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Risk Assessment With Value Added Pythagorean Fuzzy Failure Mode and Effect Analysis for Stakeholders

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ABSTRACT The new product development process (NPDP) is crucial for maintaining business up and running in manufacturing corporations worldwide. NPDP helps firms improve their profits, where stakeholder attention is mostly focused. NPDP Risk Assessment (NPDP-RA) is a vital activity to achieve a successful new product launch. However, managing different kinds of risks over the process presents enormous challenges; thus, risk assessment over NPDP still shows gaps, even when different tools are employed to identify, mitigate, and eliminate risks throughout the process. The identified gaps are mainly produced because the uncertainty added by the individuals assessing the risks, and the currently used tools are generally focused on a single phase of the NPDP, disregarding the stakeholders' project objectives. This paper presents the main NPDP risks for stakeholders through the NPDP phases; likewise, the integration of Pythagorean fuzzy dimensional analysis – failure mode and effect analysis and value stream mapping (PFDA-FMEA-VSM). This novel integrated method is intended to improve the manner to perform the NPDP-RA for stakeholders. A practical example is presented to demonstrate the proposed integration of PFDA-FMEA-VSM for stakeholders at NPDP of electronic devices project.

INDEX TERMS New product development process, risk analysis, Pythagorean fuzzy dimensional analysis, value stream mapping, failure mode effect analysis, stakeholders.

I. INTRODUCTION

While the electronic devices market is growing because of globalization, global consumers are demanding new technological products and better product upgrades. Consequently, new complex processes and challenges are presented in manufacturing companies during the new product development process (NPDP), making it crucial to overcome new and bigger engineering and scientific challenges. Subsequently, the risk of failing to introduce new products into the market is increasing. For this reason, NPDP-RA is necessary to make the right decision for stakeholders to obtain the expected project goals.

NPDP is a well-analysed process in different industries. The first most popular NPDP was introduced by Cooper,

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phase-gate for NPDP [1], and later some other proposed methods were introduced, [2]–[4].

Currently, failure mode and effect analysis (FMEA) is broadly used in the manufacturing industry [5], as well as other areas like inference systems [6], [7], moreover, FMEA in combination with other methodologies for RA during NPDP. The most common tools found in the literature [8], [9], [10], are FMEA, Pareto optimization, Graphical Evaluation and Review Technique (GERT), Bayesian Network [11], Multicriteria Optimization and Compromise Solution (VIKOR)[12], Fuzzy, Grey Theories [13], Failure Tree Analysis (FTA) [14]–[16], Quality Functional Deployment (QFD) [17], probabilistic linguistic [18], Lean methodology[19], Fuzzy and AHP [20], a combination of FMEA and Cloud Hierarchical TOPSIS in [21], including Z-numbers and projection model [22], and adding geometrical mean to the FMEA in [23].

Furthermore, there is extensive literature on risk in NPDP, such as the compiling in [24], including the main used risk descriptions and affected functional areas, as well as involving different methodologies for RA, such as Voice of the Customer (VOC) [25], and recently the risk assessment using FMEA and dynamic weights [26]. Additionally, the international standard for risk, ISO 31000 [27] includes stakeholders as part of the affected areas in the corporate world; ISO 31000 mentions how to deal with the risk.

Thus, the current RA tools are not enough to cover the identified gaps over the NPDP-RA, in the first instance because of the uncertainty while the assessment is usually slanted by human decisions. The PFDA-FMEA proposed method [28] removes the uncertainty induced by the human factor during the RA using FMEA in NPDP. Another gap in the NPDP-RA, is the use of the tools focused on a single phase of the NPDP at a time, to cover this gap, another contribution in this paper is the integration of VSM, attaining the value added through the NPDP. The identified gaps at NPDP-RA found in the literature [29]–[33] are as follow.

- Uncertainty on NPDP-RA due to the cross-functional team different opinions.
- Ambiguity because of the right use of the current NPDP-RA tools.
- Wrong ranked risks because of different NPDP phases not considered during the assessment.
- Inefficient consumption of project resources while covering risks identified because of inaccurate NPDP-RA.

