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Credit Rating Companies with Multi-Criteria Decision Making Models and Artificial Neural Network Model

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ABSTRACT

This research seeks to develop a procedure for credit rating of manufacturing corporations accepted in Tehran stock exchange. So, financial ratios of 181 manufacturing corporations in Iran stock exchange were extracted, These ratios reflect the financial ability to pay principal and interest of loan. Initially, fifty selected corporations ranked by using TOPSIS method based on financial ratios by using of Shannon entropy will be obtained the weight of each criterion. In addition, classification credit with neural network has compared by logistic regression; and finally, each had more credibility, used to rank all corporations. Then all corporations have classified by neural network. Finally, the neural network classification results compared with the expert classification. About 95% of the neural network data has placed in its respective class, and the data results indicated a robust neural network classification based on training. The neural network offered far more accurate answer than the logistic regression in this classification. At the end, the neural network ranked all corporations, and neural network classification results compared with expert opinion, showing that the neural network classification was very close to an expert opinion.
KEYWORDS: Financial ratios; TOPSIS; Artificial neural network; Logistic regression.

INTRODUCTION

Today, the credit industry plays an important role in the economy of corporations. Economic globalization and entry of new service channels such as the internet for credit applicants have provided possibility of creditors' unlimited time and space searching. Therefore, credit institutions have been willing to extend their activities to the other countries in the world.

On the one hand, the increasing demand for credit and then competition, and the emergence of new channels in new economic space have created new opportunities for credit institutions; on the other hand, they need to have new tools and methods. This issue has led these institutions to review, empowerment, and inclusion of new technologies in credit management processes.

Meanwhile, credit rating models provide most of the needed information for credit institutions to manage credits effectively. These models have used for prediction of a credit applicant's risk measure and include a wide range of qualitative and quantitative methods. Banks and financial institutions can use these models in two ways. The first method was ratings done by institutions outside the bank and was produced in the degree of risk for each corporate that currently was used in western banks. Three S&P, Fitch, and Moody's agencies are prestigious institutions at the international level that measure credit risk of various corporations and offer on special rates. Due to the long history and experienced expert' team, Ratings of these institutions have been accepted internationally and are reliable too. Therefore, Ratings of them use by most of the creditors' institutions [1-2].

Credit risk refers to the ability of a corporate to repay its debts in accordance with the loan agreement has been signed. More than one hundred years have been going since the birth of credit rating industry to identify and measure credit risk of individuals, corporations, and institutions. However, the development of credit rating models has regarded highly in the past three decades. If the organization becomes default or bankrupt, will have consequences on organization, shareholders, employers, employees, suppliers and all stakeholders of the organization. In addition, the impact on the macroeconomic environment will be noteworthy. That is why a lot of research has been done for develop and improve models of credit risk assessment in the world [3-4].

Problem statement and the research necessity

The complex economic equations arising from globalization; and development and innovation in the field of world fiscal and monetary tools may require development in banking systems as the context of these changes. Principally, intermediation role of banks cause profitability process tied to a range of different possibilities; and banks in their current

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operations experience a diverse range of risks. It is clear that the effective management of risks that banks face inevitably play a determining role in the bank's good performance, especially in its primary mission that is profitability.

General definition of risk in financial systems is fluctuations in revenues, probability of loss, and or reduction of expected returns that potentially are capable of been quantified. On the other hand, the risk system management is a comprehensive operation that formed of components such as developing the appropriate context for risk management, the application of efficient risk estimation techniques, control process, and developing the internal control system. Credit risk is the oldest and most important types of risk in the financial systems. If define credit as expectation to receive the principal and interest of paid loans; In this case, the interpretation of credit risk is not receiving this expectation, and the inevitable result is financial transactions between bank as supplier of funds and users of funds that is the nature of these transactions. On the one hand, globalization and integration of financial markets and on the other hand, increasing growth of financial knowledge have been led to the development and complexity of banking activities, and the emergence of opportunities and also new risks for financial institutions.

Increasingly intensified banks competition and increasing in their risk scope, naturally leads to a reduction in profitability and as well as insufficient capital requirements of traditional banking systems that have not aligned themselves with the rapid moving of banking developments in the world.

The profit is very important motive for commercial banks in providing facilities. In the absence of an appropriate credit risk management system, banks are faced with problems in estimate of credit risk amount and determine of probable losses emerge from the non-payment of loans. As a result, banks will lose their ability to allocate optimum capital and will face by reducing profitability rate. Banks that do not consider risk factors in the facility granting (including the borrower's financial condition, the borrower industry position in the market, exchange rate fluctuations, etc.) are facing with increasing risk of non-payment of loans, and for compensate it will have to increase their facilities reserves that will be another major factor in reducing profitability too.

