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PREDICTIVE ANALYTICS OF DATASET COLLECTION FOR ASSESSMENT OF FINANCIAL STATUS OF SMALL MEDIUM ENTERPRISES

Mahalingam R 1

Research Scholar

Annamalai University, Chidambaram,

Tamil Nadu, India.

Jayanthi K 2

Assistant Professor

Government Arts College, Chidambaram,

Tamil Nadu, India

E-Mail: r.mahalingamphd@gmail.com 1, jayanthirab@gmail.com 2

Abstract

Small and Medium Enterprises (SMEs) are integral to economic development, but they often face financial instability due to limited resources and external market pressures. Predicting financial crises in SMEs is essential to ensuring their sustainability and preventing insolvency. This research proposes a structured framework to predict financial crises in SMEs by analysing various financial and operational factors. The study focuses on the development of a comprehensive dataset based on a questionnaire designed to capture detailed business and financial information from 530 SME owners in the Cuddalore and Villupuram regions. A total of 180 features were identified, encompassing factors such as creditors, debtors, overspending, liabilities, and asset management. The predictive analytics was performed on the dataset and the results were evaluated with five different classifiers in machine learning including Random Forest Tree, Logistic Regression, Decision Tree, Support Vector Machine and Naïve Bayesian models. The outcomes suggested that the dataset was clear from errors in creation and liable for further research predictions for assessing financial status of SMEs in the future.

Keywords: Predictive Analytics; Machine Learning; Financial crisis Prediction Factors; Dataset Creation; Dataset Assessment;

1. Introduction

Small and Medium Enterprises (SMEs) [1] play a crucial role in driving economic growth, employment generation, and fostering innovation, particularly in developing regions. However, these enterprises are often vulnerable to financial instability due to limited access to capital, fluctuating markets, and operational challenges. Predicting financial crises [2] in SMEs is critical for maintaining their sustainability, avoiding insolvency, and ensuring their contribution to the economy remains robust. Accurate financial crisis prediction allows SMEs to take proactive measures, implement financial safeguards, and optimize their resource management.

The prediction of financial distress or bankruptcy in SMEs requires a thorough understanding of various financial and operational factors. A comprehensive framework that analyzes these factors can provide insights into the financial health of SMEs and help in identifying early warning signs of financial crisis. This research focuses on designing and developing a robust framework to predict financial crises in SMEs by analyzing a wide range of factors [3] that influence their financial stability. The study also emphasizes the importance of feature selection and optimization to ensure that only the most relevant factors are used in prediction models, enhancing their accuracy and reliability.

The primary objective of this research is to develop an effective financial crisis prediction framework for Small and Medium Enterprises (SMEs). The specific goals are:

1. To identify and analyze the key financial and operational factors that influence the financial stability of SMEs.
2. To design and implement a comprehensive questionnaire that gathers detailed information about SMEs, covering both general business details and specific financial factors.
3. To refine the dataset collected from SME owners, ensuring its suitability for use in financial prediction models and create an Excel dataset.

This research primarily focuses on SMEs in the regions of Cuddalore, Villupuram, and surrounding towns, gathering responses from 530 SME owners. The framework is designed to predict potential financial crises by analyzing a range of financial factors [4], including creditors, debtors, overspending, miscellaneous expenses, and liabilities management, among others. The scope extends to the development of a comprehensive dataset containing 180 features, representing diverse financial and operational aspects of SMEs.

2. Related Works

To train and evaluate the proposed framework, the different factors for financial crisis prediction regarding Small and Medium Enterprises (SMEs) have been analysed and studied to form the basis for designing the questionnaire. The factors are presented in Figure 3.1.

