1. Introduction

**Abstract**
Introduction chapter describes the credit risk evaluation of Micro, Small and Medium scale Enterprises (MSME) research problem, its background and significance. The national and international status of the MSME industry, objectives of research, hypothesis formulated, definition of the basic terms, assumptions are discussed. This chapter also covers the limitations and outline of the study.

1.1 Background of the problem
Credit risk is the risk that one party bounded by a financial contract is unable or unwilling to fulfill his obligations in due time, causing a financial loss for the other party. Credit risk is inherent in lending activity. The credit rating agency Standards and Poor’s defines a debtor as a defaulter who fails to fulfill his contractual obligations and pay in due time, default is a event of failure to make required debt payments by or at the stipulate time.

The Micro, Small and Medium scale Enterprises (MSME) segment is one of the fastest growing industrial sectors and constitute over 90% of total enterprises in most of the economies in the world. The researchers estimate that about 60% of the MSME credit is provided by commercial banks alone. Over the past few years the credit risk evaluation of MSME by banks and financial institutions has been an active area of research under the joint pressure of regulators and shareholders. The Credit Rating Assessment (CRA) forms an important part of credit risk assessment due to the risk parameters such as financial, business, industry and management. A MSME client always has more private information about the risk in his proposal, so that when a client comes with a loan request, the banks have no way to judge its risk extent from the facts in the loan documents. This is the direct reason leading to risk for the banks and the crux of the problem for the banks, an incorrect decision endangers bank’s financial capability ending up in steep decline in the margin of profits.

The recent tarnishing bankruptcies in US such as WorldCom, Enron, HealthSouth, Tyco and many other high profile banks failures in Asia, forced many banks and financial institutions to realize the need for a viable credit risk management. The early decades of this century have witnessed many sensational incidents of accounting irregularities, in which the executives have been caught cooking the books.
National status of MSME segment
The quick results of 4th all India census of MSME (2006-07) reveals that the sickness in MSME has increased from 13.98% in 2001-02 to 14.47% in 2006-07. One of the reasons for sickness is shortage of working capital. Federation of Indian Export Organizations (FIEO) president A. Sakthivel pointed out that "Interest rates in India are much above the international benchmark. The increase in prime lending rate will give a jolt to for MSME exporters.

1.1.1 International status of MSME Segment
Manufacturing sector accounts for 30–50% of GDP and drives in the economies of Asian countries such as Thailand, Indonesia, Malaysia, Singapore, Hong Kong, Taiwan, Philippines, Korea, and China. China’s manufacturing segment is 50% of GDP, but India is lagging behind with 25% share of GDP. The present conditions do not promote manufacturing in India. MSME segment has been the second largest employer after agriculture in all Asian countries. MSME ability to contribute to exports varies widely in Asia between 10 and 60%. Asian countries generally compared well with those in the developed economies such as Austria (99.5%), Canada (99.7%), U.K. (99%) and USA (99.7%).

