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FMEA ANALYSIS AS SUPPORT TO INDUSTRY 4.0 IN THE TOBACCO INDUSTRY

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Abstract: FMEA calculates the risk of using the system and possible errors, as well as their effects on the system itself. Because FMEA has an object-oriented approach that's very easy monitoring, development, use and modifies the software. Approach to solving such a complex system such as the production of cigarettes, here and abroad, have been analyzed in this way. A new approach is the analysis model and application of new tools for the analysis and synthesis model is an original scientific contribution. Because we have quality in all areas of production then we need to constant monitoring of the same. No human auditors, medals quality standards are not sufficient to at all times maintain the required level of product quality. We require adaptive expert systems for predictive control of industrial processes to be able to keep the process under constant control. This may not be the production of cigarettes, but the production of drinking water or other products. Even if the product is awarded the highest score, just one mistake can cause a bad product or a product which endangers human health.
Keywords: FMEA, Industry 4.0, Tobacco Industry

1. INTRODUCTION

The FMEA was developed and implemented for the first time in 1949 by the U.S. Army and later executed in Apollo space program to temperate the risk [5]. Purpose of FMEA is founding links between causes and effects of defects, as well as searching, solving and drawing the best decisions regarding solicitation of applicable action. Failure mode and effect analysis is an analytical technique (a paper test) that combines technology and experience of people in identifying probable failure mode of product or process and planning for its abolition. FMEA is a "before-the- event" action requiring a team effort to easily and inexpensively alleviate changes in design and production. [1]

FMEA is a systematic procedure that focuses on a system(s) in order to uncover weaknesses, i.e. what can go wrong, what could possibly cause it and what are the potential effects. [2] FMEA then focuses on these weaknesses with the objective of making them obsolete, or by reducing the likelihood of failure (or risk of failure) though the implementation of corrective methods, which in turn optimizes the system like on Figure1.

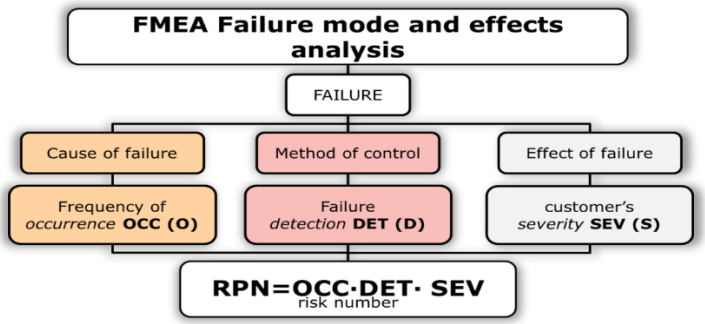

Figure. 1 FMEA analysis [5]

The Failure Mode and Effects Analysis (FMEA) is an analytic procedure for proactive systems and risks analysis. The FMEA allows to reveal existing weak spots and to initiate measures for the purposes of remedying those and preventing possibly resulting failures (preventive approach).

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Moreover, the FMEA facilitates the optimization of current products and processes (corrective approach). Furthermore, the FMEA serves companies to systematically bundle experience-based knowledge regarding relations between failures and to provide it to the planning department for the purpose of reusing known solution possibilities [3], [4].
Criticality and Risk Priority Number (RPN) is calculated by using the following formula:

$$\text{Criticality} = \text{Severity} \times \text{Occurrence} \quad (1)$$
$$\text{RPN} = \text{Severity} \times \text{Occurrence} \times \text{Detection}$$

2. FMEA ANALYSIS PROCESS OF MANUFACTURE OF CIGARETTES

FMEA analysis as we have said in the introduction is a method for assessing errors and their effects on a complete production system. In our analysis, we have used the process of manufacture of cigarettes. [6]

—Reviewing the process of manufacture of cigarettes

The motive for the review process is repeated complaints from the market and the desire of management to improve the quality of their products. The process of manufacture of cigarettes is carried out in five operations, namely:

- Operation 1. Receipt of tobacco on the ground.
- Operation 2. Reception tobacco warehouse in the tobacco factory
- Operation 3. Storage tobacco
- Operation 4. Start of production
- Operation 5. Packing and Shipping

—Prior knowledge

FMEA team during the preparation for analysis of the collected all available data and based on knowledge of the production process concluded the following:

- Sources of supply tobacco (Import and individual producers) are not systematically selected and there is no system of control by the factories of tobacco;
- At collection stations on the ground, receiving the tobacco from the producer controls the only kind of tobacco;
- At the receiving point can not control the moisture content of the tobacco, microbiological;
- In the warehouse of the Tobacco Factory have no constant maintenance of temperature and humidity in the air;