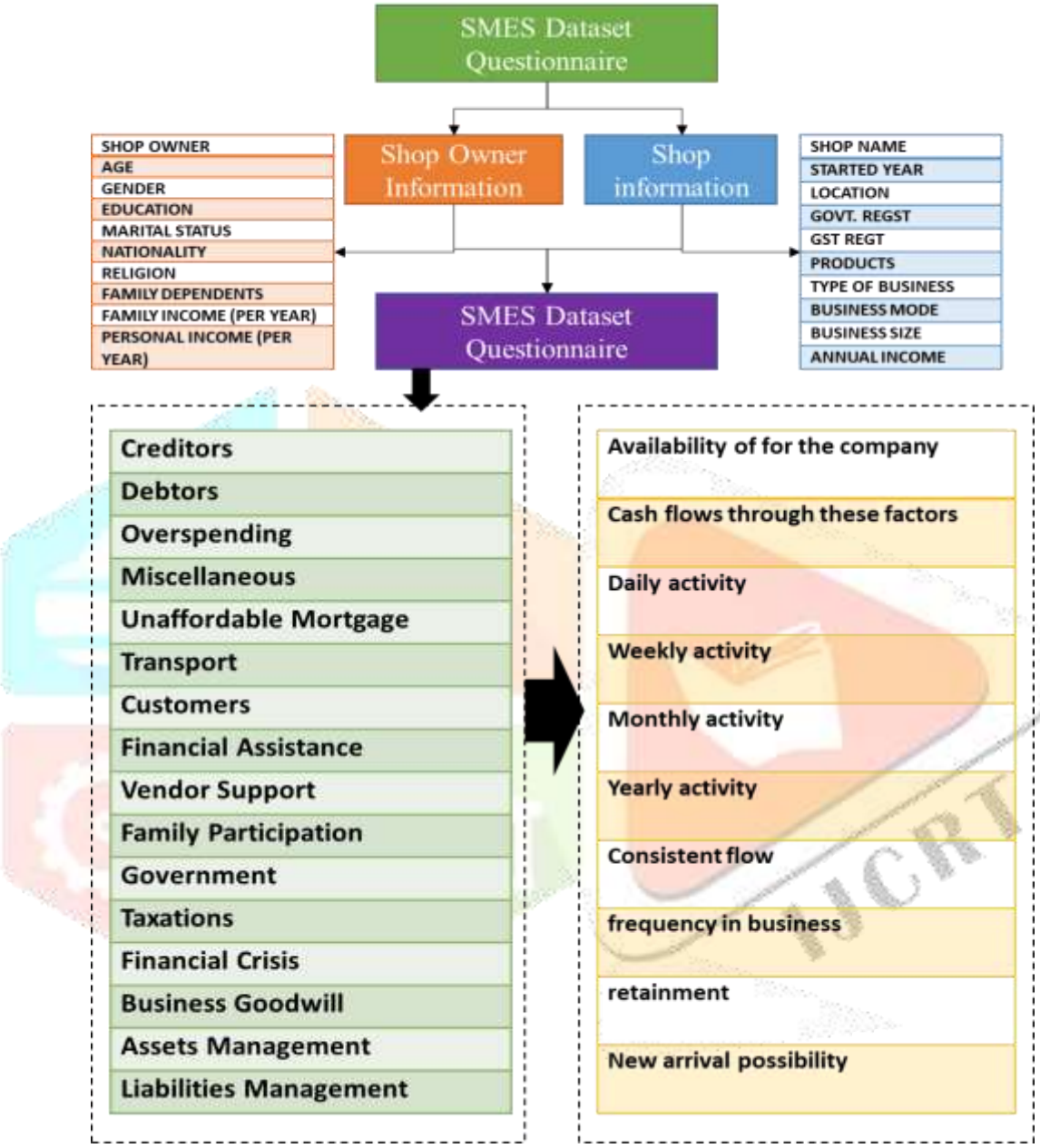
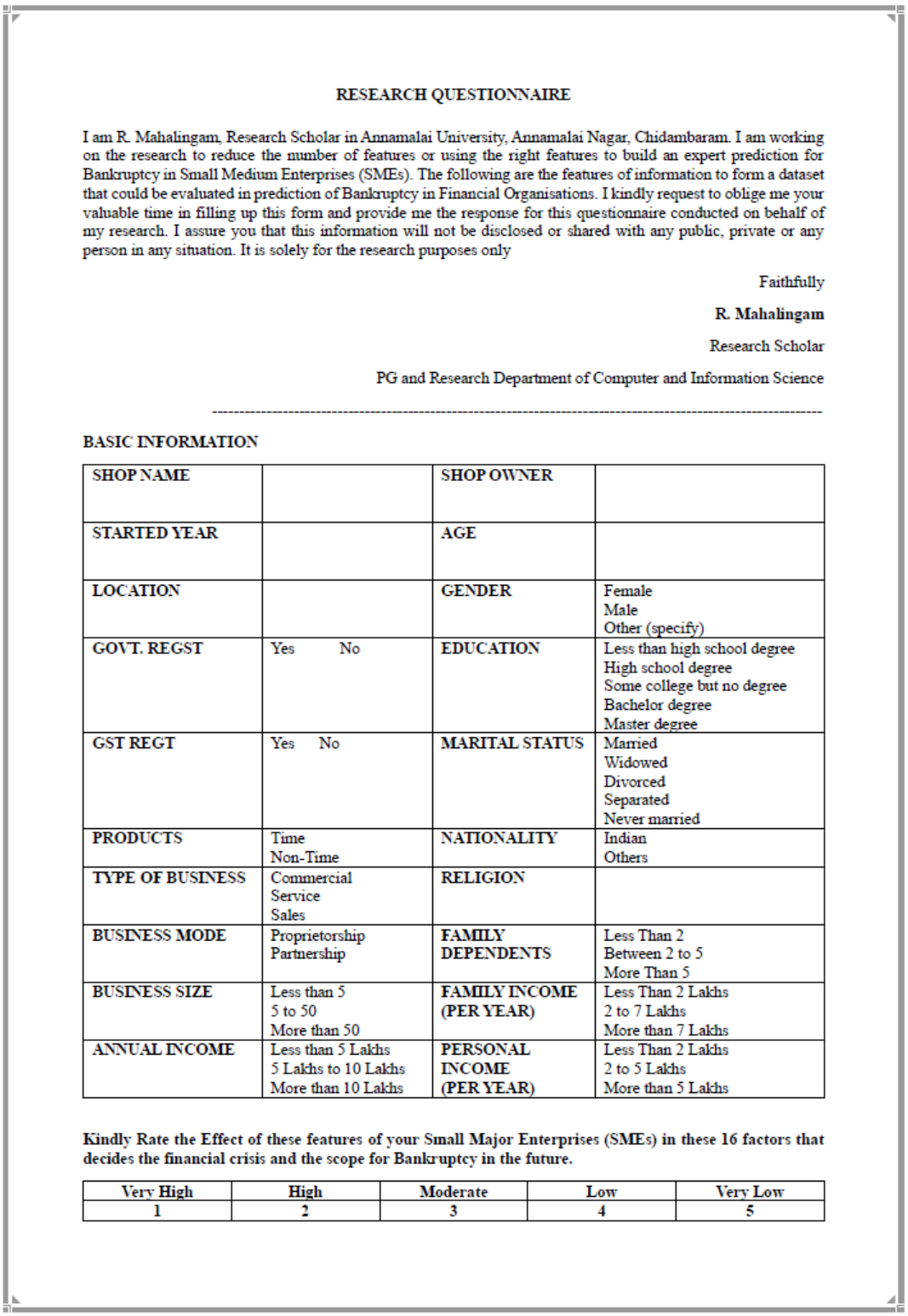