By comparing the collected information, could realize that there is no comprehensive model for risk assessment in our country's banks and financial institutions unlike other countries. High banks deposits, and banks unpaid or outstanding granted facilities indicate lack of appropriate models for credit risk measurement and risk management systems in the banking system. Another reason for the importance of this risk can assess as follows:

A. Credit risk is now the major cause of banks failures. If the customer does not repay its obligations on time, these facilities comes in the form of bank receivables outstanding and the power of bank lending to new people is reduced, and eventually will decrease profitability. In addition, it will cause disorder in the distribution of bank credits and the economy of country.

B. Measurement of credit risk with prediction of losses of credits non-repayment and producing the logical relationship between risk and return provide possibility of optimizing the composition of the credit portfolio, assets pricing and determining the economic capital of banks to reduce capital costs, and maintaining competitiveness ability, and will create an advantage for banks and credit institutions.

C. In Iran, on the one hand banks activities are based on non-usury banking law and Islamic contracts, so we cannot distinguish boundary between the money and the capital market. On the other hand, according to the country's economic structure, operations of capital market (equity and securities markets) and other non-bank networks have had no significant progress and therefore a significant part of the investment done by banking market. Therefore, the banks' success in doing these matters is important.

D. Relationship between bank and money is lost after loan lending in usury system; and the bank shall claim principal and interest of its loan regardless of the type of economic activity. Therefore, there is no need for careful evaluation of the customer by getting adequate guarantees. While in the Islamic banking system, bank is partner with applicant of facilitation in economic activities and mainly the brought share of the individual as guarantee is considered. Therefore, with intention to ownership-advocacy of resources, evaluation of customer repayment ability is very important. Nowadays, one of the major problems in commercial banks in Iran is the risk-rating problem that is the main tool in screening clients and minimizing the risk. The necessity of this research is presenting an efficient method to estimate customers default risk [5-7] .

This research seeks to develop a procedure for credit rating of corporations accepted in Tehran stock exchange. Given to that, the corporations' conditions are changing over the year and the possibility of departure or arrival of corporate from stock market is during the year. Therefore, the ability of above procedure must be to reflect such changes. The main goal of this research is to create a suitable environment for decision-makers in banks and financial and credit institutions for better decision on investing and providing credit facilities and services. Such an environment can reasonably reduce the risk of financial and credit institutions; and ensure their profitability. With attention to the above sentences, is seeking to answer to this question, "for giving banking facilities to corporations, is it possible to trust to the neural network classification after training".

Conceptual and operational definitions of validation

According to this point that research is done in the field of validation, here briefly explains the concepts of validation, and review different forms of it.

A. Conceptual definition of validation

Validation means evaluating and measuring ability of applicants to repay credit and financial facilities, and the likelihood of credits' non-repayment. Validation provides the necessary basics for comparing the credit risk of one or more economic institutions with others. Overall credit rate is an indication:

1 - The corporate profitability and financial ability

2 - Investment risk in the corporate

3 - Ability to repay principal and interest

Today, in order to, applicants' validation has been developed systems such as customers' credit scoring and credit rating.

1- Credit scoring

Credit scoring is a system that by it, banks and credit institutions assess and score the risk of non-repayment of loans by using of information from the applicant's present and past; or in other words, the probability of individual future default quantifies. This method rank customers according to statistics and quantitative information.

Traditional methods for evaluating customers are mostly subjective and based on the loan officer's perspective. Credit scorings for banks will be making it possible to measure credit risk and manage it according to credit portfolio. The most important tool that banks need to manage and control credit risk is customers' credit scoring system. Obviously, such a system will be helped the bank in favorable selecting of their credit customers and by controlling and reducing credit risk will be improved the level of process efficiency for granting banking facilities [5-9] .A group of banks and some government regulators such as central banks often set out the credit-measuring corporations to accomplish this goal. Credit-measuring corporate is an institution that related information of credit applicants' careers including individuals, corporations, and small businesses collects from banks, credit and financial institutions, and other publicly available sources. This corporate integrates the data collected from refunds, judicial judgments and bankrupts, and eventually will act to sell a comprehensive credit report to creditors. In this report in addition to raw information, credit scores awarded based on statistical mathematical models to every individual or corporate that probability of non-payment of loans were estimated by credit applicants[10-12]

2- Credit rating

Credit rating that done in two different ways is as follows:

1 - Rating of special debts or other financial obligations (such as ratings of bonds documents and specific commercial papers in terms of risks of principal and interest repayment): This rating that has much studied was famous as published credit rating or bonds documents rating. In this rating was tried to all became aware of likelihood of the principal and interest repaying of the special bonds documents in the times promised. For example, in this kind of rating were expressed that bonds documents with 6% interest and tax free, and bonds documents with 7% interest and taxed will be placed in A and BBB ranks accordingly. Institutes of Standards, Poor's, and Moody's in America do this kind of ratings.

