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# The impact of the FMEA method used on the development and improvement in the implementation of the new product in analysis of company X

# Wpływ zastosowanej metody FMEA na opracowanie oraz doskonalenie procesu wdrażania nowego produktu na przykładzie przedsiębiorstwa X

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**Abstract:** The author presents issues related to the development and improvement of the process of implementing the production of a new product on the example of the company X. The subject of the analysis were data on the course of the process and its component factors developed using the FMEA method. This method was the basis for defining the direction of improvement of the production process in a given enterprise as well as the development of appropriate corrective and preventive measures improving the current approach.

**Streszczenie:** Autorka przedstawia zagadnienia związane z opracowywaniem oraz doskonaleniem procesu wdrażania produkcji nowego produktu na przykładzie przedsiębiorstwa X. Przedmiotem analizy były dane dotyczące przebiegu procesu oraz jego składowych czynników opracowane przy użyciu metody FMEA. Metoda ta była podstawą do określenia kierunków doskonalenia procesu produkcyjnego w danym przedsiębiorstwie jak również opracowania odpowiednich działań korygujących i zapobiegawczych usprawniających dotychczasowe podejście.

**Key words:** FMEA method, implementation of new product manufacturing process

**Słowa kluczowe:** Metoda FMEA, wdrożenie nowej produkcji

## 1. Introduction

Increasingly stringent customer requirements are becoming a challenge for companies operating in the automotive industry. The developed methods and implemented procedures are often adapted to those already existing in the customer's enterprise. In this way, companies providing components and parts for the automotive industry have begun to implement the next elements and methods of effective planning, quality management and improvement. This is despite the fact that these companies do not have implemented the appropriate ISO standards required for each type of production.

The company planning to implement new parts production for the automotive industry is obliged not only to deliver a trial batch of the product, but also to ensure continuity of the process and its effectiveness. It is also obliged to declare the continuous quality of its products and assessment of the occurrence of all types of risks associated with the various stages of production. If the levels identified as critical to the client in the FMEA method are exceeded, then the manufacturer is required to declare and verify the performance and effectiveness of actions aimed at eliminating the potential threat to the process. Corrective and preventive actions at the planning stage of the implementation of the new product and in the improvement of the manufacturing process is one of the benefits of the FMEA method of analysis. They guarantee that the identified potential risks at the initial stage will be subject to special remedies that will continue to be a permanent solution to the problem. As a result, they will increase the efficiency of the production process and will contribute to customer satisfaction with the products delivered to them. This also has a direct impact on employee awareness. By taking the training and the responsibilities arising from the actions identified by the FMEA, employees are able to consciously identify potential risks to the process and provide adequate remedies to eliminate them.

## 2. FMEA method

The FMEA method is an analysis of the types and effects of possible errors. This method can be used in the design phase as well as during the manufacturing process. Using this method during design phase allows you to capture problems or defects even before the product is qualified for production. FMEA is used at such early phases mainly in situations where a company introduces a new product, uses new materials during production or implements new technologies to the process. It is applicable in cases where the use of a particular product would have to be carried out under severe, hazardous conditions and if the damage to the product would cause a significant risk to the user. The process FMEA method mainly refers to the subsequent stages of manufacturing a particular product or its parts or subassemblies. The method is used

