Implementation of the OEE Indicator in the Welding Process in an Air Conditioning Factory in Manaus City

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Abstract

Factories are continually looking for new ways to produce more at lower cost and fewer failures, thus preventing scrap or production losses. Given this, increasingly effective means of measuring performance are used so that other details can be studied that lead to difficulties and bottlenecks in production. Overall Equipment Effectiveness - OEE is a calculation that provides knowledge of machine availability, production performance, and the quality with which parts are assembled or made. This paper is a case study carried out in an air conditioning factory, with the main objective the implementation of the monthly OEE; as specific objectives, present the concepts and their applicability within a company; analyze the welding process of the factory; present a proposal for improvement through the result obtained. As expected results, the OEE can provide the information needed for internal improvement and thus, correction and prevention of failures and economic losses for the organization.

Keywords: Production; Availability; Quality; Performance; Industry;

1. Introduction

The demand for increased production that can offer the market a product that can offer satisfaction has become one of today's main challenges for the industrial sector. This is because these industries are increasingly investing in machinery that can increase the amount of products that can be assembled and offered to consumers.

The industry has been looking for ways to increase its productivity and reduce its errors or failures, making it increasingly competitive. To this end, the OEE indicator helps by highlighting machine availability, process performance and quality, which involves the ability to produce with the smallest possible error or failure.

This paper is a case study of a 7,500, 10,000 and 12,000 Btus split window and split air conditioner assembly plant. Where were used as methodology, the exploratory research, descriptive character. Using observations, Cause and Effect diagram and 5W2H to offer a proposal that can offer improvements in the welding industry.

The main objective was the implementation of the monthly OEE; as specific objectives, present the concept of OEE and its applicability within a company; analyze the welding process of the factory; submit a proposal for improvement through the result obtained by the OEE.

The lack of OEE application makes the industry vulnerable to product losses, time and reduced revenues. Compromising the entire production process in the long term, preventing them from achieving more sales and offering more satisfaction to their end customers. Given this, the question is: How can OEE help in the internal improvement of the production process of an air conditioning assembly company?

2. Theoretical Referential

2.1 Total Productive Maintenance (TPM)

With the high degree of competitiveness in the market, it has become extremely important for companies to seek to improve the efficiency of their products and their production processes so that costs are reduced as best as possible by identifying and eliminating losses and targeting the best sustainability proposals [1].

The Total Productive Maintenance (TPM) methodology proposes the overall effectiveness of the equipment, promoting the reduction of the largest waste in the production processes. This system brings improvements to the organization and equipment, as well as internal operational processes, with a focus on problem prevention.

Following the technological trajectory, currently the OEE is a new trend launched in current companies and has been widely used, and is currently being treated as the most widely accepted indicator for performance evaluation. Thus, the OEE formula is used to find where they are inserted to find the areas that will provide the highest return on assets. The OEE will identify improvements in sectors such as quality, reliability, tradeoffs, setups, and other factors that influence production [2].

2.2 OEE indicator

Turning to the measurement of improvements that are made by TPM, one can cite the tool popularly known as OEE (Overall Equipment Effectiveness), within the first methodology, with OEE it is possible to detect the equipment of the productive sector with less efficiency and performance in order to make them act more efficiently and improve them [1].

The OEE indicator can be classified according to the three indices that verify its efficiency: first, availability; second, performance; The third index that makes up the OEE is the machine analyzed is producing to the correct specifications, generating better quality parts [3].

It is noteworthy that the use of the OEE tool favors an extended view of the life of the equipment and attributes that the conditions of use are essentially influenced by its availability, performance and quality of compliance. By indicating the measurement of losses that may occur even when equipment is working, the OEE promotes problem and root cause analysis to make process improvement actions more efficient and increase equipment capacity utilization.

Thus, the OEE is also considered as a definitive indicator for measuring equipment performance, that is, a tool that assists in the planning of productive capacity, process control and improvement and the cost calculation of production losses [4]. Also regarding the definition, the OEE is an equipment loss detection system, not a fault assessment system [5]. It expresses the efficiency of the equipment in a reduced metric, allows evaluation of the effects of the improvement actions developed and the identification and quantification of the detected problems in a standardized way. The OEE shows the hidden factory that exists inside the factories, showing the costs that the waste incurs.

