

Artificial Intelligence-Based Assessment of Financial Problems among Small and Medium-Sized Businesses

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Small and medium-sized business (SMB) is vital to the world economy, yet it encounters difficult financial operations management issues. For these firms to remain viable and expand, it is essential to identify and resolve any financial concerns. Advanced tools and approaches are required since conventional approaches of financial evaluation can be tedious and vulnerable to errors by individuals. This study offers a novel method for evaluating financial issues in SMBs by utilizing artificial intelligence (AI). For the purpose of predicting financial difficulties, a novel dynamic invasive weed optimized flexible random forest (DIWO-FRF) is suggested in this paper. Potential risks can be predicted by the suggested DIWO-FRF model by using past financial data of SMBs. In addition to facilitating early financial issue detection, the suggested approach offers helpful information for preventive choices, empowering SMB to reduce risks and enhance their financial performance. The suggested method performs in predicting financial hazards when compared to other approaches. After gathering the dataset, the incredible findings showed 98% of F1-Score, 94% of accuracy, 96% of precision, and 98.5% of recall. Additionally, the system's versatility enables it to gain knowledge from fresh data, boosting its general financial well-being evaluation

process for SMBs and its forecasting abilities.

Keywords: Small and Medium-Sized Business (SMB), Economy, Financial Concerns, Artificial Intelligence (AI), Dynamic Invasive Weed Optimized Flexible Random Forest (DIWO-FRF).

1. Introduction

Small and Medium-Sized business (SMB) are significant importance in facilitating economic development and promoting development in an economy [1]. Organizations serve a crucial role in numerous sectors, serving as a fundamental support system by generating employment opportunities and making substantial contributions to the overall Gross Domestic Product (GDP) [2]. Nevertheless, while their pivotal significance, SMB encounter a variety of financial obstacles that might limit their progress and long-term viability [3-4]. Regarding the most significant challenges for SMB is the accessibility to financing. In contrast to their larger counterparts, SMB encounter challenges in accessing loans from conventional financial institutions due to their limited financial resources and lower creditworthiness [5]. The limited availability of money is a hindrance to their capacity to allocate resources towards crucial domains such as technology, expansion, and human capital, hence constraining their prospects for growth and competitiveness [6].

Additionally, SMB encounter a substantial challenge in the realm of cash flow management. Financial problems may arise as a result of irregular cash flow patterns, delayed payments from consumers, and unpredictable fluctuations in market demand [7-8]. This phenomenon can compel subject matter experts SMB to reduce crucial operational expenditures, so impeding their capacity to fulfill daily responsibilities and allocate resources towards long-term strategic endeavors. Moreover, a significant number of SMB have challenges related to insufficient financial planning and budgeting methodologies [9]. Frequently, individuals find themselves without the necessary knowledge or access to the resources to formulate comprehensive financial strategies, thereby rendering them susceptible to unanticipated expenses and economic downturns. The lack of a defined financial plan can result in suboptimal decision-making and inefficiencies, hence aggravating one's financial difficulties. In along with external obstacles, internal financial mismanagement plays a role in the predicaments encountered by SMB. Inadequate accounting practices, deficient internal controls, and inappropriate financial reporting have the potential to result in mistakes, fraudulent activities, and non-compliance concerns. These issues undermine the financial viability of the organization but also pose a significant risk to its reputation and credibility, potentially resulting in legal consequences. The present study proposes a dynamic invasive weed optimized flexible random forest (DIWO-FRF) approach to address financial issues faced by small and medium-sized businesses.

This study is organized as follows for the remained portions: Section 2: Related work; Section 3: Methodology; Section 4: Results; and Section 5: Conclusion.