Moreover, most commonly in the NPDP, the stakeholders are the group usually at high levels of the organization, which dictates the portfolio objectives, impacting each project goal, usually based on the corporate general plans. There is a literature review of stakeholders at [34], and the literature indicates that there are uncertainty identifying stakeholders [35] and stakeholder assessment [36], along with stakeholder reputation presented in [37] and [38].

Additionally, value stream mapping (VSM) is currently used to determine the optimal future state of a process under analysis [39]. Finding the value added in a process is not an easy task; VSM is usually used to capture the factors that are linked to the result in a specific process, VSM applications go from improving processes in production lines, [40], [41], to improve administrative processes, including product cost improvements [42], and recently a Social-VSM was presented in [43].

Therefore, the novel proposed method PFDA-FMEA-VSM for stakeholders is presented within the integration of the PFDA-FMEA proven method [28], then adapting VSM. Likewise, PFDA-FMEA-VSM integration will help NPDP project stakeholders to have an effective assessment based on their main project objectives. In addition, the novel PFDA-FMEA-VSM method aims to improve the NPDP by solving the problems regarding identified gaps, listed previously in this document.

Finally, the main contribution in this paper is present the PFDA-FMEA-VSM integration, that will support

NPDP project stakeholders to have an effective assessment based on their main project objectives. Consequently, our proposal method reveals contributions as following.

1. It supports stakeholders to analyze the decision-making process to assigning resources in effective manner. The resources play an important role during NPDP.
2. The PFDA-FMEA-VSM method adds key contraptions allowing to NPDP-RA.
 - a. Sub-classes (explained later in Table 2)
 - b. Risk Identification (RID)
3. An extension of cooper “Stage-gate” method. In this manner, we develop a cooper method extension to manipulate NPDP data, allowing to integrate VSM to NPDP-RA.
4. Value-added for stakeholders allowing the risks visualization at specific areas and at specific project phases. A diagram is design to visualized value-added areas, called Visualization Areas Diagram (VAD).

Nevertheless, NPDP-RA is generally executed considering just a specific portion of the NPDP and is typically focused on the activities that impact the product specifications and functional activities during the execution of the NPD project. Correspondingly, they usually miss the factors that affect the stakeholders’ goals. Likewise, a contribution presented in this study is the novel integration of PFDA-FMEA-VSM to tackle the identified gaps mentioned previously, focusing on the main goals of the risk analysis for the NPDP project stakeholders, where the potential risks are affecting, direct or indirect stakeholders’ main interests over the NPDP, offering to the NPDP stakeholders, a fuzziness mode to make decisions based on informed risk assessment by the PFDA-FMEA-VSM method.

The remainder of this paper is organized as follows. Section 2 includes the basic concepts used for this research, Section 3 covers the novel proposed approach PFDA-FMEA-VSM, Section 4 contains a practical example, Section 5 presents the results and discussion, and Section 6 presents the conclusions.

II. BASIC CONCEPTS

This section presents the basic concepts used in this study.

Definition. Equation 1 [44] was used to complete the PFDA-FMEA process.

$$PFIS_i(\omega_1^i, \omega_2^i, \dots, \omega_m^i) = \left(\prod_{k=1}^n (\mu_{\xi_j^i})^{T_j}, \sqrt{1 - \prod_{k=1}^n (1 - (v_{\xi_j^i})^2)^{T_j}} \right)$$

where $PFIS$ is Pythagorean fuzzy Index of Similarity for $i = 1, 2, \dots, m$.

Then, ω represents the Pythagorean sets, μ denotes the Membership values assigned, and v the Values of non-membership.

Next, T_j symbolizes the weights assigned to each expert, for $j = 1, 2, \dots, m, k = 1, 2, \dots, n$, and “ ξ ” is the universe

of elements measured, where $T_j \in [0, 1]$, index i is defined by the PFS.

