ORIGINAL SCIENIFIC PAPER

MODEL FOR THE ASSESSMENT OF PROCESS FAILURE MODE AND EFFECT ANALYSIS MATURITY LEVEL IN THE AUTOMOTIVE INDUSTRY TOWARD INDUSTRY 4.0 TRENDS

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ABSTRACT

According to the international industry standards, the Process Failure Mode and Effect Analysis (PFMEA) is an obligatory tool for the risk assessment in the automotive industry. Due to FMEA transition in the automotive industry (2019th), PFMEA has been subjected to a series of transformations and improvements, where the substantial change is the risk estimation. However, although it is an essential tool for the reliability assessment, the formal PFMEA is still not sufficiently compatible with the ongoing Industry 4.0 trends. Consequently, practitioners have increasing needs for guides that could support them to implement PFMEA toward Industry 4.0 in their companies. This study aims to ease this shift by proposing a novel model for the assessment of PFMEA maturity level, which considers four PFMEA maturity levels; where the first level corresponds to the manual handling of reports; while the level-four corresponds to the fully automated PFMEA. The overall maturity level was calculated by accounting the eight significant influential factors. Since each of the influential factors has a different degree of influence, their importance can be calculated by applying some Multi-Criteria Decision-Making method or by direct assessment. Finally, the usage of the proposed maturity model was demonstrated by the case study, and obtained results proved that the proposed model is suitable and applicable in a real production environment in the automotive industry, with the emphasis that it could be extended for other industries.

Keywords: *PFMEA, maturity level, industry 4.0, automotive industry*

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INTRODUCTION

In terms of the annual revenue and contribution to the national GDPs, the automotive industry with associated industries represents the most important economic sectors in developed countries [1]. According to the studies focused on investigating buyers' preferences, reliability-price ratio has been identified as the most important factor for purchasing a particular car [2]. Following the standard IATF 16949, a tool that has been recommended for the assessment of reliability in the automotive industry is a Failure Mode and Effect Analysis (FMEA). The version of FMEA dedicated for the assessment of manufacturing processes is called PFMEA. So far, PFMEA has been widely used as a qualitative method for the identification of failure modes before and during the production, as well as for the identification of causes and effects of these failures. In the previous standard for the automotive industry (ISO/TS 16949), the PFMEA was mentioned in a few clauses. However, in the new standard IATF 16949 the PFMEA was mentioned significantly more than it was in the previous standard [3] [4]. The PFMEA is becoming much more recognized and important for the automotive industry, despite existing needs for its improvements identified by various authors [5] [6]. This rising trend of the PFMEA acceptance was predicted by Liu et al. in their review [5]. Increasing demands for the digitalization and automatization of industrial processes are driving forces of industry changes - widely known as Industry 4.0 (I4.0). For example, [7] suggests the improvement of nonconformity management through automatization of ISO 9001 and brings it closely to I4.0. In order to follow these trends, PFMEA should be adapted and automated [8]. In literature, technological advances of I4.0 are known as “nine technological pillars of I4.0”[9].

In this paper we propose a novel generic model for the assessment of PFMEA maturity, which should be used as a planning tool for making optimal and progressive PFMEA shifts towards the I4.0. The maturity Model calculation is based on influential factors on PFMEA maturity and its associated weights. The influential factors were defined according to the opinion of company experts and management as well as with a help of devoted literature. Weights were calculated by using the Best-Worst Method. Data for estimation of influential factors were collected by questionnaire. Maturity model is validated in a real production environment in the automotive industry supplier company by the case study. Approach used in this paper is introduced through the following sections. In Section 2, we provide a chronological review of the PFMEA, with special attention given to PFMEA transition and literature review. In Section 3, we introduce the model for assessing maturity level of PFMEA. In Section 4, we present results of the validation of the proposed model in the automotive company. In section 5, obtained results and findings are presented and discussed. In the conclusion section, with emphasis on providing future directions for PFMEA development towards the I4.0, as well as advantages and disadvantages of the approach have been presented.

