Elaboration of a New Packaging using the Geogebra Program Avoiding Losses and Reducing the Costs

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Abstract

The design of a packaging is directly linked to society, in its economic, social and environmental development, having influence in the entire productive sector of a company. This work has the objective of analyzing the importance of the product design, in this case the packaging, to improve the packaging and identification of the pieces produced by the company and that are inserted inside the same one. In order to reduce the number of parts that are no longer being sent or lost in transport, reduce the cost of these losses and reduce the cost of packaging. To perform the research, data were collected through interviews and visits to the company. The losses data were analyzed using the software Minitab 18 and the packaging elaborated through the program Geogebra version 6.0.498, with which it was possible to observe a reduction of 1,114 pieces, with a forecast of annual savings of 68.28%, relating with the data collected from March to August.

Keywords — *Packaging, Package, Product Design, Correlation.*

I. INTRODUCTION

Reference [1] points out that due to the high competitive growth of the market, packaging has become an essential instrument for improving production processes, reducing losses, identifying, distributing and securing products. developed properly, motivates and determines satisfactory results and advantages for the company's total production chain. Reference [2] the construction of the product design is directly related to the environment and stresses that the idea of the elaboration of a product is related to the industrial design, as from the knowledge acquired in the industrial environment appear functions and forms to products.

Reference [3], the packaging sector grew by 1.96% in 2017 compared to 2016, with gross production volume of 71.50 billion and predicted a successive growth for the year 2018. Noticing that the material most employed to pack the materials is the cardboard with 42%.

The motivation to choose the theme is related to the idea of building a packaging, emphasizing the importance of product design and for better packaging and identification of the pieces. Through this, reducing the number of losses of parts, the costs related to the packaging and related to the losses of the parts. So, by reducing costs, profitability increases, and also stressing the importance of reducing losses for the company

Therefore, due to the monitoring carried out in the company under study, it was proposed to prepare a product, in this case a packaging, to better pack and identify the manufactured parts, reducing significant costs and losses.

The overall objective of the study is to propose the preparation of a package to better serve the company, through the analysis of planning and design of products and calculations of measures of the best-selling pieces, thus reducing costs with packaging and with losses of the pieces.

The specific objectives are: to carry out an analysis of the number of pieces that are no longer sent by the company, the most sold and lost in the transport, analyze the company's packaging sector and identify the packaging used.

II. METHODOLOGY

The present study was characterized as an exploratory research, with the purpose of observing, exploring, recording and analyzing facts or phenomena not accepted, more evident in the company.

Reference [4] bibliographic research is instituted through in-depth consultations in magazines, books, scientific articles, newspapers, journals, among others.

In addition, the direct and intensive observation procedure was used, reference [5] phenomena and facts of reality are verified, placing the observer in direct contact with reality.

This research project was carried out in a small metallurgical company, located in the city of Cataguases - Minas Gerais. Has 36 years of activity producing signs, numbers and logos, having as main raw materials stainless steel and galvanized sheet. To meet the demand, the company has 28 employees and the owner of the company.

Due to the loss of parts in the company, we analyzed the main factors that can lead to such losses, so the idea of creating a packaging packaging. Although the company uses standard size packaging (80x50x40cm) to pack all types of pieces produced, from small (10x2x7cm), medium (15x2x12cm) and large (20x3x17cm), the production of this new packaging can reduce the costs caused problems, as this will provide better identification, security, information and packaging.

The piece that has more orders monthly are the letters of medium size, so the focus of the work was the production of these packages, in order to reduce costs related to the packaging used by the company and the new one that will be created. Another related cost would be freight, since the company has to pay freight when the part is no longer sent or lost.

To achieve this objective, observations were made to obtain a general analysis of the company, and the main focus of the research was the packaging sector, since there are no employees trained to perform this function and consequently do not hold correct conferences of all the requests made, so it can be analyzed that it is a sector with major problems and that needs changes and improvements to reduce the number of lost parts.

Through these observations, a company layout was designed to identify the sectors, since it was detected that there are no employees specific to the function in the packaging sector.