Definition. Simplifying the NPDP phases, the SME team will refer only to “Phase 1,” “Phase 2,” and “Phase 3.” Figure 1 depicts the definition of NPDP phases.

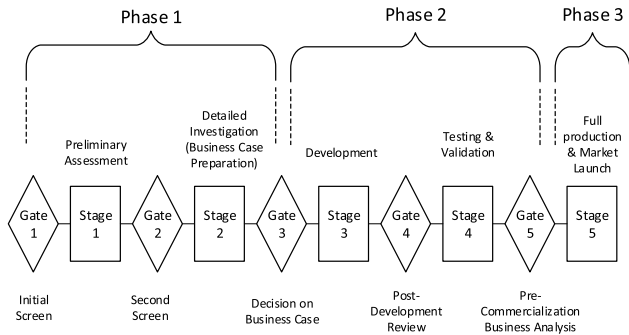


FIGURE 1. Using stage-GATE [1] diagram, NPDP tree simplified phases for PFDA-FMEA-VSM method.

Additionally, as for reference, original stage-gate NPDP process diagram is shown in Figure 2.

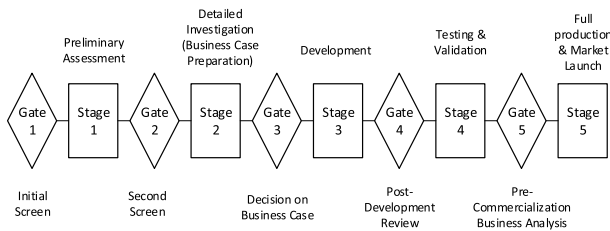


FIGURE 2. Stage-gate NPDP flow by cooper [1].

III. PFDA-FMEA-VSM FOR STAKEHOLDER APPROACH

PFDA-FMEA-VSM integration aids NPDP risk analysis based on the PFDA-FMEA approach, integrating VSM to collect the value-added risks during the NPDP, allowing the stakeholders to optimize the available resources administrating the NPDP risks. Figure 3 shows a flow diagram of the PFDA-FMEA-VSM method.

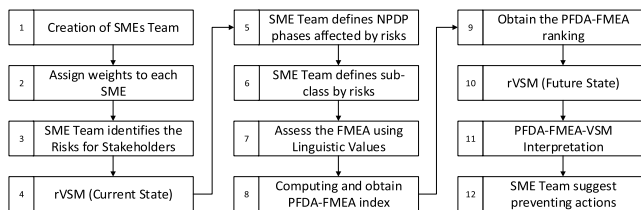


FIGURE 3. PFDA-FMEA-VSM integration flow diagram.

Step 1. The first step in this process is to create the subject matter expert (SME) team, which is usually a group of experts in the area to be assessed, and it is recommended to use different levels of expertise and experience and at least select tree experts.

Step 2. Next, the weights are equation 1 to each selected expert that will participate in the PFDA-FMEA-VSM method. The weights can be applied based on the expertise level of each expert; the higher the value, the more important the expert decision.

Step 3. Later, the SME team needs to capture the main potential risks for stakeholders (PRS) that affect stakeholders’ project key objectives. To summarize, each PRS should have a unique identification, RID, adding a consecutive number. For this step, it is recommended to have a meeting between the SME group and stakeholders prior to this exercise.

Step 4. Later, the SME team performs the risk VSM diagram (rVSM) current scenario at the NPDP, considering the risks identified.

Step 5. Next, the SME team will define and document the NPDP phase where the identified risk is commonly presented. The SME can duplicate the risk description if it applies to a different NPDP phase. Here, Figure 1 is used, and it is recommended to have a meeting between the SME team and the stakeholders to complete this exercise.

Step 6. Subsequently, the SME team must assign a functional sub-class to each identified risk. Table 1 shows the sub-classes and descriptions proposed for this method. This addition is an important part of the method, and it is necessary to successfully execute the proposed methodology, as well as helps the stakeholders to easily identify at what functional area are located the value-added risks.

TABLE 1. Sub-class description.

