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RESULTS FROM IMPLEMENTED FMEA METHODOLOGY – FOLOW UP ON A IMPLEMENTED pFMEA

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Abstract: *The aim of the paper is to present small part from the aimed results from already implemented FMEA methodology into an entity from Bitola, R. Macedonia. According to the previous results from the period November 2016 – January 2017, and according to the conducted folow up onto the same one, the paper presents fresh results after the implemented FMEA matrix, on a six mounth folow up period. The results shown into the paper are from June 2017. The business entity once again is an fireplace producer from Bitola, one of the most older ones in Macedonia and into the Balcans, and one of the largest one according to it's year production and employees (among fireplace producers). Having in mind that this is a folow up on a previous published paper, the same one has some simularities to the previous one, but finally presents the results after a several implemented matixs regarding several sub processes into the business entity, such as: cutting, shaping and drilling metals. The benefits from the implemented matrix were already mentioned in a previous paper, but after an extensive research and implementation of the FMEA methodology on a daily base, the results are more than visiable. The paper represents the same ones in addition.*

Key words*: FMEA, long term implementation of FMEA matrix, pFMEA, industrial entity from the metalworking industry, R. Macedonia*

1. INTRODUCTION

The basic aim of the paper is to present a follow up on a previously done FMEA into an industrial entity which works into the metal cutting industry, to be more precise into a fireplace production, and has a market share into the Balkan's more than 60 years. The same one is one of the largest ones in this region, by year production and employees, and has one of the best production lines among competition. This paper presents a follow up onto a previously published publication and a previously done research. The same one is also published into the TEMEL International Journal, and was done into the time frame November 2016 – January 2017. What was published into the previous publication was about the process of implementation and real daily base usage of the pFMEA matrix, which brought the company real benefits. This one is a follow up on the same one, and presents a momentarily view (done as a research into the same business entity) onto the matrixes and it's real benefits to the business entity.

Just for reminding, the first implementation brought the company reducements into the non-conformities, problem reducements, quality improvements, reducement of expenses and bigger profits through a processes of continuous reducements of the non-conformities into the production stages. So, the starting view and hypothesis according to the previous information's were that we should have small RPN's and more quality production into the business entity.

Having in mind, that the paper presents follow up on a previous done research and real implementation, done by a multidisciplinary team (conducted from person with a long term experience into the field of Technical sciences, person from a long term experience into the field of implementation of such systems, persons from the management team, workers from direct sub processes) the follow up was done from representatives from the management team and representatives from the workers from the direct processes where the matrix's were used during the 6 month period. So, in addition of the papers some of the aimed results are presented.

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2. PRESENTING FMEA METHODOLOGY

The methodology that was used while the research, same one as previously, was FMEA methodology. The same one is known as a methodology which primarily is used for detection and analyses of potential non-conformities, and is known as a method for systematically detection of potential non-conformities, but also as a one that creates potential solutions. This method is worldwide knowing as a FMEA (Failure Mode and Effect Analysis). The methodology most common is used for:

- Detection of potential non-conformities, which has a crucial influence to the system productivity
- Evaluating the effects of each detected non-conformity and its influence to the system, the influence over the functions of the elements and sub systems

FMEA is a world known as a methodology which is based on team work and it's accepted as one of the most common methods for system improvements directly, but also as one of the methods which indirectly has an influence to the quality of processes, quality of final products, business performance and finally brings financial benefits to the entity. The same one as a method has influence to all of the production stages, with a final aim of improvements from a process to a process. Whit it's usage the same one brings the subject to a situation where all of the potential non-conformities could be evaluated and could be segmented as primary, secondary ones and non-conformities as a result of human mistakes.

The methodological approach to the same one is based on a team work and created tabular views which are a multiplication of three common factors (the severity, the occurrence and the possibility for detection). Multiplication brings us to a created RPN number, shown in addition:

$$RPN = \text{severity (S)} \times \text{occurrence (O)} \times \text{detection (D)}$$

Each of the multiplication factors shown into the formula above are on a scale from 1 to 10, and could be exactly read from generated tables. Considering previous mentioned, the maximum RPN number could be 1000. One of the most important things to say at the moment is also the approach to the problems (solving approach). The same one is based from top to bottom considering the RPN number. The implementation of the method is developed considering several steps: team creation, defining time and place for implementation, creating structural, functional and non-conformity analyses after which the team approaches to a realization of a recommended steps and solutions after which there is an additional monitoring on the system.

3. REVIEW OF THE PRODUCTION PROCESS

Having in mind that the paper presents a follow up from extensive research done previously into a business entity from Bitola, which after the implementation of the FMEA methodology has some benefits and adopted the same one on a daily base use, it's more than necessary to show all of the production processes and sub processes.