Table - 1 Top 15 high value bankrupt companies

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Company</th>
<th>Bankruptcy Date (MM/DD/YYYY)</th>
<th>Total Assets Pre-Bankruptcy In $</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Worldcom, Inc.</td>
<td>07/21/2002</td>
<td>103,914,000,000</td>
</tr>
<tr>
<td>2</td>
<td>Enron Corp.*</td>
<td>12/02/2001</td>
<td>63,392,000,000</td>
</tr>
<tr>
<td>3</td>
<td>Conseco, Inc.</td>
<td>12/18/2002</td>
<td>61,392,000,000</td>
</tr>
<tr>
<td>4</td>
<td>Texaco, Inc.</td>
<td>04/12/1987</td>
<td>35,892,000,000</td>
</tr>
<tr>
<td>5</td>
<td>Financial Corp. of America</td>
<td>09/09/1988</td>
<td>33,864,000,000</td>
</tr>
<tr>
<td>6</td>
<td>Refco Inc.</td>
<td>10/17/2005</td>
<td>33,333,172,000</td>
</tr>
<tr>
<td>7</td>
<td>Global Crossing Ltd.</td>
<td>01/28/2002</td>
<td>30,185,000,000</td>
</tr>
<tr>
<td>8</td>
<td>Pacific Gas and Electric Co.</td>
<td>04/06/2001</td>
<td>29,770,000,000</td>
</tr>
<tr>
<td>9</td>
<td>UAL Corp.</td>
<td>12/09/2002</td>
<td>25,197,000,000</td>
</tr>
<tr>
<td>10</td>
<td>Delta Air Lines, Inc.</td>
<td>09/14/2005</td>
<td>21,801,000,000</td>
</tr>
<tr>
<td>11</td>
<td>Adelphia Communications</td>
<td>06/25/2002</td>
<td>21,499,000,000</td>
</tr>
<tr>
<td>12</td>
<td>M Corp.</td>
<td>03/31/1989</td>
<td>20,228,000,000</td>
</tr>
<tr>
<td>13</td>
<td>Mirant Corporation</td>
<td>07/14/2003</td>
<td>19,415,000,000</td>
</tr>
<tr>
<td>14</td>
<td>Delphi Corporation</td>
<td>10/08/2005</td>
<td>16,593,000,000</td>
</tr>
<tr>
<td>15</td>
<td>First Executive Corp.</td>
<td>05/13/1991</td>
<td>15,193,000,000</td>
</tr>
</tbody>
</table>
1.2 Statement of the problem

Micro, Small and Medium scale Enterprises (MSME) need financial assistance to establish and conduct their business activities. Credit guarantee schemes have helped MSME in improving not only the financing environment but also their business performance. MSME clients find themselves spending a significant amount of time and effort while approaching the various banks for credit. Each bank adopts a separate credit risk rating procedure for sanctioning loans. A MSME client always has more private information about the risk in his proposal than the lender, so that when a client comes with a loan request, the banks have no way to judge its risk extent from the facts in the loan documents.

The last decade has seen many credit risk evaluation methods. Even a small fraction of improvement in prediction accuracy of credit risk can bring in huge savings and reduce the possibility of credit risk to lenders. Mathematical models of evaluation are at the core of modern credit risk management systems. The goal of credit risk management is to maximize bank’s risk-adjusted rate of return by maintaining credit risk exposure within acceptable parameters. The effective management of credit risk is a critical component of risk management and essential to the long-term success of any banking organization. The banks are in need of a consistent and integrated credit risk evaluation system to optimize their lending operations.

1.3 Purpose of the study

Tarnishing bankruptcies discussed in section 1.1.2, forced many banks and financial institutions to realize the importance of credit risk management. The Credit Rating Assessment (CRA) forms an important part of credit risk assessment based on risk parameters like financial, qualitative, business, industry, and management. Mathematical models of evaluation and assessment are at the core of modern credit risk management systems.
1.3.1 Advantages of credit risk assessment

- Facilitates informed credit decision consistent with bank’s risk appetite
- Facilitates dynamic provisioning and minimizes impact of losses
- Lending decisions can be taken within the minimum time, thus lending business
- Volume can increase substantially

Hence the researchers aimed at developing an expert system prototype for credit risk evaluation of MSME segment that resembles that credit rating executive’s thought process in credit risk assessment. Authors used a hybrid soft computing technique called evolutionary neuro fuzzy logic for designing an expert system solution for credit risk evaluation of MSME.

1.4 Significance of credit risk problem

In 2007 economic crisis - WorldCom, Enron, HealthSouth, Tyco and a number of high profile bank failures in Asia and 13 large U.S. based financial institutions reported $50 billion of losses, $300 billion market capture losses. The early years of this century have given us a plenty of spectacular examples of accounting irregularities, where executives have been caught *Cooking the books*. In March 2005 American Insurance Group admitted to improper accounting that cut its net worth by more than $1.7 billion. These tarnishing bankruptcies forced many banks and financial institutions to realize the importance of credit risk management.

