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Analysis Of Scrap In The Packaging Process Of A Packing Company

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***Abstract* — The objective of this study is to perform an analysis of the scrap within a company dedicated to the packaging of condiments and spices, to perform this task the statistical tool of control chart was implemented. The results obtained demonstrate how different interventions within the packaging process affect the quality control of their finished products and raw materials.**

Keywords—Control letter; scrap; packaging.

I. Introduction

Quality is one of the main pillars in the manufacturing industry, one way to measure quality is through the detection of scrap in the manufacture of products, the higher the number of scrap, the lower the quality of the products that are manufactured. In the industrial context, it includes all waste and/or residues derived from an industrial process [1]. The generation of defects affects organizations externally through customer satisfaction and internally, it has an impact on the increase of costs, extra time in rework and discarded material because it cannot be reworked.

The world market for condiments and spices is one of the most competitive markets in the food sector and is projected an annual growth rate of 4.7% in 2025 [2]. This is why it is necessary that the quality of these products is administrated through various planned activities so that the quality requirements of the products are achieved [3], statistical process control is one of the most widely used quantitative tools for problem solving, it helps to stabilize and improve the process by visualizing and reducing the variability that exists inside the processes [4].

The main purpose of this research work is to analyze the scrap in the packaging process of a company specialized in condiments and spices in order to help the company reduce scrap costs in the packaging process. For this purpose, the statistical tool called attribute control chart was used to observe the control of the raw material packaging process.

II. Literature Review

Statistical process control can help to optimize the quality of the processes of any organization as presented in the work of [5] within which was carried out through a search in different databases, concluding the improvement of the performance in the processes and the increase in customer satisfaction through the use of statistical tools. Statistical control charts are also used to measure the variability in any process, helping to optimally identify changes in the process. In the study conducted by Vega et al. (2018) [6] where they apply these tools for monitoring the weight of soap bars, and by using the EWMA chart they truthfully identified the primary causes that disturbed the process. Through the quality tools, a failure analysis was performed in the production process [7], which was carried out through data collection for the analysis of attributes by means of the P chart. Likewise, the graph was used to show the control and process capability as shown [8]. Currently, a variable can be measured by means of univariate statistical control charts, however, the increase of variables to monitor has caused the transition to a multivariate statistical process control as in the case of the study shown by Juventino et al. (2018) [9] where they perform a statistical measurement of more than two variables obtaining a more robust process, identifying out of specification points in a simpler way.

Given the variability in the amount of production, the amount of sample regularly tends not to be always equal, for such cases it is necessary to use the P chart, as described by Perez et al. (2021) [10], where using this chart in conjunction with other tools achieved the reduction of 50.74% of defects and the reduction of the probability of manufacturing nonconforming products to 0.86%. Ata et al. (2020) [11] use the P control chart to detect the process under control and can observe that quality improvement is needed because most of the points are below the mean line. Another feature of the Laney P control chart is that it is used to detect patterns, magnitudes and frequency as demonstrated by Essam (2019) [12] finding the frequency and magnitude of epidemic outbreaks in the United States.

III. METHODOLOGY

The first step for the development of this study was the collection of scrap data from the company to be analyzed, in this case a packing plant dedicated to the sale of seasoning and spice strips. The next step was the development of a diagram that showed in a general way all the stages within the process that was analyzed in order to identify the stages of the process where the greatest amount of scrap is produced.

A. *Packaging Process*

The packaging process of condiments and spices is done manually using only a special machine for sealing the bags in which the raw material is packaged, the task of packaging is performed by 5 people who are responsible for moving, weighing, sealing, assembling the strips and storing the raw material required by the customer. Figure 1 shows the flow diagram of the process in which it can be seen that there is a section of the process where there are losses of raw material, which are the ones that concern us for this work.

