizations the ability to obtain greater competitiveness [2].

The market suffers at all times changes, mainly technology, resulting from globalization, which means that companies have to adapt to the current scenario not to stay behind their competitors and seek continuous improvement in their products and services beyond profitability, it is necessary to deploy systems capable of updating work processes as well as their technologies and people [3]. These quality problems can be avoided by means of the use of technology based on studies and techniques, as well as quality tools specific to each problem nature.

This work will deal with one of the types of quality problems, which will be the operational errors, that is, those that occur due to human failures in the execution of a manufacturing activity that is part of a productive process. A process in which operational failures occur is a process that does not have sufficient methods to prevent the fault from occurring, leaving it to the operator and his experience, along with the training received, which is often not enough to tell the problem.

This paper aims to demonstrate the applicability of using a Poka-Yoke system to eliminate an operational failure of a company in the automotive sector. According to Grout [4], "Poka-yokes are devices to prevent errors or to minimize negative impacts of errors, applying to any industry sector, services and daily life."

Research is delimited quantitatively and from a descriptive point of view, raising the data of this company in question, which is a vehicle assembler, located in the South-Fluminense region, Rio de Janeiro State, in 2016.

Continuous improvement is a theme that is involved with all the major companies that value the quality of their products and processes and also seek to reduce costs. Implementing a system that provides a reduction in the total of operational failures will bring great results for the organization, such as reducing or eliminating rework, part scrap, customer complaints, recall, among others in general.

While quality control allows the identification of the occurrence of sporadic problems and, consequently, trigger corrective actions for its elimination, restoring the normal variation of the process, improvement activities aim to reduce chronic problems, reaching a level of superior quality and consequently lower costs [5].

This work will demonstrate by means of use applicability of the Poka-Yoke system the results referring to operational failure points in the workstations, rework number and scrap.

As for this work structure, it will be organized as follows: theoretical basis on the Poka-Yoke system, lean manufacturing, Quality System and non-quality costs. The development and use of methods and tools used for implementation of Poka-Yoke in the pilot station. Following, the results obtained after implementation and finishing the work, the conclusion besides suggestions for future work followed by bibliographical references.

THEORETICAL REFERENCE

Quality Concept

According to Campos [6], "a product or service of quality is one that perfectly meets, reliably, affordably, safely and at the right time the customer's needs." In other words, in order to offer a product or service that fully meets the requirements outlined above, one must have a flawless design that does not cause defects or scrap, costing the customer least, not exposing both the employees working for execution and the end user in terms of security and delivery in the right time, place and quantity.

Of course, there is a high cost to keep all these requirements, however large companies that seek to be market leaders have to be always aiming to serve them the best way possible.

Campos [6] further states: "The true criterion of good quality is consumer preference. This is what will ensure the survival of the company: the consumer's preference for your product in relation to your competitor, today and in the future."

For an automotive environment, quality can mean that all parts and processes are produced following the specifications of drawings, processes and standardization standards, so that the assembly meets customer specifications and the product is reliable, attractive and free of defects.

Quality is not only presented to the final customer, it must be maintained throughout the process, mainly within the operation.

Good quality performance in an operation does not lead to external consumer satisfaction. It also makes life easier for people involved in the operation. Satisfying internal customers can be as important as satisfying external ones [7].

Slack [7] says "to create a unified view, quality can be defined as the adequacy degree between consumer expectations and their perception of the product or service." In figure 1, this citation is exemplified:

Figure1. *Perceived quality is governed by the gap between consumer expectations and their perceived product service [7].*

Poka-Yoke Concept

Poka - Yoke is a Japanese term and means "error - proof". It is increasingly present in several sectors, such as hospital, food, civil, among others, and is not limited to manufacturing companies.

A Poka-Yoke system is a tool or device that aims to prevent defects from occurring in order to perform 100% inspection in its steps, ensuring that the product goes to the next step without any possibility of failure [8]. A more current approach says, "poka-yokes are devices to prevent errors or to minimize negative impacts of errors, applying to any sector of industry, services and daily life" [4].

The main objective of Poka-Yoke is to detect and correct failures in a process, at the eminence of failure, taking into account that poka-yokes can function as a reactive function when detecting the defects and as a proactive function when, in addition to detect errors, prevent defects [9].

Here are some examples of Poka-Yoke products that do not allow misuse:

The diskette, represented by Figure 2, clearly demonstrates the concept of not allowing it to enter the diskette drive in the microcomputer cabinet.

Figure2. *Data diskette 1" [10]*

In figure 3, we have the example of the power socket, which has a standard on the socket body and the same fits perfectly in the wall mirror; however, the earth pin is mandatory to fit perfectly in only one position, with the middle pin facing the top position.

Figure3. *Power socket and wall mirror*

Another example in which it is possible to witness a preventing error action by means of Poka-Yoke is present in Figure 4, where there is a device that serves as a template at the street entrance, which has the same dimension as the bridge just ahead, and indicates that there is a height and width tolerance for vehicles passing by. If it were only a plate guiding that "x" meters in height and width could not pass on the bridge ahead, the driver would be assuming that he could or should not heed the warning if he knew the correct dimensions of the vehicle, and by a calculation error , could cause a serious accident. Poka-Yoke acts in this way in its essence, preventing errors, especially those that are permissible due to environmental conditions.