MSME segment make up over 80-90% of all enterprises provide over 60% of the private sector jobs, generate over 30-40% of total employment, contribute about 50% of sales or value added, share about 30% of direct total exports. Availability of timely and adequate credit is the lifeline for the MSME segment. World over the lending organizations dealing with MSME are concerned about the asymmetry of information, lack of transparency and reliability of data. In MSME sector, the failure rate is relatively higher the reasons are ranging from delayed/inadequate availability of credit, non-availability of backward and forward support system. The main reasons for the financial constraints faced by MSME are quite generic, and high on the list is the perception that MSME are historically a high risk group lacking in financial discipline and unable to provide trustworthy financial track records.
1.5 Objectives of the study
The researchers aimed at developing an expert system prototype for credit risk evaluation of MSME segment with following objectives
1. Designing an expert system incorporating local conditions and requirements
2. Designing the credit rating framework to measure and quantify all subjective and objective parameters of credit decision environment
3. The credit evaluation solution is based hybrid soft computing technique called on evolutionary neuro fuzzy approach
4. Collecting real credit data from various banks in their region and test the solution
5. Designing the solution to meet the different business lines and industries
6. Implementation of expert system using fuzzy and neural network tools

1.6 Hypothesis
1. Credit risk parameters and credit Weights are different for each MSME manufacturing, trading and service industries
2. The credit weights and their weightage for each of the parameter also varies from one manufacturing industry to other manufacturing industry
3. Lending policies will differ from priority, normal, restricted and prohibited sectors
4. Government subsidies and rebates for MSME have impact on lending policy, lending decision are purely based on objective and subjective facts disclosed in credit documents
5. Each service sector credit risk assessment is unique

1.7 Definition of the terms
Risk
ISO 31000 defines the risk as the effect of uncertainty on objectives, whether positive or negative.

Credit risk
Credit risk is the risk that one party bounded by a financial contract is unable or unwilling to fulfill his obligations in due time, causing a financial loss for the other party. Credit risk is inherent to banking activity. The risk of loss of principal or loss of financial reward stemming from borrower's failure to repay loan or otherwise meet a contractual obligation. Credit risk arises whenever a borrower is expecting to use future cash flows to pay a current debt. Investors are compensated for assuming credit risk by the way of interest payments from the borrower or issuer of a debt obligation.
Credit Risk Management (CRM)
Risk management is a two-step process determining what risks exist in an investment and then handling those risks in a way best-suited to your investment objectives. Risk management occurs everywhere in the financial world. Inadequate risk management can result in severe consequences for companies as well as individuals.

Credit Risk Assessment (CRA)
The CRA is the process of identification, analysis and either acceptance or mitigation of uncertainty in investment decision making. Essentially, risk management occurs anytime an investor or fund manager analyzes and attempts to quantify the potential for losses in an investment. He takes the appropriate action (or inaction) given their investment objectives and risk tolerance.

Credit rating
Credit rating is defined as an assessment of the credit worthiness of individuals and corporations. It is based upon the history of borrowing and repayment, as well as the availability of assets and extent of liabilities. The highest rating is usually AAA, and the lowest is D. Lenders use this information to decide whether to approve a loan.

Credit Weight
A Credit Weight is the measure of a company's / individual's creditworthiness. Credit scoring involves the quantification of a variety of factors in an individual's background, including a history of default, the current amount of debt, and the length of time that the individual has made purchases on credit. Banks and other financial institutions may use a credit weight to determine whether or not an individual is likely to default on a loan, mortgage, or other debt. The FICO Weight is the most common credit weight in the United States.

Defaulter
The credit rating agency Standards and Poor's defines a debtor as a defaulter who fails to fulfill his contractual obligations and pay in due time, a default is a failure to make required debt payments by or at the stipulate time.

MSME definition
In accordance with the provision of Micro, Small & Medium Enterprises Development (MSMED) Act 2006, Micro, Small and Medium Enterprises (MSME) are classified in two Classes: (a) Manufacturing Enterprises the enterprises engaged in the manufacture or production of goods pertaining to any industry specified in the first schedule to the industries (development and regulation Act, 1951).
The manufacturing enterprises are defined in terms of investment in plant and machinery.

(b) Service Enterprises: The enterprises engaged in providing or rendering of services and are defined in terms of investment in equipment.