Fig.1 Factors considered for Questionnaire preparation assisting data collection

As given in Fig.1., the various factors are explained in detail to have a better understanding of the factors essential for assessment of financial status of SMEs based on expert knowledge. Creditors are individuals [5] or entities to whom the company owes money. The availability of creditors, the amount of cash outflow through creditors, and the frequency of payments (daily, weekly, monthly, yearly) affect a company's financial stability. Consistent outflows to creditors and the ability to manage these payments are crucial. Difficulty in managing creditor payments can indicate financial distress. Debtors are individuals [5] or entities that owe money to the company. A high volume of debtors or inconsistent payments can strain cash flow and signal potential liquidity issues. Overspending refers to the company's tendency to spend more

than its revenue allows. Consistent overspending can deplete reserves and lead to a financial crisis. Miscellaneous expenses are unexpected or irregular costs. The company's ability to manage these expenses, their frequency, and their impact on overall cash flow are critical. Large or frequent miscellaneous expenses can disrupt budgeting and financial planning. Difficulty in managing mortgage payments can lead to severe financial distress and even bankruptcy.

Transport costs cover expenses related to logistics and transportation [6]. Monitoring the availability of transport, cash outflow, and payment frequency helps assess the impact of transport costs on overall financial health. Customers are the source of revenue. Evaluating customer availability, cash inflow consistency, and payment frequency helps gauge the company's revenue stability. A decline in customer numbers or inconsistent payments can signal financial trouble. Financial assistance includes funding or support from external sources, like investors or grants. Vendor support [7] refers to the assistance or credit extended by suppliers. Family participation involves financial support or involvement from family members. The amount, frequency, and impact of family contributions are essential. Dependence on family support can be risky if it is not reliable or sustainable. Tax obligations are significant for financial planning. Assessing the company's ability to manage tax payments, their frequency, and consistency helps gauge tax-related financial stress. High or unexpected tax liabilities can strain resources and lead to a financial crisis. A financial crisis [8] involves severe financial distress, such as insolvency or bankruptcy. Evaluating the availability, frequency, and impact of financial crises helps understand their potential effect on the company's stability. Asset management involves managing and optimizing the company’s assets to generate value. Inefficient asset management can lead to cash flow issues and financial distress. Liabilities management [9] refers to managing the company’s debts and obligations. Poor liabilities management can lead to excessive debt and financial instability. These factors collectively provide a comprehensive view of a company's financial health and can help in predicting potential financial crises. Based on these factors, the questionnaire is prepared as given in Fig.2.