2. Related work

The author [10] examined the factors contributing to the emergence of credit risk in SMB and the need of conducting risk assessments. It developed a model for evaluating credit risk in SMB, explores the key business indicators of these enterprises, and identifies a fall in their profitability. Despite it was projected that the revenue growth rate will reach 7.8% in 2020, there was evidence suggested that the growth trend was diminishing. In addition, the growth rate of net operating earnings was displaying an unstable pattern of growth. To presented a theoretical framework for the evaluation and mitigation of business risks through the utilization of artificial intelligence components. The idea was based on an analysis of scientific literature, policy documents, and risk management standards [11]. They presented the fundamental components of the framework in relation to commercial risk groupings, sources of information, and process stages. It discussed the perspectives of business companies, public policy, and academic research in providing proposals for the future creation and execution of the structure. Study [12] examined the implementations of artificial intelligence (AI) in SMB and explores the associated problems, potential solutions, and benefits of AI implementation in this context. Despite the anxiety among small SMB regarding the financial implications and time-consuming nature of integrating AI into their operations, which increases the probability of encountering setbacks, it was evident that SMB continue to rely on AI as a catalyst for expansion and leverage cloud-based services. To performed an analysis and presentation of the transformation of SMB in the context of global prospects [13]. It considered the procedures, effect, and influence of AI, globalization, and integration. It demonstrated that SMB can also experience advantages and increased profitability through internationalization and globalization processes. It showed the Italian case investigation, which establishes a positive correlation between the degree of internationalization and economic viability. Established a novel framework for identifying the factors that either facilitate the growth of SMB in the domains of electronic commerce, artificial intelligence, and agile methodologies [14]. The model was constructed utilizing intellectual visualization, specifically drawing upon strategic alternatives generation and analysis, as well as the decision-making trial and evaluation laboratory technique. Suggestions have been formulated assisted SMB in leveraging these technologies to attain a robust competitive stance in the global marketplace. To investigate the degree of SMB employing Communication AI in Indonesia, providing insights into the challenges associated with adopting AI applications in the industrial sector [15]. The primary reasons for the hesitation are attributable to the high costs, extended duration, and potential hazards associated with the development of customized software. As a result, SMB are dependent on AI-as-a-service and other cloud-based solutions.

Author [16] introduced a novel “financial crisis prediction (FCP)” model for SMB by utilizing an AI based optimum “functional link neural network (FLNN)”. The proposed approach encompasses several stages, including parameter adjustment, preprocessing, classification, and feature selection. For the most effective choosing of features, a unique “chaotic grasshopper optimization algorithm (CGOA)” based feature selection method is used. The application of the “cat swarm optimizer (CSO)” method can increase the “FLNN system's” performance. The experimental results have shown that the “CGOA-FLNN-CSO” model has achieved optimal prediction performance. To investigate the potential advantages and obstacles related to the adoption of conversational artificial intelligence (CAI) in SMB [17].

These modern technologies provide SMB with the potential to centralize their customer care processes, get important consumer insights, and improve the effectiveness of their operations. The results underscore the importance for SMB to adopt an approach that was strategic when implementing AI, taking into its prospective advantages and the obstacles that may develop. According to the study, [18] employed a combination of resources management and knowledge-based methods to construct a unique structural model that investigates the factors leading to the adoption of sustainable corporate responsibility (SCR) and AI. The researchers utilized the structural equation modeling technique to analyze the dataset obtained from 280 operational executives of small and medium-sized manufacturing companies in Vietnam. The findings of our study indicate that the implementation of AI can be facilitated by effective leadership practices. Specifically, executives can promote AI adoption by fostering an environment that values data-driven decision-making and digitization.

3. Methodology

Figure 1 illustrates the financial problem flow within SMB, with a primary emphasis on real-time datasets. The assessment of financial issues is accomplished through the dynamic invasive weed optimized flexible random forest (DIWO-FRF) method.

