The Quality Performances Improvement Using Failure Mode and Effects Analysis Method

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Abstract: - Failure Mode and Effects Analysis (FMEA) method approach allows the implementation of specific procedures for improving the quality of products, processes or technological systems focusing on risk management within a system of classification of the severity and probability of potential failure. In the case study we propose to analyze potential failure modes specific to manufacturing process considering cutting tool, machine tool, measurement and control equipment. To analyze the results it is elaborated a Pareto analysis that is a technique for prioritizing possible failure modes and effects of failure by identifying the problems that will be solved by making the corrective actions. There are identified and assessed each corrective action taking into account the risk priority number (RPN) value after this implementation action and the feasibility of this under the existing constraints of cost, resources, and time, as well as quality and reliability requirements.

Key-Words: - Failure Mode and Effects Analysis (FMEA), cumulative relative frequency chart, quality, continuous improvement, manufacturing processes.

1 Introduction

The current advancement of FMEA has come from the automotive sector as FMEAôs are required for all Designs and Processes to assure the prevention of problems. FMEA improves the quality, reliability, and safety of products / services / machinery and processes, improves company image and competitiveness and increases customer satisfaction. Process Failure Modes and Effects Analysis (PFMEA) provide a structured, qualitative, analytical framework which taps the multi-disciplined experience of the team [1], [2].

The Process FMEA is used to [1]:

- Identify the potential consequences of errors and omissions in the production process;
- Error proof the production process and develop process improvements;
- Develop the production control plan.

2 Evaluation Methodology

The FMEA takes each potential cause, or failure point, identified in the cause and effect diagram and determines the potential:

- Product and process-related failure modes;
- Effect of the potential failures expressed by the parameter "severity";
- Manufacturing process causes and identifies process variables on which to focus controls for occurrence reduction or detection of the failure conditions expressed by the parameter "occurrence";
- Process variables on which to focus process controls,
- Ability for detection;
- Root causes of the failure.
- Prioritization list of potential failure modes, thus establishing a priority system for preventive/corrective actions;

The potential causes are sorted into five categories: people, materials, equipment, methods, and environment. The diagram takes the shape of a fishbone and hence may be called a Fishbone Diagram. This well-defined list of potential failure modes for producing accurate and it was then used as the basis for a Failure Mode and Effects Analysis.

Every corrective action must be evaluated taking into account both the expected RPN value after the action implementation and the feasibility of the action implementation under the existing constraints of cost, resources, and time, as well as quality and reliability requirements.

Increased risk implies increased production costs and manufacturing of technological products.

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3 Failure Mode and Effects Analysis – Case study

Based on causes ï effects diagram it can be determined the potential failure mode for every categories. In this reason, we have developed a simulation method which shows the detailed methodology for identifying and analyzing problems (figure 1). Based on this simulation program, we can estimate the priority number specific to each category of potential failure mode.

