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An integrated lean approach to Process Failure Mode and Effect Analysis (PFMEA): A case study from automotive industry

Banduka, N.[a, b,*], **Veža, I.**[a], **Bilić, B.**[a]

[a]University of Split, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, Split, Croatia
[b]University of Kragujevac, Faculty of Engineering, Kragujevac, Serbia

A B S T R A C T

Every automotive company is using ISO/TS 16949 standard for automotive industry. According to this standard of Process failure mode and effect analysis (PFMEA), is obligatory. Also, the application of lean in automotive industry is a trend nowadays. Both, PFMEA and lean have the same main purpose – identification, prevention, and correction of failures during the production process. But, PFMEA have many shortcomings. In this paper, an integrated lean approach to PFMEA for solving specific shortcomings, is presented. This approach is new and it has not been used until now. Lean approach (tools and principles), were integrated in PFMEA. The new approach to solving PFMEA was presented in algorithm form. Some of those lean tools and principles integrated in PFMEA are: Genchi Genbutsu, Kaizen, standardized work, Jidoka, and 5 why. The approach presented was realized in a case study from automotive industry where traditional approach to PFMEA was compared to the new lean approach integrated to PFMEA. Changed and improved conditions were: number of team members, the actions taken, identification of failures, change of Severity (S), Occurrence (O), detection (D) and risk priority number (RPN) values, reduced S, O, D, and RPN values after taken actions, RPN with value over 100, and S, O, D indexes with value over 8.

A R T I C L E I N F O

Keywords:
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**Corresponding author:*
nikola.banduka90@gmail.com
(Banduka, N.)

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1. Introduction

In many cases from the automotive industry, the largest number of automobile parts (about 70 %), is produced by suppliers. Since that, design and design risk analysis are usually conducted inside car manufacturer's companies. Suppliers' job is widely related to production or assembly process, so it is very important to predict and eliminate potential defects (failures) during the process. Failures reduce product's quality, leading to production delay due to rework or additional production that leads, once more, to additional costs. With more time needed to find failures, costs are much bigger. The recommendation would be to eliminate failures with quality system on source, with prevention rather than detection [1, 2]. Therefore, if companies want to sustain market competitiveness, they have to install proactive systems for prevention of failures. According to ISO 9000 and ISO/TS 16949 standards, best classified analysis for prevention of failures during the production process is Process failure mode and effect analysis (PFMEA) [3, 4].

According to many authors, PFMEA is a very subjective method with many shortcomings, so reliability of its results is variable [2, 5, 6]. Case study for PFMEA conducted in 150 supplier companies from automotive industry shows that the biggest part of surveyed suppliers sees PFMEA as additional administrative work which wastes a lot of time, and gives back less benefits [5]. Obviously it is a problem in misunderstanding or in inadequate use of PFMEA by users. Therefore, there is still lot of space for improvement of this analysis.

From the other side, lean was created due to the need for automotive industry to progress. Main purpose of lean was identification, prevention and correction of the problems in industry. Nowadays, a wide application of lean can be found in automotive companies all over the world. From the case study carried out on 300 manufacturers, it is evident that 90 % of them are applying lean [7]. Also, according to the recent research from 2015 published by Boston Consulting Group, 30 % of the world's original equipment manufacturers use lean tools in their production systems [8]. With this data, the theory about wide application of lean approach in automotive industry, is confirmed.

Since lot of automotive companies are using lean approach and PFMEA for prevention of failures, methodology for realization of PFMEA with integrated lean approach, will be presented in this paper. Also, a case study in one specific automotive company will be realized. In a Case study, results from reports of already realized traditional PFMEA and new PFMEA with integrated lean approach, will be compared.