—Analysis

Based on available data and knowledge of individual members, FMEA team has carried out a detailed analysis of possible samples of finished cigarettes with error and concluded the following: Error on the product is the result of many possible causes including:

- Inadequate quality tobacco that goes into the process
- Moisture deviation of parameters, which causes the increased weight of the cigarette
- Low quality of domestic tobacco, which is full of moisture and the roots
- Quality control of tobacco to collection points on the field does not guarantee the protection of the production process of the presence of poor tobacco;
- Quality control of the entrance of the tobacco factory is not sufficient
- Control operation of which is only at the output, when the process of cigarette manufacture which;

—The current situation

Once completed the analysis of processes and measures to control and test the process and the product, FMEA team is using tables evaluate risk factors as shown in Table 1.

Table 1. Evaluation of error from causes

Error	Cause	R1	R2	R3	R
Increased percentage of bad cigarettes	Inadequate quality tobacco	8	8	8	512
	The deviation parameter moisture in tobacco	2	8	8	128
	A failure in the dryer	2	8	8	128

Index calculation priority risk for each pair of cause-fault, FMEA team found that all three causes critical, but it is inadequate quality tobacco is the most critical cause of error.

—Corrective measures:

Analyzing the results of the evaluation of the current situation and the conclusions from the

analysis, FMEA team found that the possible remediation of the problem is feasible through the implementation of three corrective measures:

- the introduction of systematic, continuous, checking the quality of tobacco at the entrance; [7]
- the introduction of continuous tobacco moisture measurement, as one of the most important parameters of quality of tobacco;
- measurements of finished cigarettes from the standpoint of all possible deviations quality cigarettes.

On the basis of the proposed corrective measures, FMEA team has predicted the effects of these measures on the assessment of improved conditions and the forecast is given in in the next Table 2.

Table 2. Evaluation of the effect of corrective measures

Cause	Corrective measures	The expected rating			
		R1	R2	R3	R
Inadequate quality tobacco	Systematic checks and selection of suppliers	4	8	2	64
The deviation parameter moisture in tobacco	Measurement of moisture every day, and enter into the database	2	8	2	32
A failure in the oven	Interruption of production and elimination of failure	2	8	2	32

—Rating improved condition

After realization of the imposed corrective measures, FMEA team has assessed the effects of these measures and came to the conclusion that the measures are correctly implemented, but that is due to the nature of the error (alarm later), it is necessary that professional services for a period of one year following the process and customer complaints, but only to then make a definite mark of improved conditions. In this sense, FMEA analysis is not considered concluded. Until the expiration of a period of 12 months, FMEA team will actively monitor current activities and outcomes measures.[8]

—Documenting analysis

FMEA is a document formed by the analysis of the data was entered successively, in order to form. Since the analysis is not considered concluded, the team leader not archived document, but it keeps to the validation of the results anticipated corrective measures (see Annex B).

Risk Rating = error + rating causes errors + rating error detection

Risk gives us the possibility of ranking system errors decisions to increase tobacco or to reduce it, if we want to go with a predicted Ružik quality or risk rejection output cigarettes. Risk also provides the number of cigarettes that will be provided to a reliable analysis, be accurately produced, the mass parameter cigarettes.

Eg. Risk = 6 * 5 * 5 = bad a cigarette 150 at the correct

If not for the other parameters of this kind of rule would be wrong. Looking at just this rule we would make permanent the correct cigarette, based on this parameter mass cigarettes. But investing is positive in a certain percentage of the cigarettes that are not dry. Then we look at the parameter benefits cigarettes compared to the CUG.

Data is defined as the knowledge base on the problem of change of mass based on the cigarette tobacco moisture in, as one of the factors affecting the quality of the cigarettes. Rules are built into the system, decide, depending on the target quality of the cigarettes, which provides data at input by the appropriate application data to the output. Assessment of quality of output, ie. cigarettes affects the possible corrective action. When this is examined from which supplies tobacco because it has an impact on the decision.[9]

Altogether evaluated FMEA analysis, based on which we monitor the risk identified product quality. View data from a year is more than sufficient to note the sample weight change trends in the function of moisture. On this basis, our model is decided by 7 quality level based on humidity and 10 levels parameter eligibility on the basis of other quality parameters of products. Based on this analysis, the management company decides to launch new cigarettes, as well as the risk factors of production such as cigarettes. A further task of the system is that feedback control maintains the production of cigarettes in predetermined frames.[10]

Periodically analyze financial effects and establish new corrective measures, as well as new rules of operation of the system. Stage adaptive expert system for predictive control industrial processes assist company management in order to maintain the quality of the cigarettes and the economy of the same. In Figure 2 and 3 are presented for illustrative results in the production process in the

two cases. The recorded weight change before and after the stage of use of an expert system. The diagram shows that the mass prior to use cigarette system varied from overweight shuffled to cigarettes, which caused failure rates and delays in production. The system feedback to stabilize the mass as. Figure. 1.

