Available online at http://www.journalijdr.com

IJDR

ISSN: 2230-9926

International Journal of Development Research
Vol. 08, Issue, 07, pp. 21448-21453, July, 2018

ORIGINAL RESEARCH ARTICLE

OPEN ACCESS

ANALYSIS OF UTILIZATION AND CONSUMPTION OF LUBRICANTS IN A FOOD COMPANY

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ARTICLE INFO

Article History:

Received 03rd April, 2018
Received in revised form
21st May, 2018
Accepted 16th June, 2018
Published online 30th July, 2018

Key Words:

Lubrication, Pareto, Maintenance, Lubricants, Ishikawa.

ABSTRACT

Faced with the current competitive business scenario, opportunities for increased efficiency and productivity capable of placing any industry at the level of excellence in the market are necessary. For example, production losses and costs are opportunities to standardize grease consumption in any industry in Brazil, as pointed out in the literature, through the analysis of its lubrication process. From this, three main critical lines were established through the Pareto Diagram and focused on all listed actions and root causes of the problem raised through the Ishikawa Diagram, which was used in this work to evaluate the use and consumption of grease. As the research unit, a renowned food industry was used. All proposed actions were implemented and tested to verify that no malfunctions would occur. Thus, an analysis of the current process, hitherto adopted, has opened the door to several opportunities that have led to recognition of the critical lines within the industry.

Citation: Felipe Bonatto de Lima,Wellington Gonçalves, Thiago Padovani Xavier, Rodrigo Randow de Freitas. 2018. "Analysis of utilization and consumption of lubricants in a food company", *International Journal of Development Research*, 8, (07), 21448-21453.

INTRODUCTION

The competitive landscape in which companies' function makes factors other than the human one important in the production chain. Equipment failure can lead to loss of sales, as a stationary machine means a decrease or delay in production. Therefore, it is becoming increasingly necessary to improve the reliability of equipment, making it more efficient through shorter production stops (Contador 1995, Pozo 2007, Di Domenico *et al*. 2014). Reliability is related to the mach inability of the equipment, which allows an increasing availability so that production and efficiency are always optimized. A good means of increasing machinability is to invest in conservation through well-executed maintenance (Mobley *et al*. 2014). The authors also emphasize that one of the functions of preventive maintenance is the management of lubrication, which is considered a basic and traditional factor. Correct lubrication allows equipment lifeto be prolonged and ensures constant and efficient productivity.

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It is essential to understand that the function of industrial maintenance is to provide strategies to increase the useful life of machinery and reduce failures, which consequently improves both availability and operational reliability (Donald *et al*. 2002). When performed in the right quantity and frequency, lubrication increases machine availability, improves reliability, and is effective in reducing costs and increasing productivity (Santos and Sellitto 2016). Corroborant, Belmiro, and Carreteiro (2006), indicate that lubrication is responsible for reducing wear on parts because it causes an interposition of a fluid layer between two surfaces, avoiding contact between two solid surfaces and, consequently, friction. In view of the incessant search for increased efficiency and reduction of equipment failure, maintenance work in the search for efficient lubrication is the key to achieving this objective. Also, according to Branco (2008), lubrication aims to avoid the possibility of failures and to save on repairs, maintenance time, and lost production caused by shutdowns. According to Pinto and Nascif (2009), lubrication must be performed to improve operational performance, obeying primarily a previously elaborated plan based on defined intervals of time. For this lubrication plan to be clear and consistent, the processors should undertake a thorough study regarding the method, frequency, and dosage of current lubrication, recurring failures due to incorrect lubrication procedures, and which lubricant is ideal for each type of equipment, according to the temperature and operating equipment speed. Thus, in the context of market competitiveness and cost reduction, the problem of a very high annual consumption of lubricants was seen in the target company of this study and attributed to a lack of proper planning and control for this task. The main objective of the present study was to find the lubricant that represents the largest expense within the company and to elaborate a lubrication plan for the lines on which such grease is used to reduce its consumption and extend the useful life of the lubricant.

