

Enhancing the Failure Mode and Effects Analysis Risk Prioritization Model Using Conservative Method Based on Enterprise Resource Planning Implementation

Sunita N. Dhote, Chandan R. Vichoray, Pravin Y. Karmore, Satyajit S. Uparkar

Shri Ramdeobaba College of Engineering and Management, India

Email: dhotesn@rknec.edu

Enterprise resource planning (ERP) implementation has been one of the problems of organizations recently, and there have been several obstacles to establish ERP effectively. Companies can decrease the effect of failure by recognizing their strength and weakness. Failure Mode and Effects Analysis (FMEA) is an organized way to determine and address possible issues or failures and their effect on the process or system before an adversarial event occurs. The risk priority number (RPN) index is utilized for prioritizing failures, particularly for its ease and subjective assessments of severity, occurrence, and the detectability of every failure. Hence, this paper suggests Fuzzy assisted weighted risk priority number (F-WRPN) analysis for FMEA. This model can efficiently realize dynamic, real-time, and long-term assessment of RPN under the situation of continuous knowledge accumulations. The significant contribution of the suggested method is to utilize the random ambiguity and fuzzy ambiguity in an incorporated method to resolve the complex combined model. Compared with the weight factor based on fuzzy set theories, the ambiguity measure-based weight factors for vagueness measure of the particular evaluation guarantees the inner management of the suggested technique. The findings illustrate that the suggested approach can overcome many inadequacies of conventional FMEA and efficiently help decision-makers and research and development (R&D) departments improve product reliability. The experimental results show that the suggested F-WRPN model enhances the failure classification ratio of 95.6%, an efficiency ratio of 96.3%, detection ratio of 96.2%, risk prediction ratio of 97.9%, accuracy ratio of 98.2%, and prioritizing critical failure ratio of 98.7% compared to other popular methods.

Keywords: Failure Mode and Effects Analysis Risk Prioritization, Enterprise resource planning Implementation, Fuzzy Logic, Risk Priority Number Calculation.

1. Introduction

The Enterprise Resource Planning model is a common term for a wide set of actions sustained by multi modules applications software, which supports business handle their resource [1]. The Enterprise Resource Planning system has been shown to deliver important enhancements in productivity, efficiency, and service quality, reduce service costs and make decisions more effectively [2]. Enterprise Resource Planning systems assure to provide incorporated, packaged software solutions to the data needs of businesses for replacement of legacy information system (IS) [3]. These systems are generally aging resolutions formed by information system departments or older available packages that have become problematic to handle and attain the firms' business requirements [4]. In spite of the ensure of ERP models, this software solution has confirmed: "difficult and expensive to establish, often striking their logic on a firm's policy and exiting culture [5]." The enterprise resource planning model's significance to a company's affordability and the enterprise resource planning magnitude expenses linked to the company resources indicate that administrators who establish these models and researchers studying enterprise resource planning must identify which factors are probable to enhance the probabilities of effective execution [6]. The ERP validation assures proper control of functional and operational risks, guarantees user satisfaction, and safeguards that the ERP meets users' needs and expectations [7]. The ERP system validation involves Infrastructure Qualification and software validation for equipment and Hardware [8]. The business procedure recognition known as progression mapping is a vital stage in the validation stage for ERP; risk analysis is very significant for correct system validation and improvement of system documentation which involves Functional Specification (FS), User Requirements Specification (URS), Installation Qualification (IQ), Configuration Specification (CS), and Operation Qualification (OQ) [9].

Diverse risk evaluation tools try to measure the Risk, and every tool has its features, characteristics, or criteria; these tools are discriminated from IS / ERP measurement method and model [10]. These models did not measure the risk precisely put measure ERP or IS. Risk evaluation tools utilized in industrial domains [11]. One of the approaches which can recognize and prioritize the CFF is FMEA. FMEA is a design method to thoroughly determine and examine potential weaknesses of the possible system (products or process) [12]. It contains a method for analyzing how system failures can happen, the potential effect of failure on system safety and performance, and the importance of these effects [13].

In conventional FMEA researches, the priority of a possible failure is identified via risk priority number (RPN), described as the product of detectability, occurrence, and severity of failures [14]. FMEA delivers quantitative scores to assess failure where each failure is converted into numerical values called risk priority number (RPN) [15]. The risk priority number is multiplying three variables, specifically detectability, occurrence, and severity [16]. Severity is the damage or risk that may affect the product, machine, end-user, or next operators [17]. On the other hand, the occurrence is the probability of these failures that may happen over [18]. Lastly, detectability is the degree to which these failures can be perceived. A greater RPN value signifies a greater risk priority. Suitable counteractive activities are generally identified based on the risk priority number threshold values [19]. If this threshold is extended, a risk moderation process is employed consequently. Besides, the risk priority number value

optimizes resource distribution by focusing on risks with the maximum priority number or the most critical problems [20].