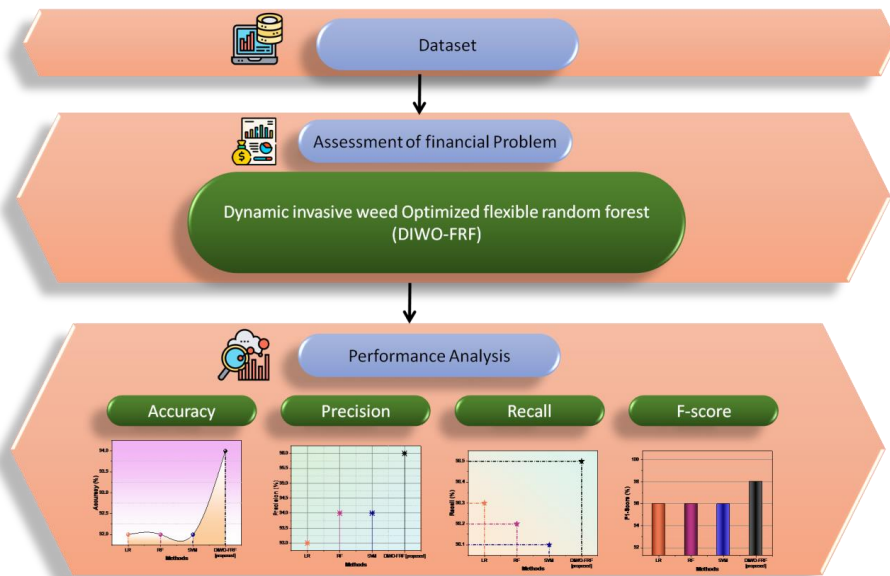


Figure 1: Overall framework [Source: Author]

3.1 Dataset

This study includes a large dataset that includes over 5,000 SMB credit histories and financial statements. For the goal of categorizing financial hardship over the course of two consecutive financial years, total of six independent variables were selected: “the current ratio, quick ratio, country code, cash ratio, debt-to-equity ratio, gross margin ratio, and profit margin ratio”. The financial status of the past and current financial years was compared, with a special emphasis

on the notable drop in credit scores, to ascertain the dependent variable.

3.2 Dynamic invasive weed optimized flexible random forest (DIWO-FRF)

The novel algorithm described as Dynamic Invasive Weed Optimized Flexible Random Forest (DIWO-FRF) was developed to handle financial issues in small and medium-sized businesses. To improve forecast accuracy and adaptability, it makes use of flexible random forest approaches and dynamic weed optimization. This makes it an effective instrument for enhancing financial decision-making and risk management in this industry.

3.2.1 Dynamic invasive weed optimization

SMB can handle financial complications with the assist of the dynamic invasive weed optimized method, which will eventually improve their long-term sustainability and market competitiveness. The dynamic IWO approach is utilized in this study to synthesize low Side Lobe Level (SLL) arrays with null control. This method's workflow is comparable to standard IWO, whereas we suggest utilizing additional hybrid processes to modify the typical computation of spatial dispersion. With a predetermined possibility of mutation, our method performs the same mutation process as a genetic algorithm. Using this procedure enhances the quality of the findings by facilitating a study of the search space. The following are the primary stages of the invasive weeds method:

- I. Initially a random population of plants will be created in the search area.
- II. A cost function is used to evaluate each plant in the colony.
- III. The process of seed reproduction occurs when a plant can yield an amount of seeds based on its cost function, which may be found in the Equation (1) :

$$M_t(O_j) = \text{integer} \left[nt + \left(\frac{N_t - nt}{AD - XD} \right) (D(O_j) - XD) \right] \quad (1)$$

Where N_t and nt are the greatest and smallest numbers of seeds that the plant O_j has produced, respectively. The price function of the most efficient plant in the colony, the cost function of the least beneficial plant, and the cost function of the i th plant O_j are represented by the characters AD , XD , and $D(O_j)$.

- IV. Evaluation of the generated seeds' geographic spread. As the seeds develop into new plants, they will be incorporated to the colony. This distribution in space is provided by Equation (2):

$$TC(itr) = \left[\frac{itr_{\max} - itr}{itr_{\max}} \right]^{\text{mod}} (TC_{\text{ini}} - TC_{\text{fini}}) + TC_{\text{fini}} \quad (2)$$

Where itr the original execution is position and $itr_{\max}$ is the maximum number of iterations. The nonlinear modulation coefficient is represented by mod , while the beginning and ending deviation measurements are denoted by TC_{ini} and TC_{fini} , correspondingly.

- V. Dynamic mutation: A mutation process is used to change spatial spread, in contrast to the conventional IWO. Initially an estimated O_n is provided. The starting value TC_{ini} of the deviation from the mean $TC(itr)$ will be substituted for the real value if O_n is lower than

an arbitrary value in the range[0,1]. If otherwise Equation (3), which calculates the median variation TC (itr), should be utilized

- VI. Limitation: only the pop maxth plants will remain in the colony after the overall amount of plants reaches its highest pointpop max. All other seedlings will be disposed out.
- VII. Stop criteria: until a maximum number of repetitions are achieved, stages (II) through (VI) will be repeated.