PFMEA BACKGROUND

Traditional PFMEA assumes the risk calculation by multiplying severity (S) of failure effect which may affect customer or company own system, occurrence (O) of the failure cause and detection (D) index which defines capability of the system to detect failure mode or cause. Risk Priority Number (RPN) was a parameter (till 2019) to order-priority of a failure, and decided which one should be approached first. RPN was calculated by multiplication of three previously mentioned indices. While all three indices have the range from 1-10, the RPN ranges from 1-1000. Each risk over 100 was obligatory to be approached, as well as if some of the indices have value 9 or 10. This traditional approach was standardized by AIAG in its first manual introduced in 1993th. Besides this one, there were three more revisions in 1998th, 2002nd and 2008th. The overall conclusion of the community was that there were no significant changes [10]. However, in 2019th AIAG&VDA introduced the first edition of a new FMEA Handbook for the automotive industry [11]. In this handbook PFMEA is considered as well. Thus, this is a new type of PFMEA because the risk assessment approach has significantly changed compared to previous PFMEA.

Liu et al. [5] presented a general review study on FMEA. In this study different methodologies were observed for solving various FMEA constraints and disadvantages and these solutions and researches are most common with I4.0. De Aguiar et al. [12] introduced a case study from Brazilian automotive industry company based on the comparison of results achieved by traditional approach and approach based on ISO 9001 standard approach, without paper application. Another common trend is integration of lean into the PFMEA, which was proposed by Banduka et al. [13]. One of the recent review studies was introduced by

Spreafico et al. [14] where authors' classified research according to the authors and source literature. Case study based on the combination of PFMEA and Grey relational analysis is introduced in [15], with comparison of results. Banduka et al. [16] introduced FSQC-PFMEA analysis based on fuzzy AHP integration of safety and cost aspects into traditional severity index. Another relevant review study is based on systematic review of MCDM methods by Liu et al. [17] followed by [18] where authors introduced failure prioritization by the product priority.

From the chronological review, it could be concluded that the development and advancement of the PFMEA in academia have gone towards developing decision support methods that should first eliminate the risk. Academic studies were more focused on advancing methodology itself, leaving to practitioners to adapt and find optimal ways of usage. Thus, in order to shift towards the I4.0, it is necessary to first determine the current maturity level of PFMEA.

THE PROPOSED MODEL FOR CALCULATION OF OVERALL PFMEA MATURITY LEVEL IN AUTOMOTIVE INDUSTRY

The proposed model recognizes four chronological maturity levels of the PFMEA (Figure 1). Chronological maturity levels are defined by authors according to the literature review. Idea is to compare PFMEA development with development of industrial trends. These levels are:

1. PFMEA 1.0 (Primitive) - PFMEA reports are manually fulfilled and managed, with no extensions or any additional methodology or technology used.
2. PFMEA 2.0 (Basic) - PFMEA reports are generated by using some text editor (i.e. MS office package or online form). There is no centralized PFMEA database, so priority calculations (like safety, cost, root cause, product importance, etc.) are still performed manually or semi-automatically.
3. PFMEA 3.0 (Proficient) - A company has a software solution for PFMEA, including a centralized database. Catalogue of products, and data related to products are centralized (like failure modes, effects, causes, etc.). Methodological extensions and/or additional priority calculations (like safety, cost, root cause, product importance, etc.) are integral parts of the software and they are performed automatically.
4. PFMEA 4.0 (Advanced) - A company has a software tool with a centralized database, which is integrated with the Enterprise Resource Planning (ERP), Manufacturing Execution System (MES) or other similar systems. The most of data are connected with PFMEA software tool. Data are controlled, analysed and optimized automatically, by AI support.