Figure4. *Example Poka-Yoke on road [11]*

Thus, by bringing this concept into the industry, Poka-Yoke's goal is to help operators avoid operational failures, such as choosing a wrong part in the assembly, even if the procedure documentation is correctly indicating what it should be even by skipping some stage of the operation either by distraction, or forgetfulness and even inadequate training, and that the product or process does not conform [12].

METHODOLOGY

The method used in this research is the bibliographic research followed by a case study. The research is delimited in bibliographical references to exemplify the concepts of Poka-Yoke in order to highlight the importance of the use of this resource in automotive companies, analyzing critically the application of this technology in a production line and use it to solve a problem operational failure.

This research is justified because, in the automotive world, there is a fierce competition among companies to remain stable and competitive in the market, and to seek technologies and resources capable of offering this scenario is achieved, it is necessary to invest more and more in quality. Eliminating possibility of errors in the assembly, that is, operational failures is a goal in big companies that seek to reduce costs with rework or waste (costs that do not add value) to be able to have a more competitive price and to offer a product more and more attending or surpassing the client expectations.

The case study was conducted in a production line of an automotive vehicle manufacturer (from July 2016 to December 2016) in which, due to a series of recurrences of an operational failure within a period of 7 days, it opened a plan of action to work on the root cause in order to eliminate the possibility of failure again. The applicability of Poka-Yoke system on the Production Line was verified to eliminate the possibility of failure occurring again.

Applicability Analysis

The case study was initiated due to an action plan that was opened by the Quality area after a single failure occurred within the 7-day period, pointing out that there was a chronic problem at the workplace. The operation is the fixation of the front stabilizer bar in the suspension, where the loose screws were caught by the quality inspectors. Immediately an action plan was opened with the intention of identifying and eliminating the root cause of failure.

Firstly, it was applied a 5-why form among the production controller, the operator involved in the operation, a quality analyst and a process engineer, where it is possible to see, in figure 05, the result of this form.

Attach Form 5-Why

It was clear that fault occurred because there is a possibility of occurring, i.e. during the fixation process, there is no productive method (physical, sleep or visual) at the workstation capable of preventing the fault from occurring or being signaled to the operator, thus allowing the operator to carry out the operation following the work instructions based on the experience and training offered to the operator and the quality inspectors that exist throughout the process.

It was proposed to implement a Poka-Yoke system as a test phase at the beginning so that the vehicle does not move to the next work station until all the operations of fixing that station are carried out, which involves the attachment of the front stabilizer bar in suspension. In this way, the production line that moves one vehicle for workstation at every 5 minutes will be stopped at the assembly station in question, if any of the fixings have not been carried out, causing the whole production line to stop and signal to the operator, multifunctional and in charge of production that there is a problem. After performing this operation, the line will run again. In order to be able to implement an anti-failure system as proposed by the action plan, it was necessary to know more about the workstation and the technology that existed in it to elaborate a survey of the possibilities, Figure 5.

Figure5. *Application example of tool 5 Why.*

In Figure 6, it is possible to observe how the layout of the workstation was when the failures occurred:

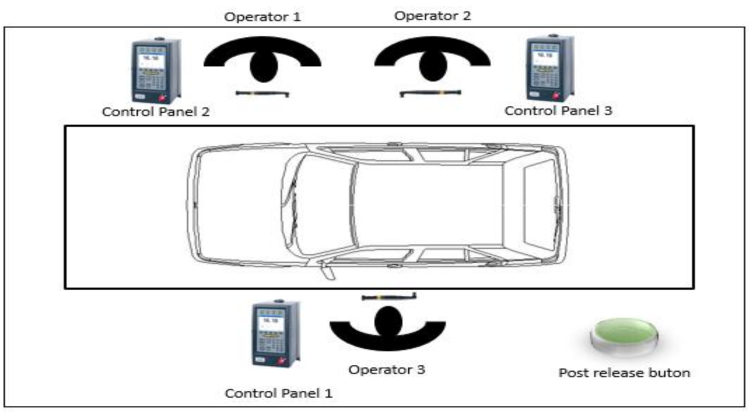

Figure6. *Alpha workstation, before the implementation of Poka-yoke [13]*

It is possible to observe that in this work station, called the Alpha station, there are 3 control panels of transducer electronic pushbuttons and a release button, which has the function, when pressed, to release a signal to the line controller (it is a system which releases the vehicle from one seat to the other). The worker only activates this button after he has finished all the operations he must carry out for that vehicle at his workstation and, if the worker does not start it, the vehicle is stopped at the station until it is pressed. This button is part of a safety system to prevent the vehicle from moving to the next position and has some worker working simultaneously with the movement of the vehicle to the next station, which can generate an unsafe condition. Portanto é uma premissa manter este sistema de liberação de veículo do posto de forma manual. The worker simply scans the vehicle's compliance sheet to do traceability of the anchorages and then picks up the squeegee of control panel 1, 2 and 3, respectively, by tightening it according to the operating instructions. The operator goes to the buttonhole and then presses the button, so that when the 5-minute cycle time is taken, the vehicle can automatically move to the next station.