RESEARCH QUESTIONNAIRE

I am R. Mahalingam, Research Scholar in Annamalai University, Annamalai Nagar, Chidambaram. I am working on the research to reduce the number of features or using the right features to build an expert prediction for Bankruptcy in Small Medium Enterprises (SMEs). The following are the features of information to form a dataset that could be evaluated in prediction of Bankruptcy in Financial Organisations. I kindly request to oblige me your valuable time in filling up this form and provide me the response for this questionnaire conducted on behalf of my research. I assure you that this information will not be disclosed or shared with any public, private or any person in any situation. It is solely for the research purposes only

Faithfully

R. Mahalingam

Research Scholar

PG and Research Department of Computer and Information Science

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BASIC INFORMATION

SHOP NAME		**SHOP OWNER**	
STARTED YEAR		**AGE**	
LOCATION		**GENDER**	Female Male Other (specify)
GOVT. REGST	Yes No	**EDUCATION**	Less than high school degree High school degree Some college but no degree Bachelor degree Master degree
GST REGT	Yes No	**MARITAL STATUS**	Married Widowed Divorced Separated Never married
PRODUCTS	Time Non-Time	**NATIONALITY**	Indian Others
TYPE OF BUSINESS	Commercial Service Sales	**RELIGION**	
BUSINESS MODE	Proprietorship Partnership	**FAMILY DEPENDENTS**	Less Than 2 Between 2 to 5 More Than 5
BUSINESS SIZE	Less than 5 5 to 50 More than 50	**FAMILY INCOME (PER YEAR)**	Less Than 2 Lakhs 2 to 7 Lakhs More than 7 Lakhs
ANNUAL INCOME	Less than 5 Lakhs 5 Lakhs to 10 Lakhs More than 10 Lakhs	**PERSONAL INCOME (PER YEAR)**	Less Than 2 Lakhs 2 to 5 Lakhs More than 5 Lakhs

Kindly Rate the Effect of these features of your Small Major Enterprises (SMEs) in these 16 factors that decides the financial crisis and the scope for Bankruptcy in the future.

Very High	High	Moderate	Low	Very Low
1	2	3	4	5

Fig.2 Questionnaire design for data collection process

As given in Figure.3.3., the questionnaire has been designed and prepared based on the different financial factors that governs the prediction of financial status of Small and Medium Enterprises (SMEs).

3. Proposed Dataset Framework

The data collection process involves distributing this questionnaire to SME owners who are willing to participate. The participants are asked to provide detailed responses to each section, ensuring that the data accurately reflects their business operations and financial conditions. The gathered data will be analysed to

identify patterns and factors that significantly influence the financial stability of SMEs. This information can then be used to assess the risk of financial crises and potential bankruptcy, allowing for better financial planning and support mechanisms [10] for these businesses. The responses are critical for understanding the financial challenges faced by SMEs and for developing strategies to mitigate these risks. The structured format of the questionnaire ensures that all relevant aspects of the business are covered, providing a comprehensive overview of each enterprise's financial health.

The Questionnaire has been circulated and collected in direct form from 530 respondents who were shop owners of SMEs in Cuddalore, Villupuram and around towns. This questionnaire is designed to gather detailed information about small and medium enterprises (SMEs) to assess various factors that could influence their financial stability and potential for bankruptcy. The questionnaire is divided into several sections that capture both general business details and specific financial factors.

3.4.1 General Business Information

This section collects basic demographic and operational details of the business:

- **Shop Name and Owner**: Identifying information of the business.
- **Started Year**: The year the business was established.
- **Age of Business**: The age of the business since its inception.
- **Location**: Whether the business operates in a rural or urban area.
- **Gender of Owner**: The gender of the shop owner.
- **Government Registration**: Whether the business is registered with the government.
- **Education of Owner**: The educational background of the owner.
- **GST Registration**: Whether the business is registered for Goods and Services Tax.
- **Marital Status of Owner**: The marital status of the shop owner.
- **Product Type**: Whether the business deals in tangible (Time) or intangible (Non-Time) products.
- **Nationality and Religion**: The nationality and religion of the shop owner.
- **Business Type**: Whether the business is commercial, service-oriented, or sales-based.
- **Business Mode**: Whether the business operates as a proprietorship or a partnership.
- **Family Dependents**: The number of family members dependent on the business income.
- **Business Size**: The size of the business in terms of the number of employees.
- **Family Income**: The annual income of the family.
- **Annual Income**: The business's annual income.

- **Personal Income**: The owner's personal income.

3.4.2 Financial Factors and Ratings

This section evaluates the influence of different financial factors on the business. The respondent rates the effect of each factor on a 5-Scale Likert [11] from "Very High" to "Very Low" (1 to 5). The factors are categorized into different groups. Creditors play a crucial role in determining the cash flow of a business. The availability of creditors, along with the regularity and consistency of payments to them, can significantly influence a company's financial stability. Businesses must also consider the potential for retaining existing creditors or acquiring new ones. Similarly, debtors affect a company's cash outflow. The frequency and consistency of payments received from debtors are vital, and companies should also focus on the possibility of retaining current debtors or acquiring new ones to ensure a steady cash inflow. Overspending [12] is another key factor that can impact cash flow. Managing overspending effectively is essential to maintaining financial stability, as recurring or uncontrolled overspending could strain resources. It is important to assess the frequency and likelihood of overspending in the future. Miscellaneous expenses also affect business cash flow, with their frequency and regularity requiring close monitoring to prevent them from becoming a financial burden.