Description	Sub-Class
Market	M
Innovation	I
People	P
Quality	Q
Time	T
Budget	B

Step 7. Consequently, the PFDA-FMEA should be assessed using the linguistic values listed in Table 3.

Step 8. In this step, Equation 1 is used to compute the collected data and obtain the PFDA-FMEA index.

Step 9. Next, ranking can be calculated based on the PFDA-FMEA index hierarchy; at the maximum index, the minimum ranking is. The ranking facilitates risk priority over the assessment. Additionally, in this step, the RID should be modified by adding a dash to the ranking number, that is, RID rank = RID10-1.

Step 10. Later, the rVSM future scenario can be performed by the SME team. The sub-class, NPDP phase, and RID rank should be considered in future VSM scenarios.

Step 11. This step refers to the PFDA-FMEA-VSM interpretation. Once the rVSM is completed, the SME team highlights the top RIDs considered as the main offensive for the NPDP. It is also recommended to meet again the

TABLE 2. Linguistic values, membership functions, and non-membership functions based on [28].

Linguistic values	Membership Function (μ_z)	Non-Membership Function (ν_z)
Low impact in quality - LQ	0.15	0.95
Regular impact in quality - RQ	0.5	0.55
High impact in quality - HQ	0.9	0.15
Low impact in Time - LT	0.12	0.92
Regular impact in Time - RT	0.45	0.56
High impact in Time - HT	0.95	0.1
Low impact in Budget - LB	0.11	0.9
Regular impact in Budget - RB	0.5	0.54
High impact in Budget - HB	0.92	0.16
Low impact in Market - LM	0.13	0.91
Regular impact in Market - RM	0.49	0.51
High impact in Market - HM	0.93	0.17
Low impact in Human - LP	0.15	0.92
Regular impact in Human - RP	0.48	0.5
High impact in Human - HP	0.91	0.15
Low impact in Innovation - LI	0.07	0.98
Regular impact in Innovation - RI	0.47	0.49
High impact in Innovation - HI	0.98	0.1

TABLE 3. List of risks for Stakeholders including the NPD phase and sub-class.

SN	Sub-class	RID	Potential Risk for Stakeholders (PRS)	NPD Phase
1	M	RID1	Wrong project revenue projected	Phase 1
2	I	RID2	Lack of manufacturing capacity	Phase 3
3	T	RID3	Long period of project on hold	Phase 1
4	T	RID4	Project execution extended	Phase 2
5	Q	RID5	Product low yield	Phase 3
6	P	RID6	Lack of trained R&D Team	Phase 1
7	T	RID7	Lack of trained R&D Team	Phase 2
8	P	RID8	Overall project bad health	Phase 3
9	Q	RID9	Product out of specifications	Phase 1
10	Q	RID10	Product out of specifications	Phase 3
11	B	RID11	Overall project cost exceeded	Phase 3
12	T	RID12	Project out of schedule	Phase 2
13	T	RID13	Project out of schedule	Phase 3
14	B	RID14	Product out of planned target cost	Phase 1
15	B	RID15	Product out of planned target cost	Phase 3
16	B	RID16	Exceed product indirect costs	Phase 2
17	B	RID17	Exceed product indirect costs	Phase 3
18	M	RID18	Product sales wrong projection	Phase 3
19	I	RID19	Product development technology not available	Phase 2

stakeholders to agree on what will be the RID rank level considered to suggest preventive actions.

Step 12. During this step, the SME team will suggest preventing actions for each of the chosen top RIDs.

IV. PRACTICAL EXAMPLE

This section presents a practical example of an NPD project at an electronic device manufacturing company. An NPD electronic device project was used to validate the PFDA-FMEA-VSM approach.