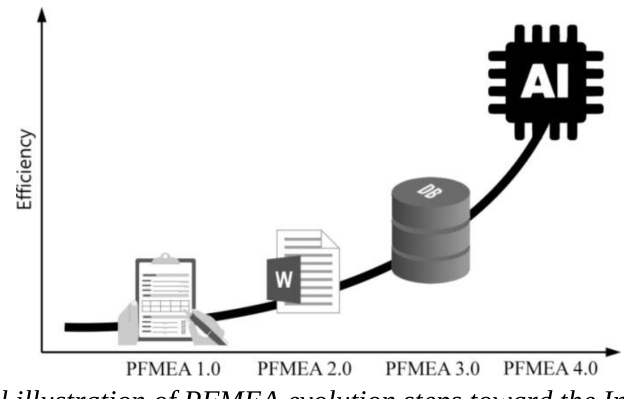

Figure 1. Graphical illustration of PFMEA evolution steps toward the Industry 4.0 transition

Calculation of the overall maturity level (M_O) is done following equation (1). PFMEA is a complex analysis and contains many influential factors, such are: team, form, product, risk estimation, improvements, etc. Therefore, the overall PFMEA maturity level has to be checked with respect to each influential factor. Therefore, the maturity of each influential factor (M_{IE}) has to be taken into account. Influential factors should be defined by experts or company management. Since the influential factors have a different degree of influence, the weight for each influential factor (W_{IE}) has to be determined. The maturity level range corresponds to PFMEA maturity levels. Therefore, the PFMEA 1.0 is in the range from 0 to 1, the PFMEA 2.0 ranges 1-2, the PFMEA 3.0 ranges 2-3 and the PFMEA 4.0 is in ranges 3-4.

Thus, the overall maturity level is calculated according to equation 1:

$$M_O = \sum_{i=1}^{n} M_{IEn} \cdot W_{IEn} \quad (1)$$

Where:
M_O - Overall maturity level of the PFMEA in automotive industry environment;
M_{IE} – Maturity level of certain influential factor;
W_{IE} - Weight of certain influential factor;
n, n = 1,…, N, where N is total number of the influential factors.

The ratio level (R) goes from 1 to 4 with the linguistic terms given in Table 1. The value of question (Q) is ranging from 0 to 3 accordingly. The R value purpose is to determine more closely Q value. Q and R needed for the calculation of the influential factors (M_{IEn}) can be obtained by fulfilling the questionnaire Finally, the maturity level of each influential factor should be calculated following equation 2.

$$M_{IEn} = Q_n + \frac{R_n}{4} \quad (2)$$

In order to define maturity level of each influential factors, some inputs from industry are needed. Therefore, we have proposed a form (example provided in the Appendix) for gathering influential parameters necessary for definition of Input parameters. Briefly, each influential factor is obtained by answering on question with four options (PFMEA maturity level descriptions) and rated by a specially developed scale (See table 1).

Table 1. Ratio value (R) scale description

Ratio level	Ratio (R)	Description
Weak	1	Organization has potential to implement elements contained in the question.
Average	2	Organization has already started with implementing some of the elements of the question.
Good	3	Organization is already using some of the elements of the question description.
Excellent	4	Organization is already using all of the elements of question description (or even more).

Besides the maturity of influential factors (MIE), other influence on the overall maturity is given by weights of each influential factor (WIE). The weight of the influential factors can be calculated by using any MCDM method, such as Analytic Hierarchy Process (AHP) [19], Analytic Network Process (ANP) [20], Simple Additive Weights (SAW) [21], Best-Worst Method (BWM) [22], etc. In this paper, the influential factor weights (WIEn) are calculated by using the pairwise comparison method (by using the Best-Worst Method). The BWM was chosen over alternative weighting methods since it gives more reliable results with less input data [22]. The application of the proposed methodology for Overall maturity level of the PFMEA (M_0) is carried out through the following steps:

Step 1. Defining influential factors on the basis of which the maturity level of PFMEA is assessed.

Step 2. Using some of the MCDM methods, determine the Weight of an influential factors, WIE.

Step 3. Defining the form for calculating Q_n factor (values from the questionnaire), and R_n factor (Ratio value).

Step 4. It is necessary to answer the questions asked in the questionnaire. In other words, it is necessary to determine the values of Q_n, n = 1,…,N. Q_n is present on a measurement scale [0-3]. Where n is influential factor (or evaluation criteria), and N is total number of the influential factors.

Step 5. It is necessary to estimate Ratio value R_n for each Q_n, n = 1,…,N, according to suggested measurement scale [1-4].

Step 6. Calculation of M_{IEn} according to the formula (2).

