I. Kuzmanov, R.Pasic; Vol.10.Iss.1. (Feb.2026) 39 - 45
https://doi.org/10.52576/TEMEL2610139k

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GENERAL OVERVIEW AFTER IMPLEMENTED FMEA METHODOLOGY INTO INDUSTRIAL CAPACITY FROM NORTH MACEDONIA

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Abstract: *The basic aim of the paper is to present only a small part from an extensive research conducted into industrial entity from R. North Macedonia, done into the period November 2016 – January 2025. The frst step of implementing was done into the period November 2016 – January 2018 till fully implemented.The industrial capacity which was taken into consideration was from the metalworking industry and the same one was till 2019 with a serious capacity and serious productivity of stoves and fireplaces on solid fuel. Since the COVID started and it was problem to get row materials the capacity has significantly reduced the numbers of fully produced pieces and problems started. It was an entity with more than 300 employees and a production which is saled in the Balcans till 2019, but since COVID crises, raw material purchase cruses the same one reduced the number of employees significantly till it was sold out as an industrial entity. The basic aim of the paper is to represent only a small part from an extensive research and application of the FMEA methodology into the entity athe early fase till 2019, but also to represent some of the achieved benefits after a short period of time, and also to present some of the problems that was restored till the crusis started. Although the FMEA methodology is aplicated in all of the business processes into the business entity, the paper represents the process of cutting, shaping and drilling metal till getting a final piece – half product that is used into other processes during the production of fireplaces and stoves. It was the main process maybe where most of the employees worked and till COVID ruses started most of them lost jobs. The paper presents the first benefits till the period of 2019 and some of the last one done into 2023. Since then till 2025 FMEA was not so important to the entity due to the financial problems and jobs cutted.*

Keywords: *FMEA, Quality Control, Quality Assurance, Benefits from FMEA, industrial entity from the metalworking industry, R. North Macedonia*

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1. INTRODUCTION

The basic aim of the paper is to present only a segment from a conducted research done into an industrial entity which works into a metalcuting industry and has a market share into Balkans more than 70 years, till it final edns with production in 2024. After the transformation of the capital from state to a private one, the business entity started to work with completely new production lines in the year 1996. But once more, the basic aim of the paper is to present only a segment from a conducted analyses considering the momentailary state of the system when FMEA as a methodology was finally adapted in 2017 and worked will the end of 2019. In this period of time there was at first stage some resistance from the management and the workers for the processes of quality assurance and quality improvements through the implemented FMEA matrix, which in the processes of application gave the company real information's about the potential problems. Also after considering wisely the potential solutions started and the same one's were implemented and gave the production system reducements of the non-conformities, problems reducement, quality improvements on one hand, and on the other achieving bigger and bigger profits through the processes of continuous reducements of the non-conformities in any stage of production. And it was so smood will the edn of the year 2019 when COVID cirses started, row matiral income was so hard, and finaly some of the employees lost work places.

One of the key elements which is worth of mentioning is to precise that the realization of the FMEA methodology was conducted with a precisely created multidisciplinary team conducted from persons from science (persons with a long term experience into the field of Technical sciences, production, long experience in production processes), persons with a long term experience into the processes of implementation of such methodologies, persons from the management team, workers from direct work places which are under review as well as workers from the following processes into the production system. Seeing the team, we could say that the same one was more than relevant to conduct such an analyses and to create real picture about the potential problems but also to create a solutions and ways which will bring the company to an improved situation to be precise till the year 2019, as well as higher quality of the final product. At this stage as we mentioned before real problems started in the end of 2019 and beginning of 2020 when due to financia loses, nobady even cared about the implementation of the methodology. So, so many problems accured such as: job reduces, financial cutings, no raw material into the warehouse, final products which were not sold out, lost of quality etc. In the following part of the paper only a segment of the research and the

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created strategy based on the previously defined FMEA matrix, as well as a comparation with the momentarily situation.

2. PRESENTING THE METHODOLOGY THAT WAS USED

The methodology that was used while the research 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 knows 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 knows 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:

$$RPN = \text{severity (S)} \times \text{occurrence (O)} \times \text{detection (D)} \qquad (1)$$

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

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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 only a small segment from an extensive conducted applicative research with a real implementation of FMEA methodology into a real entity, and a one that brought the company real results, in addition of the paper only a one sub process is shown. 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.

While doing the analysis with an aim to detect possible non conformities, an reason – consequence methodology was used. The same one brought the team identified, researched and graphical picture to all of the potential reason for defects. While creating the step, and before the FMEA methodology was actually created, the following characteristics of the process were also taken into consideration:

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

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Seeing things this way, the possibility to miss something is minimal. But there is always a possibility something to be missed, and that is the reason why this process is continued and improvements are aimed from a process to a process. In addition of the paper only a segment from the generated FMEA methodology is presented. In this case the presented part is the process of delivering and transporting the final piece to the magacine (or to other process if it's necessary), where the first hypothesis was that we would not find any non-conformities and there wouldn't be detected any problems.

4. PRESENTING ONLY A SEGMENT FROM THE FMEA TABULAR VIEW

In addition of the paper, only a segment from the research and segmented tabular view is presented. The same one is a presentation of the detected problems into the sub system – transferring final piece to the magacine or to other sub system (if it's necessary). Presented table is from the year 2016, 2017 when it started. Afterwords till the year 2019 everything was placed on the right track and significant problems were solved. Although in this part of production (year 2016) the expectations were to have only quality produced piece (in more than 99% of cases), but issues came to the table and multiple problems were detected. The tabular view is an excellent presentation of the detected problems.

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 done 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**

After detecting most of the problems (potential and real ones, and also problems for which the employees were aware), potential solutions and practical realization of the same ones were suggested. So, after a while the process of practical implementation started and after following the results, another tabular view was created. The same one is presented into the tabular view which is given in addition.

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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**

Seeing the second part of the table, result are more than visual if you see the RPN number and compare the same ones to the previous RPN numbers into the first table. But what is important to say is than the methodology could bring results to the business entity only if the same one is implemented in a long period of time. Such approach brings business and financial benefits to the entity. After this was made several fmea tables were made and they had some improved results til the year 2019.

But COVID crises came in 2020, raw material market was so hard at that stage, prices of transport were higher, financial problems were more and more often, employees lost their jobs and maybe one of the last one made tables compares what really happened. The following table is from the year 2023 and it/s a clear overview what really happened compared to the previos one.

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	7	Mistakes done by workers while transfer	5	Checking piece by piece	10	**350**
	Long time for transfer	Production delaiment, free work force with no activities to do	8	Transport equipment which is more than old	8	Checks on every piece	10	**480**
	Not appropriate conditions into the warehouses	Nus products	5	Mistakes made by the warehouse workers, and the transport workers	5	Checks on every piece	10	**250**

5. CONCLUSION

Having in mind the previous mentioned, we could consider that the paper presents only a segment from a completely conducted applicative research from the field of quality control, or to be more precise in the field of quality assurance in this stage, into a real business entity. The same one clirely represents what happened when some global trends (COVID crises,

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financial crises etc.) came what really happened to a company in which FMEA bring a lot of quality improvements in the past period. The basic aim of the paper is to present only a segment from the functioning of the FMEA methodology into real industrial entity, with an aim to present the real benefits from the practical implementation done by a multidisciplinary team. The industrial entity had some benefits in such short period of time, the kept improving from year to year and in one moment everything changed. The best representation of the same one is presented into the tabular views. At the end we could say that the paper presents only a segment from the things which were done, and considering the fact that the company no longer works it is not an ongoing process.

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