Table-2 MSME definition based on investment

<table>
<thead>
<tr>
<th>Enterprises</th>
<th>Investment in plant &amp; machinery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro</td>
<td>Investment in plant and machinery less than Rs 25 lakh</td>
</tr>
<tr>
<td>Small</td>
<td>Investment in plant and machinery over Rs 25 lakh but not exceeding Rs 5 crores</td>
</tr>
<tr>
<td>Medium</td>
<td>Investment in plant and machinery over Rs 5 crores but less than Rs 10 crores</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Enterprises</th>
<th>Investment in equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro</td>
<td>Does not exceed ten lakh rupees</td>
</tr>
<tr>
<td>Small</td>
<td>More than ten lakh rupees but does not exceed two crore rupees</td>
</tr>
<tr>
<td>Medium</td>
<td>More than two crore rupees but does not exceed five core rupees</td>
</tr>
</tbody>
</table>

**Fuzzy computing**

Fuzzy logic, the core of the fuzzy computing was introduced by Professor Lofti A. Zadeh in 1965, as an alternative approach to solve problems when the classical set theory and discrete mathematics, therefore the classical algorithms, are inappropriate or too complex to use. To address a certain class of problems which a human being can solve easily, an approach that do not relies on mathematical rigor and precision, but an approach fault tolerant that can handle partial truths.

Fuzzy computing can handle qualitative values instead of quantitative values. It can define the so called linguistic variables, instead of the classical numeric variables, and can perform computing with these variables, using fuzzy rules, simulating in a certain way the human reasoning processes. Incomplete or uncertain information can be used for computing.

Figure-3 Fuzzy inference system. The operation of a FIS can be simply described as

- Setting input (numeric values) to all input linguistic variables
- Those values will be represented internally by the system as membership values to each fuzzy set of each linguistic variable
- Computing the firing strength of each rule. This is accomplished by computing the membership of each fuzzy clause and combining those memberships with fuzzy operators
For each fuzzy rule with not null firing strength, the rule output is to be calculated. There are several methods, like the Mamdani, which reflects the membership degree of the antecedent to the consequent. All outputs (fuzzy sets) are aggregated with a fuzzy operator of OR finally, the numeric output is calculated using a defuzzification method. The defuzzification is a technique to evaluate a numerical value from a fuzzy output.

**Neural networks**

Neural networks imitate the brain's ability to sort out patterns and learn from trial and error, discerning and extracting the relationships that underlie the data with which it is presented. Most neural networks are software simulations run on conventional computers. Neural networks are good at providing very fast, very close approximations of the correct answer. Although they are not as well suited as conventional computers for performing mathematical calculations or moving and comparing alphabetic characters, neural networks excel at recognizing shapes or patterns, learning from experience, or sorting relevant data from irrelevant.

**Evolutionary computation**

Evolutionary computing is the collective name for a range of problem-solving techniques based on principles of biological evolution, such as natural selection and genetic inheritance. Evolutionary computation uses iterative progress, such as growth or development in a population. This population is then selected in a guided random search using parallel processing to achieve the desired end. Such processes are often inspired by biological mechanisms of evolution. As evolution can produce highly optimized processes and networks, it has many applications in computer science. Computer-based problem solving systems that use computational models of evolutionary processes as the key elements in design and implementation. These techniques are being widely applied to a variety of problems, ranging from practical applications in industry and commerce to leading-edge scientific research.
**Soft computing**

Soft computing is not a homogeneous body of concepts and techniques; rather it is a partnership of distinct methods that in one way or another conform to its guiding principle. At this juncture, the dominant aim of soft computing is to exploit the tolerance for imprecision and uncertainty to achieve tractability, robustness and low solutions cost. The principal constituents of soft computing are fuzzy logic, neuro computing, and probabilistic reasoning, with the latter subsuming genetic algorithms, belief networks, chaotic systems, and parts of learning theory. In the partnership of fuzzy logic, neuro computing, and probabilistic reasoning, fuzzy logic is mainly concerned with imprecision and approximate reasoning; neuro computing with learning and curve-fitting; and probabilistic reasoning with uncertainty and belief propagation.

![Soft computing models](image)

**Expert system**

Artificial intelligence based system that converts the knowledge of an expert in a specific subject into a software code. This code can be merged with other such codes (based on the knowledge of other experts) and used for answering questions (queries) submitted through a computer.