Theoretical Reference

Industrial Maintenance Process: Due to all factors present within a company that generate production stops, industrial maintenance must be well founded because it represents all the technical and administrative actions necessary to returnan item or piece of equipment to its ideal condition to perform a required action. With this in mind, according to Rosa (2006), this type of activity should avoid the degradation of equipment, production systems, and installations that is caused by the natural wear of components over time. According to Dhillon (2002) and Pinto, Xavier (2012) we can classify maintenance as either planned or unplanned. The former anticipates failures and reduces production losses, reducing cost and repair time. The latter is responsible for correcting failures and generates a production loss along with a cost increase, directly impacting efficiency. For this reason, all manufacturing plants need a maintenance plan to improve machinery efficiency and availability by increasing planned maintenance (Palmer, 2012).

Strategically, maintenance can be divided into

- Corrective: occurs when the production line has already been paralyzed due to some equipment failure that causes a fall in yield.
- Preventive: occurs according to some pre-defined criteria with the objective of reducing the probability of failure. Often there is a schedule of inspections that is generated through the dates of preventive maintenance, which include procedures, inspections, monitoring, lubrication, and replacement of parts when necessary.
- Predictive: occurs by monitoring a machine or component with devices that measure temperature, noise, vibration, and wear.

The lubrication approach within a food industry: Within industrial maintenance are many activities that must be carried out to ensure the good health of machines and equipment. Machine inspections and checks are preventive maintenance activities. Among these activities are lubrication, cleaning, replacement of parts, and tightening to avoid wear and deterioration of components (Dhillon and Neale 2001, Palmer 2012,Ungureanu,Cotetiu and Mobley 2014). Especially in the food industry, a lack of cleanliness and incorrect lubrication are determining factors that, in addition to damaging the operation of the machines, can cause contamination of foods destined for supermarket shelves. In the food industry, the importance of correct management of lubrication is great, since interferes not only in the useful life and availability of the machinery but also in the risk of contamination of the product (Gebarin 2009). According to Ungureanu and Cotetiu (2014), the lubrication plan focuses on routing; instructions on when, where and how to lubricate; and finally, on the training of the people who will perform the task. These are the basic assumptions to be made when implementing a plan to reduce consumption directed towards critical lines that use excess lubricants in their components.

MATERIALS AND METHODS

The present study was carried out in a food company in the interior of the state of Goiás, Brazil and originated from an audit of lubricant expenditures, in which an estimated consumption of around R$770 thousand was detected in 2017. This work was a field study with the objective of examining the interaction between the variables of the productive process under study and was conducted via direct observation, a method which produces more reliable results than other, indirect methods (Gil 2002, Lacerda *et al*. 2007). The objectives of this explanatory study were, in addition to recording and analyzing the studied phenomenon, to identify its causes, be it through the application of the experimental/mathematical method or through the interpretation made possible by qualitative methods (Severino2007). Thus, this work can be considered as action research, which, according to Severino (2007), is research that aims to not only understand but also intervene in the situation, with a view to modifying it. In addition, the entire study was accomplished with a pre-established goal in mind.

Data collection technique: To generate adequate information for study development, data collection was carried out by usingthe techniques of intensive direct observation, made through observation and consultation of monthly and annual reports (Kauark *et al*. 2010). The current lubrication process was observed with the aim of understanding it. The ideal process was carried out with the help of the supplier of the lubricant, which, in addition to training, provided knowledge of the correct procedure to be implemented, correcting possible errors in the current process.

Annual data expenditure on lubricants was withdrawn from the analysis of the closure of the months, and the cost of each lubricant was obtained from direct contact with each supplier. In this way it is possible to identify the consumption projected for 2017 and the expected reduction. It is important to note that the consumption reduction target for the project was set based on the months of 2016 and 2017. Finally, an analysis of the essentiality of the production lines is necessary to assign actions to critical lines so better results may be obtained during the project. With the clear objective of not spending unnecessary effort on activities that will have little or no effect, by means of the Pareto Diagram and an Ishikawa Diagram, an investigation of which production lines consume the most lubricants was carried out to draw actions with the intention of prevent difficulties (Ishikawa 1990, Tubino 2000, Slack2009).