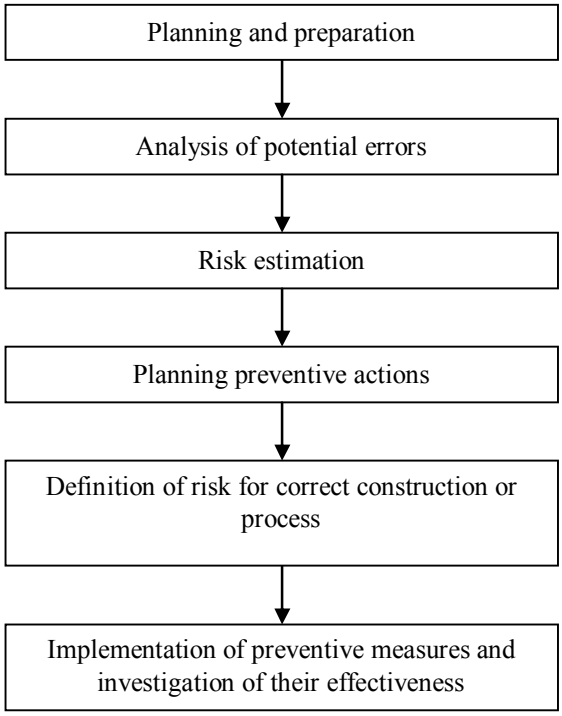
in this phase to reveal problems or factors that would adversely affect the course of the production process [1].

When using the FMEA method it is necessary to establish a team of people who should count from 4 to 8 people. It should include employees of a company that has a lot of experience and are appointed from various levels of the organization. The appointed group should be led by a selected team leader, who is primarily responsible for selecting team members, how to perform tasks, organizing meetings, setting appointments, and supervising team meetings. To his/ hers duties we can also add controlling the team in terms of their effects. The team develops successively the stages of handling FMEA method in each and every case. These steps are shown in Figure 1.

**3. Implementation of new production using FMEA in Enterprise X**

Company X is a company producing castings mainly from gray cast iron for the automotive and construction industry. It is a company with extensive experience in cooperation and production for the automotive industry. In order to achieve appropriate efficiency in implementing the process of producing a new product, the board of company X set out the objectives. The effect of which was to obtain the customers positive assessment of the production potential. One of the key goals set by the management was development and appropriate assessment of the risks and potential risks that could have an impact on the final output. The team identified the various stages of production and the errors that could affect the process and its continuation. Human errors and those caused by the company's employees were also taken into account. All factors were divided into individual items and for each of them The team determined estimates. These values helped to obtain the necessary data for further analysis using the FMEA method. Proper analysis using the FMEA method consists of several steps. In company X, the team identified defects in the product and errors in the process. The resu lts of the team work are shown in Table 1. For defects there was also determined the relationship between the individual defect-effect-cause. In the next step, we set the effects of the occurrence of these defects and their causes. The team also described current control methods that implemented for detection of these defects and causes. For each relationship, SEV, OCC and DET are calculated. These symbols stands for [3]:

- SEV – "Severity ranking" encompasses what is important to the industry, company or customers
- OCC – Rank the probability of a failure occuring during the expected lifetime of the product or service
- DET – Rank the probability of the problem being detected and acted upon before it has happened.




***Rys.1. Stages of analysis of causes and effects of defects - own elaboration (GOŁĘBIEWSKI M., JANOSZ W., POZOROWICZ M. 1999).***