Unaffordable mortgages [13] can place a significant strain on business finances. Regular mortgage payments need to be managed, and the potential for taking on new mortgages should be carefully evaluated. Transport costs are another key consideration, as the availability and cost of transport services can influence cash flow. Managing these costs effectively is essential for maintaining financial health. The availability of customers directly affects cash inflow. The frequency and consistency of customer transactions are critical, and businesses must work toward retaining existing customers while also acquiring new ones to maintain steady growth. Financial assistance, whether through loans or grants, can provide important support to businesses, and its availability, as well as the potential for acquiring new sources of assistance, can influence overall financial performance.

Vendor support is essential for smooth business operations, and the consistency and frequency of this support play a role in ensuring stability. Additionally, family participation in the business can have financial implications. Whether through direct involvement or financial contributions, the regularity and reliability of family participation should be considered. Government participation, through programs or support, also impacts cash flow, with businesses needing to assess how such involvement affects their finances. Taxation is another important factor [14] that affects business finances. Regular and timely tax payments are essential to avoid penalties, and the overall tax burden should be carefully managed. Financial crises, whether resulting from internal or external factors, can pose serious challenges. Businesses need to be prepared for such situations by assessing the likelihood and frequency of financial crises. Business goodwill can have a positive financial impact, providing long-term benefits through customer trust and loyalty. The consistency and frequency of goodwill benefits should be nurtured for continued success. Managing business assets effectively is another key component of financial health. Proper asset management ensures consistent

benefits, while liabilities must be carefully managed to avoid negative impacts on cash flow. Regular liability payments and efforts to reduce unnecessary liabilities are essential to maintaining a healthy financial position.

4. Data Collection Process

The dataset is created based on the questionnaire and samples collected from 530 respondents in excel form. The Likert's five scale format is created in Excel form and the following scales were created in cells and tables with 180 features. The first 20 features were based on the shop and customer information as listed in Table.1.

Table.1. Demographic features collected in the dataset for financial analysis of SMEs

Category	Feature #	Feature	Options/Scale
Basic Information	1	Shop Name	Text
	2	Shop Owner	Text
	3	Started Year	Year
	4	Age	Age in Years
	5	Location	Rural, Urban
	6	Gender	Female, Male, Other
	7	Government Registration	Yes, No
	8	Education	Less than high school, High school, Some college, Bachelor, Master
	9	GST Registration	Yes, No
	10	Marital Status	Married, Widowed, Divorced, Separated, Never married
	11	Products	Time, Non-Time
	12	Nationality	Indian, Others
	13	Type of Business	Commercial, Service, Sales

	14	Religion	Text
	15	Business Mode	Proprietorship, Partnership
	16	Family Dependents	Less than 2, 2 to 5, More than 5
	17	Business Size	Less than 5, 5 to 50, More than 50
	18	Family Income (Per Year)	Less than 2 Lakhs, 2 to 7 Lakhs, More than 7 Lakhs
	19	Annual Income	Less than 5 Lakhs, 5 to 10 Lakhs, More than 10 Lakhs
	20	Personal Income (Per Year)	Less than 2 Lakhs, 2 to 5 Lakhs, More than 5 Lakhs

As given in Table.1., the 20 features represent the demographic features of the dataset in Excel cells. These values will be entered as given by the respondents in the questionnaire form. However, the remaining 160 features were created as a dropdown model with Likert scale values 1 to 5 which represented 1 as very low and 5 as very high value as given in Table.2.

Financial Factors	**Feature #**	**Factor**
Creditors	21	Availability of creditors
	22	Cash flows through these creditors
	23	Daily payment
	24	Weekly payment
	25	Monthly payment
	26	Yearly payment
	27	Consistent creditors flow
	28	Cash inflow frequency in business
	29	Creditors retainment
	30	New Creditors arrival possibility

Debtors	31	Availability of Debtors
	32	Cash outflow through these debtors
	33	Daily payment
	34	Weekly payment
	35	Monthly payment
	36	Yearly payment
	37	Consistent debtors' outflow
	38	Cash outflow frequency in business
	39	Debtors' retainment
	40	New Debtors arrival possibility
Overspending	41	Overspending ability
	42	Cash outflow for Overspending
	43	Daily Overspending
	44	Weekly Overspending
	45	Monthly Overspending
	46	Yearly Overspending
	47	Consistent Overspending
	48	Cash Overspending frequency in business
	49	Stability of Overspending
	50	Future Overspending possibility
Miscellaneous	51	Miscellaneous Expenses spending ability
	52	Cash outflow for Miscellaneous Expenses
	53	Daily Miscellaneous Expenses
	54	Weekly Miscellaneous Expenses
	55	Monthly Miscellaneous Expenses
	56	Yearly Miscellaneous Expenses