RESULTS

As the main incentive, a goal was set in this study, which was strictly related to how much was spent on lubricants in 2016 and how much was projected for 2017, considering the first four months of the year. It is worth mentioning that the projected value for 2017 was based on expenditures during the first 4 months, projecting consumption for the whole year through a simple average. Another important incentive originated from a study on the environmental management of lubricants in an article by Tristão (2005) and Araújo (1997), in which he notes the importance of proper management of lubricants in order to avoid environmental contamination. In his study, the author points out that only 30% of all lubricants are properly collected by a licensed company. These data are directly related to the excess of lubricants inside the plant, thus to seeking to reduce the excess and at the same time protect the environment and contamination of food. As a result, the company's expenditure in 2016 is the basis for establishing the target. About R$641 thousand was recorded in 2016, and the projected expense in 2017was R$770 thousand in 2017, a very large difference of R$129 thousand. Within the study proposal and capturing 50% of this GAP is considered feasible in the context of changes that can be implemented in a large company. Therefore, the pre-established goal was to reduce the consumption of lubricants by 2017 by R$64.5 thousand. After this goal was established, we began to identify the high-priority lines to be worked on. By means of the Pareto Diagram, it was observed that two lubricants together represented almost 50% of the total expenditure (Figure 1).

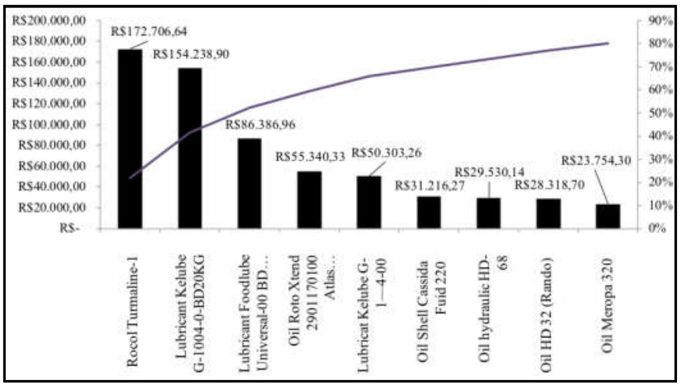

Figure 1. Pareto of the lubricants that were most consumed in 2017

To highlight the critical lines in the study, it was necessary to detect where these two lubricants were used. To reach this conclusion, a Brainstorming exercise was undertaken along with mechanics, coordinators, and supervisors. This was justified because Turmaline is a commonly used grease in two main lines:

- **Corn Stripper:** Equipment responsible for receiving the corn cob and withdrawing only the straw;
- **Corn Peeling:** Equipment that receives the corn (already without the straw) and removes all grains from the cob.

Figure 2. Photo of a plunger (A), corn stripper (B), and sealing machine (C) in the company studied

Kelubeg is used in the sealing machine, the equipment responsible for receiving the 200 grams of corn and seal them (Figure 2C). Therefore, we concluded that the critical lines for the study are theplunger, dredger, and recapper.

Definition of the root causes of the problem studied: Figure 3 shows, through an Ishikawa, all the causes that directly impact on the problem to be studied, based on root-cause analysis. In this situation, it may be noted that some of the causes are not modifiable and therefore have not been placed as a priority. The Impact-Effort Matrix (Figure 4) emerges as the tool to better manage the time allocated to each action and prevent us from losing time on low-priority activities.