The study developed FMEA's fuzzy aided weighted risk priority number (F-WRPN) analysis. Risk prioritisation mathematical model evaluation. The simulation results show that the proposed approach improves failure categorization, efficiency, detection, risk prediction, accuracy, and prioritising critical failure ratios over previous methods.

The study continues as follows: Section II reviews FMEA literature. Section III proposes the F-WRPN paradigm. Section IV discusses experimental outcomes. Section V finishes the study.

2. Literature Survey

Kübra Yazıcı et al. [21] suggested SMED-F-FMEA to save setup time. Better operations and elimination of set-up time-extending problems help firms reduce set-up time. Quality tools and approaches can minimise SMED setup times. This study develops a novel SMED model utilising regular SMED and fuzzy failure methods and effect analysis (fuzzy-FMEA). Avoid set-up delays using fuzzy FMEA. A new working sheet, Set-up Observation and Analysis Form, guides the analyst through machine examination and set-up. Pen makers employ the unique method to create plastic injection moulds. From 71.32 minutes to 36.97 minutes, setup time improved by 48%.

Sakwe et al. [22] recommended product-service systems and failure modes and effects analysis (PSS-FMEA) for conceptual performance risk prioritisation. PSS designers are currently facing the issue of identifying possible faults during PSS development in detail. Before PSS engineering, knowledge of product failures is important. This article presents a failure modes and effect analyzes (FMEA) technique to assist significant failures by designers in the development of PSS performance. The use of this approach is shown using a case study of an optical sorting system. This technique can give a knowledge of important defects in line with contractual commitments and provide the basis for design modifications to meet users' expectations. This case study has promising findings. However, only one case study is used for the study. This is mostly due to ongoing research. In addition, the business model element was not thoroughly explored.

Melih Yucesan et al. [23] used the fuzzy best-worst (FBWM) approach to weight FMEA's three risk parameters—occurrence (O), severity (S), and detection (D)—and find the failure mode's preference value based on S and D. Experts apply linguistic variables which are expressed in trapezoidal fuzzy numbers in their respective values and identify the preferred values of failure modes in the built BN according to the variable O. The FBN thereby addresses insecurity in failure data and involves a strong probabilistic risk analysis system, including expert judgments and flip-flop theory, to detect the reliability between failure events. A case study was performed in an industrial kitchen appliance production facility as a demonstration of the method. The findings of the method have been compared with existed approaches representing its strength.

Lucas Daniel Del Rosso Calache et al. [24] deliberated the Dual Hesitant Fuzzy sets (DHFS) for Risk prioritization. The first is a review of existing FMEA literature. This article offers.

Nanotechnology Perceptions Vol. 20 No. S6 (2024)

The group decision model, integrating FMEA and DHFS, will be presented. Finally, an exemplary scenario is provided for potential applications in supplier failure situations. The article provides a model combining the FMEA tool with the DHFS. A group decision process involving specialists from many fields allows for evaluating varying weights of risk variables. The model can handle the many forms of reluctance in the decisions. The conventional FMEA is not concerned with diverse decision-makers individual opinions. The novel idea may easily be implemented in many settings of analyses of possible failures taking account of various forms of reluctance in group decision-making, such as medical and humanitarian.

The survey found various ERP and risk prioritisation issues in company. This study recommends the F-WRPN model. Briefly discussing the proposed model follows.

Fuzzy Assisted Weighted Risk Priority Number (F-WRPN) Analysis

FMEA is a risk-prevention and teamwork-based management policy instrument used in many sectors. FMEA prevents future failures. FMEA describes three risk factors: failure severity, likelihood, and detection. These three risk criteria determine the failure mode risk evaluation score, which ranges from one to 10. Multiplying these three assessment scores yields a risk priority number (RPN) between 0 and 1000. Most FMEA research finds significant limitations to using RPN to assess risk, including:

- The three risk variables are not ranked.
- Different severity, incidence, and detection may generate a comparable RPN, but risk is not the same.
- The RPN's computation by multiplying the three risk variables is too simple, and the assessment model is weak.
- Risk factor changes strongly affect statistical RPN.
- Unmeasured risks include estimated expenses.
- Incorporating many experts' viewpoints too simply might lead to data loss.