2. PFMEA in automotive industry

The main objective of PFMEA is to identify potential failures, evaluate causes and effects of these failures, and to propose solutions to prevent these potential failures. The ultimate goal is a failure-free product in production process. PFMEA is one of two main types of failure mode and effect analysis (FMEA). Two main types are defined according to the phase where the product currently is. That could be design or production phase. According to this FMEA, the analysis related to design phase is a Design failure mode and effect analysis (DFMEA) and FMEA related to process is PFMEA. One of the differences between these two types is that for DFMEA the end user is a customer, but for PFMEA it can be the next user in a process. Also, PFMEA is more complicated and time-consuming then DFMEA. This analysis is a living document, which means that it have to be upgraded with new information or changed due to changes of product or process. For PFMEA report in automotive industry, a standard report form is usually used. This form is proposed in reference manual by Chrysler LLC, Ford Motor Company, and General Motors Corporation in 2008 [9]. Traditional risk priority number (RPN) is calculated by multiplication of Severity (S), Occurrence (O), and Detection (D) as it is shown on Eq. 1. These three indexes S, O, D and RPN are also defined according to standard tables for automotive industry proposed in the same reference manual. RPN goes from 1-1000 and S, O, D indexes from 1-10. Corrective actions should be taken any time, but especially when RPN exceeds 100 or one of indexes S, O or D exceeds 8. PFMEA is mostly conducted in team, with classic brainstorming technique while some standards obligate companies to realize PFMEA reports in a team [3, 4].

$$S \cdot O \cdot D = RPN \tag{1}$$

In 1973, Ford Motor Company was among the first users of PFMEA in automotive industry for preventive maintaining quality [10]. Later in the 1990s, PFMEA became the standard practise in most majority automotive companies and their suppliers, until today. Three most prestigious automotive manufacturers from USA (Chrysler LLC, Ford Motor Company, and General Motors Corporation), set PFMEA as a mandatory to their suppliers in 1990s. Because of this, suppliers had a lot of problems due to the regulations disagreement. So, in 1993 (Automotive Industry Agency Group) AIAG integrated different FMEA regulations into one uniformed document. This resulted with publishing guide reference manual [9, 11]. Today, the fourth edition of this guide from 2008 is actual [9]. The Case study from 2003 presented various use of traditional PFMEA in automotive industry in Europe [5]. Also, in review paper from 2013 a wide use of PFMEA is presented in industry, especially in automotive industry [6]. This means that a proper use of PFMEA could be of a great importance for automotive industry.

Traditional PFMEA approach have many shortcomings. Some of these shortcomings were identified in the case study realized on 150 automotive supplier companies from United Kingdom and Central Europe [5]. This case study also highlighted main opportunities for improvements: costs, S, O, and D data, technical and resource, standardization, training, PFMEA software. There is also one review paper which highlighted problems related to traditional RPN [6]. This study shows about 75 articles related to RPN improvements or alternative ways to RPN calculation. In this paper, various authors were using artificial intelligence, multi-criteria decision making, mathematical programing, hybrid approaches, and other approaches like cost-based approaches, Monte Carlo simulations, etc. All these approaches were giving more precise RPN but increasing time-consuming of PFMEA realization and therefore were very hardly applicable in real-world cases. All these improvements and different approaches are partially solving PFMEA shortcomings which was the biggest problem for its application.

Companies have to respond to customers demand fast, with right quality and with acceptable price. That means that the PFMEA team will not have the time to realize all these complicated and time-consuming methods partially. Industry has the need for comprehensive solution which will satisfy all three mentioned factors (time, quality, and cost).

3. Lean approach

Lean is American term to describe the Toyota production system (TPS). The advent of TPS is related to period after World War II. This Company was in need of a great solution which will turn the company on and make it more competitive on the market. TPS was that solution. Mass production which was widely used all over the world, was changed with "pull system", or production of the customer demanded products only [12]. Company focus were changed to continuous improvement and quality management in every step. TPS was not famous beside the Toyota company and its suppliers until 1943, when first oil crisis attacked the world. The most important fact is that the TPS led Toyota company to the first place on world's car manufacturers list. Lean became popular worldwide in the 1990s, when many companies started applying it [13].

