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The Extraction of Influencing Indicators for Scoring of Insurance Companies Branches Based on GMDH Neural Network

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Abstract

One of the key topics and the most important tools to determine the strengths, weaknesses, opportunities and threats of each organization and company is the evaluation the performance of organizational activities that rating and ranking follows the internal and external goals. In this regard insurance companies similarly are looking for evaluation of their branches through scoring, ranking and identifying the top branches. Using scoring and then ranking branches based on performance evaluation, not only helps to identify internal and external situation and provides the possibility of planning, implementation, monitoring, control, and to improve performance, but also it will be impossible comparison of branches .Since now scoring of insurance companies branches in Iran were done under a traditional framework, that apply an on-theoretical approach and based on experimental expertise ,in this study by using GMDH neural network ,Furthermore, in the process of change from a traditional framework to the systematic mechanism, we extract indicators of evaluation of the performance of the Dana Insurance company and also objective function and effective variables were determined. Moreover, results show that GMDH neural network is an appropriate alternative for traditional framework and based on this new approach, we found the ability of forecasting budget and profit.

Keywords: Scoring, Rating, Branches Evaluation, Insurance Companies, GMDH Neural Networks.
JEL Classification: C45, D04, G22, G24.

1. Introduction[5]

Despite the important role of insurance in underlying and providing

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favorable economic conditions, the current status of this industry in the national economy is significantly different from the ideal status. Public unfamiliarity, few demands for insurance products, low technical knowledge about insurance services, and failures in the management of insurance-providing branches are the reasons for the lack of appropriate development of this industry in Iran. Since all the salvations and achievements of humans have been possible through science and experience in the history, the key to this problem is to have a more scientific look at this industry and find a scientific solution. This goal cannot be achieved by moving on two paths at the same time. The first path is to build a scientific culture and expand insurance-related sciences by conducting studies and making efforts to convey and localize such sciences. The second path is to use the results of these sciences and turn theories into executive solutions (Mahdavi, 2012).

Scoring and ranking branches are the most important tools for the determination of advantages and disadvantages and the identification of opportunities and external threats at insurance companies. Some of the problems of ranking companies or their branches at national or international levels include the lack of universality and emphasis on a major indicator such as sales or income. It can be stated that the current ranking lists are intended to rank the largest company, not the best one. Scoring and ranking companies and their branches seek intra-organizational and extra-organizational goals. The excess of ease of calculation and easy procurement of ranking data of companies drove current scoring and ranking methods far away from the main goals.

The aim of this study is to present an appropriate model to rank the branches of insurance companies in order to determine advantages, disadvantages, opportunities, and threats. The results should be used to analyze and revise policies and plans to improve performance at the branches of insurance companies. This study is also meant to identify the primary and secondary performance evaluation indicators at the branches of insurance companies to prioritize and determine the importance of each indicator. The goal is to present an appropriate model to evaluate the performance at the branches of insurance companies. The research theoretical literature is reviewed in the second section. The third section deals with the research background. Methodology is described in the fourth section, and the findings are analyzed in the fifth section. Finally, the sixth section presents the conclusion and research suggestions.