**Hybrid intelligent systems**

Hybrid intelligent systems are intelligent systems that are built using a combination of soft computing techniques. In particular, soft computing includes fuzzy logic, neural networks, genetic algorithms or hybrid approaches for intelligent computing. The application of intelligent techniques for achieving the control of non-linear plants. In particular, the use of fuzzy logic, neural networks, genetic algorithms or hybrid approaches for designing intelligent controllers.

**Basel committee**
Basel committee is the international statutory banking regulatory body. Basel committee is issuing a document in order to encourage banking supervisors globally to promote sound practices for managing credit risk.

1. Establishing an appropriate credit risk environment
2. Operating under a sound credit granting process
3. Maintaining an appropriate credit administration, measurement and monitoring process
4. Ensuring adequate controls over credit risk

1.8 Assumptions

- The authors assume that the credit decisions are rational, based on subjective and objective parameters of client data
- Expert systems are tools to support credit rating executives in decision making not to replace them
- The credit weights for each of parameters corresponds to the fuzzy linguistic variables opted by rating executives
- There is always a pessimistic and optimistic approach which may vary the final credit rating of the client
- The credit rating framework covers all subjective and objective parameters of credit risk decision environment

1.9 Limitations of Existing Systems

1.9.1 Limitations of the existing credit risk management systems
The existing manual credit risk evaluation systems are quite expensive and very difficult to maintain. It involves a high cost for keeping the qualified, experienced and trained credit rating executives for this purpose. Research has shown that human brain is capable of evaluating only a small number of factors at a time, but the credit risk analyst is expected to analyze many types of parameters and arrive at proper decision with in a shortest possible time.

1.9.2 The limitations Characteristics of SME
- They are small in sales volume and turnover etc. So they cannot be further downsized
- SME are less diversified in their economic activities
- Capital structure and ability to mobilize funds is small
- Generally they do not undergo a standard credit rating process
- Less financing options
- Limited resources in terms of finance, human resources, technology and know how
- Work culture dominated by family business / owner manager
- Use of nonstandard in formal business organization practices
- Reluctance to take advice and consultancy
1.9.3 Challenges to MSME Sector
Despite its commendable contribution to the nation's economy, MSME sector does not get the required support from the concerned Government departments, banking sector, financial institutions and corporate sector, hence becoming handicap, less competitive in the national and international markets and which needs to be taken up for immediate and proper redressal. MSME sector faces a number of problems - absence of adequate and timely banking finance, limited knowledge and non-availability of suitable technology, low production capacity, ineffective marketing and identification of new markets, constraints on modernization and expansions, non-availability of highly skilled labour at affordable cost, follow up with various agencies in solving regular activities and lack of interaction with government agencies on various matters.

1.10 Outline of the study
Researchers have conducted extensive study of credit risk literature and carried out following activities

Study of
1. Foundations of research work on credit risk evaluation published in the book Knowledge base Applications in Banking and articles in Vivek Journal by Prof.(Dr.) R. V. Kulkarni and Dr. B. L. Desai

2. Literature on credit risk in the books on credit policy in banking and financial institutions

3. Study of application forms and other credit policy guidelines from the banks and financial institutions in our region

4. Interview and interactions with banking and lending experts in our region

5. Collecting the loan application forms and credit policy documents from various national and international banks and FI

Designing
1. Credit Rating Framework (CRF) by selecting the credit risk parameters from application forms and credit policy documents

2. Menu structure for capturing the credit related from the clients data and risk assessment

3. Data entry screens for capturing the credit data from client documents

4. Screen layouts and process layouts for assessing the various major risks

5. Database design for managing the client data and Credit Rating Framing (CRF) data

6. Algorithm for processing the various risk parameters

7. Rulebases for each type of Manufacturing, Trading and Service industry

8. Test plan and sample data

9. Expert system design
Design and development of Credit Risk Evaluation Expert System Software (CREES)

- The prototype of the model is tested using Expert System Builder (ESB) tool to test the operational feasibility of the prototype
- CREES system is developed using Fuzzy Jess tools in Eclipse environment
- Testing the system with various samples
- Comparing the results with that of manual existing system

Publications in journals and paper presentations in conferences
The research work and results have been published in 5 international journals and 5 international/national conferences.