The lean approach in this paper is approach made of using lean thinking, principles and tools for solving PFMEA. Lean principles can be understood best through 4 basic Toyota principles: Genchi Genbutsu (go and see for yourself), Kaizen (continuous improvement), team work and respect for people, and challenge. Based on this 4 principles, Liker, J. K. [13] preformed his own 4 principles known as 4P: philosophy, process, people and partners, and problem solving. Lean approach could be applied to any other business aspect or in any business situation [13]. Firstly, lean approach have been applied to manufacturing process – lean manufacturing. But nowadays, lean approach is applicable in many other aspects like: lean enterprise, lean office, lean start-up, lean development, lean system, etc. Lean approach in automotive industry is mostly used for production process improvements. For these improvements, various lean tools are commonly used. For example: Jidoka, Poka-Yoke, Kanban, single minute exchange of die (SMED), just in time (JIT), 5S, standardized work, 5 why, total productive maintenance (TPM), PDCA, etc.

Main purposes of lean are in identifying, preventing and correcting of failures and problems. According to that, lean approach have almost the same purpose in production process as PFMEA. Therefore, there is a lot of space for integration of lean approach in PFMEA for failure prevention improvement.

4. Integrated lean approach in PFMEA

This is the new approach in science until now. Various authors conducted several research on similar but reverse approach. They were using FMEA as a tool to improve lean system. This is not necessary, because companies which are using lean approach does not need FMEA to prevent risks and failures. Automotive company is the unique example, because PFMEA is obligatory, with most of them using lean approach also.

Shekari, A. et al. [15] were using FMEA as a tool for failure detection to improve lean system. Sawhney, R. et al. [16] presented modified FMEA approach for reliability improvements of lean system. Then, Shahrabi, M., et al. [17] applied FMEA and AHP methods for improvements due to maintenance of lean system. These papers were related to the use of FMEA in order to improve lean systems. There was one example of using lean tools to improve FMEA. Pavanasvaran, P., et al. [18, 19] used lean tool named Poka-Yoke to improve FMEA. But this tool was used separately, not as a whole lean approach.

Idea is to integrate lean approach into steps to PFMEA realization. But firstly, shortcomings which occur during PFMEA realization have to be identified and fixed with lean approach. For many of these shortcomings various solutions have been already found. For example, for RPN, costs, S, O, D indexes, etc. lot of solutions have been found. But, there is still a lot of space for improvements. Specified shortcomings identified in literature, which can be fixed with lean approach are presented in Table 1. These shortcomings are defined by various authors and they are presented in the left column. In the right column, the lean approach solutions for fixing of specified shortcomings are presented.

As it can be noticed, each of the shortcomings is solved with lean approach. Some of the used lean tools are: standardized work, Kaizen, Jidoka, and 5 why. One of principles used was – Genchi Genbutsu. These tools and the principle will be integrated as a lean approach into PFMEA, resulting with the new PFMEA approach.

The new PFMEA approach is proposed in algorithm form on Fig. 1. Proposed algorithm is divided in four phases of Deming's PDCA cycle for problem solving. Plan (P), do (D), check (C), act (A) is a four-phase-cycle for problem solving which Deming proposed in 1950 [23]. Plan phase is broken down in several segments for detailed analysis. Do phase is related to plan execution. Check phase is needed for checking of every progress. Act phase is related to recognized and standardized solution. PDCA cycle is the approach to problem solving frequently used in lean approach.

Table 1 Application of lean approach for fixing the specific PFMEA's shortcomings

Shortcomings	Lean approach for fixing the shortcomings
Wrong approach to detecting failures of root cause [5]	Root cause of failure can be identified with lean tool for identification of root cause of problem – 5 why
Unutilized existing resources [5]	There are many resources unutilized in companies which can be used for improvements during PFMEA realization. One of the most unused resources are people in company. In lean systems, all employees should be involved in improvements – Lean approach
Problem during defining RPN actions [6]	Failures should be treated respectively with higher RPN. Surely, all failures need to be solved or reduced due to the "zero failure" goal of lean approach – Kaizen
Repeating of failures in next row [6]	Failures should be solved with solutions consequently standardized. Data base also needs to avoid failure repeating – standardized work
Traditional brainstorming is boring and time consuming [11].	Failure identification should be done directly in shop floor and workers should be also involved in analysis – Genchi Genbutsu
It's impossible to use again FMEA report [20].	Use of software with tables in which revision can be done that imply a constant improvement – software solution and Kaizen
FMEA report fulfilment is very time consuming [21, 22].	Lean should be accessed slowly and thoroughly, rather than fast and superficially. Standardization of PFMEA failures will mean less failures to improve. So PFMEA realization will go faster - lean approach.