	57	Consistent Miscellaneous Expenses spending
	58	Cash spending frequency in Miscellaneous Expenses
	59	Stability of Miscellaneous Expenses
	60	Future Miscellaneous Expenses spending possibility
Unaffordable Mortgage	61	Availability of Mortgage for the company
	62	Cash outflow through Mortgage
	63	Daily Mortgage
	64	Weekly Mortgage
	65	Monthly Mortgage
	66	Yearly Mortgage
	67	Consistent Mortgage outflow
	68	Cash outflow frequency for Mortgage
	69	Mortgage retainment
	70	New Mortgage arrival possibility
Transport	71	Availability of Transport for the company
	72	Cash outflow through Transport
	73	Daily Transport
	74	Weekly Transport
	75	Monthly Transport
	76	Yearly Transport
	77	Consistent Transport outflow
	78	Cash outflow frequency for Transport
	79	Transport retainment
	80	New Transport arrival possibility
Customers	81	Availability of Customers for the company

	82	Cash inflow through Customers
	83	Daily Customers
	84	Weekly Customers
	85	Monthly Customers
	86	Yearly Customers
	87	Potential Customers availability
	88	Cash inflow frequency from Customers
	89	Customers retainment
	90	New Customers arrival possibility
Financial Assistance	91	Availability of Financial Assistance
	92	Cash inflow through Financial Assistance
	93	Daily Financial Assistance
	94	Weekly Financial Assistance
	95	Monthly Financial Assistance
	96	Yearly Financial Assistance
	97	Potential Financial Assistance availability
	98	Cash inflow frequency from Financial Assistance
	99	Financial Assistance retainment
	100	New Financial Assistance arrival possibility
Vendor Support	101	Availability of Vendor Support
	102	Cash inflow through Vendor Support
	103	Daily Vendor Support
	104	Weekly Vendor Support
	105	Monthly Vendor Support
	106	Yearly Vendor Support
	107	Potential Vendor Support availability

	108	Cash inflow frequency from Vendor Support
	109	Vendor Support retainment
	110	New Vendor Support arrival possibility
Family Participation	111	Availability of Family Participation
	112	Cash inflow through Family Participation
	113	Daily Family Participation
	114	Weekly Family Participation
	115	Monthly Family Participation
	116	Yearly Family Participation
	117	Potential Family Participation availability
	118	Cash inflow frequency from Family Participation
	119	Family Participation retainment
	120	New Family Participation arrival possibility
Government Participation	121	Availability of Government Participation
	122	Cash inflow through Government Participation
	123	Daily Government Participation
	124	Weekly Government Participation
	125	Monthly Government Participation
	126	Yearly Government Participation
	127	Potential Government Participation availability
	128	Cash inflow frequency from Government Participation
	129	Government Participation retainment
	130	New Government Participation arrival possibility
Taxation	131	Availability of Taxation for the company
	132	Cash outflow through Taxation
	133	Daily Taxation

	134	Weekly Taxation
	135	Monthly Taxation
	136	Yearly Taxation
	137	Potential Taxation availability
	138	Cash outflow frequency from Taxation
	139	Taxation retainment
	140	New Taxation arrival possibility
Financial Crisis	141	Availability of Financial Crisis
	142	Cash inflow through Financial Crisis
	143	Daily Financial Crisis
	144	Weekly Financial Crisis
	145	Monthly Financial Crisis
	146	Yearly Financial Crisis
	147	Potential Financial Crisis availability
	148	Cash inflow frequency from Financial Crisis
	149	Financial Crisis retainment
	150	New Financial Crisis arrival possibility
Business Goodwill	151	Availability of Business Goodwill
	152	Cash inflow through Business Goodwill
	153	Daily Business Goodwill
	154	Weekly Business Goodwill
	155	Monthly Business Goodwill
	156	Yearly Business Goodwill
	157	Potential Business Goodwill availability
	158	Cash inflow frequency from Business Goodwill
	159	Business Goodwill retainment

	160	New Business Goodwill arrival possibility
Assets Management	161	Availability of Assets for the company
	162	Cash inflow through Assets
	163	Daily Assets Management
	164	Weekly Assets Management
	165	Monthly Assets Management
	166	Yearly Assets Management
	167	Potential Assets availability
	168	Cash inflow frequency from Assets
	169	Assets retainment
	170	New Assets arrival possibility
Liabilities Management	171	Availability of Liabilities for the company
	172	Cash outflow through Liabilities
	173	Daily Liabilities Management
	174	Weekly Liabilities Management
	175	Monthly Liabilities Management
	176	Yearly Liabilities Management
	177	Potential Liabilities availability
	178	Cash outflow frequency from Liabilities
	179	Liabilities retainment
	180	New Liabilities arrival possibility

Table.3.2 Financial Features included in Dataset prepared in Excel form

As given in Table.2., the financial features were considered for prediction and assessment.

