American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-8, Issue-5, pp-109-114
www.ajer.org
Research Paper Open Access

Development of Maintenance Plans Appropriate to Plant Assets and Creation of a Spare Parts Database

Alex Pscheidtand Diego Alves de Miranda
Department of Mechanical Engineering – University of the Region of Joinville, UNIVILLE
89288-385, São Bento do Sul, Santa Catarina, Brazil
Corresponding Author: Alex Pscheidt

ABSTRACT :*The area of industrial maintenance is constantly evolving and more and more are looking for effective ways to have the maximum yield and availability of the assets. This article presents a model of application of maintenance strategies based on what is currently applied in companies in the timber sector. It was reviewed the assets installed in the field and created a reliable database to elaborate the plans of maintenance and programming of the activities necessary for the conservation of the same ones. For this it was necessary to understand the entire process of manufacturing MDP panels and to determine the level of criticality to each asset that is part of the process. Based on the stopping times, break history and degree of criticality, the maintenance plans of the glue injection area, which was responsible for most of the line stops, were elaborated, a minimum quantity of spare parts was determined which is necessary to be in stock to ensure the reliability of the process, it was also possible to standardize some of the components that are frequently replaced, all of this to reduce maintenance costs.*

KEYWORDS:*Maintenance Plan, Spare Parts, Criticity, Reliability.*

Date of Submission: 25-04-2019 Date of acceptance: 05-05-2019

I. INTRODUCTION

The industrial environment has always been very competitive since the beginning and nowadays with the evolution of manufacturing processes, the demand for well-developed strategies is also growing, so that processes can be competitive. According to Nascif and Dorigo [1] when asset management is concerned, it means that the facility operates continuously, with maximum revenue and with very few unforeseen or planned outages. And for this Sacchelli et al. [2] explains that one must work on ways to reduce interventions and achieve consistent results for the company.

According to Almeida [3] with the constant technological advance and a greater supply than the demand companies are forced to innovate and reinvent themselves in management techniques constantly to be competitive in the market. For this it is necessary to make a study of which parts one should have in inventory and which quantity [4]. According to Vimercati et al. [5] it is necessary to make a documentary survey and a criticality survey of the equipment so that the management becomes effective.

According to Pylon [6], it is up to the maintenance sector to carry out the criticality assessment of the plant equipment, since the decision-making is directly linked to this survey and that, if properly applied, makes the resources for maintenance more profitable and makes the company more competitive in the market . As Hünemeyer says [7], with the implementation of maintenance plans adapted to the asset we can observe the decrease of the Backlog and a better distribution of the workload between the maintainers, improving the work environment. Shaikoski Jr and Miranda [8] state that after the implementation of the maintenance plans it is healthy to the costs of the company a standardization of manufacturers and suppliers of maintenance materials. According to Kardec et al. [9] it is worth considering the other equipment of the plant and checking the common spare parts and that they apply to several other assets, aiming at the reduction of spare parts inventories.

Within this context, this article will be approached as it was done to try to solve the problem in a wood panels manufacturer, creating adequate maintenance plans for the assets and establishing minimum inventory levels for each important component, and later cataloging and creating procedures so that components are replaced correctly and efficiently

II. METHODOLOGY

In the manufacturing process we have several equipments that are arranged in the form of a production line, and when they break down, we have to apply some methods for decision making in relation to the repair action and to analyze the best way to reestablish the productive process and the types of maintenance applied to the maintenance of the factory assets.

III. ASSESSMENT CRITICAL ASSESSMENT

In evaluating the criticality of the assets, we must first be aware of the assets that make up the industrial park so that we can assign a degree of criticality to each one, since the same attention is not given to all the assets of a company. given special attention when they generate large losses or losses, generally the assets that are considered critical are those that have a high maintenance cost and those that generate more losses even if they are not operating in compliance. As seen in the analysis of criticality must have a systematic to attribute the degree of criticality to the asset.