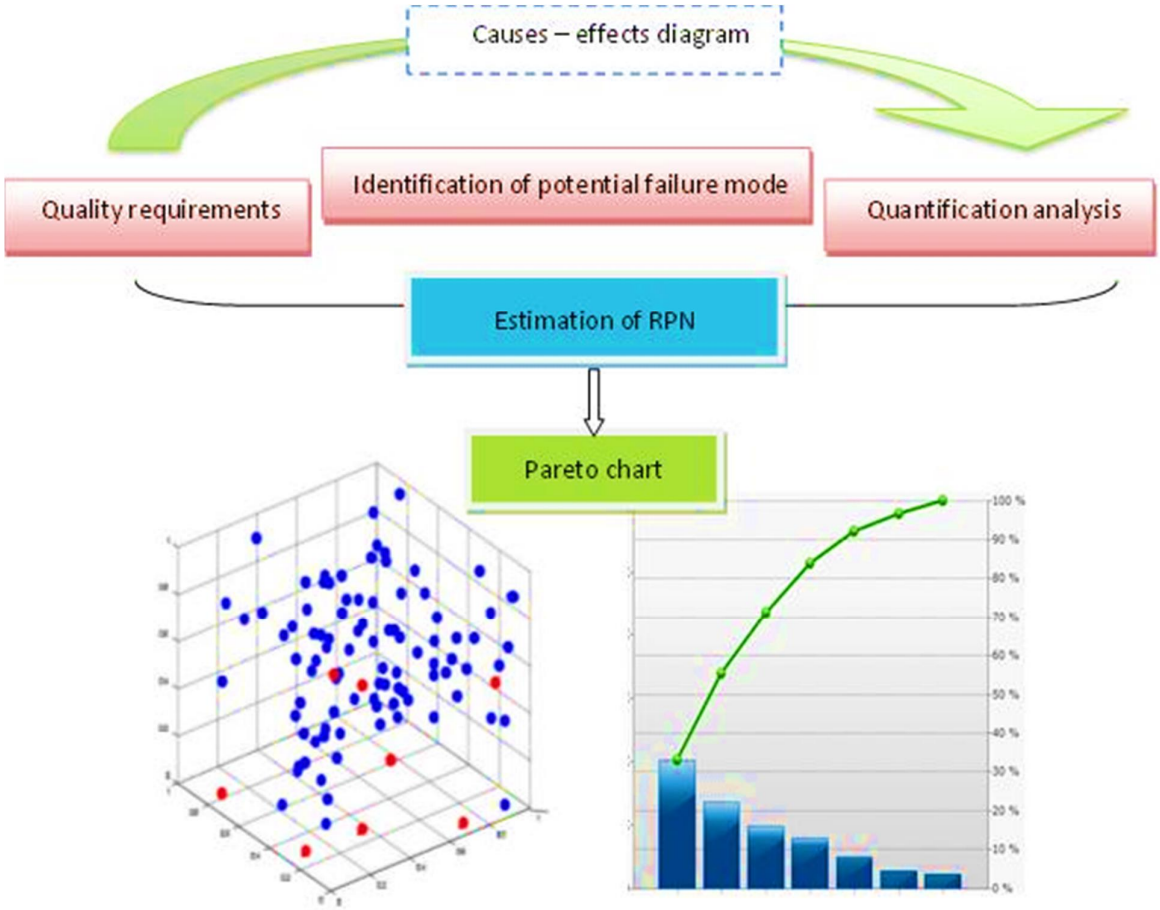

Fig. 1. Simulation method

In the case study we propose to analyze potential failure modes specific to manufacturing processes considering cutting tool wear, machine tool wear, wear of measurements and control equipment.

It was identified the potential failure modes based on cause - effects analysis for longitudinal turning, frontal turning and current control. Also, it was determined the risks priority numbers and it was made their prioritization. There are identified and assessed each corrective action taking into account the cumulative relative frequency of potential failure modes.

In figure 2 is illustrated the histogram of potential failure causes for the initial and optimized stages. To detailed the case study we have analyzed each manufacturing process and it is drawn the Pareto diagram which allows to identify the problems that will be solved by making the corrective actions.

A Pareto diagram puts data into a hierarchical order which allows the most significant problems to be corrected first. A Pareto chart can help to focus efforts on achieving the greatest improvements. It is perhaps the diagram which is most often used in management presentations [3], [4], [5].

Application of Pareto diagrams can analyze, determine, and prioritize the main potential failure modes based on the cumulative relative frequency.

Based on the experimental data, Pareto diagrams corresponding to manufacturing process were created that shows the models of representation of cumulative relative frequency distributions (figure 3 to figure 5).