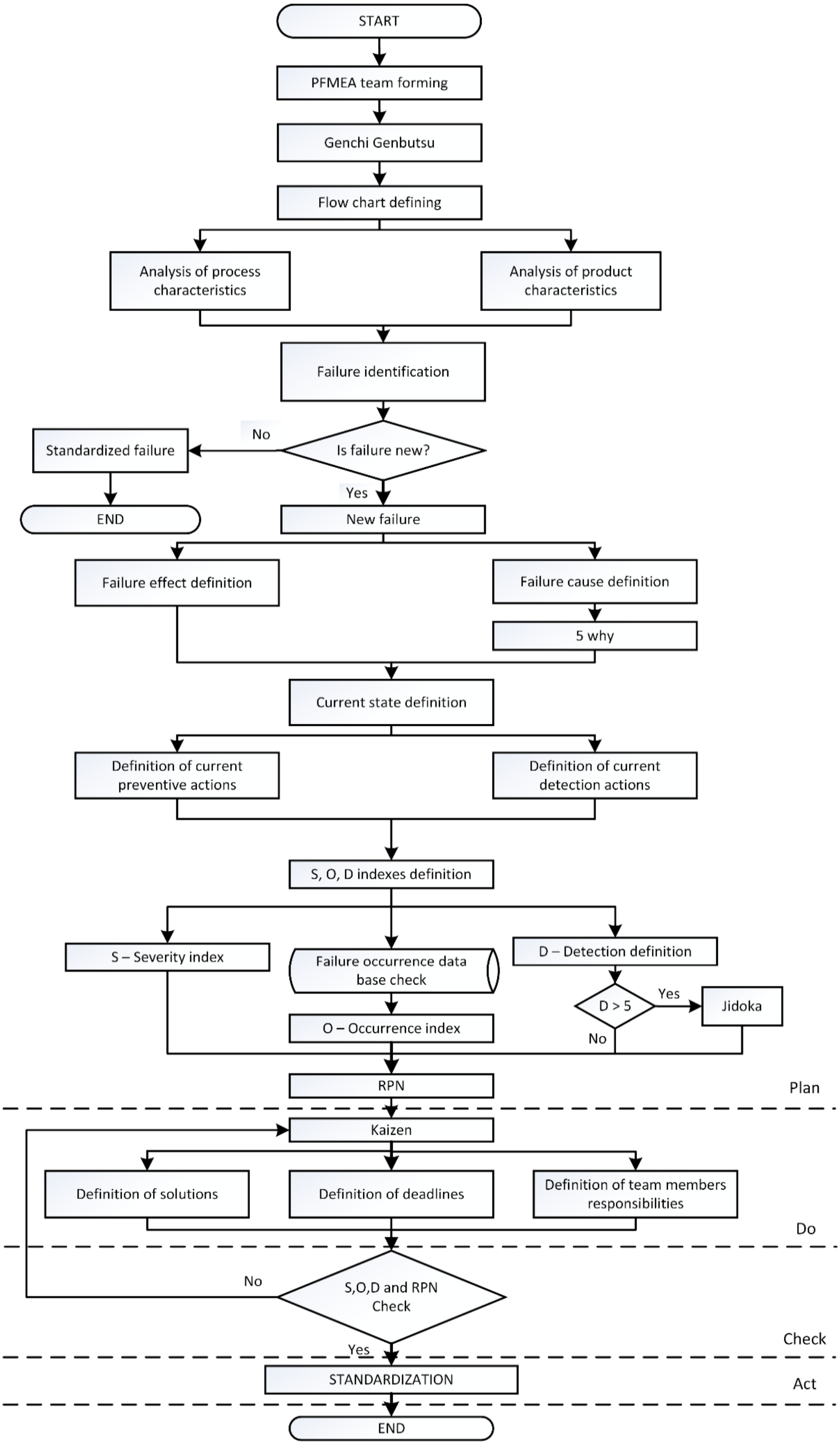

Fig. 1 Algorithm model for PFMEA with integrated lean approach

New PFMEA approach is starting with multidisciplinary team forming. When the team is formed, identification of problems should start. Firstly, team have to go directly to the place where the process is going to be performed and observe how the process really looks like – Genchi Genbutsu. Also, it is highly recommended to include shop floor workers in decision making process. Workers are directly in contact with the process, and they usually know best what kind of problems may occur. When these terms are satisfied, team should propose process flow chart. After flow chart definition, process and product characteristics should be deeply analysed. Identification of failures is one of the most important steps, because it directly depends on team members' opinion. There are two types of failures: standardized failures and the new one failures. Standardized failures are already known and they exist in data base. New failures, occurring for the first time, have to be defined, solved and standardized. For these new failures effects and causes of failures have to be identified. Team is often blending effects and causes which is a very big problem [5]. For all causes, one lean tool is specified for finding a root cause of the problem – 5 why. According to the current state, S, O, and D indexes should be defined. For O index, a special data base is needed. This data base should contain the amount of same or similar problem occurrence. D is another index with special issue, due to the lean approach purpose of producing in quality, so quality have to be provided on source - Jidoka. For the case of automotive industry, in detection table from fourth edition of reference manual guide for automotive industry, automatized control for first 5 indexes, is predicted [9]. Over 5 isn't automatized, so if D>5 then Jidoka or quality on source, should be applied. With all three indexes defined, RPN can be calculated as the end of the plan phase.

After the plan phase, do phase or realization phase follow. For all defined RPN, corrective actions or Kaizen, should be taken. Suggested improvements had to be set on a list of solutions, with exact deadlines and with responsible team members.