A complete model that includes all the aspects of ERP execution is utilized. The FMEA method is utilized to prioritize, determine, and address the major possible failure effects, possible failure cause, and control factor impacting effective ERP employment. Therefore, this study is done in the manufacturing industry. Fuzzy integrals and measures are used to improve RPN in this work. Fuzzy integrals are non-linear functions based on fuzzy measurements, which represent the importance of indicators and indicator sets. Domain experts' risk factor weights are fuzzy solidities to create fuzzy measurements that reflect the weights' variation and relevance. The integral then fuses all failure mode risk factor values to get the assessment result. Fuzzy logic measures class membership instead of exclusion or inclusion, complementing the FMEA. Fuzzy-based Failure Mode and consequences Analysis identifies ERP execution fault causes and consequences using fuzzy numbers. Failure tendencies can be classified by incidence, severity, fuzzy detection value, and fuzzy RPN. The proposed fuzzy FMEA model for enterprise resource planning execution is examined.



Fig. 1 ERP implementation model

Fig 1 shows the ERP implementation model. The procedure of implementing enterprise resource planning in any organization has numerous phases. It starts with starting the project, planning, Testing and Training, development, Review & Improve, and support and sustain. The first stage is about getting approval for ERP projects. The first documents, like the project charter, should be created in the establishment. The documents must address the project's objectives, goals, and deliverables, the business reason for the project, the first project team, their responsibilities and roles, the investment details, and the draft project plans. The project sponsor shall approve this project charter. The project manager can plan a project kick-off meeting after approvals. The planning stage is the vital phase in ERP execution. Appropriate research and study should be undertaken within the organization considering the external and internal environment, and the project team must choose the right ERP package of the organization to meet the future and current needs. The user necessities, Business Process Re-engineering (BPR) needs, best practices necessities are to be fully laid out. Gap analysis ought to be executed to comprehend the current situations and future positions of the organization. The hardware and infra needs are to be laid out. Develop stage is the real software development considering procedures available in the organization. One main reason for ERP failure is that the installed products are not meeting the stakeholders' expectations, and hence testing and training have been stated as distinct phases to deliver more focus. It is the procedure of checking the quality of products. It offers enough confidence that established products are meeting the stakeholder's and end-user needs. Structured training shall be provided to the end-users so that their feedback can be beneficial for development. The feedback and review stage involves collecting feedback from different users, reviewing their needs, and making modifications.

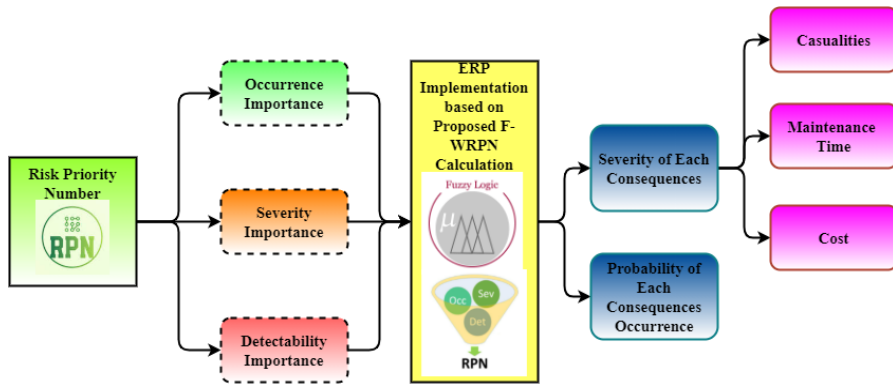


Fig. 2 Proposed F-WRPN model

Fig. 2 shows the proposed F-WRPN model. Improved fuzzy-based RPN calculation does not change the multiplication by three factors. Though this statistical formula for computing risk priority numbers is questionable, this must not be true if the factors are no longer ranked. Risk priority number outcomes are of relative significance and mean how severe a failure mode is compared with a particular condition. Detectability, Severity, and Occurrence factors are the relative significance of a failure mode compared with the worst acceptable situation in three aspects and numbers between 0 and 1. Hence there will not be any numbers that will never be risk priority number outcomes. The variances between the neighbouring risk priority numbers are the same. The purpose of RPN is to determine failure mode ranks. Failures with greater risk priority numbers are more vital. Although enhanced risk priority numbers have various meanings and three factors have dissimilar calculation approaches, failures with higher risk priority numbers have priority to be addressed for corrective activity. Three factors have various characteristics, correspondingly, and their computation methods are not the same.

A. Dempster-Shafer Evidence Theory

Statement 1: Let's consider that $\Omega = \{\theta_1, \theta_2, \dots, \theta_j, \dots, \theta_M\}$ is non-empty sets with M mutually exclusive and exhaustive event, Ω denotes the frame of discernment (FOD). The power sets of Ω contains 2^M components signified by:

$$2^\Omega = \left\{ \phi, \{\theta_1\}, \{\theta_2\}, \dots, \{\theta_M\}, \{\theta_1, \theta_2\}, \dots, \{\theta_1, \theta_2, \dots, \theta_j\}, \dots, \Omega \right\} \quad (1)$$

Statement 2: A mass functions n denotes mappings from power sets 2^Ω to the range [0,1]n fulfills:

$$n(\phi) = 0, \sum_{B \in \Omega} n(B) = 1 \quad (2)$$

If $n(B) > 0$, then B is termed as focal elements. $n(B)$ denotes the support degree of the indication on intention B.