2 – Rating of debt publishers or credit rating of business units with debts series ever have created: This shape of the ratings attributed to current opinion about financial ability of the business unit in its financial debts payment. This rating focuses on this issues that whether the borrower has the financial ability and willingness to meet its financial obligations at a certain timeframe in the contract or not. These kinds of ratings also were famous as default or publisher credit rating. Information could be obtained from this type of rating provide proper basis for decisions such as to give or not to give the credit to each business unit. Meanwhile, in the bond documents rating, information are provided for decisions such as to buy or not to buy the bond documents; but at the end, these kind of decisions also concerned to the business unit; but should be considered that in bond documents rating method are focused only on a specific debt, not commercial unit.

B. Operational definition of validation

This research will be assessed the credit rating of corporations. In this rating should be measured corporations' credit ability with financial ratios, that these corporations in what condition are in terms of credit risk and have the ability to repay debts and facilities or are having difficulty in paying their facilities. Therefore, variables should be selected that could fully explain this situation to the corporations. In this research have been tried among many the financial ratios that are available to corporations, significant ratios were selected that have a greater impact on credit standing of corporations to cover the other ratios too, and still had a good recall. All financial ratios were used in the research [13-16] were summarized in table I.

Table I. Financial ratios used in the research

Ratios Measure the Short-term Solvency or Liquidity Ratios	
Current Assets / Current Liabilities	Current Ratio
Current Liabilities / Inventory - Current Assets	Quick Ratio
Long-term Solvency Measures	
Total Assets / Total Liabilities	Total Debt Ratio
Profitability Ratios	
Sale / Net Profit	Profit Margin or Return On Sales (ROS)
Sale / Operational Profit	Operational Margin
Total Equities / Net Profit	Return On Equity (ROE)
Total Assets / Net Profit	Return On Assets (ROA)

Source: (Raei et al, 2011) (Jahankhany et al, 2009)

Methods used in the research

1 - TOPSIS[1] method

This was one of the most widely used compensating models that the first time presented by Hwang and Yoon paper in 1980. After submission of this paper, the researchers who were worked with multi-criteria decision-making were used this method in different areas. The distinction of this method than the other methods was finding the ideal answers both positive and negative in Euclidean space. This method will be entered all items with help of relations in this space and Euclidean distance of each items were calculated with positive and negative ideal points. Items would be preferred more that have less interval from positive ideal point and higher interval from negative ideal point.

2 - Artificial neural network method

Neural network is a method for computation, which has made based on the connectivity of multiple interconnected processing units. Network are formed any number of cell, node, unit, or neuron that connects inputs to outputs. Neural networks, with their remarkable ability to derive results from complex data could use in extracting patterns and detecting different trends that detecting them are difficult to humans and computers. Artificial neural networks are a smart model of the neural model of the human brain; but with this difference that the human brain can recognize patterns quickly and human brain understanding and perception are faster than artificial neural networks. By using a set of rules, artificial neural networks were trained until could do so much easier processes than the human brain.

3 - Logistic regression method

Process of Logit log-linear addressed the analysis of relationship between a dependent variable and several independent variables. Logit model Like Probit and other log-linear models is a special type of general linear models that are included regression and ANOVA models and for better performance have been provided on the two class and section variables. Logit model is similar to Log-linear model but explains one or more than one classified dependent variable. However, when there is one classified dependent variable, using two or polynomials logistic regression is more common than Logit model. Meanwhile, the logistic regression used more when the independent variables have continuous mode. In these items, not all variable surfaces are considered but variable weighted average considered at home related to that variable. This method is estimated Logit log-linear model parameters by using of Newman Rapson algorithm. The linear probability model is a technique that will allow estimating the probability of occurrence or non-occurrence of an event. This action with two-level dependent variables prediction may happen through a set of independent variables.

METHODDOLOGY

For measuring corporations' financial ability to pay principal and interest of facility will be needed financial ratios. So the ratios were needed, that have been had the highest correlation with debt payment ability. Therefore, independent variables are financial ratios of corporations in Tehran stock exchange; and its dependent variable is the corporate' rank too. In this research, one of the multi-criteria decision-making methods will be using for corporations rating, which named TOPSIS. Initially, for selected corporations were calculated variables or financial ratios. When these ratios for every corporate for several years were calculated, for each corporate will be taken the average ratios for different years and used as the basis in the calculations.