With every iteration, the mutation rate is ascertained in an adaptive manner. Non uniform mutations can be utilized to prevent an early converging in a single location. Iteratively reducing the probability of mutation is done as follows:

$$O_n(\text{itr}) = 1 - O_p \left(1 - \frac{\text{itr}}{\text{itr}_{\max}} \right) \quad (3)$$

It should be noted that the mutation probability O_p has a fixed starting value of 0.8. The process of mutation causes the search space to move in the direction of favourable areas, which could contain the global optimum. Compared to the fixed search space, this dynamic search space enables the IWO to provide fresh solutions that enhance the plant colony's diversity (Figure 2).

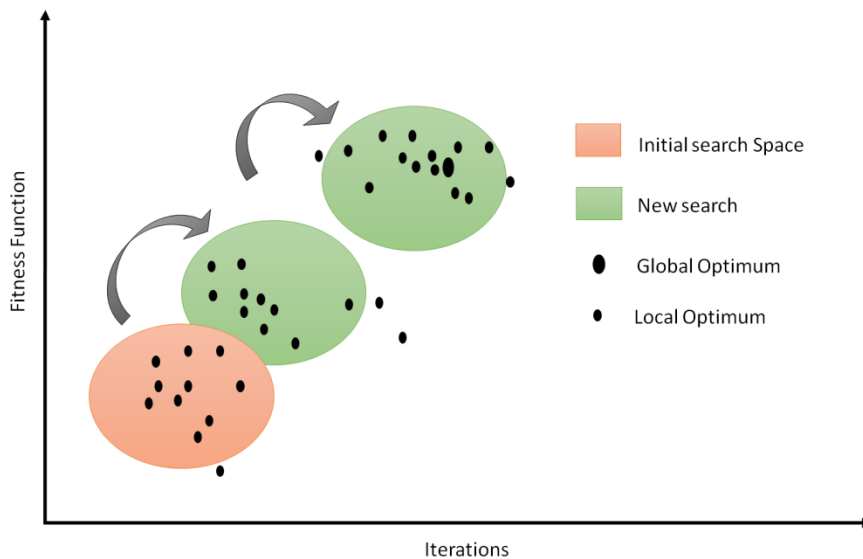


Figure 2: DIWO Technique [Source: https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcSKbPjukVBjJOjKYFgisrxjB6Vl_VoYBYgkAToPXAYt19lnylz]

3.2.2 Improved Random Forest Algorithm

The Random Forest algorithm can benefit lenders and businesses equal by improving its predictive accuracy in assessing credit risk and helping to make more educated lending decisions by utilizing financial data from small and medium-sized firms. The random forest

approach has been shown in numerous studies to have better classification accuracy, a decent sensitivity for outliers and noise, and low susceptibility to exaggerated. Using a flexible parameter selection procedure, the DIWO-FRF algorithm presented this study improves the strategy of separating a decision tree into components, hence increasing the algorithm's classification accuracy. The distinct properties will result in various decision trees when alternative node splitting strategies are chosen for the same data set. The random forest classification has a varied efficiency. It should be considered that, in order to decide on the tree of choices, the most suitable feature for splitting the nodes be selected in addition to create an additional separation criteria for the selection and division of node characteristics. Thereafter, the node splitting technique is split up into linear combinations. The information gain and the Gini index are displayed by the node splitting algorithm when attributes and are utilized to split the sample set C to b in Equations (4-5).

$$\text{Gain}(C, b) = \text{Ent}(C) - \sum_{u=1}^U \frac{|C^u|}{|C|} \text{Ent}(C^u) \quad (4)$$

$$\text{Gini}(C, b) = \sum_{u=1}^U \frac{|C^u|}{|C|} \text{Gini}(C^u) \quad (5)$$

where C^u denotes that all of the instances in the C with a value of U a on the attribute an are contained in the b^u branching nodes as shown in Eq. (6-7).

$$\text{Ent}(C) = \sum_{l=1}^{|Z|} o_l \log_2 O_l \quad (6)$$

$$\text{Gini}(C) = \sum_{l=1}^{|Z|} \sum_{l' \neq l} o_l o_{l'} = 1 - \sum_{l=1}^{|Z|} o_l^2 \quad (7)$$