***Tabela 1. FMEA form for the new product being deployed in Enterprise X***

| Enterprise X | FMEA | NAME OF CASTING: INERTIA RING | | No. ANALYSIS: | | No. TECHNOLOGY CARD: | | | |
|---|---|---|---|---|---|---|---|---|---|
| | CUSTOMER: *Customer Y* | EXECUTIVE TEAM: *Manager T* | | APPROVED: *Executive Manager Z* | | PAGES: 2 | | | DATE: |
| **PROCESS OR OPERATION TECHNOLOGY** | **POSSIBLE DEFECT** | **EFFECTS OF DEFECTS** | **SEV** | **CAUSE OF DEFECTS MECHANISM** | **OCC** | **CURRENT CONTROL PREVENTION** | **DET** | **RPN** | **RECOMMENDED ACTION** |
| RAW MATERIAL INSPECTION | WRONG CHEMICAL COMPOSITION | CASTING DISQUALIFICATION | 10 | INCORRECT ENTRY INTO PRODUCTION SCRAP | 2 | CHEMICAL ANALYSIS, VISUAL INSPECTION | 2 | 40 | INCREASED CONTROL OF RAW MATERIAL IN ACCORDANCE TO SPECIFICATION NORMS |
| TOOLS | OUT OF DIMENSION | CASTING DISQUALIFICATION | 10 | DAMAGED EQUIPMENT | 2 | CHECKING OF TOOLS DIMENSION | 2 | 40 | RIGOROUS EQUIPMENT CONTROL |
| PREPARATION OF GREEN SAND | LARGE AND SMALL BLOW HOLES | CASTING DISQUALIFICATION | 10 | INCORRECT DATA OF GREEN SAND | 3 | CHECKING THE PARAMETERS OF GREEN SAND/ VISUAL INSPECTION | 2 | 60 | PROVISION OF RELEVANT PARAMETER OF THE GREEN SAND FRQUENT INSPECTIONS INSIDE OF THE FORMS |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| MAKING FORMS | GREEN SAND DETACHMENT FROM THE FORM | CASTING NEEDS REPAIR | 10 | INCORRECT DATA OF GREEN SAND | 3 | CHECKING THE PARAMETERS OF GREEN SAND | 1 | 30 | PROVISION OF RELEVANT PARAMETER OF THE GREEN SAND |
| CUPOLA LOADING | WRONG CHEMICAL COMPOSITION OF IRON | CASTING DISQUALIFICATION | 10 | WRONG CUPOLA LOADING | 2 | CHEMICAL ANALYSIS VISUAL INSPECTION | 2 | 40 | INCREASED CONTROL OF RAW MATERIAL IN ACCORDANCE TO SPECIFICATION NORMS, INCREASED SUPERVISION OF EMPLOYEES |
| MELTING | WRONG CHEMICAL COMPOSITION OF IRON | CASTING DISQUALIFICATION | 10 | WRONG CUPOLA LOADING WRONG CONDUCTING OF MELTING PROCESS | 2 | CHEMICAL ANALYSIS MEASUREMENT OF TEMPERATURE | 2 | 60 | CONTROL OF CHEMICAL COMPOSITION AND TEMPERATURE OF LIQUID METAL |
| POURING | CASTING DEFECT | CASTING DISQUALIFICATION | 10 | LOW TEMPERATURE FOR METAL | 2 | CONTINUOUS MEASUREMENT OF TEMPERATURE | 1 | 20 | ENSURING PROPER TEMPERATURE OF METAL |
| KNOCKING OUT | MECHANICAL DAMAGE | CASTING DISQUALIFICATION | 10 | CASTING DAMAGE, INCORRECT REMOVAL TECHNOLOGICAL MATERIAL EXCESS | 3 | VISUAL INSPECTION | 1 | 30 | STAFF TRAINING |
| CLEANSING | CROOKED CASTING | CASTING DISQUALIFICATION | 10 | DAMAGE RESULTING FROM THE CLEANING IN THE CLEANER | 2 | VISUAL INSPECTION | 1 | 20 | STAFF TRAINING |
| SORTING | DEFECTS IN SHAPE AND SURFACE | CASTING DISQUALIFICATION | 10 | WRONG PROCEDURES EXECUTION DURING THE MANUFACTURING PROCESS | 3 | VISUAL INSPECTION | 2 | 60 | INCREASED SUPERVISION OF THE PRODUCTION PROCESS |
| GRINDING | MECHANICAL DAMAGE | CASTING DISQUALIFICATION | 10 | INCORRECT REMOVAL TECHNOLOGICAL MATERIAL EXCESS | 3 | VISUAL INSPECTION | 1 | 30 | STAFF TRAINING |
| MECHANICAL TREATMENT | DIMENSIONS OF CASTING OUT OF SPECIFICATION | CASTING DISQUALIFICATION | 10 | IMPROPER CASTING PLACEMENT IN MOUNTING JAWS FOR MACHINING , IMPROPER MACHINING PARAMETERS | 3 | DIMENSIONAL INSPECTION | 1 | 30 | INCREASED CONTROL OF PARAMETERS MARKED AS OF GREAT IMPORTANCE, DIMENSIONAL INSPECTION OF MACHINED CASTING |
| FINAL INSPECTION | DEFECTS IN SHAPE AND SURFACE | CASTING DISQUALIFICATION | 10 | WRONG PROCEDURES EXECUTION DURING THE MANUFACTURING PROCESS | 3 | VISUAL INSPECTION | 2 | 60 | INCREASED SUPERVISION OF THE PRODUCTION PROCESS |