2. Research Theoretical Literatures

To carry out the legal duties under the Fifth Development Plan and move towards the competitiveness of Iran's insurance market, the Central Insurance of Islamic Republic of Iran was assigned to rank insurance companies. For this purpose, nearly 40 financial, human resource, and technical indicators are determined to rank the insurance companies so that policyholders can easily select the appropriate insurer (Karimi, 2013). The performance evaluation of different organizations and companies can be described as the human spine. In the exact same way as the human spine, the performance evaluation system sends the information to the decision and action center in the brain of an organization so that the decisions can be sent to every part of the organization. Therefore, it is regarded as the vital part of every organization. A healthy spine operating correctly enables the brain to be always in contact with all the accessible sensitive inputs. Organizations work exactly in the same way (Azar, 2007). Supervision and evaluation have been taken into account since the advent of classic management theories. In other words, all of the management theories have somehow considered supervision, control and evaluation and regarded them as the main management duties. Therefore, performance evaluation is not a new subject. However, the important point is the changes of attitudes in this regard. The development and expansion of duties in organizations made the performance evaluation inevitable. On the other hand, magnificent changes in the management knowledge have influenced evaluation mechanisms. What is regarded as performance evaluation today is a guiding look at supervision seeking to improve the performance. Given this achievement, it is necessary to make evaluation systems proportional to the positions and functions of organizations. In fact, the organizational performance management is taken as control system and a closed loop including policies and strategies. In this loop, feedbacks are received from different levels to manage business performance. The performance evaluation system is a type of information system which is the heart of the performance management process. It is essentially important for the effectiveness and efficiency of the performance management system (Azar, 2007). Performance evaluation is a process which measures organizational activities in a way that the organization can reduce costs and improve the operations by improving activities. It should also support organizational missions (Sheri, 2005). Performance evaluation results in continuous education, guarantees a high level of learning, and motivates the workforce, something which is the quintessence of management performance (Lassam, 2005). Therefore, the definitions of performance evaluation have been regarded as activities for improvement. This evaluation is conducted not only on employee, but also on the entire organization. Performance evaluation is so important that (Kanji, 2002) believes that the prerequisite for achievement, development and professional superiority is to develop and complete a system for performance evaluation. Therefore, the performance evaluation of organizations has a major role in orienting their future decisions. In this regard, the efficiency and productivity of organizations should be measured to monitor the economic growth in future decisions. In the current era, achieving economic growth by improving productivity is one of the most important economic goals of organizations. Productivity can be improved with the optimal use of production. It plays an important role in achieving continuous economic growth and sustainable production. One of the appropriate and efficient tools is the GMDH neural network approach. Neural networks are the new generation of data mining techniques which have been developed greatly in the past two decades. Artificial intelligence methods are highly capable of predicting and providing a better performance in dealing with nonlinear problems and other difficulties of modeling time series. The main advantages of neural networks are their extraordinary learning capability and their stability against negligible input disturbances. Accordingly, the GMDH neural network approach was employed in this study to model and predict the target variable.