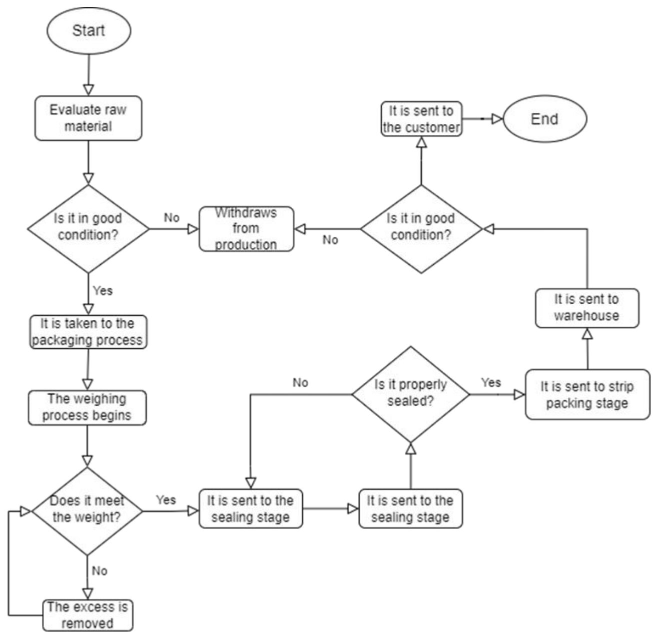

Fig. 1. Flowchart of the process of packing spices and seasonings.

Once the data had been collected and the entire raw material packaging process had been identified, the control chart was prepared.

B. *Elaboration of the graph p with n variable*

For the elaboration of the control letter P, it is necessary to follow a series of steps which are reflected in the diagram of Figure 2.

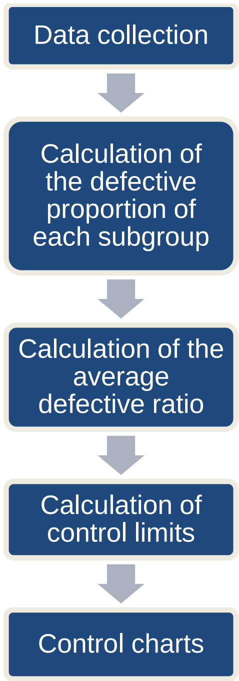

Fig. 2. Example Diagram for the elaboration of the control letter P.

According to the previous diagram, the first step consists of collecting the data, which were obtained with the help of the personnel in the company's packaging process, where scrap records have been kept since 2014. Once the data were obtained, the subsequent calculations were made.

In the following formula (Eq. (1)) is shown for the calculus of the defective proportion.

$$p_i = \frac{D_i}{n_i} \quad (1)$$

pi = defective ratio per subgroup.
Di = Number of defective parts per subgroup
ni = Sample size (variable).

Then the calculus of the average defective proportion is obtained (Eq. (2)).

$$\bar{p} = \frac{\sum_{i}^{k} D_i}{\sum_{i=1}^{k} n_i} \quad (2)$$

Di = Number of defective parts per subgroup.
ni = Sample size (variable).

Finally, the calculation of the control limits is performed using Eq. (3-5).

$$UCL_p = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \quad (3)$$

$$CL_p = \bar{p} \quad (4)$$

$$LCL_p = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \quad (5)$$

Laney P-chart control charts are useful for checking the defect rate in a manufacturing process when the data are too dispersed, since this situation causes the normal points of the P-chart to increase beyond the control limit, indicating an insufficient warning. If the fraction of damaged units is assumed to be binomially distributed, a dispersion greater than the upper confidence limit is considered evidence of overdispersion in the data [13]. To perform the P Laney plot, steps of the diagram shown in Figure 2 were followed with some additional steps and modifications in the formulas used [14]. First, the calculation of the defective ratio is performed with the help of Eq. (1). Then the average defective ratio was calculated using Eq. (2). Unlike the normal P-plot in this one the calculation of the scale for each of the observations is added (Eq. (6)).

$$z_i = \frac{(p_i - p)}{\sqrt{\frac{p(1-p)}{n_i}}} \quad (6)$$

Next, the absolute amplitude range is calculated for each of the observations, for this purpose Eq. (7) is used.

$$AM_i = |z_i - z_{(i-1)}| \quad (7)$$

Then the calculation of the estimate of the standard deviation for the limits of the graph is made, which is given by Eq. (8).

$$\partial z = \frac{\overline{AM}}{1.128} \quad (8)$$

Finally, this estimate is multiplied by the upper and lower limits of the graph to obtain a larger spectrum of data dispersion.