Statement 3: The basic probability assignment (BPA), known as the body of evidence (BOE) or basic belief assignment (BBA), is described as the focal set and the respective mass function:

$$(\mathfrak{R}, n) = \{\langle B, m(B) \rangle : B \in 2^\Omega, m(B) > 0\} \quad (3)$$

As inferred from equation (3), where $\mathfrak{R}$ indicates the subset of power sets 2^Ω .

Statement 4: A basic probability assignment n can be denoted by the belief function Bel or the plausibility function, described by:

$$\begin{aligned} Bel(B) &= \sum_{\phi \neq A \subseteq B} m(B), \\ Pl(B) &= \sum_{A \cap B \neq \phi} m(B) \end{aligned} \quad (4)$$

Statement 5: In Dempster-Shafer Evidence Theory, 2 independent mass functions n_1 and n_2 can be fused with Dempster's rule of grouping:

$$m(B) = (n_1 \oplus n_2)(B) = \frac{1}{1-l} \sum_{A \cap C \neq \phi} n_1(A) n_2(C) \quad (5)$$

As found in equation (5), where l denotes a normalization factor described by:

$$l = \sum_{A \cap C \neq \phi} n_1(A) n_2(C) \quad (6)$$

B. Failure Mode and Effects Analysis

FMEA is an extensively utilized tool for possible risk analysis and system management (SFMEA), risk identification in product design (DFMEA), process management (PFMEA). One of the most significant problems in employing the FMEA technique is identifying the risk priority of failure mode based on RPN models.

Statement 6: In FMEA, the RPN is described by

$$RPN = Q \times W \times D \quad (7)$$

As shown in equation (7), where Q refers to the likelihood of the occurrence of an FMEA item, W refers to the severity degree if failures occur concerning the respective Failure Mode and Effects Analysis item, and D denotes the likelihood of a possible Failure Mode and Effects Analysis item being perceived.

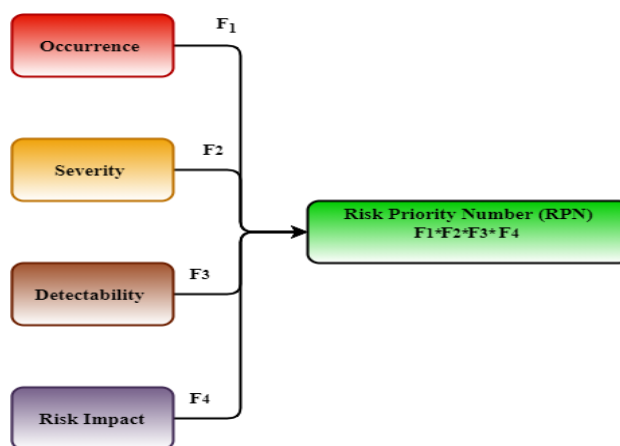


Fig. 3 Factors influencing claim ranking and weights of each factor.

Fig.3 shows the Factors influencing claim ranking and weights of each factor. Ambiguity measures satisfy ambiguity needs in the discrete cosine transform model, involving likelihood consistency, set reliability, the range of aggregate uncertainty, additivity, and subadditivity.

Statement 7: Ambiguity measure is described by

$$AM(n) = - \sum_{y \in Y} Bet P_n(y) \log_2(Bet P_n(y)) \quad (8)$$

As discussed in equation (8), where $Bet P_n$ denotes the pignistic probability distribution of the mass functions n , described by:

$$Bet P_n(B) = \sum_{A \subseteq Y} n(A) \frac{|B \cap A|}{|B|} \quad (9)$$

As derived in equation (9) where $|B|$ refers to the cardinality of the set B .

To manage the relative weight of every risk factor in FMEA models, a new RPN model is suggested based on the ambiguity measure in the discrete cosine transform model. Initially, the ambiguity measures the evaluation's uncertain degree as basic probability assignments in the discrete cosine transform model. Next, the comparative weights of every risk factor can be modeled as exponential weight factors of Q , W and D correspondingly, depends on the outcomes of the ambiguity measure. Lastly, the F-WRPN can be computed on statement 8.