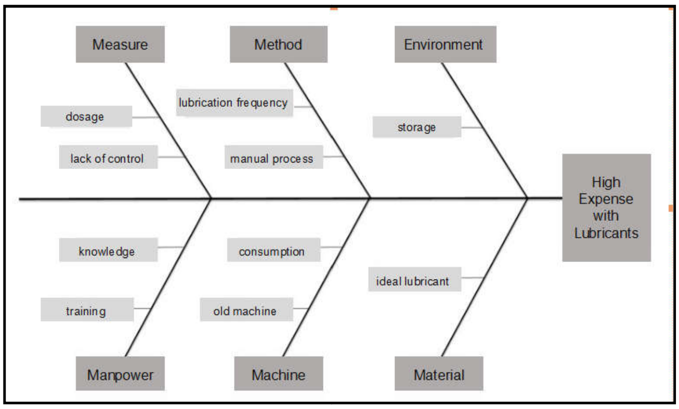

Figure 3. Definition of the causes of the problem

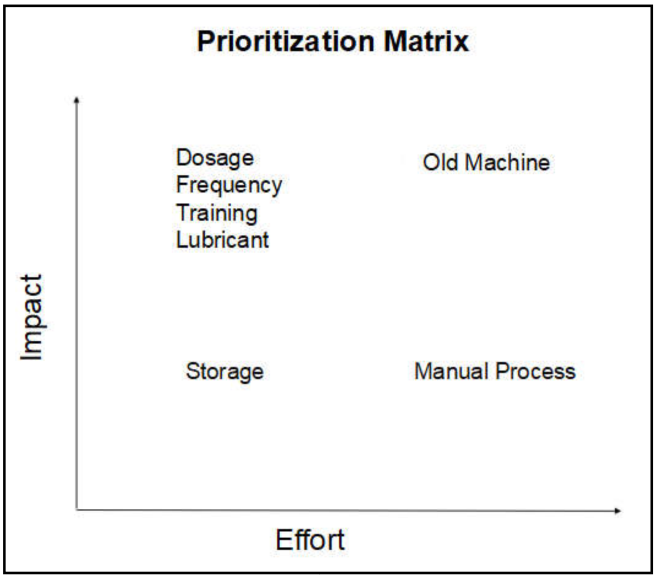

Figure 4. Stress-Impact Matrix for the causes of excess lubricants

The priorities are thus represented. It is clear from Figure 4 that the main causes that must be addressed and in which changes are attainable are the dosage and frequency of lubrication, training for lubricators, and type of lubricants to be used on each piece of equipment.

Pillars of action

Process: In view of the data obtained and the analysis performed before the lubrication procedure that was then adopted, actions related to the lubrication process were adopted for each of the critical lines.

- **Collapses:** scenario in which lubrication was carried out automatically, that is, there was a system that directed the grease to each part of the equipment for each of the six pieces of equipment, which are arranged in sequence (Figure 5A).

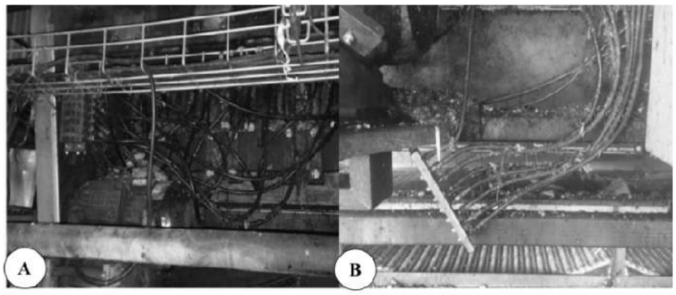

Figure 5. Automatic system / manual system implemented

Following 2 weeks of analysis, it was noted that this procedure was inefficient since the lubrication system was de-calibrated and failed. For this reason, a large amount of grease was wasted or only directed to a plunger, the other parts being unlubricated. The solution found was to change the lubrication method, that is, from the automatic to the manual system. To this end, steel plates were installed with hoses in each grease nozzle to manually lubricate each part of the equipment (Figure 5B).During a test period, it was noticed that the machinery, with the new procedure, had fewer failures than the automatic system previously in use. Figure 5A shows how lubrication was carried out previously, in which several hoses were interconnected in the automatic system and a large amount of grease was lost during the process. Figure 5B shows the proposed system with the steel plate that was installed and the hoses directed to each part that needed grease to operate. • Scrapers: For the scrapers, after studying the equipment lubrication process, we found that it was being over-lubricated and that the company was facing a very large economic loss. Therefore, with the assistance of a specialist on the subject, the frequency and dosage of each lubrication was changed. In the previous scenario, lubrication was performed thrice daily, and 15 g of grease was made available for each grease nozzle. In the proposed scenario, lubrication was performed once daily, and only 4 g of grease was used for each nozzle. With these change, there could be a negative response from the equipment, such as failures and production stop due to lack of lubrication.