In this study, a table was adopted according to Table 1, with criteria of safety, environment, downtime, quality and cost of repair, one asset is taken at a time and scored according to the criterion, at the end a sum and assigned the degree of criticality

Level	Consequences				
	Safety (*S*)	Environment (*E*)	Loss of Production (*LP*)	Quality (*Q*)	Repair Costs (*RC*)
5	Risk of Major Fires or Accident with Fatality	Severe and Long-Term Environmental Damage Risk	Loss Greater than 16 Hours in an Occurrence	Failure Generates Irreversible Quality in Final Product	Cost Greater than the Monthly Budget of Maintenance Costs
4	Risk of Localized Fires or Accident with Permanent Disability	Long-Term Environmental Damage Risk	Stop Between 8 and 15.99 Hours in an Occurrence	Failure Generates Poor Reversible Quality in Final Product	Cost Greater than 80% of the Monthly Cost of Maintenance Costs
3	Accident Risk with Lost Time	Short-Term Environmental Damage Risk	Stop Between 5 and 7.99 Hours in an Occurrence	Affects Indirect Product Quality (controllable)	Cost Greater than 50% of the Monthly Cost of Maintenance Costs
2	Accident Risk Without Lost Time	Minor Environmental Damage Risk	Stop Between 3 and 4.99 Hours in an Occurrence	Little effect on quality	Cost Greater than 20% of the Monthly Cost of Maintenance Costs
1	Accident without risk to people	No Environmental Damage	Stopping Less Than 3 Hours in an Occurrence	No Impact on Final Product Quality	Cost Less than 20% of the Monthly Cost of Maintenance Costs

Tab.1.Criteria for composing equipment criticality.

Table 1 gives us quantitative and qualitative parameters to evaluate each process equipment according to company policies. Criticity (Eq. 1) is the sum of the consequences (risks) to the process of each category.

$C = S + E + LP + Q + RC$ (1)

Where:

$\text{If} C < 7, \text{theequipmentratingwillbeC}$ (2)

$\text{If} C \geq 7, \text{theequipmentratingwillbeB}$ (3)

$\text{If} C \geq 12, \text{theequipmentclassificationwillbeA}$ (4)

$\text{If} C \geq 15, \text{theequipmentclassificationwillbeAA}$ (5)

However:

$\text{If} S = 5, \text{theequipmentratingwillbeAA}$ (6)

However:

$\text{If (EorLPorQorC)} = 5, \text{EquipmentA}$ (7)

Based on this degree of criticality, the maintenance plan for the asset was elaborated. The asset should have systematic inspection plans, preventive maintenance plan and predictive maintenance plan.

IV. KNOWING THE PROBLEM

Based on the information recorded on the equipment stops (Figure 1) and stopping times, through a graph, one can identify the most frequent breaks and where the largest voice is in order to make the intervention decision on the equipment that makes up the production line.

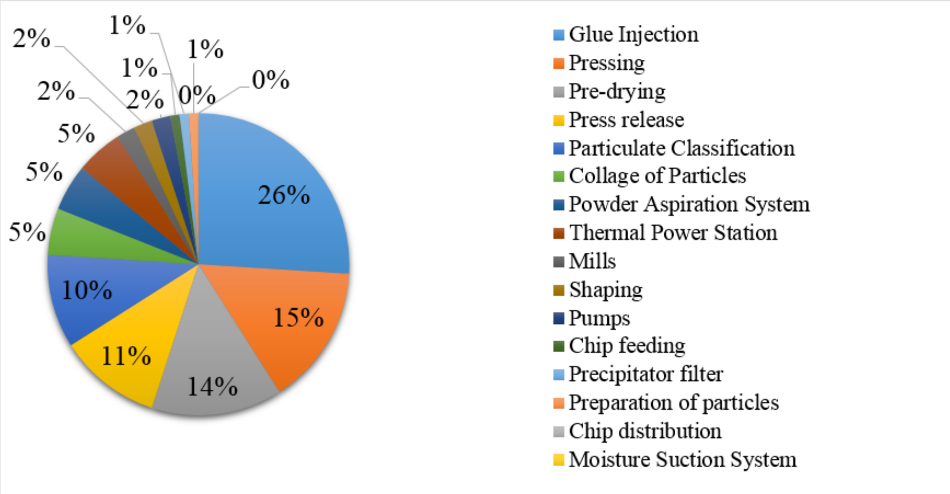

Fig. 1. Percentage of time of stops by areas.