Statement 8: Among $m(m \geq 1)$ independent experts in a Failure Mode And Effects Analysis team, undertake that every team associate has equivalent weight on last evaluation, uncertainty measures weighted risk priority numbers for every failure mode is described:

$$F - WRPN = \sum_{j=1}^m \frac{1}{m} Q_j^{e^{-AM(Q_j)}} \times W_j^{e^{-AM(W_j)}} \times D_j^{e^{-AM(D_j)}} \quad (10)$$

As shown in equation (10), where $AM(\cdot)$ indicates the uncertainty degree of experts concerning the respective risk factors. $e^{-AM(\cdot)}$ denotes the comparative weight of every risk factor evaluated by similar experts; $e^{-AM(\cdot)}$ refers to the ambiguity and uncertainty on the evaluation of the respective risk factors. Q_j , W_j and D_j are the combined evaluation rating value of every risk factor Q , W , and D evaluated by the j th experts.

C. The fuzzy preference programming model

Supposing that the pairwise comparison with m criteria is shown employing the fuzzy number. The overall of n fuzzy comparison judgment is provoked from decision-maker, signified by sets $F = \{\tilde{b}_{ji}\}$, where $n \leq m(m - 1)/2$. Every comparison judgment is denoted as fuzzy triangular numbers $\tilde{b}_{ji} = (k_{ji}, n_{ji}, v_{ji})$.

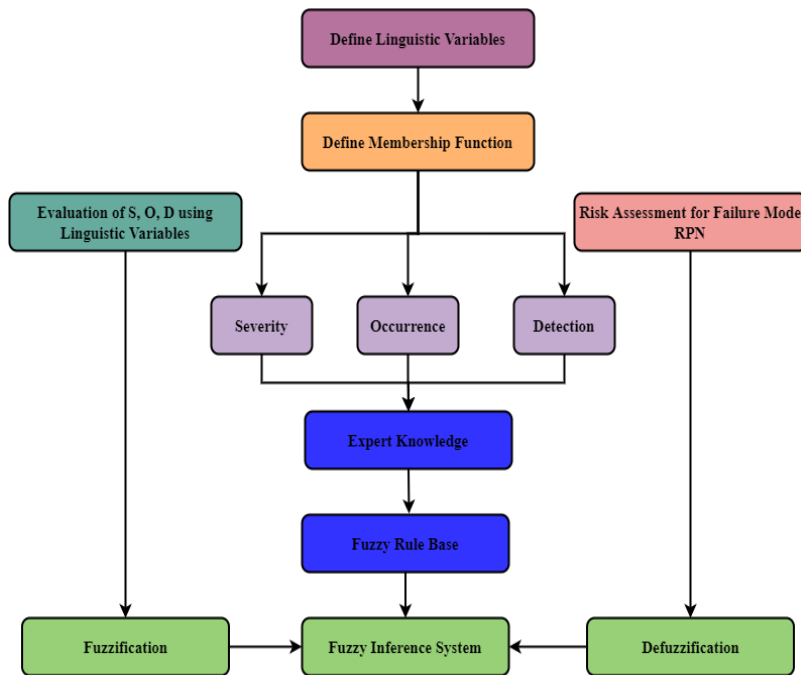


Fig. 4. Flow chart of FMEA analysis based on Fuzzy logic model

Fig 4 shows the flow chart of FMEA analysis based on the fuzzy logic model. The fuzzy model is an important theory which deals with the failure of data. In Fuzzy-Failure Mode and Effects Analysis, the risk indexed variables like Detection, Occurrence, and Severity are fuzzified with appropriate membership function. This is a knowledge-based method and can be formed with ability and knowledge in the form of the Fuzzy IF-THEN rule. A more practical and appropriate knowledge-based method can be constructed utilizing expert knowledge and decision. The fuzzy assumption is then defuzzified to attain the risk priority number values. The notions linked with fuzzy, i.e., Fuzzy rule base, Fuzzification, and Defuzzification. Fuzzification transforms input variables into membership degree measures, which direct the input variables in the qualitative linguistic term. Expert knowledge and decisions can be used to define the degree of membership functions for specific parameters. With Fuzzification, a fuzzy logic controller obtains input data, termed the fuzzy parameter, and analyzes it as delineated by customer categorized figures called membership function.

The fuzzy preference programming method aims to derive a priority vector $s = (s_1, s_2, \dots, s_m)^T$ in which the priority rates are roughly within the scope of the first fuzzy judgments as provided in equation 11

$$k_{ji} \leq \frac{s_j}{s_i} \leq v_{ji} \quad (11)$$

Every resulting crisp priority vector fulfills the double-side inequality (equation. 11), articulated by membership functions in equation 12.

$$\mu_{ji}\left(\frac{s_j}{s_i}\right) = \begin{cases} \frac{\left(\frac{s_j}{s_i}\right) - k_{ji}}{n_{ji} - k_{ji}}, \frac{s_j}{s_i} \leq n_{ji} \\ \frac{v_{ji} - \left(\frac{s_j}{s_i}\right)}{v_{ji} - n_{ji}}, \frac{s_j}{s_i} \geq n_{ji} \end{cases} \quad (12)$$

The membership function in the equation. 12 coincides with the fuzzy triangular judgments $\tilde{b}_{ji} = (k_{ji}, n_{ji}, v_{ji})$.