Step 1. Beginning the process, the project manager (PM) leading the NPD project, chose a group of three experts, including a senior program manager, a senior engineering

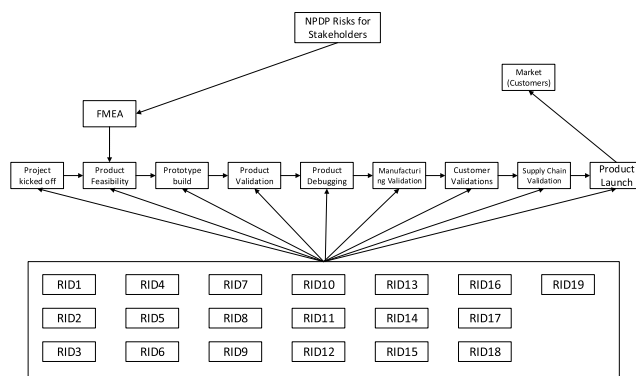


FIGURE 4. NPDP process rVSM current scenario.

TABLE 4. PFDA-FMEA index by RID.

RID	PFDA-FMEA Index
RID2	9.7×10^{-5}
RID9	7.0×10^{-5}
RID11	6.9×10^{-6}
RID16	3.5×10^{-6}
RID8	3.2×10^{-6}
RID19	3.1×10^{-6}
RID17	2.0×10^{-6}
RID6	1.6×10^{-6}
RID13	1.3×10^{-6}
RID4	1.3×10^{-6}
RID5	9.0×10^{-7}
RID7	3.7×10^{-7}
RID18	2.9×10^{-7}
RID10	2.8×10^{-7}
RID12	1.4×10^{-7}
RID15	1.4×10^{-7}
RID14	6.0×10^{-8}
RID3	2.2×10^{-8}
RID1	3.4×10^{-9}

leader, and a senior finance leader. Immediately after the SME team was created, the PM led a meeting between the experts and the identified stakeholders, the Research and Development Director, supply chain director, program management officer, and general manager. During the meeting, the SME team captured the main concerns about the project results, as well as the most important objectives for each stakeholder, which will help the SME team to gain a better understanding of the potential risks information required for the next steps.

Step 2. Next, the project manager assigns weights considering equation 1 to each expert in the team. For this example, the assigned weights are the same for each expert because SME team members have the same level of expertise.

Step 3. Later, the SME Team defines the PRS.

Step 4. Next, the SME team evaluates the PRS, and based on the NPDP, creates the NPDP process rVSM current scenario. Figure 4 depicts the current scenario results of this practical example.

TABLE 5. PFDA-FMEA index and RID rank by RID.

RID	PFDA-FMEA INDEX	RID RANK
RID2	9.7×10^{-5}	RID2-1
RID9	7.0×10^{-5}	RID9-2
RID11	6.9×10^{-6}	RID11-3
RID16	3.5×10^{-6}	RID16-4
RID8	3.2×10^{-6}	RID8-5
RID19	3.1×10^{-6}	RID19-6
RID17	2.0×10^{-6}	RID17-7
RID6	1.6×10^{-6}	RID6-8
RID13	1.3×10^{-6}	RID13-9
RID4	1.3×10^{-6}	RID4-10
RID5	9.0×10^{-7}	RID5-11
RID7	3.7×10^{-7}	RID7-12
RID18	2.9×10^{-7}	RID18-13
RID10	2.8×10^{-7}	RID10-14
RID12	1.4×10^{-7}	RID12-15
RID15	1.4×10^{-7}	RID15-16
RID14	6.0×10^{-8}	RID14-17
RID3	2.2×10^{-8}	RID3-18
RID1	3.4×10^{-9}	RID1-19

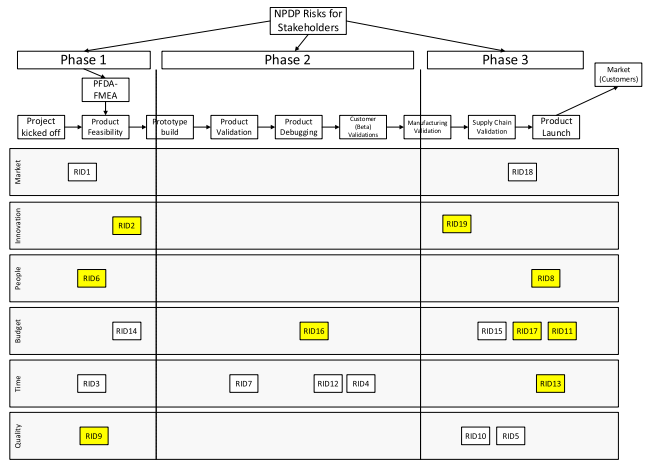


FIGURE 6. Visualization Areas Diagram (VAD), highlighting the main risk impacting stakeholders.