The instrument used was the Interview, with the company owner on May 7, 2018, containing questions to obtain clarification, assessments and data collection. In addition to information related to the movement of the company, such as: quantity of parts produced, orders flow, number of pieces that were not sent and that were lost in transportation, price list of each material, number of employees who carry out the packaging process in the company and if they are offered training to carry out the same, among others.

In addition, scheduled visits were made to the company, which took place on 05/21/2018, 06/10/2018, 07/15/2018, 07/26/2018 and 05/08/2018. At each visit, observations were made regarding the working environment, the way in which the pieces are manufactured and packed, and how the measurements of the medium size letters were made to make the new packaging.

According to the data collected and the research carried out, the new package contains a volume of 14400 cm^3 and a base of 960 cm^2 and dimensions of 24 x 40 cm of base.

For verification of the statistical process and data analysis, Minitab 18 software was used, facilitating data management, graphing and Pearson regression and correlation equations, etc. For the construction of the new packaging, the GeoGebra Classic program version 6.0.498 was used, since it relates algebra and geometry through a single graphical user interface, being possible to insert functions and geometric constructions.

In order to realize the financial forecast to reduce the cost with the new packaging, Excel Software was used.

And using the metrics of monitoring and constant observation of the process of packaging by the owner of the company, already with the implantation of the elaborated packaging and with the specific and trained employee, the data of reduction of the quantity of pieces lost was provided, and through this it was calculated using Excel 2016 software to reduce costs, on average, related to the previous months of data collection.

III.RESULTS AND DISCUSSION

A. Correlation of loss of parts using Minitab 18 software

After the interview with the owner of the company to obtain data related to the quantity of lost parts, costs of losses, monthly gross and net sales, size of the most sold pieces and packaging used by the company, quantitative.

For that Minitab 18 software was used,and the quantity of parts produced was related to the quantity of parts lost in the process (that is, the parts that were not sent together with the total order) and the quantity of parts produced was related to the number of pieces lost during transport, in order to obtain the Pearson correlation which, reference [6] seeks to calculate the intensity of linear association of one variable with respect to the other and the regression to explicit form as shown in figure 1, 2, 3 and 4 below.

Figure 1 shows the correlation between the produced pieces and the parts that are no longer sent, together with the regression equation formed by the variables. This figure 1 produced is also shown in figure 2 through the scatter plot, which indicates the intensity of the linear relationship between the variables. Figure 3 shows the correlation between the variables: parts produced and parts lost in transport and also demonstrated through the regression equation. Then, in Figure 4, with the construction of the scatter plot, it is possible to observe the adjustment and precision of the variables.

Correlation: X; Y

Correlations

Pearson's correlation	0,879
P value	0,021

Regression analysis: X versus Y

Analysis of variance

Fonte	GL	SQ (Aj.)	QM (Aj.)	Valor F	Valor-P
Regressão	1	1470542	1470542	13,62	0,021
X	1	1470542	1470542	13,62	0,021
Erro	4	431729	107932		
Total	5	1902271			

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S	R2	R2(aj)	R2(pred)
328,530	77,30%	71,63%	40,43%

Coefficients

Termo	Coef	EP de Coef	Valor-T	Valor-P	VIF
Constante	-341	416	-0,82	0,459	
X	0,1010	0,0274	3,69	0,021	1,00

Regression equation

Y = -341 + 0,1010 X

Figure 1: Correlation between the pieces produced and those that were no longer sent

The Pearson correlation coefficient between the quantity of pieces produced and the quantity of pieces that are no longer sent is 0.879 and represents a strong and positive correlation between variables because it is close to 1. The sign of each coefficient indicates the direction of the relation, reporting that if both variables tend to increase or decrease together, the coefficient is positive. The P-value is 0.021, so it is different from 0, showing a statistically very significant correlation, since the value obtained with the correlation is smaller than the maximum level of significance that is 0.05, that is, the correlation between the quantity of pieces produced with the quantity of parts that are no longer sent is less than the cut-off value of 5%. The R2 represents the percentage of variation, in this case indicates that the data are explained by 77.3% and the R2 (Aj.) Is the comparison of models that have different numbers of predictors and in this case they fit in 71.63%.