3. Empirical Background

In Iran, different studies used multi attributes decision making

(MADM) methods for performance evaluation. Raee (2015) used MADM to identify the most important financial ratios and variables influencing the financial statuses of Iranian insurance companies by prioritizing these ratios and variables and finally ranking insurance companies accordingly. Mohammdian (2015) used the data envelopment analysis to evaluate the performances of Dana Insurance branches. The output of this analysis was the identification of efficient and inefficient branches. In a paper, Khadivar (2015) conducted a case study on Bank Tejarat to design a decision support system for ranking back branches. In this paper, the PROMETHEE method was used to rank two branches according to performance evaluation indicators including quantitative and qualitative indicators. Finally, decision makers were provided with a useful sensitive analysis. Afsordeh & Moridipour (2014) carried out a study to investigate the performances of insurance company representatives in Iran. In this study, the DEA method was used to determine the productivity of each representative. TaghaviFard (2014) conducted a case study of Ghavamin Financial and Credential Institute to explain a hybrid credit ranking model by using the genetic algorithms and fuzzy expert systems. The accuracy of the proposed method is higher than other compared methods. MoazemiGoudarzi et al. (2014) conducted a study on the evaluation of relative efficiency and ranking bank branches. They believed that it would not be possible to evaluate and control organizational units, regarded as the necessity of management, without evaluating the efficiency of supervised branches. Nemati (2014) evaluated the performances of Iranian insurance companies in 2008, 2009, and 2010 by using MADM methods to rank them linearly. Sameri (2013) used the DEA method to evaluate the performances of Iran Insurance Company branches. Out of the available nonstandard models, the integrated DEA model was selected to evaluate the performances of Iran Insurance Company branches, then the obtained statistics were analyzed accordingly. In a paper, Motameni (2012) evaluated the performances of an insurance company branches by using the hybrid balanced scorecard and fuzzy MADM techniques. The results indicated that the financial aspect was the most important criterion in the flourishment of branches in the from the customer perspective. Moreover, insurance premium issuance had a major role in the development of insurance branches. Bazaee (2012) identified the key factors of success in ranking banks based on electronic services and the rank determination of each bank. It was clarified that banks had different capabilities in providing electronic services. In a paper, Ekhtiari (2012) introduced a developed VIKOR method for the credential ranking of bank customers. In this study, a numerical instance was provided for the credential ranking of bank customers to explain the proposed method and to determine the best option for granting facilities. In a case study of a private insurance company, Kazazi et al. (2012) used the gray theory and DEMATEL method to rank the elements of a SWOT[1] matrix in uncertain conditions. In the results, the elements of this matrix were ranked as opportunities, threats, strengths, and weaknesses with respect to their causal relationships. Amiri (2011) conducted a study to investigate the applications of the balanced scorecard and VIKOR in ranking insurance companies. According to the results, the ratio of profit to sales was allocated the greatest weight in the financial aspect. Regarding internal processes, the greatest weight was allocated to administrative costs. In the customer aspect, the greatest weight was allocated to the growth of the number of representatives. Regarding growth and learning, the greatest weight was allocated to the rate of investment. In a study, Sanchez (2016) evaluated the credential scoring systems for bank credits and investments with respect to cost, profit and the assessment of applied services and loans granted by financial and credential institutes. Campbell (2016) conducted a study to revise the performance evaluation and indicated that better predictions were made in the method applied on an instance tested on financial resources. Lazarides (2015) dealt with bank ranking in divergent-convergent Europe. The value and innovation of this paper lies in the use of a systemic approach to find ranking indicators and excluded four groups of important non-statistical indicators (ownership, size, capital structure, and development). The results show that bank ranking depends on ranking countries and the environmental macro economy. Somehow, it is an excessive and significant factor. In a paper entitled *a Credential Scoring Model for*

1. Strengths, Weaknesses, Opportunities, and Threats

Loan-Granting Banks Based on the Fuzzy Optimized Classification Using the Differential Evolutionary Algorithm, Ibtism (2015) indicated that the proposed model provided a more accurate ranking rate than the decision tree model on average. Hi Bong (2015) conducted a study on modeling the double-step production of American large banks using a neural network and DEA hybrid method. In their study, proved an integrated approach for modeling the continuous double-level performance of a manufacturer by probing into the prediction capacity of the neural network after dissemination regarding DEA. Zay (2010) used the DEA method to compare the efficiencies of public and private insurance companies in the US. According to the results, these companies were more willing to become public because of the access to more resources and capital despite the high efficiencies of private insurance companies.

The innovation of this research can be evaluated from 3 aspects:

- Most of previous studies have used data envelopment analysis to evaluate insurance companies; however, this is the first study to use intelligent techniques for ranking and rating companies in the insurance industry.
- The present study provided a ground to analyze different actions and reactions between variables, determine their importance and finally, to predict influential variables such as budget and profit.
- A detailed and logical method was presented for rating and ranking various branches of insurance companies.

Table (1) shows the different research works conducted on Ranking and Evaluating of Insurance Companies.

Table 1: A Brief Review of Studies

Row	Title	Authors
1	Ranking Insurance Companies Based on Financial Ratios and Variables Using MADM Methods	Raee et al. (2015)
2	Evaluating the Performances of Dana Insurance Branches by Using the DEA Method	Mohammadian et al. (2015)
3	Designing the Decision Support System for Ranking Bank Branches	Khadivar & Mohammadi (2015)