5. Predictive Analytics

The Predictive analytics was performed on the data collected from different SMEs based on demographic sources.

Table.3. Demographic Information of SME Owners

Category	Frequency	Percentage (%)
Gender (Male)	350	66.04
Gender (Female)	180	33.96
Education (Graduate)	290	54.72
Education (non-graduate)	240	45.28
Government Registration (Yes)	430	81.13
Government Registration (No)	100	18.87

From the demographic data in Table.3., it is evident that the majority of SME owners are male, constituting 66.04% of the respondents, while females account for 33.96%. A significant number of SME owners (54.72%) have completed their graduation, indicating a fairly educated group, but there is still a notable percentage (45.28%) without a graduate degree. Additionally, 81.13% of the SMEs are officially registered with the government, reflecting formal business operations, while 18.87% are unregistered, possibly informal or small-scale businesses.

Table.4. Business Age and Financial Performance

Business Age (Years)	**Mean (Years)**
Business Age	12.5
Annual Income (INR)	**Mean (INR)**
Annual Business Income	15,00,000
Personal Income	3,50,000

From Table.4., the average age of the businesses surveyed is 12.5 years, suggesting that most SMEs are relatively well-established. In terms of financial performance, the mean annual business income is INR 15,00,000, with an average personal income of SME owners at INR 3,50,000. This indicates that SMEs provide a stable income for the owners, though business earnings are much higher than personal take-home income, reflecting reinvestment into the business or operational expenses.

Table.5. Creditors and Debtors Statistics

Factor	Mean (INR)	Frequency of Payment (Days)
Creditors (Cash Outflow)	1,80,000	30
Debtors (Cash Inflow)	2,00,000	45
Frequency of Payments (Creditors)	-	Weekly
Frequency of Payments (Debtors)	-	Monthly

From Table.5., the data on creditors and debtors highlights that, on average, SME businesses have a cash outflow to creditors amounting to INR 1,80,000, with payments made on a weekly basis. The average cash inflow from debtors is INR 2,00,000, with payments typically received every 45 days. This suggests that while cash flow from debtors is slightly higher than outflows to creditors, there is a time lag between incoming and outgoing payments, which could potentially lead to liquidity management issues.

Table 6. Financial Risk Factors (Likert Scale Ratings)

Factor	Mean Rating (1 to 5 Likert Scale)
Overspending	3.7
Unaffordable Mortgage	4.2
Miscellaneous Expenses	3.9
Financial Assistance	3.4
Vendor Support	3.6

From Table.6., the Likert scale ratings reveal that financial risk factors such as unaffordable mortgages (4.2) and miscellaneous expenses (3.9) are perceived as high concerns by SME owners. Overspending (3.7) is also seen as a moderate risk. Financial assistance and vendor support are viewed as moderately important, with mean ratings of 3.4 and 3.6, respectively. These ratings suggest that SMEs are highly sensitive to managing mortgages, controlling unnecessary expenditures, and maintaining consistent vendor support, all of which impact their financial stability.

Table 7. Business Operational Information

Business Type	Frequency	Percentage (%)
Commercial	210	39.62
Service-Oriented	160	30.19
Sales-Based	160	30.19
Business Mode (Proprietorship)	380	71.70
Business Mode (Partnership)	150	28.30

From Table.7., the operational data shows that the majority of SMEs are commercial in nature, with 39.62% of businesses falling into this category, followed by service-oriented (30.19%) and sales-based businesses (30.19%). Furthermore, most SMEs (71.70%) operate as sole proprietorships, while only 28.30% are partnerships. This indicates that the entrepreneurial ecosystem in the region is dominated by individually owned and managed businesses, which may also affect decision-making processes and risk tolerance levels. The same was expected from the demographic variables which will result in good classification and enhancement of results. The dataset comprised of 530 responses each entered as separate rows and the outcomes are recorded in Excel sheet as given in Fig.3.