Step 7. Calculation Overall maturity level of the PFMEA (M_0) according to the formula (1).

THE CASE STUDY

The case study was conducted in a tier-1 automotive supplier company that has over 1000 employees. The company is producing upholstery equipment for car interiors. It is regularly certified by ISO 9000 and IATF 169494 standards. Company is using PFMEA analysis actively for more than 7 years. PFMEA realization in the company was based on the 4th “Potential FMEA" manual, with small specific modifications demanded by customers. PFMEA transition was conducted recently and company is now using PFMEA based on AIAG&VDAs “FMEA Handbook”. PFMEAs are always done in a multidisciplinary team. The team is composed of at least three members with expertise in production, quality and engineering.

According to first step of the proposed algorithm the influential factors are defined: 1) Fulfilment, 2) Cost, 3) Degree of process automatization, 4) Product, 5) Risk estimation, 6) Current way of control, 7) Team readiness, and 8) Improvements. These influential factors were defined according to the authors by support of literature and experience from the practice. These factors can be changed, reduced or increased depending of the necessities. For the calculation of the influential factor weights (Step 2 of the proposed algorithm), the conventional Best-Worst method proposed by Rezaei [22] was used. Conventional BWM is realized through the following steps:

1) It is necessary to define a set of considered criteria:

In this case, considered criteria are influential factors, and those are: Fulfilment (n = 1), Cost (n =2), Degree of process automation (n = 3), Product (n = 4), Risk estimation (n = 5), Current way of control (n = 6), Team readiness (n = 7), and Improvements (n = 8).

2) Determine the most important (the best) criterion and the worst criterion from the considered set of criteria.

For the best criteria, was selected the Fulfilment (n = 1), and for the worst, was selected the Cost (n = 2) criteria. Fulfilment was chosen as the best criteria because the biggest problem of the users is fulfilment and filtering of robust FMEA data. Cost is the rarely used extension in practise; therefore, we chose it as the weakest.

3) The preference of the best criterion A_B in relation to other criteria by using a measurement scale [1-9].

$$A_B = (a_{B1}, a_{B2}, \dots, a_{Bn}) \qquad (3)$$

Where a_{Bn} indicates preference of the best criterion B to considered criteria n.
In this case, the preference of the best criterion B to considered criteria n is (Table 2):

Table 2. The preference of the best criteria B to considered criteria n

Criteria	(n = 1)	(n = 2)	(n = 3)	(n = 4)	(n = 5)	(n = 6)	(n = 7)	(n = 8)
Best criterion (n = 1)	1	9	2	8	3	4	6	7

4) The preference of the other criteria in relation to the worst criterion A_W by using a measurement scale [1-9].

$$A_W = a_{1W}, a_{2W}, \dots, a_{nW}{}^T \qquad (4)$$

Where a_{nW} indicates preference of the considered criteria n to the worst criterion W.
In this case, the preference of the considered criteria n to the worst criterion W is (Table 3):

Table 3. The preference of the considered criteria n to the worst criterion W

Criteria	Worst criterion (n = 2)	Criteria	Worst criterion (n = 2)	Criteria	Worst criterion (n = 2)	Criteria	Worst criterion (n = 2)
(n = 1)	9	(n = 3)	8	(n = 5)	7	(n = 7)	4
(n = 2)	1	(n = 4)	2	(n = 6)	6	(n = 8)	5

5) Finding optimal values (weights): $(W_1^*, W_2^*, \dots, W_n^*)$, where n = 1,…, N, and N = 8. First of all, the consistency of assessments is calculated as follows [21]:

$$Consistency\ ratio = \frac{\xi^*}{Consistency\ index} \qquad (5)$$

As consistency is important only for the validation of input data, this procedure is not presented, but can be found in the paper Rezaei [22]. It should be noted that the Consistency index is a tabular value, which depends on comparison of best to worst criteria. In this case, Consistency ratio value is 0.361, which means that the consistency of the assessments is acceptable. The obtained weight vectors are:

$W_{IE1} = 0.34$ $W_{IE2} = 0.03$ $W_{IE3} = 0.21$ $W_{IE4} = 0.05$

$W_{IE5} = 0.14$ $W_{IE6} = 0.10$ $W_{IE7} = 0.07$ $W_{IE8} = 0.06$

The questionnaire for this case study was filed by middle management and confirmed by top management, as well as the procedure for calculating Q_n and R_n (Step 3 of the proposed algorithm). Questionnaire given in the Appendix is provided to the company. Questionnaire form is filled online in MS Word format. Results obtained from the questionnaire are presented in Table 4. With available data, maturities of each influential factor are calculated according to equation 2. Question (Q) and Ratio (R) values are obtained by questionnaire method and introduced in Table 4 (Stap 4 and Step 5 of the proposed algorithm).

Table 4. Data obtained by questionnaire and maturity of influential factors calculated according to equation 2.

Number of the influential factors (n)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Question value (Q)	1	0	0	0	1	0	1	0
Ratio value (R)	2	1	3	2	3	3	4	4
Maturity of influential factor (M_{IE})	1.5	0.25	0.75	0.5	1.75	0.75	2	1

An example of the calculation for one influential factor according equation 2 (result is given in table 3. The same is repeated for all the other 8 influential factors) is given bellow (Step 6 of the proposed algorithm):

$$M_{IE1} = Q_1 + R_1 \cdot 0.25 = 1.5$$

By accounting influential factors maturity (Table 3) and their accompanying weights (Table 1), the overall maturity level was calculated according to equation 1 (Step 7 of the proposed algorithm): $M_O = 1.22$. By calculating the overall maturity level, it was determined that the company belongs to the 2nd level of maturity of PFMEA.

RESULTS AND DISCUSSION

The maturity of all influential factors is calculated and presented in Figure 2.

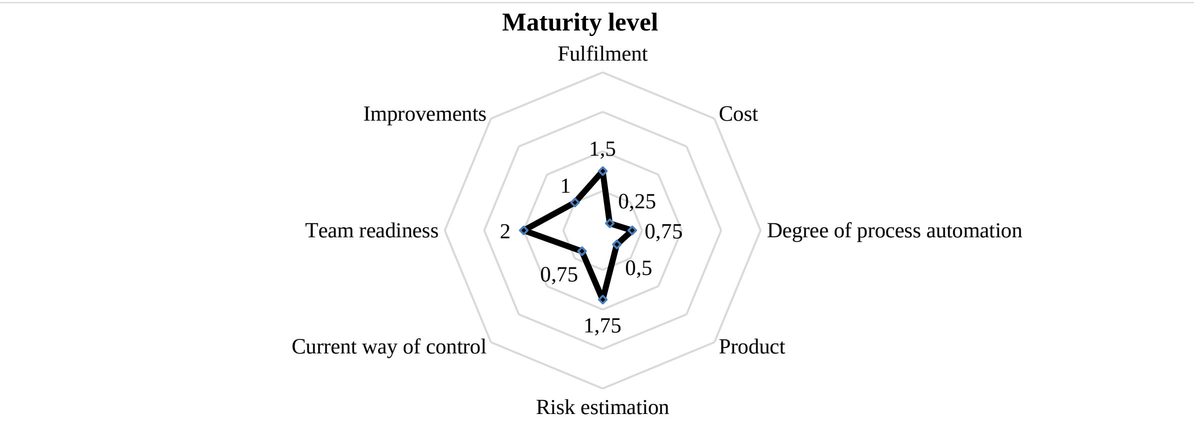

Figure 2. *Maturity of influential factors*

The obtained results indicate that the PFMEA of a company involved in the presented case study belongs to the PFMEA 2.0 maturity level. This means that the company is using MS office tools for the PFMEA realization. PFMEA documents are not centralized and there are no additional extensions (methodological or technological) in use. The most progressive and extensive element used by the company is the decision-making algorithm for the risk estimation. The team is very skilled, which is important if a company wants to raise its maturity level. Still, the company has a poor degree of automatization and failure control, which is not promising if the PFMEA is expected to evolve toward the I4.0. While the influential factors have different influences on the overall maturity of the PFMEA, a weighting method has been applied. The applied BWM method is easy to use and it saves a lot of time. Weighting estimation is done only with the most important influential factor and the least important.