The regression equation is an algebraic representation of the regression line, assuming the linear model obtained as follows: Y = -341 + 0.1010 X, where x is the quantity of pieces produced and y the number of pieces left to be sent.

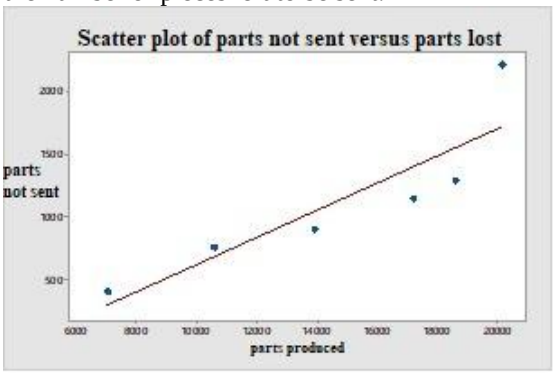

Figure 2: Scatter plot between the parts produced and those that are no longer sent

The scatter plot of Figure 2 uses Cartesian coordinates to display values from a set of data. In this case, a strong linear relationship between variables is indicated, where the relation is positive, and as one variable increases, the other one also increases, this occurs because it is an increasing function and because the variables are correlated with each other.

Correlation: X; Y

Correlations

Pearson's correlation	0,983
P value	0,000

Regression analysis: X versus Y

Analysis of variance

Fonte	GL	SQ (Aj.)	QM (Aj.)	Valor F	Valor-P
Regressão	1	8804,4	8804,42	116,78	0,000
X	1	8804,4	8804,42	116,78	0,000
Erro	4	301,6	75,40		
Total	5	9106,0			

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S	R2	R2(aj)	R2(pred)
8,68310	96,69%	95,86%	93,72%

Coefficients

Termo	Coef	EP de Coef	Valor-T	Valor-P	VIF
Constante	13,4	11,0	1,22	0,289	
X	0,007816	0,000723	10,81	0,000	1,00

Regression equation

Y = 13,4 + 0,007816 X

Figure 3: Correlation between the produced parts and the lost ones in the transport

The Pearson correlation coefficient between the quantity of pieces produced and the quantity of pieces

lost in the transport is 0.973 and indicates a strong correlation between the variables, since it means that the coefficient is very close to 1. The P-value is 0.000 showing a statistically significant correlation, the level of significance being 0.05. R2 is explained by the value of 95.86% and R2 (Aj) by 95.86%.

The regression equation obtained with the correlation between the variables was: Y = 13.4 + 0.007816 X, where x is the quantity of parts produced and y the quantity of parts lost in transportation.

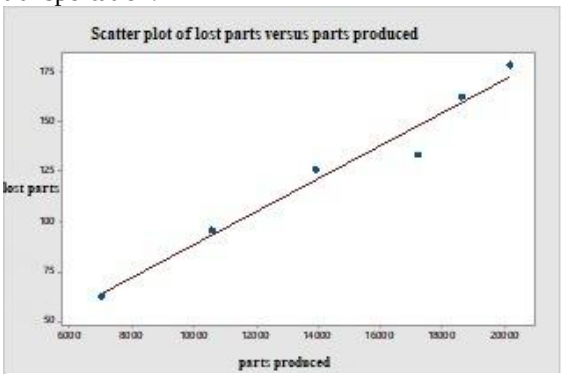


Figure 4: Scatter plot between parts produced and lost in transport

The relationship between the variables shown in this scatter plot of Figure 4 is strong and positive, and when the dependent variable y and the independent variable x are directly correlated, they increase together, that is, the more pieces are produced, the more they are lost. And it is observed that the data is adjusted and modeled with precision around the line.

B. Definition and construction of packaging in the Geogebra program

Based on the data collected regarding the quantity of parts that were no longer shipped or lost in transportation and the importance and growth of the product design, a new packaging was studied and developed for better identification and packaging of the parts, both for the company itself and for the final customer.