Table 1: A Brief Review of Studies

Row	Title	Authors
4	Performance Evaluation of Representatives of Insurance Companies in Iran Using Analytic Network Process (ANP) and Data Envelopment Analysis (DEA)	Afsordeh & Moridipour (2014)
5	Explaining the Hybrid Credential Ranking Model by Using the Genetic Algorithms and Fuzzy Expert Systems	TaghaviFard et al. (2014)
6	the Application of the DEA Method in the Evaluation of Relative Efficiency and Ranking the Branches of Bank Refah in Lorerstan Province and Comparing the Results with the TOPSIS Technique	MoazemiGoudarzi et al. (2014)
7	Ranking Insurance Companies by Using the MADM Methods	Nemati & kazemi (2014)
8	Evaluating the Performance of Iran Insurance Company Branches by Using the Integrated DEA Method;	Sameri et al. (2013)
9	Evaluating the Performance of an Insurance Company Branch by Using the Hybrid Method of Balanced Scorecard and Fuzzy MADM Techniques	Motameni et al. (2012)
10	The Key Factors of Success in Ranking Banks Based on Electronic Services and Determining the Rank of Each Bank	Bazaee& Dehghanpour (2012)
11	Introducing a Developed VIKOR Method for the Credential Ranking of Bank Customers	Ekhtiari (2012)
12	Ranking the Elements of SWOT Matrix in the Conditions of Uncertainty	Kazazi et al. (2012)
13	The Application of Balanced Scorecard and VIKOR for Ranking Insurance Companies	Amiri et al. (2011)

4. Research Methodology

In this study, the GMDH neural network was used to model and predict the target variable.

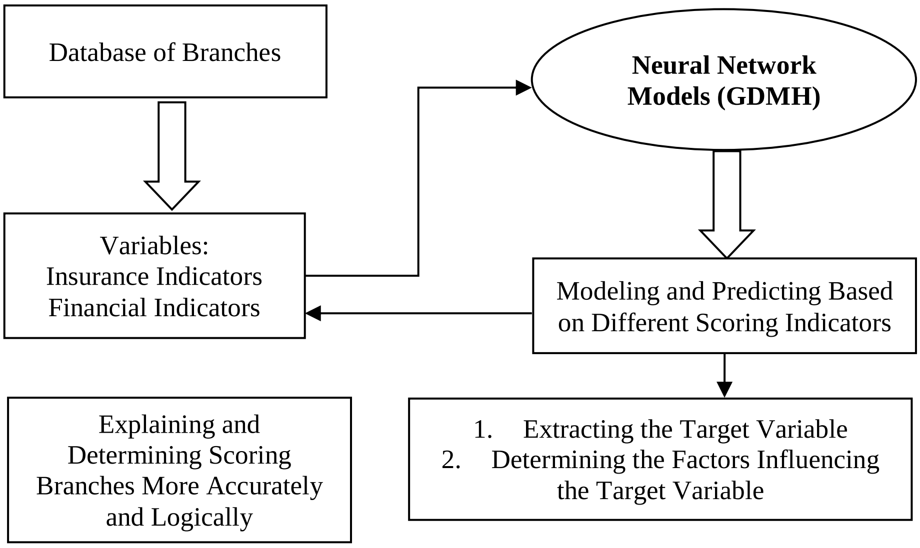

Figure 1: Research Model
(Moeini, Behradmehr, Ahrari, & KhademShariat, 2011; 2012)

Artificial Neural Networks (ANN) is biologically inspired network based on the organization of neurons and decision making process in the human brain. In other words, it is the mathematical analogue of the human nervous system. This can be used for prediction, pattern recognition and pattern classification purposes. It has been proved by several authors that ANN can be of great use when the associated system is so complex that the underline processes or relationship are not completely understandable or display chaotic properties (Priestley, 1988). Development of ANN model for any system involves three important issues: (i) topology of the network, (ii) a proper training algorithm and (iii) transfer function. Basically an ANN involves an input layer and an output layer connected through one or more hidden layers. The network learns by adjusting the inter connections between the layers. When the learning or training procedure is completed, a suitable output is produced at the output layer. The learning procedure may be supervised or unsupervised. In prediction problem supervised learning is adopted where a desired output is assigned to network beforehand (Jang and Sun, 1995).