As can be seen, the percentage of line stop hours, the highest percentage of stop times is in the injection of blow-line glue. Analyzing these times, it was evident that the higher frequency of stops was in the sector of dosing of glue of the agglomerate line, we can also observe that the equipment repair time is higher than normal because no information is available component techniques and spares registration. For this reason, it was necessary to create an information bank and review the maintenance plans for that area of the process.

V. CREATING A DATABASE

In the beginning we had several brands of items that often did not meet the design requirements and outdated maintenance plans with the actual installed, which generated a lot of rework and high expenses with parts not recommended. To solve this lack of information and registered parts a technical survey of spare parts that are necessary to have in stock was carried out. Raised quantities, recommended manufacturers and for parts that are obsolete or that are no longer manufactured are sought after manufacturers that meet the same specifications. Alloftheseparts are registered in the SAP system andeachpartreceives a codethatwillbeorganized in a hierarchicalstructurethatfollowstheprocessflow.

VI. THE SAPSOFTWARE

SAP is a German enterprise software developer for business management, all the information and data are inserted in this system for the correct management of the company, at the end of the review and elaboration of a maintenance plan it was necessary to insert the information in SAP so that this generate the programmed service orders according to the frequency that was preset. Also included in this software are the spare parts reference codes and a minimum and maximum level of inventory that each part must have in stock. When it exceeds the minimum level the system itself generates an automatic purchase order to replenish the stock. It is also in this software that the ordering of the orders executed by the mechanics and electricians is carried out, so that you can have a history of everything that was done in that particular equipment, such as inspections, preventive, corrective.

VII.MAINTENANCE PLANS

On the basis of the times of stop and for repair we can define the types of maintenance that will be applied to the asset. An analysis is performed on the equipment's maintenance history, consult manufacturer's manuals, and talk with maintenance managers so that all details are covered in the inspection, preventive and predictive plans and lubrication plans. This team feedback that performs in the field the activities of the maintenance plan is very important for the enrichment of information and details of the activities.

For the assets considered "A", lubrication, inspection, preventive and predictive plans are systematically adopted in the SAP system so that work orders are generated according to the planned frequency of that type of maintenance. For the execution of the activities of the plans of this asset class, a maintenance stop is performed. Because the asset is classified as "A", it is a weight factor in the decision-making process to stop the process for maintenance.

For the assets considered "B" a lubrication, inspection and preventive plan is adopted, also in a systematized form in SAP that generates orders according to the frequency. For these assets, programmed stops are carried out according to the opportunities between production orders.

For the assets with criticality "C" is adopted inspection plan and some assets are used until the break, since it is considered that these will not interfere in the process and neither generate problems or have bypass. Maintenance orders are performed according to what is detected in routine inspections and many assets are repaired when the process is running by by-pass.

After execution of the maintenance orders, the indicators of compliance with these plans are also analyzed to measure their effectiveness.Therefore, it is very important that we have a reliable source of data to generate the maintenance indicators. This type of study is fundamental and must be carried out by the maintenance engineering team that elaborates the plans for the assets, which in turn is constantly improving according to the PDCA and Lean Manufacturing cycle. Maintenance engineering has a strategic function for the company's results and for the reliability of processes and products, it is very important for making decisions in the face of unexpected events together with management.