Considering that the best-selling pieces have a size of 12x2x15 cm in centimeters, the developed packaging was a rectangular parallelepiped box, where the pieces will be organized interspersed with cardboard dividers, as well as informative labels on the contained within the packaging.

In choosing the dimensions of the packaging was considered the measure of the most sold piece by the company. The depth of the box was equivalent to the height of the piece, that is, 15 cm, so that the customer could see all of them when opening the package.

Since the quantity of the pieces sold on average is 40 units per customer, the packaging was elaborated with a volume of 14,400 cm³, a depth of 15 cm, as previously mentioned and a base of 960 cm². By measure of economy and optimization of space, the smallest perimeter was chosen for the base, the width being a multiple number of 12 and the length a multiple number of 2, so the most convenient option was 24x40cm of base, as shown in the figure 5 and 6 below.

Figure 5 shows the assembled carton, indicating its respective dimensions. Figure 6 shows the package with its respective dimensions.

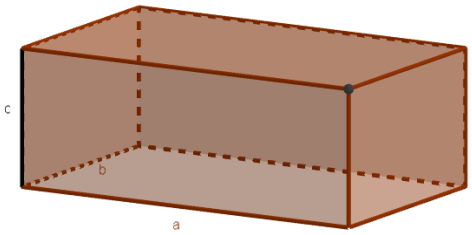


Figure 5: Packaging made in Geogebra

The graphical representation of the packaging was made in the program Geogebra classic version 6.0.498, with scale 1:10, being **a** the length, **b** the width and **c** the depth.

The steps for the construction of the Worksheet in the program Geogebra version 6.0.498, for the design of the packaging, will be presented next.

Using the 3D window:

(1º) Three sliders are created: a = length, b = width, and c = depth.

(2º) In the input field we enter the following commands: A = (0,0,0); B = (length, 0, 0); C = (length, width, 0); D = (0, width, 0). Then, also in the input field, we requested the drawing of the base polygon (ABCD).

(3º) We select the extrusion command for prism or cylinder for finalizing the prism design.

(4º) Next we determine the dimensions, in the 1:10 scale.

The packaging is with its planned representation and with its respective informative labels, for a better identification and care with the products contained within the same are being represented in figure 6.

C. Reduction of parts losses

According to the data obtained, the Company stopped sending in the period from March to April 2018, a total of 6,685 pieces, indicating 245 pieces per week and a total of 756 pieces were lost in transportation, indicating 32 per week.

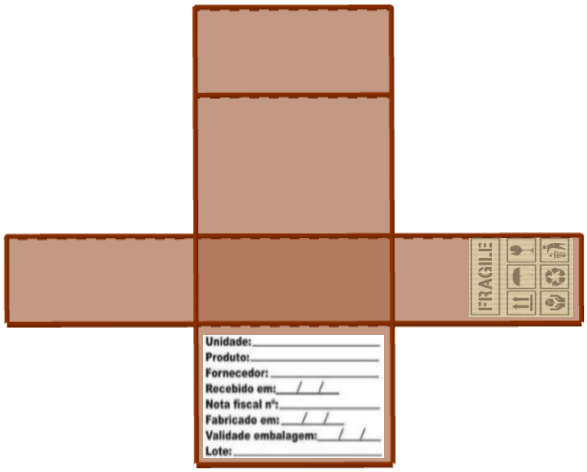
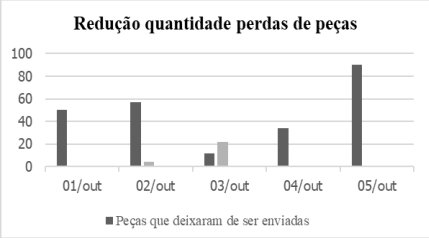


Figure 6: Planned packaging with their respective informative labels

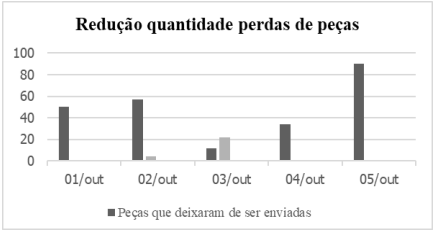
From this, with the use of the new packaging for a week, and already with the specific professional and trained for the sector, the owner of the company carried out a more frequent follow-up in this sector and obtained a reduction of these losses, as shown in graphic 1.