***Tabela 2. A summary of the data by which the results of the FMEA analysis in enterprise X are interpreted***

| **Probability of occurrence OCC** | | **Severity SEV** | | **Detection DET** | | **Risk priority number RPN** | |
|---|---|---|---|---|---|---|---|
| Rating | Score | Rating | Score | Rating | Score | Rating | Score |
| Very low | = 1 | | | High | = 1-2 | | |
| Low | = 2-3 | Significant (only aesthetics) | = 1 | Medium | = 3-4 | Low | = 1-50 |
| Medium | = 4-6 | Significant (for function.) | = 2-6 | Small | = 5-6 | Medium | = 50-100 |
| Large | = 7-8 | Great importance | = 7-8 | Very small | = 7-8 | High | = 100-200 |
| **Very large** | **= 9-10** | **Extremely large (for function.)** | **= 9-10** | Improbable | = 9-10 | **Very high** | = 200-1000 |

## 5. Interpretation of the data obtained in the analysis

In order to accurately interpret the data received, a table was used to determine the main factors influencing the production process.

FMEA analysis identified elements of the production process that needed improvement. In three of the thirteen stages of production potential defects exceeded the risk level of 60 (medium risk). When analyzing the data obtained we should consider which risks are most important to us. Taking care of all takes a lot of time. This way we also obscure the picture of the whole problem and the factors which we should devote the most attention. For this purpose, the rule for determining the severity of problems described in the Paretto-Lorenz method should be taken into account, where 20% of the causes of nonconformity are the basis for the occurrence of 80% of the defects. This was also stated in Enterprise X where the reasons for RPN = 60 were treated as the main ones. Based on them, actions were taken to eliminate these causes. Due to the rigorous approach of the customer to the quality of the parts supplied, the effects of the defects were assigned a value of 10 defined for the extreme importance for the operation. The company set preventive measures for the main causes identified as those with the greatest level of risk. The first of which was the activities planned for preparation of the Green Sand. Preventive measures have been identified to secure proper data for the use of Green Sand as well as increased control of casting mold cavity. The remaining stages in which the RPN value was 60 were the sorting of elements (after purification) and the final inspection in which potential defects of shape and surface can be overlooked through potential failure of following procedures and instructions. In both cases, the current preventive measures used were visual inspection. The recommended remedy in this case was to increase the supervision of the entire production process for both factors. The implementation of the mentioned actions and their verification at a later date proved to be an effective remedy which, while stabilizing the process during its implementation, led to greater efficiency. It also had a direct impact on customer satisfaction.

## 6. Summary and conclusions

The example of the solution to the problems related to starting a new production presented in the article gives the basis for the conclusion that the method of FMEA risk analysis used for this purpose is an ideal way to approach the whole concept of the production process and the threats to its effective functioning. It provides the opportunity to unambiguously interpret potential threats to the process and determine the level of risk. Company X correctly determined on the basis of an analysis the preventive actions that resulted in a reduction in the potential risk of nonconformity. This has also increased the efficiency of the new production being implemented and raised the customer satisfaction with the quality of the products received.

## Literatura

[1] Urbaniak M., 2004: „Zarządzanie jakością: teoria i praktyka", Warszawa.
[2] Gołębiewski, M., Janosz W., Prozorowicz M., 1999: Zarządzanie jakością w przedsiębiorstwie, Szczecin.
[3] https://www.isixsigma.com/tools-templates/fmea/quick-guide-failure-mode-and-effects-analysis/