Third phase is check phase where the action taken has to be checked with repeating of RPN calculation. If there is no progress, then Kaizen should be performed again. This check phase have to be realized very carefully, because after this phase failure should be standardized.

Last phase is act phase. When the solution is finally found and the progress has been made, failure and elected solution have to be standardized and ready to use.

5. The new PFMEA approach: Case study from automotive industry

The company elected for the case study is automotive company which produce electronic circuit boards and electronic cables for automobiles. Company is supplying automotive suppliers and corporations all over the world. This company applies lean approach in their production system for a long time and also use PFMEA for prevention of failures and risks. The use of PFMEA in this company is obligatory according to ISO9000 and ISO TS16949 standards.

PFMEA for product MSM6BL was already realized on traditional way. Results are presented in Table 2. Measured conditions taken for comparation are: number of team members, identification of failures, change of S, O, D and RPN values, reduced S, O, D, and RPN values after taken actions, RPN value over 100, and S, O, D value over 8. These conditions are measured in total amount for whole PFMEA. The goal is to compare them with the new approach and see the differences after its implementation. S, O, D and RPN value changes are also calculated in total change regardless if it is increased or reduced value.

Methodology set in algorithm form from Fig.1 is used for realization of PFMEA. Realized PFMEA report is shown in Appendix 1. The changes made after the new approach are painted in grey in Appendix 1. They have been implemented and used for calculation. The data for a new state are presented in Table 2. These data were taken from Appendix 1, also. After this step, the comparation between the state after traditional approach to PFMEA realization and the new approach to PFMEA realization with integrated lean approach, was made. These results are also presented in Table 2.