Regarding the data collection, only Q and R were needed for the calculation of influential factors maturity (M_{IEn}) - and they were acquired through filling the intuitive questionnaire form by the chosen automotive company. Questionnaire is based on four questions (per influential factor) related to the PFMEA maturity descriptions, but descriptions are adjusted to the influential factors. The ratio is used in order to more precisely define the current degree of influential factors implementation regarding PFMEA Maturity level. This type of questionnaire could be also useful for mass research with many companies involved, like in the research study given in literature [8]. The table for ratio definition has a common descriptive section useful in any case, but also has a descriptive section with more specific descriptions. If a user cannot make a choice there is an available alternative for the ratio estimation. In general, for a company it is the most important to balance influential factors in order to achieve a successful transition from one maturity level to another. Special attention should be given to more important influential factors. Degree of automatization and digitalization is a key aspect toward I4.0. Recently, a research study was introduced by Švingerová and Melichar [23], where RPN (previous index for risk prioritization) was significantly reduced (from 33 to 84%) due to production process automatization.

Since companies may be at various/lower stages of technological readiness, it is important to provide their management team with a generic and intuitive guide on how to adapt, improve and proceed to the next stage of PFMEA maturity and readiness. In this study, we presented four different PFMEA maturity stages. At the moment, digitalization of PFMEA documents could be done by using various artificial-intelligence algorithms [24, 25]. Described digitalization of documentation represents the technological transition of PFMEA and it is not technologically challenging because there are affordable or free tools that could help to convert a scan (image) into digital document (PDF, or MS Word). Since the output of these algorithms is unstructured text, it is commonly stored and managed with some document management software [26]. However, document management software is expensive and complex - consequently, many companies avoid investing in it. More importantly, the data in separate documents are commonly unstructured - so that companies with sufficient budgets prefer to develop dedicated software information systems instead [27] [28]. Briefly, it assumes development of dedicated user-interface, which are used by employees to feed a centralized relational database system. Having data in structured form is important because it enables one to easily manage, query and extract information in a computationally efficient way. In the last five years, with the rapid evolution of artificial intelligence, there is an emerging trend to use Data mining algorithms for extracting "hidden knowledge" contained within data patterns that was not possible to describe in analytic or class-if algorithmic form [5]. The key expected benefit of the last maturity level of PFMEA is the efficiency, which grows exponentially with the automation and usage of AI.

CONCLUSION

In this study, we presented a novel maturity model for the assessment of PFMEA maturity level toward I4.0. The model was developed using a multi-methodological approach, and it includes a systematic literature review, conceptual modelling, and both qualitative and quantitative methods for empirical validation. According to our best knowledge (based on the presented literature review), this is the first model for the PFMEA maturity level estimation. We recommend that this assessment should be a starting point when a company wants to improve its PFMEAs, especially from the point of view of the influential factors. Furthermore, companies should analyse the level of maturity and readiness of each factor before transitioning from one level of maturity to another (in order to set up road maps for the improvements and transition to the next stage of readiness of PFMEA). The conceptual model allows one to collect data easily with respect to the linguistic descriptions (weighting of influential factors was based on the BWM method). The overall method is very user-friendly and easy to use, but it also suits very well with overall maturity calculation. A potential disadvantage of the proposed method can be subjectivity of choice for the influential factors. One another disadvantage is R index which is rough for definition of influential factors maturity level. However, the proposed model is suitable for a change or addition of new influential factors or linguistic descriptions given in form. Currently, the proposed model is developed specially for the PFMEA in the automotive industry. However, it could be used in other industries (with production processes) - which we recommend as a future research direction. Another future direction should be development of a model for readiness estimation and development of road maps for PFMEA transition from one maturity stage to another.

