The effects of machine maintenance in productivity of a disposable cups industry

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Abstract
This research aims to increase the productivity of a disposable cup industry by maintaining their machines. The main findings are reducing setup time and the amount of downtime, and increase the speed of cups production machine.

Keywords: Manufacturing Operations, Maintenance, Increased Productivity, Reducing Setup Time

INTRODUCTION

This survey was conducted in Bonoplast industry, disposable manufacturer. The study is a pesquisação was identified as the current situation, made propositions and compared the data after the intervention of the researcher (Yin 2015). Knowing the equipment stop reasons was the key point for decision-making, another point was the relevance of the issue when it identifies the loss of production due to the stop.

This work is justified because it is understood that the equipment needs to work at its nominal capacity as long as possible and thus proactive maintenance will be a major factor for this.

METHOD

Case study action research using the problem-solving method (Campos 2004). Was chosen this method of research was raised as the current situation of the company, then we made some interventions and then collected the results.

Industry has found a disposable cup production system and disposable plates with some characteristics: the production of approximately 50,000 cases per month of which did not have all the mix of products in stock, in the industrial park had some stops machines for lack of spare parts, maintenance was only corrective and usually removed parts from another machine to maintain a functioning, people were discouraged and with a very high rate of absenteeism, the productive sector had a goal and people did not know that he had to produce in the month, this was the initial scenario of the industry.

The engine producing 180 ml glass with the smaller cycle than 25 beats per minute, each beat with 70 cups produced being that lack of adjustment in the mold always lost 2-3 glasses a hit, the stock keeping unit (SKU) of 180 ml glass is 25 box sleeves, each sleeve 100 disposable polystyrene cup units each weighing about 4,200 box (four kilos and two hundred grams). Importantly, the nominal capacity of the equipment is 30 cycles per minute and the Brazilian benchmarking in an industry in the south of the country is 33 cycles per minute.

The engine stop control and quality were carried out manually making it difficult to tabulate the data and monitoring of improvements, much time was lost to get up the information thus causing a lot of rework.

Had a cooling problem of water conformadora term, Teresina is one of the hottest cities in the country and in the afternoon had been a reduction in production due to the water that heated and could not manage to keep the cooled system, was a single cooling system with a chiller for extruzoras and termoconformadoras.

Was often the termoconformadora stop due to lack of air, ie the compressors could not handle the need for air to all installed equipment coming to choose which machine will work and what will stop.

There was a mismatch between the the production and sale which caused an inventory swing and a lack of regularity of the mix of products, in other words, the production was a product that the sale was not needing another time not delivered the request for lack of product. Did not exist in the factory process a regular meeting production planning, or lack of communication between sales, production, financial and human resources this problem entailed several others such as box strangulation about to make urgent promotions to meet the need of the company's cash which usually caused a drop in profitability; the company's profitability causing the need for a capital contribution of other group companies to supply the gap of working capital; some both production line of products lacking in stock sales area decided to withdraw from the price list which prevented the sale of this product.

In the production of the coils had another feature that was stopping the extruzora, ie the three equipment only one was working and the other two were standing what characterized an installed capacity to spare in the industrial park.

In the extrusion process the raw material is mixed in a mixer resin like an animal feed mixer where it joins the resin with pigments and perforated chips. The chips are stored in cilos and is not heavy which causes spare fault or shavings. The chips are not separated by colors (two colors - black and transparent), which causes an increased consumption of resin for the manufacture of clear product. After this process involves the extrusion itself and two points of the first controls the thickness off the extruzora and then the finished coil was heavy on a scale where the employee put the coil of approximately 1.5 tons in the chisel on the scale to check the weight.

THEORETICAL

The study by Assis et al. (2015) says that any kind of industrial process is necessary to take measures for the proper functioning of equipment in order to reduce equipment failure and undesirable stoppage of production. These unwanted halts in production are seen with a burden on company finances, as it implies production loss. Maintenance is one of the ways used to solve these problems.

Petronius in (Martins 2015) says that the maintenance facility aims to keep them operating in conditions for which it was designed. Today within a modern concept seeks to adopt the principle of zero breaks. Basically there is a corrective, preventive and predictive maintenance. The first seeks to correct, restore, restore productive capacity. The second aims to perform work such as spare parts, oil, grease, cleaning, suggested in the manufacturers manuals. Since the last aims to monitor certain parameters to anticipate the identification of a future problem.