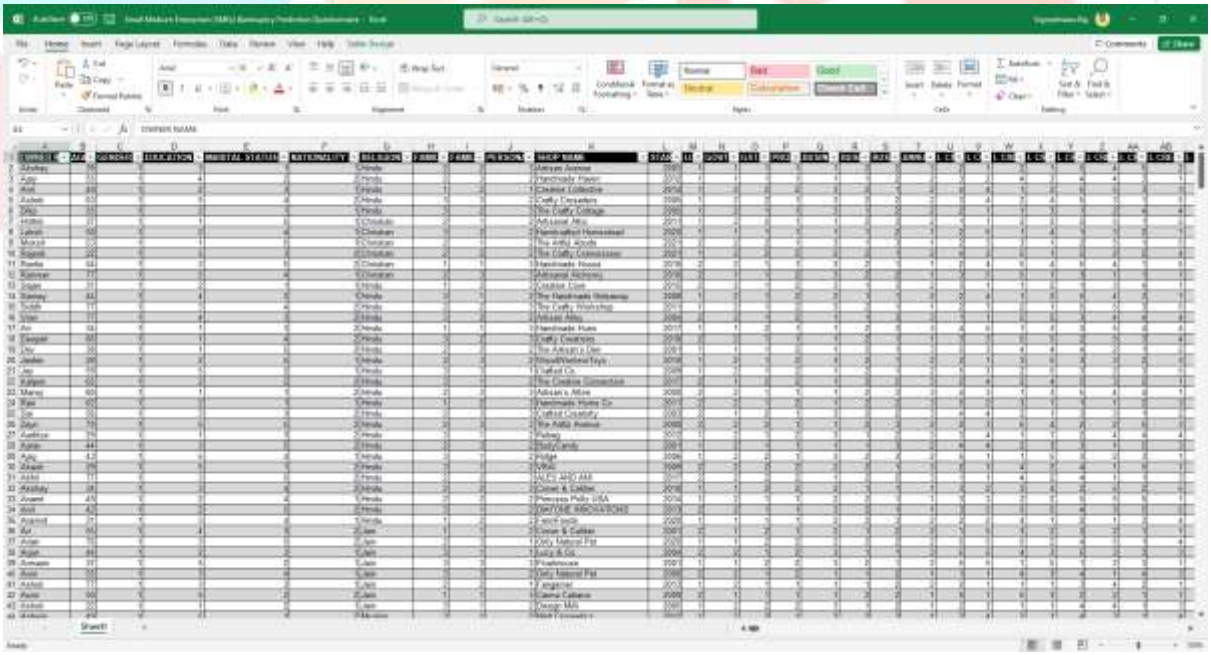

Fig.3. The created excel form with the responses of SMES containing 530 rows.

As given in Fig.3., the developed excel sheet has been formatted and made ready to be used in the MATLAB experimental environment for evaluation and feature pre-processing works in three different phases of implementation. The overall dataset comprised of high dimensional data with 530 records and 180 features accounting to 95,400 individual data for financial crisis or status prediction of Small Medium Enterprises (SMEs). Table.8 presents the evaluation results for predicting financial crises in SMEs, using various machine learning models [15] (Random Forest, Logistic Regression, Decision Tree, Support Vector

Machine, and Naïve Bayes). The evaluation metrics include Accuracy, Sensitivity (True Positive Rate), Specificity (True Negative Rate), Type-I error (False Positive Rate), and Type-II error (False Negative Rate).

Table 8. Model Evaluation Results for Financial Crisis Prediction in SMEs

Model	Accuracy (%)	Sensitivity (TPR)	Specificity (TNR)	Type-I Error (FPR)	Type-II Error (FNR)
Random Forest	92.5	0.91	0.94	0.06	0.09
Logistic Regression	85.7	0.83	0.88	0.12	0.17
Decision Tree	87.3	0.86	0.89	0.11	0.14
Support Vector Machine	89.1	0.88	0.90	0.10	0.12
Naïve Bayes	82.4	0.80	0.85	0.15	0.20

As identified in Table.8., Random Forest achieved the highest accuracy (92.5%), indicating that it is the best performing model for predicting financial crises among SMEs. Naïve Bayes performed the lowest across all metrics, suggesting that it may not be the most suitable model for this dataset. Support Vector Machine and Decision Tree also performed well, though slightly less effective than Random Forest. Logistic Regression had moderate performance, though it still produced a reasonable balance between sensitivity and specificity. These results provide insights into which models are most effective in identifying financial risks in SMEs, helping to make informed decisions about predictive analytics in this context.

6. Conclusion

This research focused on identifying key factors that influence the financial stability of Small and Medium Enterprises (SMEs) and predicting financial crises using a data-driven approach. By collecting and analysing data from 530 SME owners, the study explored various financial, demographic, and operational factors affecting business sustainability. A structured questionnaire helped in gathering detailed information, which was processed using statistical and machine learning techniques. The application of machine learning models, including Random Forest, Logistic Regression, Decision Tree, Support Vector Machine, and Naïve Bayes, provided valuable insights into the predictive capabilities of these algorithms. Among the models tested, Random Forest proved to be the most effective, yielding the highest accuracy, sensitivity, and specificity in predicting financial crises. Other models, such as Decision Tree and Support Vector Machine, also showed strong performance, while Logistic Regression and Naïve Bayes performed moderately.

The study's findings underscore the importance of monitoring critical financial variables, such as creditor payments, overspending, and asset management, to predict and prevent financial distress in SMEs. The

research also highlights the significance of employing predictive analytics to proactively identify financial risks and implement timely interventions. By refining feature selection and model accuracy, this study contributes to enhancing the prediction models for SMEs, offering a practical framework that can be used for financial planning, risk management, and decision-making. The results can assist SMEs in better understanding their financial health, helping them to avoid potential crises and improve long-term sustainability.

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