VIII. RESULTS AND DISCUSSIONS

All this work has generated positive results, as the maintenance backlog has gone down, that is, the time and manpower is being used in preventive in this area and this is a good sign that shows the improvement in the services of planning and execution of all the maintenance . The numbers show us that earlier and this work the breaks were more frequent and random, and there was no maintenance history for adequate intervention. After the collection of spare parts and the enrichment of information in the maintenance plans, it is possible to know what should be done to keep the asset in operation. Table 2 shows what maintenance strategies were adopted for each asset.

Active	Criticity	SensitiveInspection	Instrumentation Inspection	Predictive	Preventive	Detective
Pumpingofglue 30M1	A	X	X	X	X	X
WaterFlow Meter	A	X	X	X	X	X
CatalystFlow Meter	A	X	X	X	X	X
WaterPumping 30M25A	B	X	X		X	
WaterPumping 30M25B	B	X	X		X	
CatalystPumping 30M12B	B	X	X		X	
30T1 Field Panel	C	X			X	
CatalystDosingTank	C	X			X	
Resintank	C	X			X	
Paraffintank	C	X			X	

Tab. 2.AssetStrategies.

Through this framework is defined the maintenance strategy to be applied in the assets of the preparation and injection sector of blow line glue that is responsible for mixing the glue to other chemicals to be applied to the wood particles. Sensitive inspection, instrumented, predictive, preventive and detective inspection were adopted for "A" equipment. In the sensory inspection, the items that were important and common to all the equipment that needed this type of inspection were evaluated and a standard list of items that must be verified in this inspection was set up.

We had an improvement in the maintenance requests that before, was very focused on the equipment and not in the peripherals of this one, however the peripherals of this one are important for the good operation of the process and for the safety of the people. The backlog decreased and the available time per manutentor is being better utilized, since the average hours demand generated by the old maintenance plan was 27.6 hours of work, but the hours available per week per employee was 43.2 hours, taking as a base 6 days a week, as the company works with 6x2 scale is considered 7 hours and 20 minutes per day. This value of weekly hours multiplied by the productivity factor that is 0.5 we have 21.6 hours per week to be planned execution of inspections, preventive, predictive and detective.

As the maintenance plans have been redone and the execution time has been revised, it is now possible to execute all the orders generated by the plans according to the maintenance staff. Some instrumental inspection activities did not have a consolidated procedure in the team and the way of measuring equipment was done without a standard, each maintainer had his way of gauging. All this descriptive of how to do the inspection with instruments was described the step by step in the work order that is generated by the inspection plan and that the employee must have at hand at the time of execution. Thus a pattern is followed for performing the sensitive and instrumented inspections.

Preventive maintenance was also a case that applied to all equipment, because even if the equipment is of low criticality one should carry out a preventive even if at longer intervals. The preventive plan has been developed in accordance with the manufacturer's recommendations and based on the experience of the manufacturers. A description was made of each preventive step, the list of parts to be replaced, the way to replace, part stock code, required outsourced and specialized services, and assembly gaps and adjustments. facilitated the planning and execution, because one has the information in hand.

Planning a stop for preventive is richer in detail and you can make stops with less time. In some cases where we have duplicate equipment in the same function, the preventive is being executed with the line in production and running by bypass equipment. This has made it possible to reduce the number of work orders to be carried out on monthly stops and the hiring of outsourced labor for execution.

For the predictive activities a monthly route for data collection was formulated with the data analyzer, this equipment was already used by the predictive team that maintained its use. What was modified was the route that included the pumps that were considered critical in the glue preparation area.

For flowmeters implemented in the SAP system a flow monitoring plan that is performed on a weekly basis, this plan contemplates how the flow of the meter should be checked through a step-by-step and an order for service order guidance in the if the value found in the conference is not correct.

The strategies in Table 2were used to make the maintenance plan for the area and for each asset individually. For sensitive inspections, it was determined that all equipment in the area must have, so in this case an inspection route was applied to be able to optimize the maintenance professional's working time. The instrumented inspections were another case that several area equipment should have this type of strategy, and the inspection route was applied.