TABLE 6. Preventive actions by SME team for the top 9 RID ranks.

RID Rank	Preventive action	Tailoring activity
RID2-1	Cross-functional meetings since early Development phase	Manufacturing capacity based on customer requirements
RID9-2	Early product prototypes build, product simulations, and recurrent VOC reviews	Product specifications based on VOC
RID11-3	Project planning sessions involving cross-functional areas experts	Budget plan vs spend by functional area
RID16-4	BOM scrub and design reviews by R&D and Sourcing since early Discovery phase	Indirect costs vs budget target
RID8-5	Monitoring cross-functional deliverables by phase	Cross-functional deliverables by phase
RID19-6	VOC and feasibility analysis performed since Discovery phase	Technical reviews since discovery phase
RID17-7	BOM scrub and design reviews by R&D and Sourcing since early Development phase	Indirect costs vs budget target
RID6-8	Team technical capabilities assessment & balanced if required	Team training completion
RID13-9	Cross-functional project plan meetings since Discovery phase	Master Schedule reviews

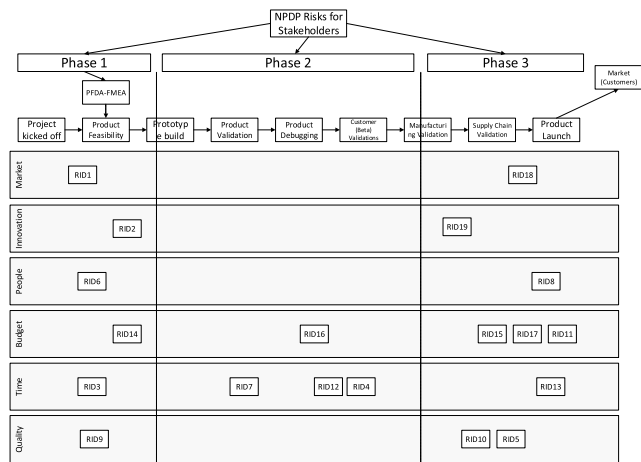


FIGURE 5. NPDP rVSM future scenario, for risk interpretation.

Step 5. Then, for each identified risk, an NPDP phase was identified. The NPDP phase was chosen based on the location of risk. Figure 1 is considered for this step to identify the NPDP phases: “Phase 1,” “Phase 2,” and “Phase 3.”

Step 6. Next, the subclass should be completed for each PRS using Table 1. Table 4 presents the charts created until this step.

Step 7. Consequently, the PFDA-FMEA should be assessed using the linguistic values listed in Table 3.

Step 8. Using Equation 1, the PFDA-FMEA is performed, and the PFDA-FMEA index is shown in Table 5.

Step 9. Likewise, the ranking is obtained by sorting the index in a descending manner, then considering the maximum index value as the number one ranked, followed by ascending numbers to obtain the full list. Additionally, to obtain the RID Rank, the RID is concatenated with the rank, as shown in Table 6.

Step 10. Later, the rVSM future scenario can be performed by the SME team, considering the highest risks identified, the sub-class, and the NPDP phase. The results are shown in Figure 5.

Step 11. This step refers to the interpretation of the PFDA-FMEA-VSM. Figure 6 shows the VAD highlighting the main risks, where it is easy to identify by the stakeholders in what functional area and project stage, the risk impact can occur.

Step 12. The SME team considered the top nine RIDs to generate major problems during the NPDP, following a list of preventing actions being deployed. Table 7 shows the suggested actions for the NPDP.

TABLE 7. PFDA-FMEA-VSM for stakeholders. Practical example results table (continue).