The solution of the fuzzy preference programming entails two suppositions. The initial supposition is the presence of a non-empty fuzzy viable region O on the $(m - 1)$ -D simplex $Q^{(m-1)}$ provided in the equation. 13.

$$Q^{(m-1)} = \{(s_1, \dots, s_m) | s_j > 0, \sum_{j=1}^m s_j = 1\} \quad (13)$$

The feasible fuzzy extent is described as the connection of membership functions. The membership functions of the feasible fuzzy region are provided by equation.14.

$$\mu_O(s) = \min_{ji} \{\mu_{ji}(s) | j = 1, \dots, m-1; i = 2, \dots, m; i > j\} \quad (14)$$

Fuzzy preference programming assumes that the equation's combined membership functions have the highest membership degree. 14 determines priority vectors. Due to $\mu_O(s)$ denotes convex sets, there is constantly priority vectors $s^* Q^{(m-1)}$ that has a high degree of membership as provided in the equation. 15.

$$\lambda^* = \mu_O(s^*) = \max_{s \in Q^{(m-1)}} \min_{ji} \{\mu_{ji}(s)\} \quad (15)$$

Linear programming can replace maximin. The equation for high prioritisation linear programming is. 16.

Maximize: λ

Subject to:

$$\lambda \leq \mu_{ji}(s), j = 1, 2, \dots, m-1, \quad i = 1, 2, 3, \dots, m, \quad i > j$$

$$\sum_{k=1}^m s_k = 1, s_k > 0, k = 1, 2, \dots, m \quad (16)$$

As the membership functions in the equation. 12, the linear programs are provided in the equation.16 can be converted into bilinear programs as provided in the equation. 17.

Maximize: λ

Subject to:

$$(n_{ji} - k_{ji})\lambda s_i - s_i + k_{ji}s_i \leq 0$$

$$(v_{ji} - n_{ji})\lambda s_i + s_i - v_{ji}s_i \leq 0$$

$$\sum_{l=1}^m s_l = 1, s_l > 0, l = 1, 2, \dots, m$$

$$j = 1, 2, \dots, m-1, i = 1, 2, 3, \dots, m, i > j \quad (17)$$

Non-linear optimisation solutions can find the best solution. The resolution shows the priority vector with the highest membership in the viable fuzzy area and its degree. If positive, early hazy judgements are dependable. The equation provides inequality. 11, pleased. Resolution rates approximate every double-side inequality if is unfavourable. Thus, may test hazy judgements' stability.

In line with the description of the expression 8, the uncertainty measure of every risk factor by j th experts can be computed:

$$\begin{aligned}
 AM(Q_j) &= - \sum_{Q_j \in B \subseteq Y} BetP_n(B) \log_2(BetP_n(B)) \\
 AM(W_j) &= - \sum_{W_j \in B \subseteq Y} BetP_n(B) \log_2(BetP_n(B)) \\
 AM(D_j) &= - \sum_{D_j \in B \subseteq Y} BetP_n(B) \log_2(BetP_n(B)) \quad (18)
 \end{aligned}$$

As inferred from equation (18), where B denotes the proposition of the needed risk factors. Y is a discernment of risk factor frame, and $Y = \{Q, W, D\}$. $BetP_n(B)$ indicates the likelihood dispersal of mass functions $n(B)$. The combined evaluation rating value of every risk factor Q_j , W_j and D_j by the j th expert can be computed as follows:

$$\begin{aligned}
 Q_j &= \sum_{i=1}^{10} R_i n_i(Q_j) \\
 W_j &= \sum_{i=1}^{10} R_i n_i(W_j) \\
 D_j &= \sum_{i=1}^{10} R_i n_i(D_j) \quad (19)
 \end{aligned}$$

As derived in equation (19) where $1 \leq i \leq 10$, R_i denotes rating values evaluated by FMEA expert., ($R_1 = 1, R_2 = 2, \dots, R_{10} = 10$) $n_i(Q_j)$, $n_i(W_j)$ and $n_i(D_j)$, are the mass function of the respective rating value evaluated by j th experts. It must be prominent that, in F-WRPN, the number of experts is not a problem due to weight factors of risk factors that come from the evaluation of an expert themselves. The suggested F-WRPN model enhances the failure classification ratio, efficiency ratio, detection ratio, risk prediction ratio, accuracy ratio, and prioritizing critical failure ratio compared to other existing models.