From Table 2, it can be seen that almost all conditions are changed, except one - S. Two conditions; the actions taken and identification of failures, are very important for analysis because they are related to the purpose of analysis to detect a failure and take action to improve it. Genchi Genbutsu have mostly contributed to these changes. Lean approach stimulated involvement of more employees, including six workers. As it was predicted, workers contributed a lot to failure identification because they are directly involved in a process. But Genchi Genbutsu stimulated PFMEA team to go directly in process and observe an actual status. Increased identification of failures and the taken action can avoid hidden failures reaching customer. Also, they affected the changes of S, O, D indexes and RPN values. Moreover, during these changes, value of some S, O, D indexes exceeded 8 and RPN values exceeded 100. The lack of situations when S, O, D and RPN exceed predicted values for improvements, may cause problems if failures reach a customer. Only one condition which is not reduced is S index due to the actions taken, which is not a big issue due to the O and D indexes reduction for that failures. This was achieved due to the application of Kaizen. Also, some of D indexes were reduced due to the application of Jidoka. Causes of failures were superficially defined and some resulted with mixing of causes and effects. With application of lean tool - 5 why, root causes of failures were deeply analysed. The actions taken were oriented on fixing root causes of failure, not effects. One more lean tool used in this case study, is standardized work. Some of failures were standardized. This means that in the next PFMEA for some of the new processes or products, standardized solution will be used. That will save a lot of time. Along these integrated lean tools into PFMEA, Poka-Yoke and 5S were also used as the lean tool for recommended actions during PFMEA realization.

Table 2 Comparison of state before and after lean approach integration in PFMEA

Measured conditions	State after traditional approach	New state after lean approach	Improvements (%)
Number of team members	2	9+6 workers	85
The actions taken	1	19	95
Identification of failures	18	27	33
Change of S value	155	227	32
Change of O value	64	105	39
Change of D value	85	161	47
Change of RPN value	1642	3720	56
Reduced RPN value due to taken actions	2602	3366	23
Reduced S value due to taken actions	226	226	/
Reduced O value due to taken actions	80	127	37
Reduced D value due to taken actions	121	139	13
RPN value over 100	/	16	100
S, O, D values over 8	/	3	100

6. Conclusion

The new approach with the integration of lean approach into PFMEA for improvement of specific shortcomings, is presented in this paper. This new PFMEA approach has proven to be very good and practical combination for identifying and fixing problems and failures. The case study realized from the automotive industry was used for the new approach testing. The state with traditional PFMEA is compared with the new state where almost all measured conditions were changed and improved. Therefore, this approach was practically approved.

The main advantage of this approach was in improvement of process and product quality, which is mostly important for customers. For a change, this approach is applicable in real-world cases in every process or industry where the lean approach is implemented. Also, it is very simple and practical to use and does not require big investments, implementation of new technology and complicated additional education. The way this approach has stopped potential failures to reach a customer was not identified with traditional approach. This was presented on practical example. Therefore, this new approach increased identification and prevention possibilities as well.

This new approach have also few constraints. It is used for specific group of shortcomings and it is not comprehensive. Also cannot be applicable in processes and industries where the lean approach has not been implemented. Costs are not included and there is different aspect of looking on it from perspective of PFMEA and lean approach.

Future work should be oriented to fixing all other shortcomings of PFMEA, costs especially. Lean approach is oriented to long term thinking about costs. From PFMEA team perspective is different. During PFMEA realization team have to percept immediately if the solution is profitable. Thus in further research, the balance should be found between urgent need for costs from PFMEA aspect and long term thinking profitability from the lean approach aspect.

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Appendix 1

FMEA Number		Part Name/Part No	Realized by:
51		BSH MSM6BL / E index: A1	Project manager
FMEA Date (Orig)		FMEA Revision Date	Prepared by:
2/18/2015		20.04.2015. Rev.02	Project Leader
FMEA Team			
Project Leader x2, Project manager, Quality manager, Logistics manager, Procurement manager, R&Dx2, Maintanance manager + 6 workers			