Goes on to say that TPM - Total Productive Maintenance is an innovative concept Japanese, the origin dates back to 1951 and consists of zero failure or zero break. The TPM is supported by three fundamental principles: improving people, improvement of equipment and overall quality. The TPM speaks of 6 large losses: Breaks, adjustments or setup, short breaks (idle time), low speed, poor quality, losses on start-up. Barrozo (Sousa 2012) adds the concept of proactive maintenance would be the shop-floor workers to work doing preventive maintenance. Can adopt various maintenance policies among them:. Preventive, more machines with less use, operator training, sturdy design, maintainability and serviceability, size of the maintenance crews, bigger stock of spare parts and equipment redundancy (Martins 2012).

Importantly, this research work appears a lot to consulting work, has some features of the external consultant that resemble the researcher, one of them is impartiality is not involved in everyday life, the other is the question of capacity (Oliveira 2015) and that's what happened in practice the production manager believed that production was at a satisfactory level however could be improved as the work reveals this change such as the cycle of 25 to 30 cycles per minute.

Manage is to measure only manage what you can measure (Campos 2004). The first step in good management is the reporting of anomalies by the worker and sequence the record that failure by the production supervisor for the manager to work with the troubleshooting method.

In Table 1 it is shown the types of work performed by each function within the organization. It is observed that in routine management with anomaly situation, the worker reports, records supervisor and supervisor along with manager comes and identifies the root causes to solve the problem by changing the process. In the company under study we observed the unmanaged routine anomaly occurrence of the event.

Table 1

FUNCTION \ SITUATION		NORMAL	OCCURRENCE OF ANOMALY - WITH ROUTINE MANAGEMENT	OCCURRENCE OF ANOMALY - WITHOUT ROUTINE MANAGEMENT
MANAGEMENT	DIRECTION	Establish TARGETS that ensure the company's survival from the strategic plan. Experience	Establish TARGETS in order to correct the "Current Status". It comprises the "Current Status Report"	Unaware of the "Current situation", do not know the real problem, believes it's okay.
	MANAGEMENT	Achieve TARGETS (PDCA). Training supervision function.	Makes once every six months the "Current Status Report" to headship. Eliminate the chronic anomalies, acting on the fundamental causes (PDCA). Review periodically the anomalies, detecting chronic abnormalities (Pareto Analysis). Check daily the anomalies at the scene, acting as a complement to the supervisory function..	Gets irritated with the error, speaks foul language, threats dismiss the subordinate, personally goes "to solve the problem", has no data to analyze, does not investigate the causes. Often conceals the error of direction. Always want to find a culprit.
OPERATIONAL	SUPERVISION	Verifies whether the operation function is fulfilling standard operating procedures. Training operation function	Record the anomalies and report to the management function. Conducts the anomalies analysis, attacking the immediate causes (p.ex.:has been the standard met?))	Reports to management function and no records. Simply speaks.
	OPERATION	Meets the SOP - Standard Operating Procedure.	Reports the anomalies	Reports the anomalies

Source: (Fields 2004) Adapted by the author.

THE PRODUCTION PROCESS

The initiation of the process begins with the arrival of the raw material which is stored and transferred to the production area by production order, the first phase is a mixture, in an ordinary mixer is placed in suitable proportions all components to be extruzados. The extrusion process consists of merging evenly resins and then form the coil, this step starts the inspection process to measure the thickness with a micrometer and the weight on the scale. The coil after is ready in a stock Product intermediary process until prompted by the following process which is the term conformation. The term conformation is where the glass takes the form of glass, the process consisting of heating and conformed in a cooled mold with water. Then will be packed in packages of 100 units to 25 100 units packages correspond to a SKU that is a disposable glass box 180 ml weighing approximately 4,200 kilograms and four hundred grams. After following packed for the stock, then for shipping, logistics and customer.