For the preventive maintenance plans were prepared individually for each asset, and with different periodicity in the SAP system. In the equipment that was defined that would be necessary the detective, was also applied the concept of the inventory management and placed in warehousing equipment reserves, since this one has great impact in the production and it depends on order for manufacture. All of these components are listed in the SAP system in the asset tree, which has several sub-levels according to complexity. These sub-levels start from the plant set and are subdivided up to component level. Parallel to this was created a digital technical file in the industrial ede according to the areas of the process, in this file was gathered and organized folders with technical manuals, photos of platelet, datasheet, digitized project and procedures of execution of each equipment.

With this review of practically the whole process of maintenance of this area it was possible to detail the entire process at the component level, the number of spare parts carrying out the same function, ie several brands for the same stock item, was reduced. This has allowed us to define reliable and quality assured suppliers for the replenishment of maintenance materials. All of this optimization in the maintenance planning process has led to reductions in downtime from the production line and facilitated maintenance management, which now has reliable data, consolidated maintenance procedures for field equipment and well-defined strategies. This shows that planning is fundamental to perform a good management of the company's assets.

IX. CONCLUSIONS

After applying this model of maintenance planning, it is concluded that the PCM exercises a strategic function for the fulfillment of the goals established by the organization and for the decision making. Even with an assembled structure of PCM, it is necessary to have control means to measure the team's performance and the willingness of the employees to assert what the strategies propose for the smooth running of the maintenance. To successfully maintain maintenance, everyone needs to share the same culture of doing well.

REFERENCES

[1]. Nascif, J.; Dorigo, L. C. Manutenção orientada para resultados. 1. ed. Rio de Janeiro: Qualitymark, 2010.

[2]. Sacchelli, C. M.; Miranda, D. A.; Dreschler, M.; Nogueira, A. L. Simulação computacional da injeção de termoplásticos: comparação de ferramentas tipo CAE. Congresso Brasileiro de Engenharia de Fabricação, Joinvile. 2017.

[3]. Almeida, D. AIP-Programa de Gerenciamento de Ativos. O Papel. V 77, n 4, pp 87-97, 2016.

[4]. Miranda, D. A.; Cristofolini, R. Análise de Retorno Financeiro Aplicado a Dois Robôs Autônomos Manipuladores que Atuam na Descarga de Peças no Processo de Injeção de Termoplásticos. VI Congresso Brasileiro de Engenharia de Produção. Ponta Grossa, pp1 – 12, 2016.

[5]. Vimercati, M.; Mendonça, M. F. A. B.; Miranda, M. A.; Silveira, L. F. V. Análise conjunta da curva abc e do fator criticidade em uma farmácia de manipulação de guaçuí – ES. Simpósio de excelência em gestão tecnológica. 2012.

[6]. Pilão, J. M. R. Elaboração de análise crítica e definição de plano preventivo de um equipamento. Porto, FEUP. Dissertação (Mestrado) – Pós Graduação em Engenharia Mecânica da Faculdade de Engenharia do Porto, 2017.

[7]. Hünemeye, R. F. Proposta de implantação das funções de planejamento e controle da manutenção (PCM) em uma linha de produção. Trabalho de Conclusão de Curso (TCC) – Engenharia de Produção Univates. Lajeado, 2017.
[8]. Shaikoski Jr, R.; Miranda, D. A. Implementação do Indicador de Eficiência Global de Equipamentos para Diagnóstico e Melhoria do Desempenho Produtivo: Estudo de Caso. VIII Congresso Brasileiro de Engenharia de Produção. Ponta Grossa, pp1 – 12, 2018.
[9]. Kardec, A.; Nascif, J.; Baroni, T. Gestão Estratégica e Técnicas Preditivas. Rio de janeiro Editora Qualitymark; Abraman, 1988.

Alex Pscheidt" Development of Maintenance Plans Appropriate to Plant Assets and Creation of a Spare Parts Database"American Journal of Engineering Research (AJER), vol.8, no.05, 2019, pp.109-114