The enhanced clarity of the data collection after divide should constitute the primary focus of the nodes separating concept, which leads to the following combined nodes dividing Equation (8) and adaptable variable choice procedure.

$$G = \min_{\alpha, \beta \in Q} G\{C, b\} = \alpha \text{Gini}(C, b) - \beta \text{Gain}(C, b) \quad (8)$$

$$\text{s.t.} \begin{cases} \alpha + \beta = 1 \\ 0 \leq \alpha, \beta \leq 1 \end{cases}$$

Here, α, β stands for the attribute splitting weight coefficient. G has a negligible value in the interim. To find the best combination parameters, the adaptive parameter selection method is used. This indicates that to maximize the classification effect, ID3 and CART are the best options for node partition criteria. The accuracy rate and the classification error rate are utilized in the experiment to gauge performance. Equation (9) defines the sample C categorization error rate.

$$F(e; C) = \frac{1}{n} \sum_{j=1}^n \mathbb{I}(e(w_j) \neq z_j) \quad (9)$$

Equation (10) defines an accuracy ratio.

$$\text{acc}(e; C) = \frac{1}{n} \sum_{j=1}^n \mathbb{I}(e(w_j) = z_j) = 1 - F(e; C) \quad (10)$$

3.2.3 DIWO-FRF

The novel method known as Dynamic Invasive Weed Optimized Flexible Random Forest *Nanotechnology Perceptions* Vol. 20 No. S2 (2024)

(DIWO-FRF) is used to solve financial issues in small and medium company enterprises. This approach offers adaptable and reliable resolutions to financial problems by combining the strength of flexible random forests with optimization for invasive weeds. By maximizing financial methods, DIWO-FRF provides a dynamic way to filter out problems and enhance decision-making for organizations. The DIWO-FRF is shown in Algorithm 1.

Algorithm 1: Dynamic invasive weed optimized flexible random forest (DIWO-FRF)

- Step 1: Initialize parameters and hyperparameters
 - Step 2: Define the dataset containing financial information
 - Step 3: Split the dataset into training and testing sets
 - Step 4: DIWO Optimization Phase
 - Step 5: Initialize weed population
 - Step 6: Set the maximum number of generations
 - Step 7: Define the objective function to be optimized
 - Step 8: for generation in range(max_generations):
 - Step 9: Evaluate the fitness of each weed in the population
 - Step 10: Select the best-performing weeds
 - Step 11: Apply invasive weed optimization to update the weed population
 - Step 12: Flexible Random Forest Phase
 - Step 13: Initialize an ensemble of decision trees
 - Step 14: Set the number of trees in the forest
 - Step 15: Define hyperparameters for decision tree construction
 - Step 16: for tree in range(num_trees):
 - Step 17: Randomly sample data for each tree (bootstrap aggregating)
 - Step 18: Select a subset of features for tree construction
 - Step 19: Grow a decision tree using the selected data and features
 - Step 20: Add the tree to the forest
 - Step 21: For a given financial problem instance:
 - Step 22: Apply DIWO optimization to adapt to the specific problem
 - Step 23: Use the ensemble of flexible random forests to make predictions
 - Step 24: Aggregate the predictions to provide a robust financial solution
 - Step 25: Assess the performance of the DIWO-FRF model on the testing dataset
 - Step 26: Return the financial recommendations and performance metrics
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4. Results and Discussions

The suggested DIWO-FRF has been implemented using the Python 3.11 platform in this study. The device in question is a laptop running the Windows 10 operating system, equipped with an Intel i7 processor and a substantial 32 GB of random access memory (RAM). This section analyzes the measures of accuracy, precision, recall, and F1-score. The existing techniques, such as logistic regression (LR), random forest (RF), and support vector machines (SVM) [19].

Accuracy in financial problems within the context of SMB refers to the ratio of accurately predicted results to the total number of predictions made. The Equation (11) can be expressed as:

Accuracy = (Number of Correct Predictions)/(Total Number of Predictions) (11)

Figure 3 and table 1 illustrates the comparison of accuracy between the existing and recommended approach. In comparison to the LR, RF, and SVM approaches, which achieved scores of 92%, 92%, and 92% respectively, the DIWO-FRF strategy demonstrated a higher score of 94%. It shows that our proposed method is superior to the existing method for SMB.