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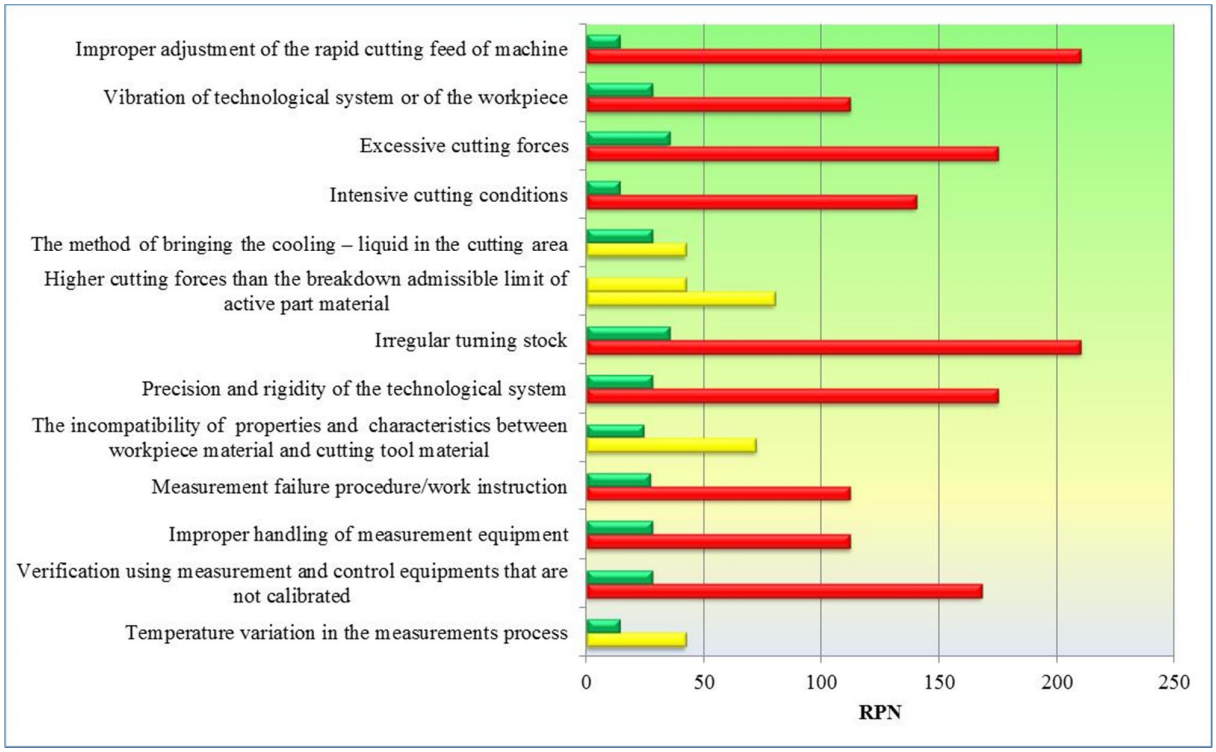