3. Simulation Analysis

Performance measures such failure classification ratio, efficiency ratio, detection ratio, risk prediction ratio, accuracy ratio, and prioritising critical failure ratio were used to test the F-WRPN model.

A. Failure Classification Ratio

Process and design FMEAs are separated. Process Failure Mode and Effects Analysis examines production failures and ongoing hazards. During product design, design Failure

Mode and Effects Analysis describes product weaknesses, important elements, and probable failure modes, underlying causes, and effects. There are many success factors for the FMEA method: Correct risk classification and identification, Correct control factors to sufficiently manage risks, Exact prioritization and allocation of resources based upon risk priority number, Information system reliability, Process Knowledge, Data integrity, Data accuracy. The ERP Data Management module handles all the project data, including drawings, documents, specifications, and material classifications. It delivers version control and creates the final records of projects directly associated with knowledge management modules. Fig 5 demonstrates the failure classification ratio.

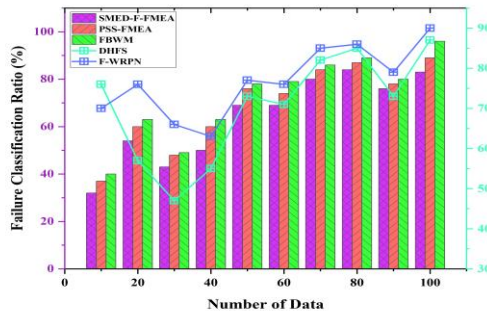


Fig. 5. Failure Classification Ratio

B. Efficiency Ratio

There are many advantages to utilizing ERP applications in organizations; it increases the effectiveness of organizational functions and operations, positively impacts business progressions within the organization, and provides data required for various users within the organization; ERP applications support policy, decision making, and management because its capability to provide data analysis for various aspects of the organization. Furthermore, ERP applications can even be utilized to support the application of project management approaches. As per the rank, poor testing quality, ERP system misfit, deprived top management support, the greater turnover ratio of a project team member, and uncertain notion with users have the most significant factors that may cause the failure to adopt ERP models. Fig 6 signifies the efficiency ratio.

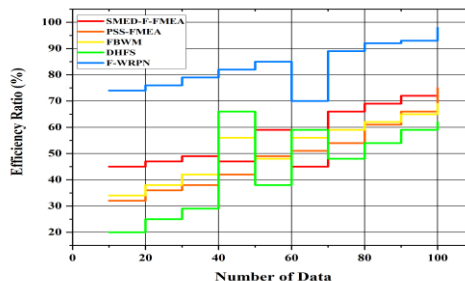


Fig. 6 Efficiency Ratio

C. Prioritizing Critical Failure Ratio

One of the most significant stages in the FMEA process is prioritizing risk for corrective activities. As soon as Occurrences, Severity, and Detection ratings have been identified for every failure mode and related cause, the next stage in an FMEA is to prioritize the risk and determine which problems need corrective activities. The RPN score is computed by multiplying the criticality/severity, the likelihood of occurrence, and the likelihood of detection. The results found that deprived top management support and deprived testing quality are the two most critical failure aspects for ERP acceptance. While establishing ERP models, an organization must prioritize these failure factors based on these ranks to guarantee ERP employment accomplishment. Fig 7 shows the prioritizing critical failure ratio.

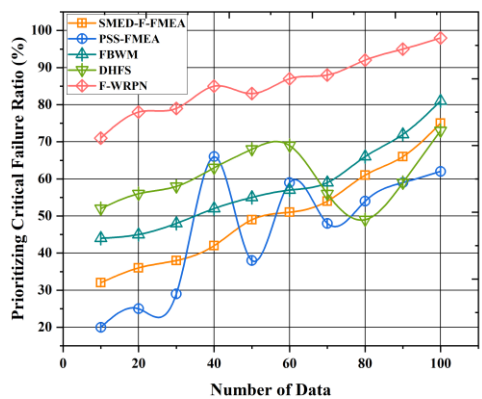


Fig. 7. Prioritizing Critical Failure Ratio

D. Detection Ratio

The flaw of RPN and FMEA is not restricted to the uncertainty of the Failure Mode and Effects Analysis textual description nor its quantitative depiction, and it encompasses the significance of being responsive and proactive to failures. Once a failure is perceived until it is ranked and solved, the flow of information is important to ensure less influence and restricted implication. Another shortcoming of the traditional Failure Mode and Effects Analysis method is that its documents are organized during the products or processes design phases, making them obsolete after production begins. Thus, these documents are compulsory to be dynamically authorized and updated continuously. Fig 8 illustrates the detection ratio of the suggested F-WRPN method.