Figure 6. Lack of adhesion of the grease on the harvester

To guard against this, the equipment was monitored for 2 months, and the new process was validated when no failure or stoppage due to lack of lubricant was identified.

- **Recoating:** For this change, it was identified the correct type of lubricant should be used. In the previous situation the lubricant did not adhere to the equipment, as can be seen in Figure 6; for this reason, the equipment was lubricated six times daily.

To address this problem, it was proposed that the type of lubricant be replaced (also accompanied by the supplier). The new lubricant, according to technical specifications, was consistent with the working temperature of the machine and therefore would present greater adhesion to the equipment than the old one. Predicting better adhesion, the frequency was also changed to thrice daily. For 2 months the change was also monitored, and no malfunction or lack of performance was identified.

Persons: The work of Anschau (2017), which presented a study of lubrication management, emphasized the importance of the company having accepted the changes proposed in their work because it invested in training operators. This result was concordant with the present study, since the company studied also decided to invest in further training. The second pillar of action addressed the people who were responsible for the lubrication of the factory. Firstly, training was provided for all lubricators and mechanics who had a direct impact on the process. The training was conducted on July 14, 2017, and its basic objective was to align the lubricators with the process that was being adopted to seek greater uniformity in the amount of grease used for lubrication. Figure 7 represents how lubrication was unmanned, with training being an alternative to changing this scenario.

Reaching the goal: With the central aim of reducing the consumption of lubricants, a sequence of actions and measures were taken. After the test phase and application of all the actions were completed, the results were measured to determine if any significant reduction occurred.

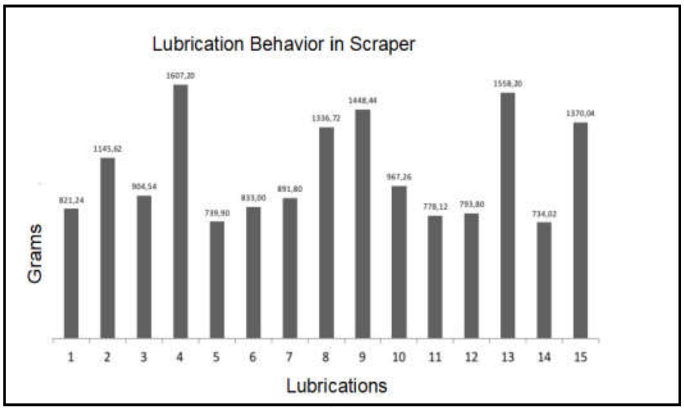

Figure 7. Variation in the amount of grease used by different people performing lubrication on the same lubrication points

Figure 8 represents the reduction in grease used for each of the critical lines, both in Rea is (R$) and in the quantity of grease. The initially stipulated target of R$64.5 thousand was exceeded, and the result for annual reduction of lubricant consumption reached R$102 thousand.

Equipamento	Cenário Anterior (KG)	Cenário Proposto (KG)	Savings em graxa (Kg)	Savings em R$
Despalhadeira	170	129.6	40.4	R$21,335.29
Desgranadeira	78.7	38.4	40.3	R$21,388.24
Recravadeira	50	50	-	R$60,029.41
REDUÇÃO				R$102,752.94

Figure 8. Reduction in the quantity and cost (R$) of grease for each critical line

Lubricant monitoring costs: To evaluate the results, we used the quantification method of Anschau (2017), which is concerned with analyzing the scenario before and after the implementation of the results. This shows the relevance of the topic of lubrication management within the manufacturing scenario.In the consumption reduction scenario, more rigorous monthly follow-ups began, as we compared month-by-month all that the company had spent on lubricants to more rigorously control costs. It is also noted from Figure 9 that since the beginning of the project's execution in February, we have already begun to compute a significant reduction when compared to the March expense.