Due to the shortcomings of statistical models and neural network algorithms in accurate model identification and in providing accurate predictions, other methods with less predictive information requirement have been developed. The GMDH (group methods of data handling) has been developed following the studies in the area of artificial intelligence in self-organizing systems, information theory, control and computer science. It is a statistical network training technology. This algorithm can be used in many economic, social, climatic, technical and engineering areas. GMDH is not a classic statistical modeling technique. It is a systematic process to overcome statistical shortcomings and neural networks.

The history of theoretical research on GMDH can be divided into three phases. In the first phase, the Ukrainian scientists A.G. Ivakhnenko first established the algorithm in 1967 (Ivakhnenko, 1971).Then, in the 1970s, Barron developed the concept of network training and in the 1980s, Elder presented the algorithm for synthesis of polynomial networks (ASPN). In the third phase and in the 1990s, a German named Müller developed some of the previous basic achievements of GMDH and GMDH has since been known as the main algorithm for simulation and prediction of complex systems. The GMDH theory has been developed on the basis of evolution theory. This algorithm is based on four stages of evolution, return to the previous steps, change and choice. Therefore, the GMDH modeling process involves simple to complex evolutionary developments. Since the 1990s, rapid development of computer sciences made it possible for researcher to apply GMDH in modeling of complex economic systems. Many scholars from all over the world studied self-organizing data algorithm and many software were introduced to solve GMDH problems. GMDH is nowadays a valuable tool in system analysis and decision making with simulation software (S.K.Oha and W.Pedrycz, 2000), forecasting (A.G.Ivakhnenko, 1995), modeling (A.G. Ivakhnenko, 2000) and the sample classification in complex systems (R.E.Abdel-Aol, 2005).Thanks to the efforts of Iwakhnenko and Muller, GMDH has been effective in the development of many branches, such as economics, management, ecosystem and meteorology. Systematically, this technique mainly combines various stages of modeling, systematic sciences, information, control theory and evolution theory to conduct intelligent modeling. Many issues in the real world take place under uncertainty conditions; therefore, their modeling should also be based on uncertainty of information and cause and effect relationships and their prediction should be conducted on the basis of the uncertainty principle. Many scientists involved in uncertainty studies have contributed to the development of this field. Pawalak first presented the theory of rough set to prove that describing uncertainty-related issues can be effective in modeling. In economics and management, rough sets can provide a good description of issues in the absence of accurate information to enable the modeler to model decision maker's mentality and idea. This new algorithm, known as the R-GMDH algorithm, is considered a solution to random problems in complex systems. Other algorithms such as fuzzy GMDH and random GMDH are proposed to combine uncertainty conditions. The application of GMDH algorithm in uncertainty conditions still undergoes its early stages.

So far, many articles have been published on application of GMDH algorithm in economics. The identification and prediction of financial systems are among the initial research areas which were conducted using this algorithm. In macroeconomic systems, the limited number of observations and the dynamic behavior of variables make it impossible to identify models through using usual methods. According to Scott, these usual methods fail, because they cannot provide a specific technique for selecting the input variable. Because of their mere nonlinear nature, such systems cannot explain the small relationships between variables and their interactions. Therefore, it seems that the GMDH algorithm has been very effective in this area.

4.1 GMDH Neural Network

GMDH neural networks are based on the concept of pattern recognition, and in that sense such networks are a refinement of traditional methods of technical analysis. They are highly flexible, semi parametric models, and have been applied in many scientific fields, including biology, medicine and engineering**.** The GMDH is the inductive sorting-out method, which has advantages in the cases of rather complex objects, having no definite theory, particularly for the objects with fuzzy characteristics.

For economists, neural networks represent an alternative to standard regression techniques and are particularly useful for dealing with non-linear unvaried or multivariate relationships.