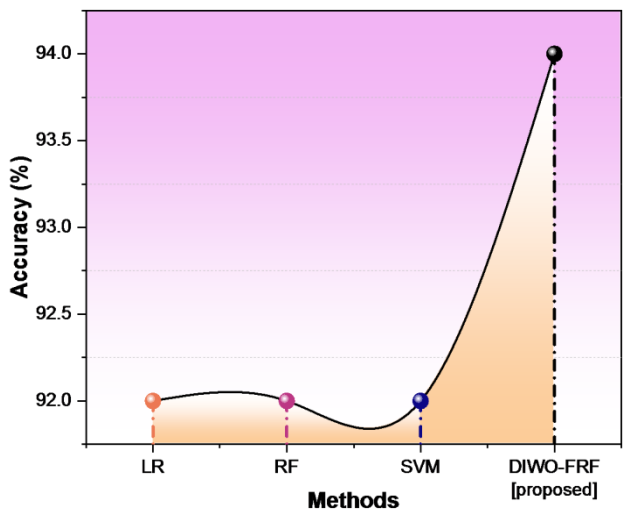


Figure 3: Results of Accuracy

Table 1: Values of accuracy

Methods	Accuracy (%)
LR	92
RF	92
SVM	92
DIWO-FRF [proposed]	94

Prcision, within the context of financial challenges faced by SMB, refers to the degree of accuracy is recognizing genuine financial difficulties in relation to the overall number of issues identified. This can be mathematically represented by the following Equaiton (12):

$$\text{Precision} = \text{True Positives} / (\text{True Positives} + \text{False Positives}) \quad (12)$$

To accomplish optimal productivity and ensure high levels of precision, it is essential to optimize both hardware and software components. Figure 4 and Table 2 present a comparison of the precision achieved by the recommended method and the standard method. In comparison to LR, RF, and SVM, the DIWO-FRF technique demonstrated a precision score of 96%, whereas LR, RF, and SVM achieved scores of 93%, 94%, and 94%, respectively. Consequently, the proposed approach exhibits much superior performance in SMB.

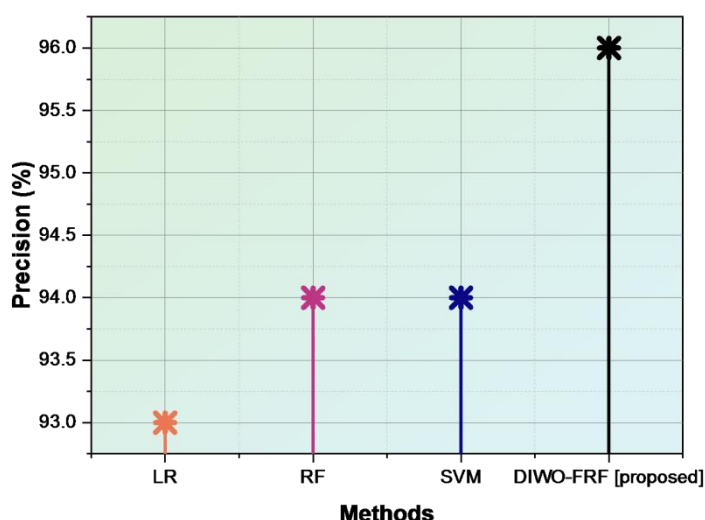


Figure 4: Results of precision

Table 2: Values of precision

Methods	Precision (%)
LR	93
RF	94
SVM	94
DIWO-FRF [proposed]	96

The recall framework of financial difficulties faced by SMB, pertains to the capacity to retrieve and utilize previously borrowed or invested funds in order to solve present financial obstacles. Figure 5 and Table 3 provide a comparison between the recall Equation (13) of the recommended approach and the standard approach. The performance of various machine learning algorithms, including LR, RF and SVM was evaluated and compared to existing methods. The accuracy scores achieved by LR, RF, and SVM were 98.3%, 98.2%, and 98.1% respectively. In contrast, the suggested method, DIWO-FRF, achieved a significantly higher accuracy score of 98.5%. This outcome contributes to the enhanced effectiveness of the methodology we have suggested.

$$\text{Recall} = \text{True Positives} / (\text{True Positives} + \text{False Negatives}) \quad (13)$$