The same one is a part from a production line which produces stoves, where the process is separated to the following sub processes:

- Buying raw materials
- Quality control – on the raw material
- Segmenting the raw materials into magacines
- Cutting on small and large scissors
- Making holes to the material
- Using hydraulic presses
- Delivering the final piece to magacine or to another process

Generally, the first research and implementation had in mind all of the characteristics of the sub processes which could bring to non – conformities, and according to the policy of doing right follow up, the same one was taken into consideration once more. So, these were the characteristics which were also taken into consideration:

- Machines
- Methodology of work
- Material
- Human factors
- Measurement instruments
- Work conditions

Seeing things once more after a period of 6 months, and after a daily base usage, the mistake factor is more than smaller. We could say at this point that the workers which use the same one on a daily base had some routine and have considered how to use the same one better and better. But as a live mathery the business entity still has some problems, especially with the newest employees, while their adaptation process, where non-conformities and problems still show up.

4. PRESENTING THE RESULTS FROM THE FOLLOW UP

This segment maybe is the most important part from the paper. The same one presents three tabular views, which present the results from the first conducted FMEA matrix ever done, the ACTIONS done and the redocument of the RPN factor into the frame January 2017, and finally the results from the follow up done into the two weeks period in June 2017. So, seeing the same one the reducements are more than valuable.

Process	Potential Failure	Nus – effects	S	Reason	O	Reason	D	RPN
Transferring the done pieces into the warehouse	Damaged piece	Replacement time sequences which are long	4	Mistakes made by workers while transfer	3	Checking piece by piece	4	**48**
	Long time for transfer	Production delaiment, free work force with no activities to do	5	Transport equipment which is more than old	7	Checks on every piece	2	**70**
	Not appropriate conditions into the warehouses	Nus products	3	Mistakes made by the warehouse workers, and the transport workers	4		6	**72**

The first table, shown above presents the starting point, or to be more precise it's the first matrix ever done into the business entity. The same one is done after a long-term cooperation between the multidisciplinary team members, and presents the firstly spotted non-conformities into the sub process – transferring the done pieces into the warehouse.
The second table shown below, presents the matrix made after a while (with actions taken with an aim to reduce the raw pieces and non-conformities) and presents the benefits in a short period of time after the implemented pFMEA methodology into the business entity.

Actions TO DO	Actions TAKEN	RESULTS FROM THE TAKEN ACTIONS – NEW RPN			
		S	O	D	RPN
Motivation on work force – control of the materials, pieces	Motivation and TEAM BUILDING actions	3	5	2	**30**
Replacement of the transport equipment, as well as maintaining the ones that are already in use	Done maintance on all of the machinery which is in use	3	4	2	**24**
New warehouses, and taking some measures to renovate the ones in use	Generating warehouses which are with appropriate conditions for the use.	2	3	2	**12**

But, what is more than important is to present the momentarily view of the same sub process, where we could see real benefits after using the pFMEA methodology on a daily base. These benefits are achieved only by the members of the team, created only by the members of the business entity, which uses the pFMEA matrix on a daily base with a real communication with the employees. The tabular

view number 3 is more than appropriate view of the benefits. The same one is shown in addition. Seeing the tabular view, it's more than important to say that the daily base usage of the methodology brought the company smaller RPNs and brought them to visualize all of the problems which are the reasons for non-conformities, and also to face the same ones. Such things weren't practice in the past into the same industrial entity, so we could say that the implementation of such methodology is more than necessary for every business entity.

Process	Potential Failure	Nus – effects	S	Reason	O	Reason	D	RPN
Transferring the done pieces into the warehouse	Damaged piece	Replacement time sequences are faster since the past, but still take some time	3	Mistakes done by workers who are new at the company and made such mistakes	3	Checking piece by piece Checking the pieces brought by employee who are new	2	**18**
	Human mistakes (made usually by the newest employees)	Production delay, free work force with no activities to do Additional training and coaching activities to the newest employees	2	Transport equipment which is older and heavy to use No training activities while the process of employment	5	Checking the pieces Checking the work of the newest employees	4	**40**
	Mistakes made by the employees which work into the wearhouse's	Nus products	2	Mistakes made by the warehouse workers, and the transport workers	2	Checking pieces before using the same one	2	**8**

Seeing the table, show above and comparing the same one with the first one, we could see one newest potential failure with a high RPN, but also, we could see smaller RPNs into the other two potential failures. The reason why these RPNs are smaller are the daily base activities done by the team, but also the commitment of the management team for such activities, after seeing the financial benefits of the same one.

4. CONCLUSION

Having in mind that the paper presents a follow up on a previous done research and real implementation, from which a paper was published already, the basic aim is to present a small part from the aimed benefits from an everyday usage of methodology such FMEA, or pFMEA. Seeing the tabular views, it's more than visible that the company had benefits in several key points: team commitment, management commitment, financial benefits, reducement of non-conformities. What is necessary to say at this stage is to say that the company usage and implementation of such methodology brought some benefits and brought the team from a multidisciplinary team (from inside and outside members) to an inside team, with a knowledge to do such things. On the other hand, we could say that the research previously done and it's follow up have considered several processes into the company, and here in the paper only one sub process is presented, so more papers in near future could be published with general information about the benefits and the processes.

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