Brief introduction to FMEA methodology

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The maintenance function has experienced over the years several stages of importance and consideration within organizations. One can notice, however, a trend that has shown a positive evolution. Factors such as scientific and technological development, the existing competitiveness in the global economic panorama or even the ramped up environmental, safety and health legislation, compel organizations to look increasingly at maintenance as a function with a significant strategic importance.

Assuming the paramount importance of this function, the maintenance strategies themselves have evolved considerably, highlighting, among others, predictive maintenance, Reliability Centred Maintenance (RCM) or Total Productive Maintenance (TPM).

Of those strategies, RCM is an extension of the Failure Mode and Effects Analysis (FMEA) technique, evaluating the functions and potential failures of physical assets, seeking to optimize maintenance actions in an efficient and profitable way [1]. Thus, the application and definition of the FMEA technique is critical for the implementation of the RCM strategy. It is this technique that we will cover in the following paragraphs.

The main reference document for conducting an FMEA analysis in any organization is IEC 60812:2018, which considers FMEA as a technique for analysing the reliability of a system, providing a systematic method for identifying failures and possible consequences in the items. It turns out that FMEA method is a proactive analysis process, and the identification of failures in an item is carried out before they occur, being, in this way, opposite to Root Cause Analysis (RCA), which considers to be a reactive analysis process, insofar as the identification of root causes of failures is carried out after they occur.

In fact, it can be considered that there are several types of FMEA, depending on the entity to which this analysis will be applied. The Design FMEA (DFMEA), which is widely used in the development of new products, and the Process FMEA (PFMEA), used in industrial processes, are perhaps the best known and most implemented.

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September of 2022

The implementation of a FMEA methodology determines the initial identification of five fundamental concepts, specified below:

- **Main function:** function that a particular item should perform during a certain process;
- **Functional requirements:** definition of technical or procedural parameters expected for a given item or process;
- **Failure mode:** When touching upon items, EN 13306:2021 standard defines failure as the “loss of ability of an item to perform a required function”. This means that the first two concepts mentioned above are very important, since failure modes can be defined as the way in which a failure may occur;
- **Failure effects:** identification of possible consequences arising from a given failure mode
- **Failure causes:** identification of possible causes of failure modes.

After defining the possible failure modes for the established items/processes, the next step is evaluating of the risk of each failure mode previously identified. At this stage, failure modes will be prioritized, depending on their probability (or frequency) and the severity of the consequences. An event with a high rate of occurrence and, simultaneously, with severe effects is considered an event with a high level of risk.

The classification of failure modes according to their relevance should be carried out by determining the respective severity, occurrence and detectability indices, commonly classified on a scale of 1 to 10:

- **Severity index:** evaluates the impact that a particular failure mode will have on the organization. Failure modes with high severity consequences are classified with higher values;
- **Occurrence index:** it considers how often a particular failure occurs. Recurrent failure modes are rated with a higher value;
- **Detection index:** it is a function of the greater or lesser ease in detecting the failure mode before its consequences arise. Failures that are more easily detected before they have an impact on the organization are rated lower.

After defining these indexes, they must then be compiled and arranged in a descending order according to their degree of risk, and for this it is necessary to calculate the risk priority number (RPN). RPN is the result of the product between severity, occurrence and detection indexes:

RPN = Severity x Occurrence x Detection

An analysis that incorporates the FMEA methodology is not limited by this identification of possible failure modes and their degree of risk. It is essential to define improvement actions that reduce the value attributed to each of the three mentioned indexes. The classification assigned to the severity, occurrence and detection indexes must be constantly validated and updated, depending on the defined improvement actions, in a clear exercise of continuous improvement.

REFERENCES

[1] SOBRAL, J., & ABREU, A. (2013). Manutenção Produtiva Total. In Manutenção Produtiva Total e Gestão Lean