SN	Sub-class	RID	PRS	NPD Phase	S
1	M	RID1	Wrong project revenue projected	Phase 1	9.3×10^{-5}
2	I	RID2	Lack of manufacturing capacity	Phase 3	2.3×10^{-1}
3	T	RID3	Long period of project on hold	Phase 1	1.8×10^{-3}
4	T	RID4	Project execution extended	Phase 2	1.8×10^{-3}
5	Q	RID5	Product low yield	Phase 3	7.5×10^{-2}
6	P	RID6	Lack of trained R&D Team	Phase 1	7.6×10^{-3}
7	T	RID7	Lack of trained R&D Team	Phase 2	1.8×10^{-3}
8	P	RID8	Overall project bad health	Phase 3	1.3×10^{-3}
9	Q	RID9	Product out of specifications	Phase 1	1.5×10^{-1}
10	Q	RID10	Product out of specifications	Phase 3	5.6×10^{-5}
11	B	RID11	Overall project cost exceeded	Phase 3	4.0×10^{-2}
12	T	RID12	Project out of schedule	Phase 2	6.5×10^{-3}
13	T	RID13	Project out of schedule	Phase 3	1.8×10^{-3}
14	B	RID14	Product out of planned target cost	Phase 1	5.7×10^{-3}
15	B	RID15	Product out of planned target cost	Phase 3	7.3×10^{-5}
16	B	RID16	Exceed product indirect costs	Phase 2	4.0×10^{-2}
17	B	RID17	Exceed product indirect costs	Phase 3	1.8×10^{-3}
18	M	RID18	Product sales wrong projection	Phase 3	1.5×10^{-3}
19	I	RID19	Product development technology not available	Phase 2	3.6×10^{-3}

TABLE 8. PFDA-FMEA-VSM for stakeholders. Practical example results table (continuation).

SN	O	D	PFDA-FMEA Index	PFDA-FMEA Rank	RID Rank
1	4.5×10^{-3}	8.2×10^{-3}	3.5×10^{-9}	19	RID1-19
2	3.6×10^{-3}	1.1×10^{-1}	9.7×10^{-9}	1	RID2-1
3	6.5×10^{-3}	1.8×10^{-3}	2.3×10^{-8}	18	RID3-18
4	5.7×10^{-2}	1.2×10^{-2}	1.3×10^{-6}	10	RID4-10
5	6.1×10^{-3}	1.9×10^{-3}	9.1×10^{-7}	11	RID5-11
6	4.0×10^{-3}	5.2×10^{-2}	1.6×10^{-6}	8	RID6-8
7	1.8×10^{-3}	1.1×10^{-1}	3.8×10^{-7}	12	RID7-12
8	4.6×10^{-2}	5.2×10^{-2}	3.2×10^{-6}	5	RID8-5
9	6.1×10^{-3}	7.5×10^{-2}	7.0×10^{-5}	2	RID9-2
10	6.7×10^{-2}	7.5×10^{-2}	2.9×10^{-7}	14	RID10-14
11	1.8×10^{-3}	9.2×10^{-2}	6.9×10^{-6}	3	RID11-3
12	1.2×10^{-2}	1.8×10^{-3}	1.5×10^{-7}	15	RID12-15
13	6.5×10^{-3}	1.1×10^{-1}	1.3×10^{-6}	9	RID13-9
14	5.7×10^{-3}	1.8×10^{-3}	6.1×10^{-8}	17	RID14-17
15	4.0×10^{-2}	4.7×10^{-2}	1.4×10^{-7}	16	RID15-16
16	4.7×10^{-2}	1.8×10^{-3}	3.6×10^{-6}	4	RID16-4
17	1.0×10^{-2}	1.0×10^{-1}	2.0×10^{-6}	7	RID17-7
18	4.2×10^{-2}	4.5×10^{-3}	2.9×10^{-7}	13	RID18-13
19	2.3×10^{-1}	3.6×10^{-3}	3.1×10^{-6}	6	RID19-6

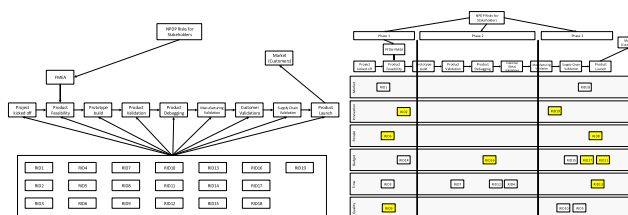


FIGURE 7. Comparison between VSM current and future states.