By applying GMDH algorithm a model can be represented as set of neurons in which different pairs of them in each layer are connected through a quadratic polynomial and thus produce new neurons in the next layer. Such representation can be used in modeling to map inputs to outputs. The formal definition of the identification problem is to find a function f^ that can be approximately used instead of actual one, f, in order to predict output y^ for a given input vector X = (x1, x2, x3 . . . xn) as close as possible to its actual output y. Therefore, given M observations of multi-input-single-output data pairs so that:

$$y_i = f(x_{i1}, x_{i2}, x_{i3}, ..., x_{in}) \quad i=1, 2 \ldots M \tag{3}$$

It is now possible to train a GMDH-type neural network to predict the output values y^i for any given input vector X = (xi1, xi2, xi3, . . .xin), that is:

$$\hat{y}_i = \hat{f}(x_{i1}, x_{i2}, x_{i3}, ..., x_{in}) \quad i=1, 2, \ldots M \tag{4}$$

The problem is now to determine a GMDH-type neural network so that the square of difference between the actual output and the predicted one is minimized, in the form of:

$$\sum_{i=1}^{M} [\hat{f}(x_{i1}, x_{i2}, x_{i3}, ..., x_{in}) - y_i]^2 \rightarrow \min \tag{5}$$

General connection between inputs and output variables can be expressed by a complicated discrete form of the Volterra functional series that is:

$$y = a_0 + \sum_{i=1}^{n} a_i x_i + \sum_{i=1}^{n}\sum_{j=1}^{n} a_{ij} x_i x_j + \sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n} a_{ijk} x_i x_j x_k + \ldots$$

$$n=1, 2, .., N \tag{6}$$

This is known as the Kolmogorov–Gabor (Farlow, 1984; Iba et al., 1996; Ivakhnenko, 1971; Nariman-Zadeh et al., 2002; Sanchez et al., 1997). The full form of mathematical description can be represented by a system of partial quadratic polynomials consisting of only two variables (neurons) in the form of:

$$\hat{y} = G(x_i, x_j) = a_0 + a_1 x_i + a_2 x_j + a_3 x_i x_j + a_4 x_i^2 + a_5 x_j^2$$

$$i=1 \ldots M, \ j=1, 2 \ldots N \tag{7}$$

In this way, such partial quadratic description is recursively used in a network of connected neurons to build the general mathematical relation of inputs and output variables given in Eq. (6). The coefficients a_i in Eq. (7) are calculated using regression techniques (Farlow, 1984; Nariman-Zadeh et al., 2003) so that the difference between actual output, y, and the calculated one, y^, for each pair of xi, xj as input variables is minimized. Indeed, it can be seen that a tree of polynomials is constructed using the quadratic form given in Eq. (7) whose coefficients are obtained in a least-squares sense. In this way, the coefficients of each quadratic function Gi are obtained to optimaly fit the output in the whole set of input–output data pairs, that is:

$$E = \frac{\sum_{i=1}^{M} (y_i - G_i)^2}{M} \rightarrow \min \tag{8}$$

In the basic form of the GMDH algorithm, all the possibilities of two independent variables out of total n input variables are taken in order to construct the regression polynomial in the form of Eq. (7) that best fits the dependent observations (yi,i = 1,2,. . . ,M) in a least-squares sense. Consequently, $\binom{n}{2} = \frac{n(n-1)}{2}$ neurons will be built up in the first hidden layer of the feed forward network from the observations {(yi, xip, xiq); (i = 1,2. . . ,M)} for different p, q $\in$ {1, 2, . . . ,n}. In other words, it is now possible to construct M data triples {(yi, xip, xiq); (i = 1, 2 . . . , M)} from observation using such p, q $\in$ {1, 2 . . . n} in the form:

$$\left[\begin{array}{cc|c} x_{1p} & x_{1q} & y_1 \\ x_{2p} & x_{2q} & y_2 \\ \hline x_{Mp} & x_{Mq} & y_M \end{array}\right]. \tag{9}$$

