Reduction of defective products by empiric analysis: the production line case in a factory of automotive parts.

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Abstract. As all massive line production, in the production line under study, exist the possibility of produce defective products, so like all companies based in continuous improvement, it wants to know all the facts about these defective products, for example, how many are they? in which areas do they arise? Why do they arise? And among other questions, in order to suggest and implement some solution alternatives.

1. Introduction
This paper was made in a manufacturing company of harness for the automotive production, located in Hermosillo, Sonora, Mexico. Through this study, we will see how some data of defective products can lead to the root cause. To clarify, the data provided in this paper, was generated during 28 weekends, the 4 lately weeks of 2015 and the first weeks of 2016.
On the other hand, an empirical analysis will help us to find the problematic root cause, because empirical analysis is a scientific model of investigation based on observation and experimentation [1]. Moreover, a defective product is when it does not meet with the standard characteristics established by the company [2], and a defective product is considerate as the main kind of west [3]. In the company under study the defects can be classified by 44 types, however, there are someone that are more important than others, for example, the three main defects are: Lock open, exposed filaments and no hipot point. Figure one shows a graphic of defects, where it can be observe that the defects mentioned before are the most important.
Through figure one we can observe that the defect named “Lock open” it’s the one that generate more defects, however, we can know how the defect is named, but, do we know what is it? This is fundamental to propose solution alternatives.
2. Backgrounds

To understand what is “Lock open” is necessary mention the main components of a harness. A harness is composed of 4 main components: The cable, sub-assembly, housings and locks. For a harness function in the correct way this component must work as the following way: The sub-assembly is adhered to the cable, one time adhered, the housing is assembled in the sub-assembly and finally the lock is stuck in the housing to avoid that the sub-assembly get separate from the housing (Go to figure two).

When a lock does not get down until the housing is safe, the “Lock open” appears (go to figure three).

One time defined what lock open is, it identified in what product (part number) it comes frequently this kind of defect. The part number with more “lock open” are show in the figure 4.
The figure above show us that the part number 1832195-5 with 229 defects, it’s the one that more lock open generate. To understand better the defects nature of this product go to the figure 5(a), which is a pie chart that show the kind of defects and their percentage.

Figure 4. Lock open by part number (Own elaboration, 2016).

Figure 5. Kinds of defects of the 1832195-6 part number (Own elaboration, 2016).
In the figure 5(b) we can realize that of 229 defects shown in the part number under study, the lock open represents the 44% whence, it’s considerate the principal factor to cause defects in this part number. This numeric data made us research closely about this defect, particularly in this part number. However, despite the analysis done until this moment, some questions arise: The lock open is already something of the past? Why this defect happens? And, is it a defect that will be more frequent?

3. Analysis and discussion

In order to initiating the analysis, it has been created a time chart, which it shows Parts Per million (PPM) of lock open defect, starting from de week number 50 of 2015 year, and ending at the week number 24 of the 2016 year, moreover, to the time chart it has been added a trend line, that displays the growing data.

It is worth to mentioning, the missing weeks in the chart above, it´s because there was not an inspection of that part number, because there was not production that days. During the problematic analysis, it questioned the way that the operators did the assemble between the housing and the lock. To the operator can do this assemble (in this part number in specific), is necessary that the operator wear bandage in their fingers. However, to produce others part numbers this bandages are not necessary.

In a quick talk with the operator that produce this part number (1832195-6), all of them agreed that the lock for this part number is more difficult to assemble than others, moreover, because of this kind of lock that it came a 90 grades clip, made the cable bend 90 grades (go to figure 6).

![Part number with normal lock vs Part number with 90 grades lock](image)

**Figure 6. Normal Lock vs 90 grades lock (Own elaboration, 2016).**

The operators supposed that for this kind of assembly they need more force in their finger. It made an experiment in the own company lab of metrology. The experiment consisted in realize three times the assemble with a force gauge. The first time, it was made with no cable and, only the housing and a normal lock. The second time was made with cable, normal housing and the lock, and finally, the last experiment, was made normally: cable, housing and the 90 grades lock. The results of these experiments are show in the table 1.
Table 1. Experiment results.

| Assembled with                  | LbF (Pounds strength) | Comments                                      |
|---------------------------------|-----------------------|------------------------------------------------|
| Housing and lock                | 8.06                  | Any part numbers go with this assemble        |
| Housing, lock and cable         | 13.28                 | The most of part numbers (except the under study product) the assemble is like this. |
| Housing, cable and 90 grades lock | 54.28               | In this way is how the part number under study is manufactured. |

4. Conclusions
Based in the figure 5 we can say that the lock open quantity in the part number 1832195-6, it will rise according with the trend line. Hence the importance of attack this kind of defect. In other words, the lock open is going up, moreover, is one of the most common of all kind of defects in the production lines in the company under study.

According with the table 1, the difficulty of this kind of assembly is because of 90 grades lock. The same table shows a big gap between the LbF used in the assembly with a normal lock and the other one assembled with a 90 grades lock, therefore in this part of the analysis we can realize that the 90 grades lock made the assembly more difficult, however, this component (90 grades lock) it can’t be removed of this part number, because is a request of the client.

To avoid this type of defect, the authors decided to implement a fixture that helps with this assemble. This fixture is intended to be a semi-automatic, this in order that the operator just put the components into a fixture, and it active a sensor (or a button), and the fixture would do the task currently made by an operator. By the implementation of this fixture we will avoid the fingers weathering of the operators, and by this way we care the health of these. Furthermore, the quantity of open locks it would significantly reduce, because of the fixture would do this operation, so the process variation drops, according to the settings of the fixture, which are manipulated by the engineering team of the company.

Finally, we conclude that an empiric analysis can help to solve a problem from the root, or well, it can let find the problematic from an unfavourable situation, moreover, trough by the same analysis find the solution.

References
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