However, by analyzing this process, it is possible to note that if the worker skips any of the fastening steps and simply releases the release button, the vehicle goes to the forward position and some part of the vehicle will be released and may cause disturbances in the rest of the process.

Looking further at the workstation, these control panels, which are responsible for controlling the fixations that are performed by the electronic fasteners, are capable of performing batch control and emit a signal after this batch is complete, which signal can be through a pulse. From this concept, a programming was carried out in panel 1, which defined it as the master control panel, making it responsible for emitting a pulsed signal to a 2-position switch that will be installed on the release button. The 2-way switch, installed on the release button, will be in position 1 (position that allows only the button feed by means of batch OK signal from the master control panel 1, which feeds the release button until it is activated and soon after the 2-position switch returns to position 1). This release button then loses the feed which was once continuously and is fed only when it receives an OK batch signal from the master control panel 1, which also will only issue an OK batch signal to the release button after receiving the OK batch signal from panels 2 and 3, besides performing the actual fastening sequence which is programmed for it. In other words, if the worker does not make all the anchorages according to the working instruction, the vehicle will not leave the workstation, even if the worker activates the release button and detects the operation failure at the moment it occurs, the worker or multifunctional worker completes the operation and, according to the programming of the master control panel 1, sends the signal to the key that releases the power of the release button, then it can be activated, causing the vehicle to move to the next workstation.

This 2-way switch (position 1 closed and position 2 open) is activated only by a specific switch, and may be changed only in cases of maintenance of any control panel or any incident that may occur and only who has this switch is the leader of the post and the incumbent. When this switch is manually turned to position 2, the release button is fed back continuously, that is, the condition prior to the Poka-Yoke implementation. When the switch is in position 1, it only changes to 2 when it receives a batch OK signal from the master control panel 1, feeding the release button only until it is activated just once, causing it to immediately cut feeding signal and return to position 1.

We can see in Figure 7 how the Alpha workstation will look after the Poka-Yoke implementation:

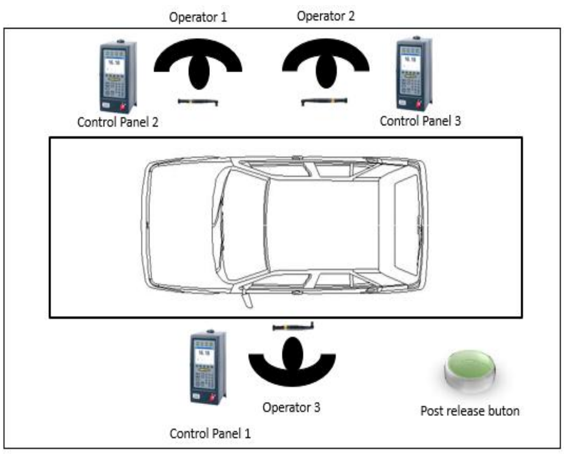

Figure7. *Alpha workstation, after the implementation of Poka- Yoke [13]*

Soon after the development of this Poka-Yoke system in the Alpha workstation, all working instructions were updated and ON THE JOB was carried out with all the employees involved.

Following and monitoring the areas, mainly Quality, should continue to verify the results of the Poka-Yoke implementation, which, as structured, will avoid any failures due to fixations in this post, tending to zero failures.

Conclusion

In virtue of the mentioned facts, the distinct quality problems that can occur in a manufacturing process, it is necessary to act on these problems, in order to reduce them or eliminate them so that it does not affect both the company's profit and its image linked to the market.

It is concluded that preventive action prevents major problems from occurring, such as recall, field action or yard impediment, for example. Moreover, a tool that enables this action is the "Poka-Yoke" anti-failure system that allows to eliminate/ detect that defects, mainly operational failures, will occur/impact the production or the various customers along the production chain.It is necessary to have an entire planning, with action plan, schedule and technical staff, and investments to develop and implement Poka-Yoke in products and processes, even in view of a cost that may be high, depending on the technology used, but it is understood that it is a cost of quality, which is preferable to having a relatively higher cost when compared to the costs of non-quality related to rework, parts scrap, recall, among others and besides always seeking compliance with the specifications, requirements and satisfaction of final customers.

The application of Poka-Yoke in the case study was of extreme importance for the company, since a totally robust anti-failure process was elaborated, which eliminated 100% of the operational failures related to fixations performed by the electronic pinchers of the Alpha station, since it had recurrence of operational failures in a period of less than 7 days and that worked with a plan of action until arriving at the solution that was to implement the Poka-Yoke in the alpha post. The cost of implementation was very low, since the existing facilities were used, as well as 100 m of wire and a 2-position switch and labor of the process engineer, programming technician and maintenance (all resources of the same company), a relatively lower cost than if a bid was launched to implement another anti-failure system, which would be effective in the same way but at a much higher cost.

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