However, it should be noted that there are many challenges associated with implementing OEE to monitor and manage production performance, for example: How it is defined, interpreted and compared; How OEE data are collected and analyzed; how it is monitored and by whom; Its alignment with the overall production strategy; how it could be used for sustainability [6].

Thus, it is possible to relate the six major losses mentioned in the TPM to the OEE factors. As for the types, they are classified in 3 indices, known as: Availability, Performance and Quality [7]. Where calculations are made differently, the availability present in the formula is calculated by dividing the actual time required for production by the time available for production. Performance is calculated by dividing the speed at which the equipment requires to be ready by the nominal speed on the process sheet [8]. Thus, it is added that quality is calculated by the ratio of the quantity of products in good condition to the total quantity of products produced. The complete formula is represented by Figure 1.

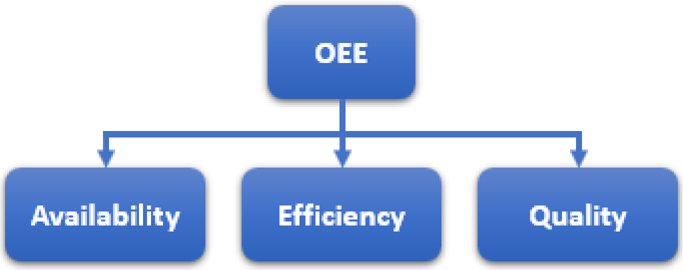

Figure 1: Formula for calculating OEE
Source: Koda (2013).

2.3 The use of OEE in the refrigeration industry

In the application of OEE in refrigeration, the injection of polyurethanes was used, an idea proposed by the company's manager. His goal was that after one year of the OEE utilization period, the company would have an efficiency performance of 85% per month compared to the OEE non-utilization period. It was concluded from Lima's experience that the study generated positive feedback, as it contained the 85% target, that is, the use of the OEE indicator provided success [2].

In order to be deployed in a refrigeration industry, the equipment that most causes delays or bottlenecks in production needs to be analyzed by checking its availability [10] and its efficiency in the production process [11], as shown in Figure 2.