Fig. 2. The histogram of potential failure causes

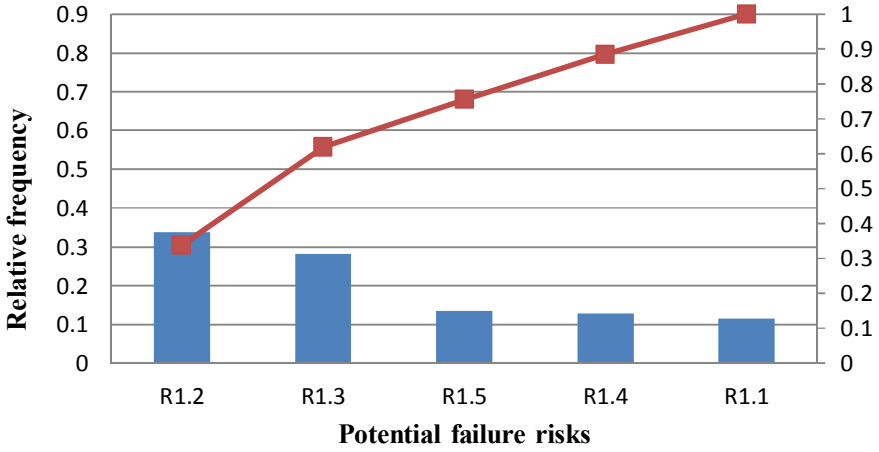

Fig. 3. Pareto diagram for frontal turning

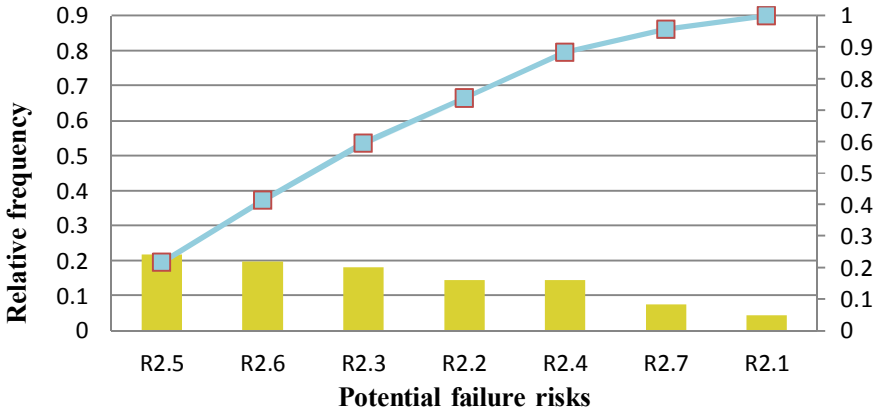

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Fig. 4. Pareto diagram for longitudinal turning

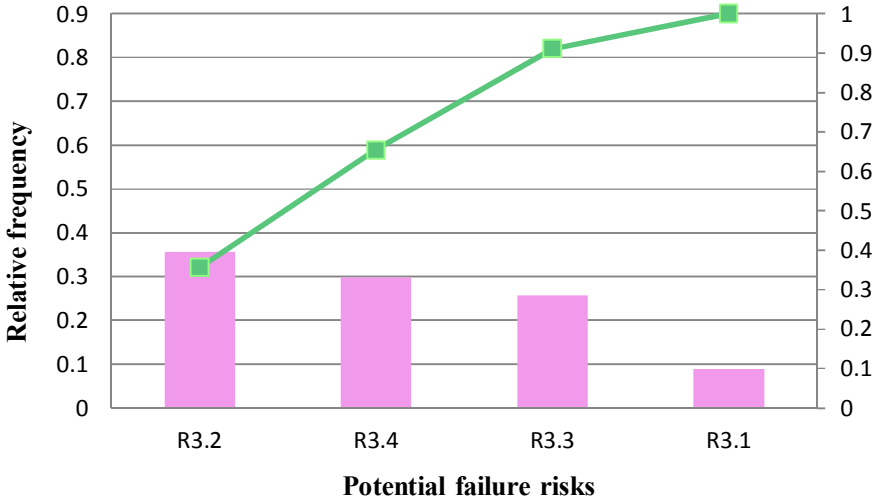

Fig. 5. Pareto diagram for current control

Analyzing the results using Pareto diagram for optimized stage, it can be prioritized the occurrence causes of potential defects. Hierarchical classification of the main causes of potential failure risks in their order of importance gave the following results (figure 3 to figure 5):

- Frontal turning: 61.98% were caused by the first two potential failure causes ï Precision and rigidity of the technological system and processing cutting parameters;
- Longitudinal turning: 59.5% were caused by the first three potential failure risks- material of edge cutting tool, cutting parameters and cutting fluid;
- Current control: 65.4% were caused by the first two potential failure risks - Checking using measurement and control equipment that are not calibrated and the nonconformity with measurement procedure.

4 Conclusions

- In quality and reliability engineering, Failure Mode and Effects Analyses are one of the most widely used techniques for evaluating the potential problems of industrial processes and systems.
- Cause and effect diagrams for the most serious failure modes identified in the FMEA (failure points with the top-scoring RPN) - for each of the failure modes points, additional root causes were explored to help ensure that the strategies selected for action would be most successful.
- To exemplify our researches we approached the FMEA method that allows us to determine the corrective/preventive action for the analyzed process. In correspondence with FMEA based on estimated risk priority number, it is drawn and analyzed the cumulative frequency chart (Pareto charts). By using this approach, we can prioritize the individual changes that will most improve the processes quality performances.
- Each failure point was assigned a risk priority number (RPN), and a determination was made whether to accept, control, or eliminate the risk of the potential failure modes. Finally, error prevention strategies were suggested for the failure points that could not be accepted.

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