IV. Results and Discussion

In the first instance, the control chart was built by attributes of type P with the registered defects of the company in the last 7 years, since it was required to measure the proportion of defective units (scrap) that the company was repotando in order to observe if the process is in control. Fig. 3 shows the result obtained from the control chart p for the data obtained from the company.

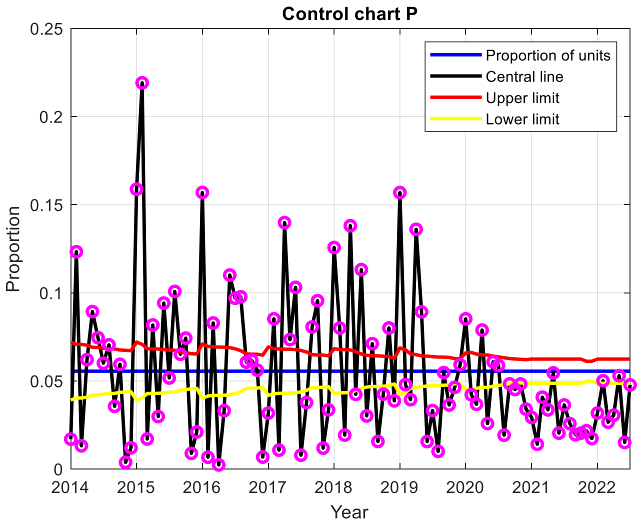

Fig. 3. Result of the control chart by P attributes.

Since most of the scrap data is overdispersed, we decided to use a control chart of the p-Laney type to identify the control within the production lines shown in Fig. 2 and facilitate the analysis to find possible causes of the reported defects. Fig. 4 shows the result obtained from the control chart P Laney.

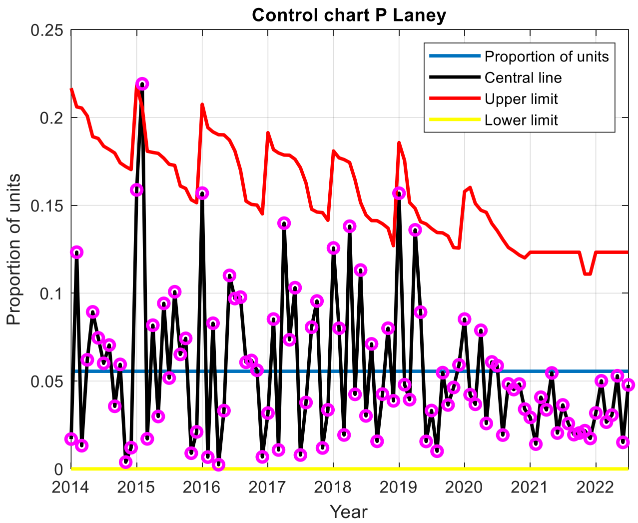

Fig. 4. Result of the control chart by attributes P Laney.

V. Conclusions

The objective of this research was to analyze the losses that exist within the packaging process of condiments and spices. In order to achieve the proposed objective, a flow chart of the complete packaging process was first made, where it was discovered that the processes of revision of the raw material and the storage of the seasoning and spice strips are the stages in which the loss of merchandise within the company is found.

Also according to the data obtained in Figure 4 shows that there is only one data that is outside the control limits, it was determined with the data collected and with the help of the workers in charge of this area that this is due to the overproduction of merchandise that in 2015 exceeded the demand that existed in the market at that time and the problem arose within the warehouse since there was no inventory rotation and did not meet the quality standard that the company manages.

The analysis of the control chart shows that over the years the control in the packaging process has been decreasing its variability, in the middle of the year 2020 until the records of 2022 shows a sudden change where all data fall below the average, this is due to a change of personnel in the packaging area and that more attention was paid to each of the stages in the process. The over-dispersion of the data shown in the first years is due to the fact that the packaging process was not inspected and the only objective was to comply with a number of finished products without verifying any other aspect.

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