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QUALITY ANALYSIS OF THE MOTOR PUMP ASSEMBLY PROCESS USING THE FMEA TECHNIQUE.

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Abstract. In the presented work, a quality tool was used to analyze the process of an assembly line of motor pumps. At some point in the process, it was verified that the sector was experiencing many difficulties, which caused delays in the assembly process, with that, the possibility of using a tool to check the problem that was causing this delay was analyzed. With the data collected, the FMEA was applied to discover the causes of recurring faults and the origin of these delays. After analyzing the data, it was found that the biggest reason for faults was the origin of the machining sector, and mainly in the assembly of the model 01 (Table 2). After this analysis, an action plan was created with some procedures to be followed in the sector of origin to arrive at the assembly without any type of problem, with the action plan already being practiced, there was a 23% reduction in the first month after the application of the tool, thus bringing a great benefit to the analyzed process.

Key words: Machining, motor pumps, assembly.

2. Development

The market is characterized by its high competitiveness, forcing organizations to constantly strive to improve their performance against competitive criteria valued by customers, such as quality, reliability, cost, safety, among others [1,2]. The profile of the current customer is marked by low attachment to the brand, and by the search for products that exceed their expectations [3]. Therefore, it is vital that the production management systems is concerned with the development of the quality of its processes, ensuring that the products offer comply with market needs [2,3].

Failure mode and effect analysis (FMEA) is a systematic and documented process used to assess and reduce risks and failures in products, projects or processes [1, 4]. The systematic identification of failures, the evaluation of their effects and the treatment of their causes improves the productive flow, the offer of fault-free products and the competitiveness increase, factors that contribute to the economic sustainability of the organization [1, 2].

This paper goal is to analyze the assembly stage of the manufacturing process of different models of motorcycle pumps, produced by a company located in the state of Santa Catarina (Fig. 1). The assembly operation is decisive for the organization, as it is characterized by presenting a high level of added value to the product, due the intense use of specialized labor, a factor that strongly impacts on the total cost of the product, and on the company's competitiveness. Therefore, the development of actions that minimize the level of rework and its impacts are fundamental to the process. For this study, the FMEA method was used in order to identify possible assembly failure modes and in sequence to determine its risk priority number (NPR), based on the product of severity, occurrence and detection indicators (Tab. 1). Based on the NPR values, an adjusted action plan was developed to act on the severity parameters, occurrences and means of detecting failures. The results obtained point to different failure modes in the assembly of five motor pump models, here called M1, M2, M3, M4 and M5 (Tab. 2). The data analysis shows NPR values between 28 and 108. It is verified

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for all models analyzed that the degree of severity of the failures is low (2). The values for frequency of occurrence are high for the failure modes observed in models M1 (9) and M3 (8). For the failure modes observed in models M1, M2 and M3 there is a degree of detection 6, while the failure mode of model M4 showed degree 7. It was also verified that the potential cause of most of the identified failure modes is associated with operational errors in the machining step.

The largest NPR (108 and 96) are associated with locking rotors failures and locking the bottom plate, identified in models M1 and M3. The high frequency of failures (9 and 8) associated with greater difficulty in detecting (6 and 6) are determinant for the observed NPR. Table 3 presents the action plan for process improvement. The actions were developed focusing on reduce the frequency of failure occurrences and on increasing the detection capacity and directed to the machining process, aiming at the components delivery without defects for the assembly step. The actions proposed here were developed with the participation of professionals from the company's production team. These actions are in the implementation phase (development of parts delivery form) and evaluation (machining, metrology and project interpretation training).

Preliminary data indicates that after the training of workers, there was a 23% reduction in the number of machining failures in the first month, a satisfactory result for the moment. It was observed that the training provided an improvement in the reading and interpretation capacity of the projects by the workers and also contributed to the adequate use of the machining equipment, which indicates the correlation of the actions developed with the reduction of the percentage of failures in the work. analyzed period.