V. RESULTS AND DISCUSSION

This section reveals the PFDA-FMEA-VSM integration results, as well as a discussion comparing the current and future state scenarios analyzed in the practical example presented in Section 4 of this document.

Table 8 and 9 illustrate the PFDA-FMEA-VSM results, including the sub-class, RPS, NPDP phase, PFDA-FMEA results, and RID Rank.

Furthermore, Table 8 and 9 (continuation), depict proposed method additions in columns: Sub-class and NPD Phase, that are the key elements allowing to integrate VSM to PFDA-FMEA method. Likewise, this contribution facilitates to visualize later in the VSM, where to assign just the required resources to mitigate the value-added risks identified.

Sub-class is an added subject to classify the main interest stakeholder area, goal, or objective to achieve. Likewise, this integration gives a visual picture about the specific areas

because of the VAD. Following, RID in Table 8, represents the PRS identification, acting as an abbreviation, required to reflect the value-added risks at VSM diagram.

Figure 7 shows a comparison between the current and future state VSM. It is clearly identified that first, the current state is not well organized, making difficult to identify what is the risk and where it can hit the stakeholder objectives, is hitting the appreciated that. Later in the PFDA-FMEA-VSM future state, it is clear and organized what is the risk, what is the area where can be affected, and what is the possible stakeholder goal area (sub-class) impacted. This feature allows the application of the necessary resources to avoid the risks, just to the specific area where it is required.

In addition, to prove the consistency of the PFDA-FMEA-VSM, an experiment was performed by changing the weights



FIGURE 8. Relationship between 22 experiments using different SME weights.

assigned to the experts. Even when changing the weights, the method yields the same trend, which means that the method is trustworthy. Figure 8 illustrates the experiment results.

VI. CONCLUSION

There is still room to improve the NPDP, according to the literature examination. However, PFDA-FMEA-VSM for stakeholders, is a novel integrated method beating the main gaps identified, giving an advanced resolution for risk assessment methods, adding value, and avoiding jeopardizing the stakeholders' project objectives.

Following, the main conclusive findings and benefits to use the PFDA-FMEA-VSM for stakeholders method.

1. PFDA-FMEA-VSM for stakeholders integration, avoids jeopardizing the NPDP main objectives for stakeholders, removing the fuzziness of human intervention at the risk assessment, and providing an accurate and visual way to identify the focal area and the specific NPDP phase where the risk can occur.
2. Value-added risks highlighted, allowing us to focus the resources, at the right time, at the right area that it is required, allowing the optimization of the resources available.
3. High visibility for stakeholders on where is required to apply more resources, depending on the NPDP phase, and the possible impact of the identified risks.

The precise risk ranking in PFDA-FMEA-VSM for stakeholders makes possible to focus on the available resources in the right place where is required, for individual stakeholder objectives, and for specific NPDP phases.

The PFDA-FMEA-VSM for the stakeholder method is capturing in a systematic way, the value-added risks because of the VSM integration, and applying PFDA-FMEA-VSM for stakeholder methods, the project available resources can be used wisely, depending on the appropriate required phase, which is possible because of the integration of the proposed method.

Subsequently, the ambiguity for NPDP-RA is removed using PFDA-FMEA-VSM for stakeholders, allowing to

clearly and accurate pinpointing the area and project phase where the resources are required.

Furthermore, future work is considered to create a PFDA-FMEA-VSM automated template, making it easier to use this method in any industry by any stakeholder group to optimize the NPDP resources.

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