Then by using of TOPSIS method will be ranked these corporations. By using of Shannon entropy will be obtained the weight of each criterion. TOPSIS methods due to the large volume of information are required more time; and with arrival of a new corporate must be repeated rating process. Therefore, for convenience, precision, high speed of rating also turns to artificial intelligence. The method is as follows that first, a limited number of corporations results which is ranked by using of TOPSIS method was entered to the neural network as input variable and the neural network function were trained to classify corporations. Then, into neural network algorithm are entered all the corporations. Based on trained function are ranked all data in neural network. If any new corporations enter the market, the algorithm with entering the corporate' financial ratios will be determined the category in place.

[1] Technique for Order Preference by Similarity to Ideal Solution

Statistic populations of this research were comprised of corporations in Tehran stock exchange. For this research have been selected corporations that must have certain requirements to be ranked the same. Financial ratios of 181 manufacturing corporations selected that their financial year were March 29. Financial ratios calculation of these selected manufacturing corporations represents the same interpretation. Nevertheless, investment corporations, banks, and insurances were required other ratios for credit rating. In the present research, from financial statements for 2009-2011 years were derived corporations' financial ratios and then average of ratios in three years considered as the basis of the calculations. Considering that, financial statements of 2012 of some corporations at the time of this research had not audited, and corporations could provide the audited financial statements 4 months after the fiscal year under the terms of the stock exchange. on this basis, financial statements of 2009-2011 years were analyzed and financial ratios were calculated.

RESULTS

According to what has stated in the research, first, the initial ratings will be doing by TOPSIS method by using of the financial ratios of the corporations. By Shannon entropy method will be obtained weight of each TOPSIS criteria and then will have done the rating. TOPSIS were assigned to each corporate a number between zero and one that the classification will be performed by using that. Classifications of these corporations use as training data for the neural network that finally, with neural network training, data of all corporations transmit to the neural network and neural network will be classified these corporations.

1- TOPSIS method

TOPSIS rating method does rating based on distance or closeness to ideal point. In table I were described financial ratios which were considered as the rating criteria, and corporations were discussed as rating options. In addition, positive and negative criteria are apart in rating criteria. First, from financial statements were extracted corporations' financial ratios and were used as rating criteria and then fifty corporations from 181 manufacturing corporations were selected randomly and will be ranked by using of criteria derived from TOPSIS method. By Shannon entropy method will be obtained the weight of each variable. Expert opinion has no effect in Shannon entropy method about criteria weight and reduces probability of error and preferences decisions. That is why for weighting criteria in this research was used Shannon entropy method.

Each corporate were assigned a number between zero and one in TOPSIS method that how much is closer to one is farther the negative ideal option and is closer to the positive ideal point. This research will be divided corporations into four categories, which in Formula 1are described.

Formula (1):
$$\begin{cases} 0.6 < C \leq 1 \; A\ Rank \\ 0.4 < C \leq 0.6 \; B\ Rank \\ 0.2 < C \leq 0.4 \; C\ Rank \\ 0 < C \leq 0.2 \; D\ Rank \end{cases}$$

Rank A Corporations. Corporations were ranked in this category have extremely strong capacity to pay principal and interest of debt.

Rank B Corporations. Corporations were ranked in this category have sufficient capacity to pay the debt and will rarely have problem in crisis conditions.

Rank C Corporate. Corporations were ranked in this category usually are more vulnerable and debt repayment ability depends on favorable economic, commercial, and financial conditions.

Rank D Corporate. Corporations were ranked in this category are extremely vulnerable and will not have sufficient capacity to pay the debt.

First, by using Shannon entropy is calculated the criteria weights, which in table II is summarized.

Table II. Criteria weight in Shannon entropy

	ROA	ROE	Operational profit margin	Net profit margin	Debt ratio	Quick ratio	Current ratio
E j	0. 9480	0. 9727	0. 9550	0. 9402	0. 9823	0. 9639	0. 9745
D j	0. 0520	0. 0273	0. 0450	0. 0598	0. 0177	0. 0361	0. 0255
W j	0. 1975	0. 1037	0. 1709	0. 2270	0. 0671	0. 1371	0. 0967

Now with calculating these weights for the criteria, corporations rank by TOPSIS methods, which the results presented in table III:

Table III. Rating of corporations in TOPSIS

Raw	Corporate Name	Distance Ratio	Rank	Raw	Corporate Name	Distance Ratio	Rank
1	Khark Petrochemical	0. 912	A	26	Esfahan Oil Refining	0. 319	C
2	Ghaen Cement	0. 783	A	27	MAPNA (Iran Powerplant)	0. 319	C
3	Hormozgan Cement	0. 761	A	28	Iran Contour Building	0. 318	C
4	Chadormalu	0. 658	A	29	Brake Lining	0. 299	C
5	Arta Ardebil Cement	0. 627	A	30	Behnoush	0. 296	C
6	Building Development	0. 618	A	31	Tabriz Oil Refining	0. 286	C
7	Gol Gohar	0. 599	A	32	Esfahan Petrochemical	0. 272	C
8	Iran National Copper Industries	0. 576	B	33	Loabiran	0. 264	C
9	Dashtestan Cement	0. 552	B	34	Sarma Afaryn	0. 262	C
10	Iran Khakchyny	0. 552	B	35	Doroud Farsit	0. 261	C
11	Pars Drug	0. 509	B	36	Iran Transfo	0. 237	C
12	Iran Telecommunication	0. 499	B	37	Gharb Cement	0. 229	C
13	Informatics Services	0. 489	B	38	Sazeh Pouyesh	0. 224	C
14	Fanavaran Petrochemical	0. 455	B	39	Motojen	0. 213	C
15	Darab Cement	0. 418	B	40	Nilou Tile	0. 204	C
16	Bama	0. 414	B	41	Petrochemical transportation	0. 201	C
17	Electric Khodro	0. 389	C	42	Khuzestan Steel	0. 179	D
18	Isfahan Mobarakeh Steel	0. 383	C	43	Iran data-processing	0. 161	D
19	Iran Ferro silica	0. 382	C	44	Pyazr	0. 142	D
20	Alborz Drug	0. 381	C	45	Pars Oil	0. 135	D
21	Magsal	0. 379	C	46	Pars Khazar	0. 124	D
22	Aloe Murad	0. 377	C	47	Iran Khodro Diesel	0. 110	D
23	Yazd Jooshkab	0. 371	C	48	Nirou Mohaeke	0. 107	D
24	Farabi Drug	0. 370	C	49	Iran Tire	0. 101	D
25	Zahravy Drug	0. 357	C	50	Neyshabaur Sugar	0. 023	D

2- Neural network method

In neural network method, by using of ratings obtained by TOPSIS method was trained the neural network function. First, ratios of fifty corporations with their rank are being giving as input to the network. According to the corporate financial ratios and rating, network will start to learn the function; then the validity of the model is measured. Software were used for neural network called WEKA software that the function were trained once by neural network, and once again by the logistics function, and ultimately each has been had more credibility will be used to rank all corporations.

At this stage, in the neural network has been entered financial ratios and were gained rating of each corporate, and the desired function has been specified by neural network and has been done the test. In this test, the neural network has placed 95% of data in its respective class. Moreover, the data results indicated a robust classification of neural network based on training. In table IV, see the results.

Table IV. Test results of the neural network

TP Rate	FP Rate	Precision	Recall	F measure	ROC Area	class
1	0	1	1	1	1	A
0. 778	0. 049	0. 778	0. 778	0. 778	0. 946	B
0. 84	0. 12	0. 875	0. 84	0. 857	0. 949	C
0. 889	0. 049	0. 8	0. 889	0. 842	0. 978	D
0. 86	0. 078	0. 862	0. 86	0. 86	0. 961	Ave

As is evident in table IV, the area under the ROC curve is very close to the one that represents the result is very good. ROC values for each category are close to one. In addition, TP rate ,which is indicating the correct diagnosis in that classification, is close to one. Moreover, FP rate, which is indicating the wrong detection in the classification, is very low. For example, in ROC area, the number 0.946 represents those corporations that have taken place in the category B, classified with high precision.

Table V. Classification results of the neural network method

A	B	C	D	classified
7	0	0	0	A=A
0	8	1	0	B=B
0	0	24	1	C=C
0	0	1	8	D=D

As see in table V, has been diagnosed A category quite right. In the B group classification were nine corporations that function have placed eight corporations in the B group and one corporate on the C category. In

addition, of 25 corporations related to the C category, have been diagnosed 24 corporations properly and only one corporate has been placed in the D category. In the D group classification were nine corporate, that the function has placed eight corporations in the D group and one corporate in the C group.

3- Logistic regression method

To make comparison between neural network and logistic regression was used logistic regression, and with neural network were compared results. In table VI sees test results of the logistic regression and in table VII sees logistic regression classification.

Table VI. Test results of the logistic regression

TP Rate	FP Rate	Precision	ROC Area	class
1	0.023	0.875	0.983	A
0.667	0.049	0.75	0.81	B
0.8	0.12	0.87	0.916	C
0.889	0.073	0.727	0.973	D
0.82	0.085	0.823	0.917	Ave

Table VII. Classification Results of logistic regression method

A	B	C	D	classified
7	0	0	0	A=A
0	6	2	1	B=B
0	2	20	3	C=C
0	0	1	8	D=D

As you can see, logistic regression has classified 82 percent of the data in its proper place and has acted much weaker than the neural network. Based on this, by the neural network model were performed the ratings of all corporations.