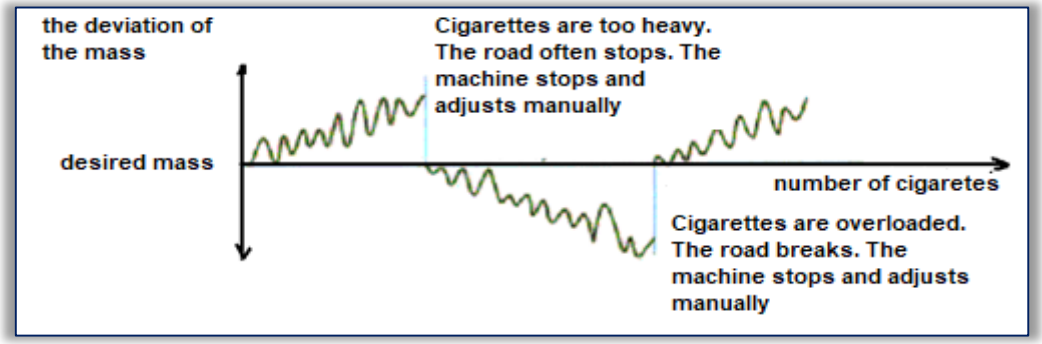

Figure 2. Change of mass as a function of time prior to the introduction of Phase expert system for predictive control industrial processes

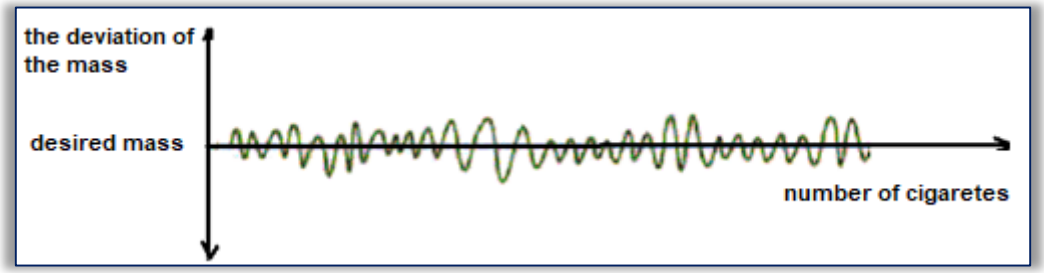

Figure 3. Change of mass as a function of time after the introduction of Phase expert system for predictive control industrial processes

The results have been directly applied to cigarette tobacco factory Banja Luka. The parameters are set machine for producing cigarettes.

Table 3. The parameters for producing cigarettes

FILENAME	LONG.brn
NUMBER OF BRAND	1234
NAME BRAND	LONG
SPEC. WEIGHT	898.0
LENGTH OF TIME	63
START the door strike to reject CIGARETTE	2
Pulse width OPENING DOORS FOR REJECTING CIGARETTE	0
OFFSET A	236
OFFSET B	238
SCOPE histogram	125

4. CONCLUSIONS

FMEA is a methodology for analyzing errors and their effects on a process, service, or product, to continually improve the process. It is a systematic approach to risk analysis, definition, assessment and assessment. FMEA analysis is a standard setup process that reduces setup time and improves process quality and efficiency. FMEA helps to improve the manufacturing process and it's quality while reducing the number of defective products and saving costs and repair time. For each procedure, we need to know the preventative measures and put them into tables or programs that can significantly reduce the waste of time and money in the manufacturing industry.

We had one approach in the paper, which proved to be the most effective. One is Failure Mode Analysis and Effect Analysis (FMEA) and is one of the formal tools used to effectively plan the production process. The FMEA prevents or corrects identified or potential failures. The next step is preventive action, noting in the initial procedure and recommending preventive or corrective measures and taking them at an early stage based on the input data. In this paper, we have explained in detail and done one such system in the production of cigarettes at the Tobacco Factory in Banja Luka. Developing an information system for data acquisition and preventive error detection, based on the rules we have inserted as data into the knowledge base, enables such a system. The development of this FMEA production process information system overcomes the

problems encountered with the introduction of the FMEA System. Industry 4.0 needs such systems because of the quality of the output product and the quality of the process by which it is produced, all in real-time production.

Note:

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