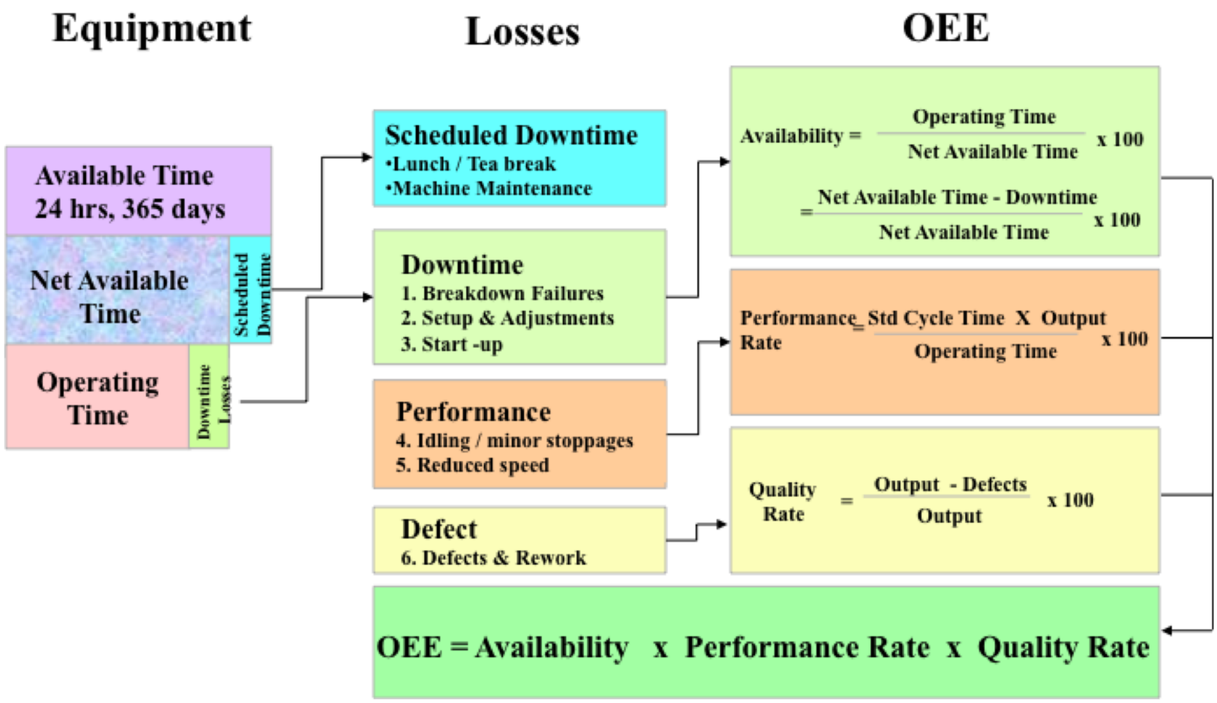

Figure 2: OEE Deployment Process
Source: Rodrigues et al. (2013).

3. Methodology

The company studied is an assembly plant for air conditioning parts. The knowledge of the difficulty presented in the factory was discriminated from the visit that was made to the place where the subassembly of the parts is made. For in-depth knowledge of the procedures performed, observations and interviews were conducted with the responsible leader and welding operators to know the time used in the process.

In order to know the welding process of the parts and the bottleneck that is hindering the efficiency of the production process, it was necessary to perform mappings directed to the obstacles of a fast and efficient production [12]. Thus it was obtained the knowledge that the parts that are assembled in the welding sector are fitted in the converter and air evaporator, are small irons that are joined through a process called brazing.

4. Applied Studies

The sector with a delay within the factory is welding. This sector consists of 06 stations, which work daily in two 10h shifts. The site consists of a support table where each operator feeds his station with the parts that need to be welded. It is used a device that is changed after the welding of three pieces that compose the process. These parts are part of the internal structure of the air conditioner.

The welding process is carried out by torch, using LPG gas to ignite the flame, along with oxygen. As a necessary utensil and assembly, a welding rod is used. In this way, the parts are assembled, boxed and directed to the warehouse, then the parts will be redirected to other sectors that will use these parts to

assemble the 7.500, 10 thousand and 12 window and split model air conditioner. thousand Btus.
For the realization of the bottlenecks presented in this sector it was necessary to make an in-depth observation of the procedures performed by the operators at the time of welding of the parts, for this it was necessary to use the cause and effect diagram and the action plan and storm of ideas.

4.1 Problems Identified

The welding process of the air conditioning factory currently has 06 stations, with two shifts daily, 10h each. Each station has a number of welded parts according to the model of the air conditioner. For window models, the established production average is 123 pieces / hour per shift. For split models, 87 pieces / hour per shift were set.

Assuming that it is 10h each shift, then the production projection is: For window models it is 1,230 per shift; for split 870 shift welded parts. According to documentary analysis performed at the post observed, at the end of each shift the operators are presenting as average quantity produced for each model: 84 pieces per hour, for the window model, 847 pieces per shift, a difference of 360 pieces. For split models the output is 455 pieces, a difference of 415 pieces.

These differences are known to have a significant impact on process performance, where efficiency contributes to the agility and manufacturing of larger quantities of the product. Thus, analyzing the availability of the equipment found the following characteristics:

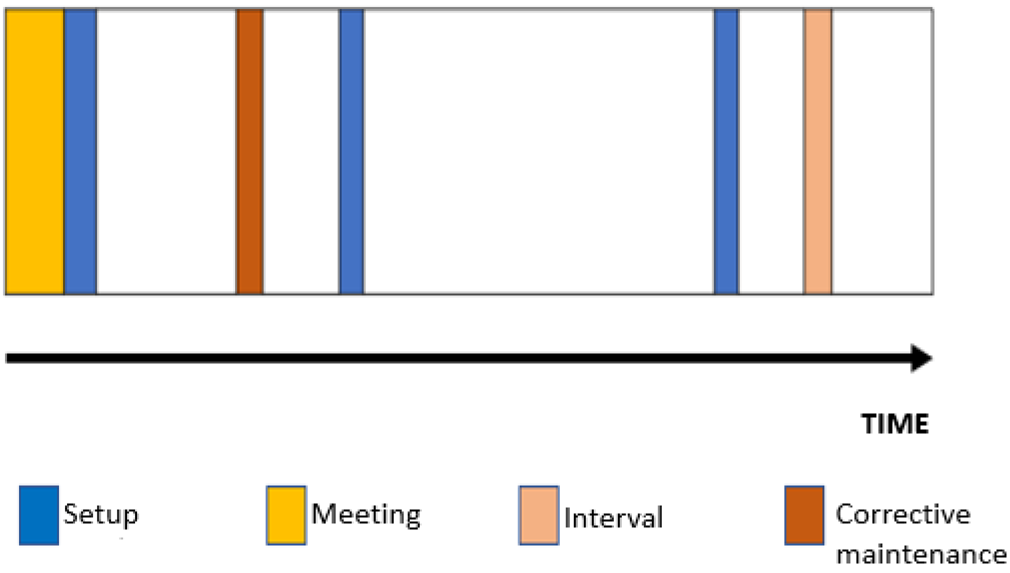

Figure 3: Timeline demonstrating equipment availability
Source: Author, 2019.

The figure above shows the availability of welding equipment, as well as the losses suffered by the intervals that occur during the shift. The blank space corresponds to the production time the equipment is actually being used, the colored gaps show the stops that prevent the equipment from being fully available and make the number of welded parts smaller.

5. Results and Discussions

According to the mapping performed in the parts welding industry, the production leader with the responsible for quality and performance needs to implement the OEE to be aware of the availability, performance and quality of available equipment.

Once the proposal for the verification of the important percentages for decision making power in the production line was accepted. Calculations were made for measurement and knowledge of the numbers that will allow the welding process to have continuous improvements.

Thus, considering that the company has two shifts of 10h each, and currently has 50 minutes of scheduled shutdown in each of the shifts and 20 minutes of maintenance at the end of both shifts, it can then be developed to calculate the percentage of availability of the system. equipment within the industry:

5.1 Calculation Availability

Scheduled time = (20 x 60) - 100 min = 1,100 min

Time available for production = 1,100 - 20 min = 1,080 min

1,080 min / 1,100 min = 0.98% = 98%

NOTE: The average according to Word Class is 90%.

The speed at which production is performing the welding process can be represented by calculating Performance. Considering that in the shift that was observed, at the end of the observation it was verified that the quantity produced was 762 pieces, considering that in average it gets to produce 60 pieces / hour, when it takes an average between the quantity hourly output of the two models mentioned above. It is understood that it is one piece per minute. Performance can be ascertained as follows:

5.2 Performance Calculation

Scheduled time = 1,100 min

Production Time Available = 1,080 min

Time that should produce 762 pieces = 762 min

762min / 1,080 min = 0.70 = 70%

NOTE: The default by Word Class is 95%.

Some details negatively impact the company's performance, one of them is the employee's ability to perform their activities more efficiently using the full capacity of the equipment. However, the lack of skill acquired by the employee's ability to perform the activities faster makes the company obtain a reduced percentage compared to the Word Class standard.

Next, quality is geared towards production with minimal errors, faults that generate scrap. During the observation and visit at the company, it was found that at the end of the shift visited, 11 refuses were obtained. Based on this information the quality was calculated:

5.3 Quality Calculation

Quantity = 762 - 7/762 = 0.98 = 98%

It can be observed that the materials that are distributed for welding are of quality, the attention given to the process is made with quality because the losses are small compared to the amount produced in the established conformities. Based on these three results, the OEE calculation can be performed, as shown below:

5.4 OEE Calculation

OEE = 0.98 x 0.70 x 0.98 = 0.67 = 67%

As can be seen, the implementation of the OEE to measure availability, performance and quality analysis provides information on what can be improved to make the company obtain even higher revenues than in the previous period. You may find that the company can still improve the welding process of parts. The smallest item is performance, which shows that although the company has a projected production of parts per hour, operators are still not being able to reach enough speed to produce this quantity even if the equipment has good availability.

However, based on these data, the main focus for performance improvement allowed an analysis of the stops performed in the shift, seeking a way to reduce the 50 minutes of scheduled shutdown. Setup only takes 20 minutes and 10 minutes for corrective maintenance for the welding machine. For this an analysis was developed from the cause and effect diagram and the 5W2H.

5.5 Storm of Ideas

From the information gathering and interview with the welding operators, it was attributed to this difficulty in the speed of production to: the lack of manpower, lack of parts to supply the table, need to dedicate this same person to forward the assembled parts up to the warehouse.