Process No./Function		Requirements	Potential Failure Mode	Potenial Effect(s) of Failure	Severity	Classification	Potential Cause(s) of Failure	Occurrence	Current Process Controls: Prevention	Current Process Controls: Detaction	Detection	RPN	Recomended Action(s)	Responsibillity	Target Completetion Date	Action Results					
																Actions Taken	Effective Date	Occurrence	Severity	Detection	RPN
E110	Axial insertion																				
E110	Axial insertion		Component failed	PCB with failed function; No function	6		No components in storage	2	Intern schooling, working instruction	Process approved	6	72	No								0
E110	Axial insertion		Component with false value	Badly equipped PCB; PCB with failed function; No	6		Wrong components in storage	2	Intern schooling, working instruction	Process approved	6	72	No								0
E110	Axial insertion		Wrong orientation of	Incorect or no function	6		Machine failure	2	Intern schooling, working	Process approved	6	72	No								0
E412	Manual inserting																				
E412	Manual inserting		Mechanical damaged component	Trouble in process	5		Inattention	4	Intern schooling, working instruction	Visual control; Process approved	6	120	Increase workers precaution	Project manager		Work instructions		5	1	6	30
E412	Manual inserting		Component failed on PCB	PCB with failed function, no function	5		Inattention	5	Visual inspection before use	Visual inspection by end inspection	5	125	Poka yoke	Project manager		Aditional tool for chack out of components		5	1	6	30
E412	Manual inserting		Wrong component	PCB with false components	7		Inattention	4	Intern schooling, working instruction	Process approved	8	224	kaizen workshop	Project manager		Process improvement + check out after component election		7	1	8	56

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Process No./Function		Requirements	Potential Failure Mode	Potenial Effect(s) of Failure	Severity	Classification	Potential Cause(s) of Failure	Occurrence	Current Process Controls: Prevention	Current Process Controls: Detaction	Detection	RPN	Recomended Action(s)	Responsibillity	Target Completion Date	Action Results: Actions Taken	Effective Date	Occurrence	Severity	Detection	RPN
E412	Manual inserting		Contact badly placed	Trouble in process	8		Inattention	4	Intern schooling, working instruction	Visual control; Process approved	8	256	Kaizen + poka yoke	Project manager		Process improvement + tool for contact set up		8	1	8	64
E500	Wave soldering																				
E500	Wave Soldering		Too much solder on solder joint	Short circuit on PCB	7		False setting the process parameter – speed of soldering line is wrong	4	Intern schooling, working instruction	Visual inspection, check the parameter before use	5	140	Preventive machine maintanance	Maintanance manager		Check out of parameters before start of machine		7	1	4	28
E500	Wave Soldering		Use of false temperatur e profil	Bad or not soldered joints between pads and component	8	§	Inattention, false setting of machine parameters	5	Intern schooling, working instruction	Visual inspection	5	200	Preventive machine maintanance	Maintanance manager		Check out of parameters before start of machine		8	1	6	48
E500	Wave Soldering		Uncorect solder joint	Unreliable joint - unreliable function	8		False setting the process parameter –	5	Intern schooling, working instruction	Visual inspection, check the parameter before use	5	200	Preventive machine maintanance	Maintanance manager		Check out of parameters before start of machine		8	1	6	48
E500	Wave Soldering		Not enough solder on solder joint	Bad solder joint	8		False setting the process parameter	4	Intern schooling, working instruction	Visual inspection - check the parameter before use	5	160	Preventive machine maintanance	Maintanance manager		Check out of parameters before start of machine		8	1	5	40
E500	Wave Soldering		Cold contact	Bad solder joint	7		False setting the process parameter	4	Intern schooling, working instruction	Visual inspection, check the parameter before use	5	140	Preventive machine maintanance	Maintanance manager		Check out of parameters before start of machine		7	1	5	35
E650	Function test																				
E650	Function test		Skipped the final control	Bad parts can be sent to the customer	8		Inattention	3	Intern schooling, working instruction	Process approved	8	192	One piece flow	Worker		Work instructions		7	1	5	35
E521	Rework; visual inspection																				