Graph 1: Reduction of the losses of parts with the use of the new packaging, during a week, in relation to the months of March to August.

As shown in graph 1 above and relating to the data collected, it is possible to observe a reduction, and on 03/10 the reduction of the parts that were no longer sent was higher, reaching 233. And on 01/10/10 and 05/10 were the days in which they obtained greater reduction of the pieces lost in the transportation.

With the reduction of the number of lost parts, it was also possible to obtain a reduction in the cost, on average, related to the previous months, as shown in graphic 2.



Graph 2: Reduction of costs of lost or lost parts in transportation.

The costs are related to the value of the freight, because the company has to pay the freight when they stop sending the pieces and the making of new pieces when they are lost.

D. Costs related to packaging

Through interviews with the owner of the company, it was permissible to obtain data related to the packaging used by the company, which has standard dimensions of 80x50x40 cm, and its cost is R $ 3.00 each.

So, according to the table, the average monthly savings was R $ 569.00, consequently an annual savings and an increase in profitability of R $ 6,828.12, and it could also reach an increase in profitability of up to R $ 34,140, 60 in five years, according to the forecast.

From this, with the elaboration of a new packing to cease the losses of the pieces, being that it has dimensions of 15 cm of height and 24x40 cm of base, it was possible to obtain a reduction of 56,67% (R $ 1.70) in the unit cost.

With this reduction, using the data collected from March to August, it was possible to make a financial forecast using the Excel 16 software for company savings, as shown in Table I.

Table I: Savings on the cost of the new packaging

Months	Economy
March	R$ 645,35
April	R$ 562,60
May	R$ 498,65
June	R$ 371,50
July	R$ 622,32
August	R$ 713,64
TOTAL MONTHS	**R$ 3.414,06**
Average	R$ 569,01
Yearly	R$ 6.828,12
Increase Profitability	R$ 6.828,12
Next 5 years	R$ 34.140,60

Accordingly, according to the table, the average monthly savings was R $ 569.00, consequently an annual savings and an increase in profitability of R $ 6,828.12, and it could also reach an increase in profitability of up to R $ 34,140, 60 in five years, according to the forecast.

IV. CONCLUSION

The study is of paramount importance for the company, since the packaging has the objective of storing a product in containers or wrappers, avoiding losses, with the purpose of storing, packaging and packaging products, aiming also the transportation, manipulation and storage of the same.

The purpose of the research was to analyze and correlate the quantity of pieces produced with the quantity of pieces that are no longer sent to the customer together with their total order or lost in transportation, using Minitab software. Other aspects analyzed were: if there are specific employees for the sector of conference and packaging of the pieces, if it has training, it was also identified the quantity of pieces sold and the current packaging used by the company.

With this, the preparation of a new packaging through the Geogebra Classic program was presented for possible improvements in packaging, protection and cost reductions.

The obtained results between the number of pieces produced and the number of pieces lost in the transport are demonstrated in the Pearson correlation resulting in 0,973 or between the quantity of pieces produced and the quantity of pieces that are no longer sent, result in Pearson's correlation in 0.879.

The study also analyzed the data provided on the reduction of lost parts and the reduction of costs, with the use of the packaging in the company obtained an average reduction of 1,114 pieces and a cost of R $ 5,645.10 in total, from 1 to 5 October in relation to the previous months.

The construction of the new packaging was evaluated, which presented a unit cost reduction of 56.67% (R $ 1.70).

For the study the forecast was made to increase the company's annual profitability of 68.28% (R $ 6,828.12) using the new packaging. And also the need for training, and to have professionals defined to hold the right conferences of the pieces to be packed. Another important factor was the analysis of growth and the importance of planning and designing products.

Thereby, the study is of great contribution to the company, in the reduction of cost, quality, packaging, safety and increase in profitability with the elaboration of the new packaging.

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