From the data analysis, it was concluded that the application of the FMEA method proved to be adequate to the motor pump manufacturing process and that the careful analysis of the results obtained allowed the development of actions adjusted to the specific characteristics of the studied problem. The machining step was characterized as the main potential cause of the failures and that they propagate through the process. The NPR values are strongly influenced by the combination of high frequency and low fault detection capacity, becoming more evident for the failure modes observed in models M1 and M3.

The proposed improvement actions are aimed at increasing the detection capacity and decreasing the frequency of failure occurrences. Capacity-building training proved to be crucial in reducing the percentage of failures in the first month. These actions are educational and organizational nature and can be implemented at low cost, quickly, without requiring significant changes in the structure of the production system.

Table 1: Evaluation criteria for determining the severity, occurrence and detection of failures.

Data for NPR determination			
Severity	**Ocurrence**	**Detection**	**Risk Level**
10	10	10	Very High: Failure jeopardizes operation safety.
9	9	9	
8	8	8	High: Failure effectively interferes with the quality of the process but does not affect its safety.
7	7	7	
6	6	6	Moderate: Low interference in the quality and safety of the process.
5	5	5	
4	4	4	Low: No interference with safety, with a slight drop in the quality of the process.
3	3	3	
2	2	2	Very Low: No interference in the safety or quality of the process.
1	1	1	

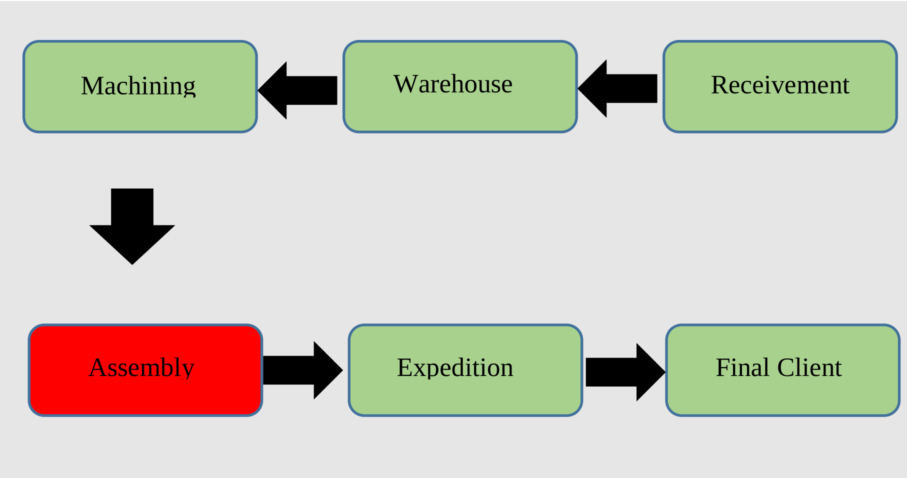

Figure 1: Simplified flowchart of the motorcycle pump manufacturing process.

Table 2: Analysis of the failure and NPR modes of the different motor pump models evaluated.

Model	Failure Mode	Potential Effect	Sev.	Potential Cause	Ocorr.	Detec.	N.P.R
M1	Defective rotors	Downtime	2	Machining error	9	6	108
M2	Locking rotors	Downtime	2	Machining error	4	6	48
M3	Locking bottom plate 10mm	Downtime	2	Machining error	8	6	96
M4	Defective engine	Downtime	2	Engine quality out of standard	2	7	28

Table 3: Action plan developed based on FMEA analysis.

Action Plan				
Overview	**Analyzed Sector**	**Action Plan**	**Start Target**	**Responsible**
Considering that the biggest flaws are in the machining sector, the following plan was developed to improve the quality of the process.	Machining	Machining Recycler Course	15/09	Machining Coord.
	Machining	Metrology course and technical/mechanical drawing reading	30/09	Machining Coord.
	Machining	Each operator will sign a form stating the quality of the part.	30/09	Machining Coord.

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