4 - Rating of all manufacturing corporations based on neural network

Now, all manufacturing corporations that have been extracted their financial ratios are given as input to the neural network and the rating is done based on neural network that the results of 40 corporations are listed in table VIII. In appendix I has been given rating result of all 181 manufacturing corporations.

Corporations rating by using of neural network **Table VIII.**

Corporate Name	Corporate Num	Predicted	Corporate Name	Corporate Num	Predicted
Abadgardan	1	2:b	International Pars Products	21	4:d
Absal	2	4:d	Pars Pamchal	22	4:d
Azaryt	3	3:c	Pars Khazar	23	4:d
Alumtek	4	4:d	Pars Khodro	24	3:c
Aloe Murad	5	3:c	Pars Drug	25	2:b
Offset	6	4:d	Pars Ceram	26	4:d
Alborz Drug	7	3:c	Pars Switch	27	3:c
Electric Khodro	8	3:c	Pars Minoo	28	3:c
Ema	9	3:c	Esfahan Oil Refining	29	3:c
Iran Argham	10	3:c	Tabriz Oil Refining	30	3:c
Iran Tire	11	4:d	Paksan	31	3:c
Iran Transfo	12	3:c	Abadan Petrochemical	32	3:c
Iran Khodro	13	4:d	Esfahan Petrochemical	33	3:c
Iran Khodro Diesel	14	4:d	Khark Petrochemical	34	1:a
Iran Drugs	15	3:c	Shazand Petrochemical	35	4:d
Iran Yasa	16	3:c	Fanavaran Petrochemical	36	2:b
Bama	17	2:b	Esfahan Pegah	37	4:d
Behnoush	18	3:c	Khorasan Pegah	38	4:d
Butane	19	3:c	Plaskokar Saipa	39	3:c
Georgian Biscuits	20	4:d	Pyazr	40	4:d

DISCUSSIONS

Initially, based on financial ratios criteria were ranked fifty selected corporations by TOPSIS rating method. TOPSIS were assigned each corporate a number between zero and one, which based on the distance ratio were classified to four categories A, B, C, and D that the conditions and criterion for each category fully were explained. By using of classification that has given by TOPSIS method were trained neural network model and then on the data were performed test. The results indicate that were done 95% of the classifications properly and the model was reliable for classification.

To make sure the neural network model was good for ratings; for this research was used logistic regression model too. Logistic regression results were placed only 85% of the data in its respective categories properly; and demonstrates that the model is weak than the neural network model to solve this problem and utilizing neural network is preferred.

By using of neural network were classified 181 manufacturing corporations. The financial ratios have given as input to the model, and the output model was the class that the neural network has attributed to the corporations. Neural network is a powerful tool for classification because it could perform this rating with high precision in the least possible time. Moreover, this method is very appropriate for high number of corporations and multiple rating criteria as well.

First, for comparing neural network model with expert classification, fifty corporations were chosen that had been determined their class with neural network. In this research, were selected ten experts that according to the classification criteria that presented in table I will be determined the ability to pay principal and interest of facilities. To these ten experts were given fifty corporations, and requirements for each category were presented in the appendix II, and expert will be decided the category of corporation. Corporation with majority of votes placed in determined class. In table IX are discussed the results of these two categories.

Table IX. Comparison of neural network and expert opinion results

Category	Expert Opinion	Neural Network Model			
		A	B	C	D
A	5	5	0	0	0
B	14	0	12	2	0
C	24	0	1	20	3
D	7	0	0	1	6
Total	50	5	13	23	9

As see, neural network model is very close to an expert opinion and therefore this subject confirmed that the neural network is an efficient model for classification.

The problem are being facing many banks is that they do not know in what category put each corporate and with what interest rate each corporate will be received facilities. Bank can rank corporations that request loan with the classification proposed in this research. The A group has high grade and reliability, and high ability to repay the principal and interest of facilities and will have very little risk to the banks; so will be getting loans at lower interest rates. Moreover, the credit will be reduced whatever moving from A group to D group, and corporations should be taken facility with higher interest rate from the bank. One of the features that were discussed in this research was that if bank gives financial ratio of a corporate which is requested facilities to the neural network model; this model will describe this corporate in what class will be placed, and bank will decide that with what interest rate and ceiling gives the loan to corporate.

Research limitations/implications

1. Some of the corporations in this research may have influenced by macroeconomic variables, so the derived ratios and research results are affected. Therefore, it is not possible to control these variables.