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Process No./Function		Requirements	Potential Failure Mode	Potenial Effect(s) of Failure	Severity	Classification	Potential Cause(s) of Failure	Occurrence	Current Process Controls: Prevention	Current Process Controls: Detaction	Detection	RPN	Recomended Action(s)	Responsibillity	Target Completion Date	Action Results: Actions Taken	Effective Date	Occurrence	Severity	Detection	RPN
E521	Rework; visual inspection		Not sensed missing element	PCB with false function	7		Inttenation	3	Intern schooling, working instruction, changing workers	Visual inspection	5	105	Kaizen + poka yoke	Project manager		Process improvement + tool for contact set up		7	1	4	28
E521	Rework; visual inspection		Not sensed wrong orientated element	PCB with false function	7		Inttenation	2	Intern schooling, working instruction, changing workers	Visual inspection; Function test	5	70	No								0
E521	Rework; visual inspection		Not sensed mechanical damages	No function	6		Inttenation	2	Intern schooling, working instruction	Visual inspection	5	60	No								0
E521	Rework; visual inspection		Not sensed shoort circuit	No function	8		Inttenation	3	Intern schooling, working instruction, changing workers	Visual inspection; Function test	6	144	Jidoka	Project manager		Implement testing of current flow		8	1	4	32
E521	Rework; visual inspection		Not sensed broken connections	No function	8		Inttenation	3	Intern schooling, working instruction, changing workers	Visual inspection; Function test	6	144	Isolation of part for special inspection	QS		Rework after check		8	1	8	64
E710	Marking																				
E710	Marking		No data about the product	Bad tracking of product, tracking unpossible	4		Inattention	2	Intern schooling, working instruction	Visual inspection	5	40	No								0
E710	Marking		In the wrong place labeled product	Unwilling customer, customer reclamation	4		Inattention	2	Intern schooling, working instruction	Visual inspection	5	40	No								0

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Process No./Function		Requirements	Potential Failure Mode	Potenial Effect(s) of Failure	Severity	Classification	Potential Cause(s) of Failure	Occurrence	Current Process Controls: Prevention	Current Process Controls: Detaction	Detection	RPN	Recomended Action(s)	Responsibillity	Target Completion Date	Action Results					
																Actions Taken	Effective Date	Occurrence	Severity	Detection	RPN
E710	Marking		Wrong data on product	Bad tracking of product, tracking unpossible	4		Inattention	2	Intern schooling, working instruction	Visual inspection	5	40	No								0
E531	PCB separation																				
E531	PCB separation		Damage the PCB, outline is not clear	Trouble by assembling in houssing	6		Innatenation, damaged tooling	6	Intern schooling, working instruction	Visual inspection	5	180	Jidoka	Project manager + workers		Kvalitet na izvorištu		6	1	8	48
E531	PCB separation		Break the PCB	Useless of PCB	8			3	Intern schooling, working instruction	Visual inspection	5	120	kaizen workshop	Project manager + R&D		Made tools for automatic removing of excess		8	1	2	16
E900	Final control and packing																				
E900	Final control and packing		Mixed products in the box	Unwilling customer, customer reclamation	2		Operator error, mess at the working place	2	Intern schooling	Visual final inspection	9	36	5S + Work instructions	Project manager + workers		organisation of work place + aditional worker education		2	2	8	32
E900	Final control and packing		Quantity is false	Unwilling customer, customer reclamation	2		Inattention	2	Intern schooling	Visual final inspection	9	36	5S + Work instructions	Project manager + workers		organisation of work place + aditional worker education		2	2	8	32
E900	Final control and		VDA label is uncorect full field	Identification, tracebility is not assure	2		Mistake in system, not enough datas	2	Intern schooling	Visual final inspection	9	36	Kaizen	Project manager + workers		System for VDA markers chose		2	1	1	2
E900	Final control and packing		Wrong products in the box	Unwilling customer, customer reclamation	8		Operator error, mess at the working	2	Intern schooling	Visual inspection	8	128	Jidoka	Project manager + workers		Kvalitet na izvorištu		8	1	8	64

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