The company has a quality management system requirement Imetro, all products are standardized and has a technical specification required by law. In this management system frequency and the amount of collection is set to be gauged, that is, every time it collects a sample of 5 sleeves (100 units package) to give the amount in the sleeve also compares the weight a glass and 100 cups to ensure the quality of the final consumer. Failure to comply causes an opening of a report of non-compliance and has the power to stop production until the problem is resolved.

RESULTS AND DISCUSSION

At baseline speech of the management of production was that it would not be possible to modify the speed of gear with the investigation met in manual speed recommended by the manufacturer for 30 cycles per minute, then to research the companies of the same segment in southern Brazil found a plant with the same equipment model with a 33 cycles per minute. Was then asked after the maintenance actions implemented increasing speed managing to reach 30

cycles per minute, this represents a 20% increase in production. Total production came to 50,000 boxes to 60,000 boxes at an average price of R $ 40.00 (forty reais) each box is R $ 400,000.00 (four hundred thousand reais) per month of revenue that makes a total of about 4 million and eight hundred thousand reais over revenues per year. All results of this undoubtedly was the most relevant for disposable cups industry.

The engine stop control was once noted in a manual form, that is, on paper, happened to be in the form online in Google Drive and shared with the charge, manager and directors where everyone can check in real time the engine stop control. With this control model rework are eliminated to raise the data to build a chart report. This control still caused an improvement of information for maintenance of equipment. The same control mechanism has been deployed in the quality control being registered all the data of the samples and their anomalies.

The cooling water used to cool the molds of thermoforming was solved with the acquisition of a heat exchanger for the extrusion cooling system and the full separation of cooling thermoforming, with this measure was eliminated 100% of the charts for failure of cold water in the mold. This was one of the measures required investment by the company.

Lack of compressed air that was constant in the industry study was solved with a measure of simple corrective maintenance, it was exchanged all compressed air hoses of the equipment and made a correction of leaks across the board by placing thread sealing in connections. Important to remember that the company does not have a maintenance system assembled and documented that cause periodic exchange for some items according to the manufacturer's instructions for each component of the equipment in accordance with the life thereof.

The gap between sales and production was naturally being resolved as the maintenance guarantee production. This more systematic production caused an increase of the produced quantity of each item, was working a standard mix based on the history and production capacity. Important to remember that it was not produced transparent line for lack of "time" and then these actions in maintaining it was possible to complete the entire mix of transparent. Also it was systematized a weekly planning meeting where production managers are called, purchasing, logistics and finance to ensure the production and sale. In the period under review came to produce 70,000 boxes where the historical average was 50,000.

Increased production in the thermoforming caused a greater demand for coils of extruzoras going to connect the second device thus reducing idleness them.

As can be seen many of the solutions found by the researcher were implanted with significant results are however some suggestions were not followed such as deploying a 100% weighing system of the raw materials in the mixing process, automatic system analogous to a feed industry ensuring the proportion of the product structure; weight control system in each case with a flow balance at the end of the production process ensuring the amount of sleeves in the packaging and by checking the proportion of the product having the structure; Use of a jumbo car in thermoforming it further reduce machine setup time, the use of a slitter is currently necessary to lift the coil.

CONCLUSION

In this study it is concluded that the effects of maintenance on the productivity of the factory of disposable cups are relevant and direct. The results were significant for the pesquisação the machine speed was 25 cycles per minute for 30 cycles per minute, the stops generally was

reduced. Stop by reason of lack of chilled water was completely eliminated with the purchase of a heat exchanger for extruzora and separation of the estruzora cooling system with conformadora term. The stop for lack of compressed air has been resolved without the compressor purchase, with exchanges of hoses and leakage was sufficient to remove the stops from lack of air. The troubleshooting method was fundamental for getting the root causes of each problem and act correctively.

What was striking in this work and the relevance of the time, every second production is a lot of money in the final revenue and consequently the financial results of the organization, in the specific case every minute chart is R $ 33.60, ie at a time stop R $ 2,016.00 for lost revenue, time is an element that can not stock. Another detail is found that these values refer to only one studied machine, the lack of revenue can be placed even greater when the other equipment of the organization.

The result of this research can be seen that the maintenance can improve the productivity of any industrial company as it reduces the machine stop and extends the life of the equipment.

It can be suggested for future research in other industrial enterprises to verify the efficiency and effectiveness of maintenance relating to the productivity increase.

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