2. Data considered for this research have calculated from the corporations' financial statements. Although, accuracy were evaluated with the stock exchange information center, but always the lack of all financial ratios of corporations in the stock market over the past years were considered the limitations of these studies.

3. Existing ratios, that representing affordability, for all corporations are not the same. Therefore, in this research only were used the manufacturing corporations that the results were cited.

Conclusions

Rating is meaning commenting on corporate' legal ability and commitment about the principal and interest repayment of the debts. Credit rating models provide most of the credit institutions' needed information for effective credits management. In predicting the size of the risk of a credit applicant were used these models and were included a wide range of qualitative and quantitative methods. Given that, rating is very good by using multi-criteria decision-making models and give good answers; but due to the large volume of information and growing of problems should be sought models that easily and in less time and with most precision do this rating also. Thus, according to these conditions, for this research have been used ultra-initiative models. Neural network model for high speed and very high precision in problem solving is very suitable. For training the neural network function has been used the initial TOPSIS rating.

The Data that used for this research were financial ratios, which have extracted from manufacturing corporations in Tehran stock exchange. First, financial ratios of fifty corporations were ranked by the TOPSIS method and then based on the results were classified on four categories. Classification results and financial ratios have given as input to the neural network, the neural network trained, and the model validity tested after training. From the neural network have been received good results. Then, the same data have given to logistic regression model and the results compared to the neural network. The results indicated that the neural network model had higher efficiency.

Then the data of 181 manufacturing corporations transferred into the neural network model and neural network were classified corporations in four categories. To compare this classification, also is sought expert opinion; to do this were designed forms and in them were mentioned the criterion for each category too. At the end, with neural networks was compared the experts' opinion. The results indicated that the neural network classification was very similar to the experts' opinions.

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Appendixes

Appendix I. corporations' classification by neural network

Corporate Name	Corporate Num	Predicted	Corporate Name	Corporate Num	Predicted
Abadgardan	1	2:b	Tehran Cement	92	2:b
Absal	2	4:d	Khazar Cement	93	4:d
Azaryt	3	3:c	Darab Cement	94	2:b
Alumtek	4	4:d	Dashtestan Cement	95	2:b
Aloe Murad	5	3:c	Doroud Cement	96	3:c
Offset	6	4:d	Sepahan Cement	97	2:b
Alborz Drug	7	3:c	Shahroud Cement	98	2:b
Electric Khodro	8	3:c	Shargh Cement	99	2:b
Ema	9	3:c	Shomal Cement	100	3:c
Iran Argham	10	3:c	Gharb Cement	101	3:c
Iran Tire	11	4:d	Fars Cement	102	3:c
Iran Transfo	12	3:c	Neo Fars Cement	103	2:b
Iran Khodro	13	4:d	Fars and Khouzestan Cement	104	1:a
Iran Khodro Diesel	14	4:d	Qaen Cement	105	1:a
Iran Drugs	15	3:c	Mazandaran Cement	106	3:c
Iran Yasa	16	3:c	Hormozgan Cement	107	1:a
Bama	17	2:b	Hegmatan Cement	108	3:c
Behnoush	18	3:c	Karoon Cement	109	2:b
Butane	19	3:c	Kurdistan Cement	110	2:b
Georgian Biscuits	20	4:d	Kerman Cement	111	2:b
International Pars Products	21	4:d	Shahid Ghandi	112	4:d
Pars Pamchal	22	4:d	Hamadan Glass	113	3:c
Pars Khazar	23	4:d	Shishe and Gas	114	4:d
Pars Khodro	24	3:c	Darou Pakhsh Chemistry	115	3:c
Pars Drug	25	2:b	Sina Chemical	116	3:c
Pars Ceram	26	4:d	Iran Chemical Industries	117	3:c
Pars Switch	27	3:c	Sepahan Industrial	118	4:d
Pars Minoo	28	3:c	Behshahr Industrial	119	3:c
Esfahan Oil Refining	29	3:c	Ahvaz Farsit	120	3:c
Corporate Name	**Corporate Num**	**Predicted**	**Corporate Name**	**Corporate Num**	**Predicted**
Tabriz Oil Refining	30	3:c	Doroud Farsit	121	3:c
Paksan	31	3:c	Iran Refractory	122	3:c
Abadan Petrochemical	32	3:c	Azar Refractories	123	4:d
Esfahan Petrochemical	33	3:c	Iran Ferro Silica	124	3:c
Khark Petrochemical	34	1:a	Khavar Spring	125	4:d
Shazand Petrochemical	35	4:d	Zar Spring	126	4:d
Fanavaran Petrochemical	36	2:b	Amir kabir Steel	127	3:c
Esfahan Pegah	37	4:d	Khuzestan Steel	128	4:d
Khorasan Pegah	38	4:d	Isfahan Mobarakeh Steel	129	3:c
Plaskokar Saipa	39	3:c	Khorasan Steel	130	4:d
Pyazr	40	4:d	Iran Fibre	131	4:d
Tayd Water	41	3:c	Esfahan Sugar	132	4:d
Tractorsazi	42	4:d	Piranshahr Sugar	133	4:d
Tehran Drug	43	4:d	Lorestan Sugar	134	3:c
Tehran Chemistry	44	4:d	Nghsh Jahan Sugar	135	3:c
Building Development	45	1:a	Neishabour sugar	136	4:d
Tolypers	46	4:d	Hegmatan Sugar	137	4:d
Takin Koo	47	3:c	Bahman Group	138	3:c
Jam Drug	48	4:d	Gol Gohar	139	1:a
Joosh and Oxygen	49	4:d	Goltash	140	3:c
Yazd Jooshkab	50	3:c	Glucosan	141	3:c
Chadormalu	51	1:a	Sahand Rubber	142	4:d
Charkheshgar	52	4:d	Pars Shahab lamp	143	4:d
Iran Chini	53	3:c	Pak Dairy	144	4:d
Petrochemical transportation	54	3:c	Kalbr Dairy	145	4:d
Touka transportation	55	4:d	Loabiran	146	3:c
Iran Khakchyny	56	2:b	Brake Lining	147	3:c
Informatics Services	57	2:b	Pipe and Machinery	148	3:c
Pars Animal feeds	58	3:c	Margarine	149	4:d
Iran data-processing	59	4:d	Nirou Mohaeke	150	3:c