5.6 Cause and Effect Diagram

From the information provided by the collaborators themselves, it was possible to trace the main causes that may have led the industry not to reach the quantity of parts produced at a considerable speed.

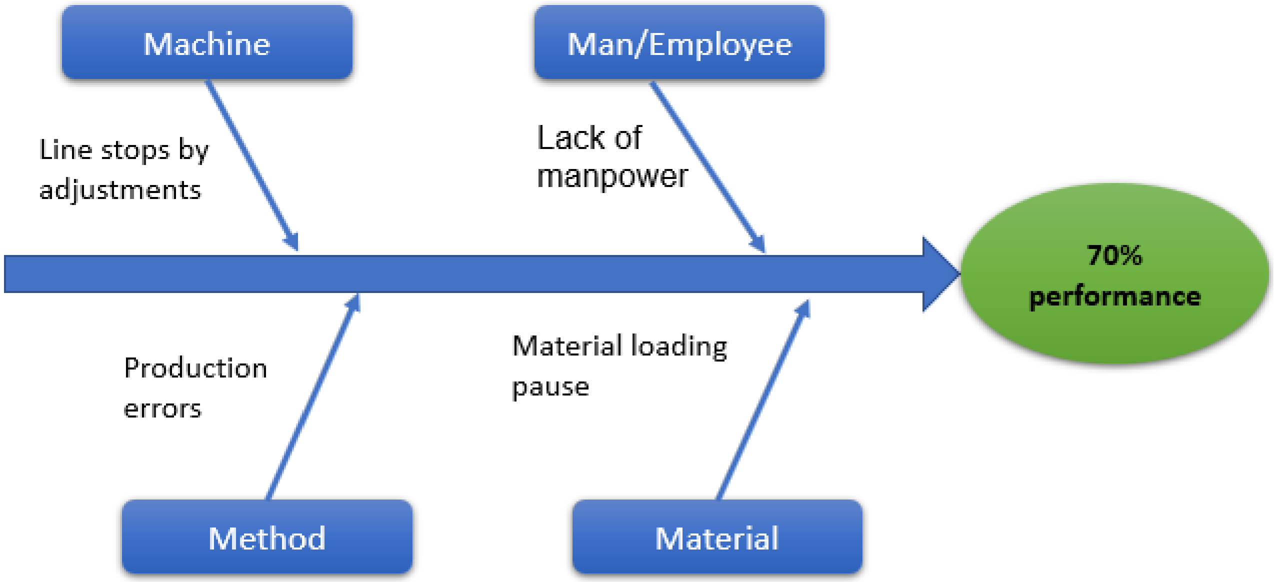

Figure 4: Cause and Effect Diagram of the Welding Process
Source: Author, 2019.

5.7 5W2H

Following the survey of the Cause and Effect Diagram, it was possible to develop an action plan aimed at continuous improvement in performance, so that this percentage known through the OEE is gradually increased and the performance measurement is performed monthly as a means of analyzing the difficulties or bottlenecks of production and, solved in a timely manner so that it has no effect on revenues.

Table 1 - 5W2H focused on improving OEE performance results

What	Why	Where	When	Who	How
Development of welding employee activities	Step by step training	Welding Sector	15 days	Leader of production	Free
Welding Machine Maintenance Scheduling	Weekly Inspection	Welding Sector	weekly	Machine Maintenance	R$ 1500,00
Welding Machine Maintenance Scheduling	Add another operator in the process	Welding and Storeroom Sector	30 days	Additional labor	Free

Source: Author, 2019.

6. Final Considerations

With the technological advancements of the market, the industries are every day looking to satisfy the needs of the customers, with this more and more products focused on the welfare and practicality of the company is launched in the commerce. The air conditioner, in turn, is an appliance of utmost need in most homes, so its demand becomes increasingly constant.

Being a continuous scale of production, measuring the quality, availability and performance of a machine process makes the bottlenecks and difficulties pertinent to a production process known.

In the case study of this article, it is noted that the welding plant had almost full availability of equipment to produce full capacity, but it is impossible for machinery to be available 100% due to the required and required shutdowns, considering also in this range breaks for the operator to go to the toilet. However, this performance can be improved by taking advantage of time by preventing unnecessary downtime.

Thus, further studies are focused on the impacts that such procedures may have on the long term for the factory, considering the quality of the final product and market satisfaction.

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