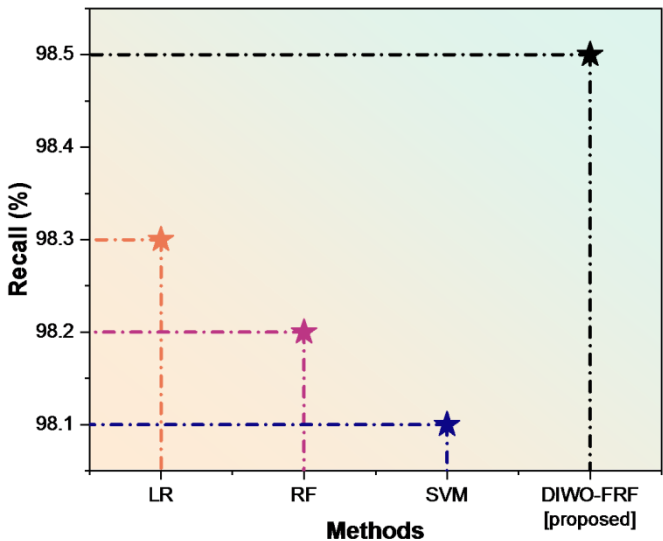


Figure 5: Results of recall

Table 3: Values of recall

Methods	Recall (%)
LR	98.3
RF	98.2
SVM	98.1
DIWO-FRF [proposed]	98.5

The F1-score pertaining to Financial Problems within the context of SMB serves as a metric to assess the accuracy of a model by taking into account both precision and recall. It aims to achieve an equal number between false positives and false negatives. The calculation of the F1-score is follows Equation (14):

$$F1 - score = 2 * (precision * recall) / (precision + recall) \tag{14}$$

The F1-Score of the suggested strategy is evaluated and compared to the F1-Score of the usual approach in Figure 6 and Table 4. In comparison to established methodologies such as LR, RF and SVM, the respective accuracy scores achieved were 96%, 96%, and 96%. Conversely, the novel methodology, referred to QP-CNN, demonstrated a higher accuracy score of 98%. These results directly contribute to the improved performance of our suggested strategy.

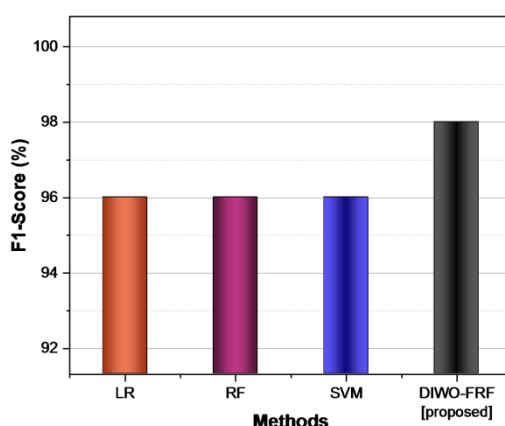


Figure 6: Results of F1-score

Table 4: Values of F1-score

Methods	F1-Score (%)
LR	96
RF	96
SVM	96
DIWO-FRF [proposed]	98

5. Conclusion

Small and medium-sized enterprises' financial difficulties may motivate creativity and cost-cutting strategies as well as the pursuit of outside capital and expert financial guidance. This study used a dynamic invasive weed optimized flexible random forest (DIWO-FRF) to evaluate small and medium-sized businesses (SMB) financial issues. The recommended approach demonstrated a high degree of effectiveness. After gathering the dataset, the incredible findings showed 98% of F1-Score, 94% of accuracy, 96% of precision, and 98.5% of recall. These metrics show the model anticipates financial problems in SMB, achieving an appropriate compromise between obtaining real positives and reducing false negatives and false positives. Furthermore, the comparison with the current approach demonstrated the suggested strategy performed. These results suggest that SMB can improve their financial stability and decision-making skills by using the DIWO-FRF strategy as an effective way of identifying and addressing financial issues. The accuracy of the model in forecasting financial issues may be impacted by restricted access to a variety of up-to-date financial data. To improve prediction accuracy and deliver timely financial insights for sustainable business growth, advanced data analytics and AI-driven solutions will be integrated into the future scope of treating financial challenges among SMB.

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