			Machinery		
Aboureihan Drug	60	3:c	MAPNA (Iran Powerplant)	151	3:c
Osveh Drug	61	2:b	Mehvar Khodro	152	3:c
Amin Drug	62	3:c	Iran Telecommunications	153	2:b
Exir Drug	63	3:c	Bahonar Copper	154	4:d
Corporate Name	**Corporate Num**	**Predicted**	**Corporate Name**	**Corporate Num**	**Predicted**
Jaber Ibn Hayan Drug	64	3:c	Iran Manganese Mines	155	2:b
Damlran Drug	65	3:c	Magsal	156	3:c
Razak Drug	66	3:c	Iran National Copper Industries	157	2:b
Zahravy Drug	67	3:c	Mahram	158	4:d
Subhan Drug	68	1:a	Mehrcam Pars	159	4:d
Abidi Drug	69	3:c	Daroupakhsh Materials	160	3:c
Farabi Drug	70	3:c	Motogen	161	3:c
Luqman Drug	71	3:c	Boroujerd Textile	162	4:d
Kousar Pharmaceuticals	72	3:c	Nasir Machine	163	3:c
Dasht Morghab	73	4:d	Pars Oil	164	4:d
Negin Coal	74	2:b	Rolling Steel Parts	165	4:d
Iran Radiator	75	4:d	Reconstruction and Construction	166	2:b
tractor Casting	76	4:d	Nyrou Trans	167	3:c
Mashhad Wheel	77	4:d	Nyrou Mohareke	168	4:d
Zamyad	78	3:c	Iran Carburetor	169	3:c
Sazeh Pouyesh	79	3:c	Iran Carton	170	4:d
Salemin	80	3:c	Daroupakhsh Pharmaceuticals	171	3:c
Saipa	81	3:c	Esfahan Tile	172	4:d
Saipa Azin	82	4:d	Alvand Tile	173	3:c
Sahkt Ajand	83	3:c	Pars Tile	174	4:d
Ardekan Ceramic	84	4:d	Hafez Tile	175	3:c
Srma Afaryn	85	3:c	Nilou Tile	176	3:c
Arta Ardabil Cement	86	1:a	Calcimine	177	3:c
Urmia Cement	87	2:b	Iran carbon	178	4:d
Esfahan cement	88	2:b	Iran shipping	179	4:d
Ilam Cement	89	3:c	Iran Contour Building	180	3:c
Bojnourd Cement	90	3:c	Kymydarou	181	3:c
Behbahan Cement	91	2:b			

Appendix II. Feedback Form of Experts

Corporations' classification form by experts	
Expert Name	
Conditions of Each Category	
Category A	Corporations were ranked in this category have extremely strong capacity to pay principal and interest of debt.
Category B	Corporations were ranked in this category have sufficient capacity to pay the debt and will rarely have problem in crisis conditions.
Category C	Corporations were ranked in this category usually are more vulnerable; and their debt repayment ability depends on favorable economic, commercial, and financial conditions.
Category D	Corporations were ranked in this category are extremely vulnerable and will not have sufficient capacity to pay the debt.