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APPENDIX

n	Influential elements (IE)	Questions	Q
1	Fulfilment	A) The fulfilment is done manually, by using a pen. Most frequently, it is done by a single person.	0
		B) The fulfilment is done during the PFMEA meeting by a person that use some sort of software or technology (i.e. Excel, online forms, or similar). The PFMEA is in the most cases done in a multidisciplinary team, but on a traditional way during the meeting.	1
		C) The fulfilment is done by users, which uses a technology (software tools) with logical suggestions and knowledge-based approach. Each user is filing PFMEA form with its competences and sometimes within a multidisciplinary team (when the consensus is needed).	2
		D) The fulfilment is done by user/operator/AI using some technology. Some parts of reports are automatically filed and user is just informed to check and confirm reports. Some data are inserted online directly in-line by operators using tablets or mobile phones. Some data are used from other software tools that are connected with the PFMEA software.	3
		Ratio (R): 2	
2	Cost (profitability)	A) Costs (profitability) are not considered at all.	0
		B) Costs (profitability) are taken into account. Analytics is calculated manually.	1
		C) Costs (profitability) extensions are integral part of the software tool. Analytics is calculated automatically.	2
		D) Costs (profitability) are predicted by AI or ML and user is informed in real-time about changes or predictions. Analytics is calculated automatically and user is informed when it is needed.	3
		Ratio (R): 1	
3	Degree of process automation (Detection or Prevention)	A) $D \leq 5$ in less than 25% of cases.	0
		B) $D \leq 5$ in less than 50% of cases.	1
		C) $D \leq 5$ in less than 70% of cases.	2
		D) $D \leq 5$ in less than 90% of cases.	3
		Ratio (R): 3	
4	Product	A) For group of products (or part numbers) one PFMEA is used.	0
		B) For each product (or part number) one PFMEA is used.	1
		C) Each PFMEA is developed for each product, but all products are centralized in a single database.	2
		D) Each product has appropriate PFMEA, but all PFMEAs are centralized and arranged by AI (to group of products or similar products).	3
		Ratio (R): 2	
5	Risk estimation	A) User is estimating risk on traditional way with the manual calculation	0
		B) User is estimating risk on the traditional way, but with automatic calculation. User is using an additional methodology for the risk prioritization calculating.	1
		C) User is estimating risk by comparing it with common risks in database and/or using automatic decision making algorithms based on keywords. User is using additional methodology for the calculation of risk prioritization and it is integral part of a PFMEA software. Software tool have an option for different prioritization (quality, safety, costs, profitability, root cause, product priority, etc.) set up by user.	2
		D) AI is helping a user to make decision by suggestions and/or automatically. Prioritization is done automatically by AI combining different priorities (quality, safety, costs, profitability, root cause, product priority, etc.).	3
		Ratio (R): 3	
6	Current way of control	A) Control plan is used for control, but only formally. There is no statistical follow up of acquired data.	0
		B) Control is done by a control plan, with check lists and crosschecking (these data are inserted into statistic manually).	1
		C) Control is done by a control plan and user is responsible for filing PFMEA software with data from control. Statistics is done automatically.	2
		D) Control is done automatically by AI taking data from other software and digital locations or directly by operators from line using tablets/phones.	3
		Ratio (R): 3	
7	Team readiness	A) Team is not skilful for PFMEA analysis and most of analyses are done formally in order to satisfy standard.	0
		B) Team is able to use PFMEA analysis and some extensions.	1
		C) Team is familiar or able to use PFMEA software, or other software tools.	2
		D) Team is familiar with the Industry 4.0 concept and its pillars. Team has experience with ERP or other specialized software forms. Team has full analytical skills and it is able to analyse and make decisions according to AI suggestions and calculations.	3
		Ratio (R): 4	
8	Improvements	A) Improvements are only done when it is necessary or demanded by customer. Efficiency is followed by recalculation of AP.	0
		B) Improvements are not only done when it is necessary or demanded by customer. Improvements are done additionally according to priority. Efficiency is followed by recalculation of AP. Profitability is taken into account.	1
		C) Improvements are always done according to priority. Company has a culture of continuous improvement. Profitability is taken into account. Efficiency is followed by recalculation of AP.	2
		D) Improvements are always done according to priority. Company has a culture of continuous improvement. AI is alarming user to improve. PFMEA Software using ML for failure and cost benefit predictions real-time. PFMEA software is providing to user analytics and profitability of implemented improvement during the time.	3
		Ratio (R): 4	

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