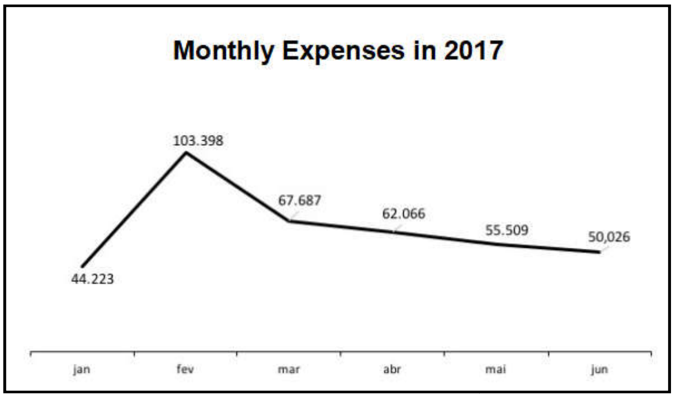

Figure 9. Monthly monitoring of lubricant consumption in the company studied

The entire lubrication process that was conceived and implemented was computed in SAP so that all service orders related to lubrication for these critical lines were already released with the changes proposed by the study. In this way, it is impossible for all work done to be lost.

Fluxogram to analyze excess of lubricants: Seeking new opportunities to reduce consumption, a procedure has been created that follows the logic of a step-by-step solution to the problem. In addition to being used in the aforementioned study, the flowchart created, shown in Figure 10, facilitates decision making since it is a graphical analysis tool of great utility to diagnose and aid in the restructuring of processes. According to Slack (1999), the act of recording each stage of the process quickly brings out or facilitates the identification of disorganized flow. For this reason, this flowchart was created to encompass all stages of the process of analyzing the consumption of lubricants within the company. In this way, it is easier to analyze improvement points and bottlenecks to better identify what actions should be taken to address the problem in question.

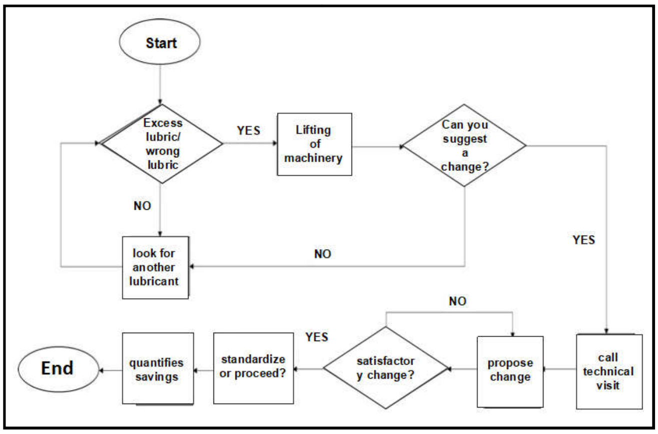

Figure 10. Excess lubricant analysis flowchart on the production line

Final Consideration: We observed that the company needed emergency actions to contain the high expense of lubricants. These actions were simple but generated significant results. In view of the above, a simple analysis of the current situation of the process hitherto adopted has opened the door to several opportunities that have arisen during the study, opportunities that lead to recognition of the critical lines, that is, those that represent higher grease consumption, which culminated in assertive work to alleviate the problem. In the context of action research, the study was enlightening, since analysis of the whole problem lead to implementation of actions and practical observation of the results. In the flowchart that serves as the basis for future work, it is evident that the project followed a logical order so that no action, analysis, or data would be lost. The main legacy of the study is the implementation of a new lubrication process that brings benefits not only to operators but also to the company, which sees reduction of expenses and new opportunities for internal investment. Finally, considering the initially established goal and the "step-by-step" plan of action, up to the point where the results are consolidated, the project can be considered a success. In addition, since all the work was focused only on the most critical lines, as it would not have been feasible to reach all the lines of the plant, there is still a lot of opportunity and much to be achieved regarding the reduction of grease consumption.

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