Recognition of research work - UGC MRP assistance
The credit risk assessment carries out SWOT analysis of overall MSME client, helps to refine bank’s lending policies and internal credit rating systems. This research work has significance in promoting industrial and economic development of MSME.

Researcher’s minor research project proposal based on present research work was approved and funded Rs 1,20,000/- by University Grants Commission (UGC) in November 2012. (Approval letter is enclosed in annexure: 1).

Best paper of the international conference award
The paper presented Expert System Design for MSME Credit Risk Rating in International Conference on Management of MSME - MSMECON-2010 at Institute of Management Technology (IMT) in Nagpur has been awarded as Best Paper of conference with Cash prize of Rs. 10,000/-.

1.11 Chapter plan
1. Introduction
The contents of this chapter are Background of the Problem, Statement of the Problem, Purpose of the Study, Significance of the Problem, Objectives of the Issues, Hypothesis and Definition of the Terms, Assumptions, Limitations & Delimitations and Outline of the Study.

2. Survey of literature
This chapter covers survey of MSME status in India and across the world, article extracts on credit risk in chronological from 1964 to till date referred from various international journals and proceedings of conferences.
3. Research methodology and design of the study

3.1 Credit rating frameworks design
3.2 Rulebase design
3.3 Expert system prototype design
3.4 CREES design
3.5 User interface design
3.6 Credit risk assessment design
3.7 Report design
3.8 Test plan and data design

4. Credit Rating Frameworks (CRF) design
4.1 Study of credit risk parameters
4.2 4.2.1 Manufacturing industry CRF
     4.2.2 Trading industry CRF
     4.2.3 Service industry - healthcare - nursing home CRF
     4.2.4 Service industry - hospitality - hotels CRF

4.3 Rulebase design
4.3.1 Manufacturing industry rulebase
4.3.2 Trading industry rulebase
4.3.3 Service industry - healthcare - nursing home
4.3.4 Service industry - hospitality - hotels

4.4 Algorithm design

5. Expert System Prototype Design
5.1 Expert system prototype design and development
     5.1.1 Introduction to Expert System Builder(ESB) software
5.2 5.2.1 CREES design
5.3 Database design
     5.3.1 Manufacturing industry
     5.3.2 Trading industry
     5.3.3 Service industry
5.4 User interface design
     5.4.1 Manufacturing industry data entry screens
     5.4.2 Trading industry data entry screens
     5.4.3 Healthcare industry – nursing home data entry
     5.4.4 Hotel industry data entry screens
5.5 Implementation and testing
6. Result Analysis

6.1 Case Study
6.2 Analysis of client case using ESB
6.3 Results discussion
6.4 Conclusions and recommendations
6.5 Limitations of present work
6.6 Scope for further research
6.7 Funding and recognition of work

7. References

7.1 Text books and study materials
7.2 Websites references
7.3 Research journal articles
7.4 Questionnaire on Small Scale Industries (SSI) loan evaluation methods
7.5 Interactions with banking experts
7.6 Major funding organizations to MSME
7.7 List of service industries
7.8 Sample loan application forms studied

8. Appendices

8.1 Research paper presentation photos in international / national conferences
8.2 Research paper presentation certificates

9. Research publications and conference presentations

10. Acceptance letters and reprints of research papers
# Chapter - 2  Survey of literature

<table>
<thead>
<tr>
<th></th>
<th>Review of the literature</th>
<th></th>
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<tbody>
<tr>
<td>2.1</td>
<td>Survey period 1961-1970</td>
<td>32</td>
</tr>
<tr>
<td>2.2</td>
<td>Survey period 1971-1980</td>
<td>32</td>
</tr>
<tr>
<td>2.3</td>
<td>Survey period 1981-1990</td>
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<tr>
<td>2.4</td>
<td>Survey period 1991-2000</td>
<td>33-36</td>
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<td>2.5</td>
<td>Survey period 2001-2010</td>
<td>36-55</td>
</tr>
<tr>
<td>2.6</td>
<td>Survey period 2011- Onwards</td>
<td>56-59</td>
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</table>