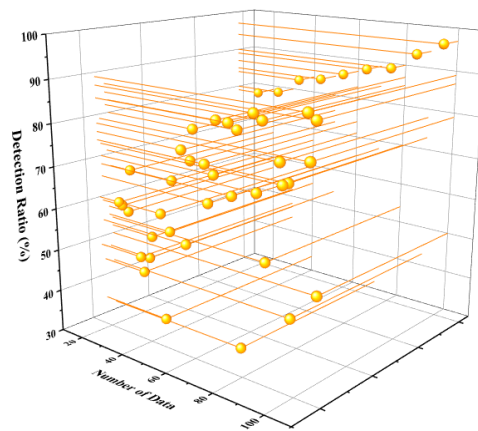


Fig. 8. Detection Ratio

E. Risk Prediction Ratio

Data that includes failures with their explanation, detectability, occurrences, and severity is utilized to progress four methods to forecast occurrence, severity, and detectability values. Data mining-based technique has been considered for isolating fault based on Failure Mode and Effects Analysis variables to increase predictive maintenance utilizing big past information to make data-driven methods. Future failures can be forecasted effectively and accordingly evade failures at very critical operational items. Precision is the true positive prediction percentage for every positive prediction (true positives and false positives). The recall is the positive predictions percentage of true between every real value (true positives and false negatives). Fig 9 demonstrates the risk prediction ratio of the recommended F-WRPN method.

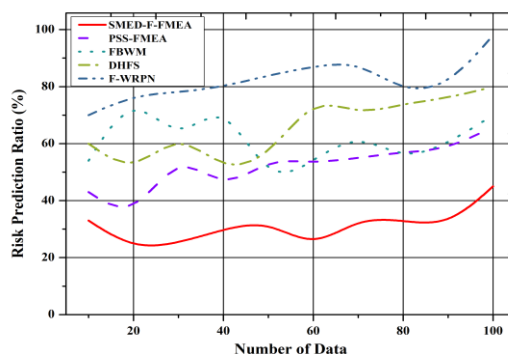


Fig. 9. Risk Prediction Ratio

F. Accuracy Ratio

In conventional FMEA, ratings of risk factors are multiplied to determine a risk priority number. However, the rationale for utilizing the multiplication operations is unclear, and the

resulting risk priority number does not create a precise ranking. For that cause, this research uses the fuzzy graph-theoretical matrix approach technique for ranking failure modes. In place of multiplying the ratings of risk factors for every failure mode, the fuzzy graph-theoretical matrix approach depends on the graph theories that consider every probable permutation of interaction among risk factors and yields precise ranking with no loss of data. Many rules are needed to enhance the accurateness of the fuzzy Failure Mode and Effects Analysis model. Interactions within every permutation in the graph are considered in the final rankings. Thus, more precise rankings are determined. Fig 10 shows the accuracy ratio of the suggested F-WRPN model.

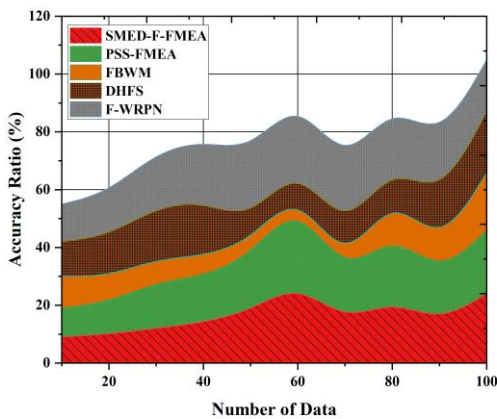


Fig. 10. Accuracy Ratio

The recommended F-WRPN method improves the failure classification ratio, efficiency ratio, detection ratio, risk prediction ratio, accuracy ratio, and prioritizing critical failure ratio when compared to other existing single minute exchange of die method fuzzy FMEA (SMED-F-FMEA), product-service systems, and failure modes and effects analysis (PSS-FMEA), fuzzy best-worst (FBWM), Dual Hesitant Fuzzy sets (DHFS) methods.

4. Conclusion

This paper presents the F-WRPN method for FMEA analysis and risk prioritization based on ERP implementation. Risk assessment research conducted for the enterprise resource planning implementation produces proactive solutions for effectively managing various sources of risks linked with ERP. The suggested method exhibits a desirable element that helps overcome the disadvantages of the conventional RPN and FMEA analysis. An ERP software firm understands the offered technique. The results reveal that failing to ensure important user engagement, understanding and responding to changing consumer requirements, and integrating enterprise-wide models are the biggest risks of failure. The organisation publishes its discoveries and creates several active techniques to fix ERP setup failure. The simulation analysis shows that the proposed F-WRPN model improves failure classification, efficiency,

detection, risk prediction, accuracy, and prioritising critical failure ratios compared to other popular approaches.

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