Using the quadratic sub-expression in the form of Eq. (7) for each row of M data triples, the following matrix equation can be readily obtained as:

$$A\,\mathrm{a} = Y \tag{10}$$

Where a is the vector of unknown coefficients of the quadratic polynomial in Eq. (7)

$$\mathrm{a} = \{a_0, a_1, a_2, a_3, a_4, a_5\} \tag{11}$$

And $Y = \{y_1, y_2, y_3, ..., y_M\}^T$ is the vector of output's value from observation. It can be seen that:

$$A = \begin{bmatrix} 1 & x_{1p} & x_{1q} & x_{1p}x_{1q} & x_{1p}^2 & x_{1q}^2 \\ 1 & x_{2p} & x_{2q} & x_{2p}x_{2q} & x_{2p}^2 & x_{2q}^2 \\ \hdashline 1 & x_{Mp} & x_{Mq} & x_{Mp}x_{Mq} & x_{Mp}^2 & x_{Mq}^2 \end{bmatrix}$$

(12)

The least-squares technique from multiple-regression analysis leads to the solution of the normal equations ac shown in Eq. (13):

$$\mathrm{a} = (A^T A)^{-1} A^T Y \tag{13}$$

This determines the vector of the best coefficients of the quadratic Eq. (7) for the whole set of M data triples. It should be noted that this procedure is repeated for each neuron of the next hidden layer according to the connectivity topology of the network. However, such a solution directly from normal equations is rather susceptible to round off errors and, more importantly, to the singularity of these equations. Recently, genetic algorithms have been used in a feed forward GMDH-type neural network for each neuron searching its optimal set of connection with the preceding layer (Nariman-zadeh et al., 2003). Jamali et al. (2006) have proposed a hybrid use of genetic algorithm for a simplified structure GMDH-type neural network in which the connections of neurons are restricted to adjacent layers. In this paper using GA for finding GMDH-type neural networks for modeling the Pareto optimized data (Amanifard et al., 2007, Atashkari et al., 2007).

Table (2) shows the different research works conducted on economy using the GMDH algorithm in Iran.

Table 2: A Brief Review of Studies Conducted on Iran's Economy Using the GMDH Algorithm

Row	Title	Authors
1	Modeling and Predicting Economic Growth in Iran	Abrishami et al. (2009)
2	The Effects of Globalization on Non-Oil Exports	Abrishami et al. (2009)
3	Modeling and Predicting Price and Cash Yield of Tehran Stock Exchange	Mehrara et al. (2009)
4	Modeling and Predicting Inflation in Iran	Mehrara et al. (2010)
5	Different Effects of Globalization of Economy on the Total Demands for Workforce, Skilled Workforce, and Unskilled Workforce in Iran	Abrishami et al. (2011)
6	Predicting Iran's Population Growth with Respect to Economic-Social Components based on an Interdisciplinary Approach	Mahmudi et al. (2012)
7	The Effect of Life Insurance on National Production Based on Human Resource Development Approach	Kardgar and Ahrari (2014)
8	The Effects of Developing Life Insurance from the Perspective of Social Capital	Zibari et al. (2016)

5. Analysis of Research Findings

The common methods of evaluating and ranking the branches of Iran's insurance companies are based on expert opinions in a linear combination of weights allocated to each variable. Accordingly, they calculate a total score by which branches are evaluated and ranked. It has long been considered that the branches of each insurance company are ranked according to its performance in order to determine the area of activity, delegate duties in different areas, grant rewards, bonus and other items. Therefore, a number of parameters are selected and weighted to act according to the expert-based method.

The investigations indicated that this method has some disadvantages:

1. The expert opinion was the main criterion for determining the weights, and the relationships of variables were not true in the framework of modeling processes. It is obvious that if the expert opinion changes, the combination of weighting variables will be changed.

2. Scoring and evaluating the branches in this method is a constant construct which does not include the process and systemic nature of main foundations of a systematic and analytical process. The system lacks the rules resulting from the behavioral nature of variables, and only the limited and determined opinion of experts exists. In fact, the relationships of input variables and their effects on the output variable and objective function are not determined.
3. The history data which indicate the effect of variables on each other do not have any roles in the evaluating and scoring process of branches.

Therefore, this study was meant to design a system for evaluating and scoring insurance branches based on previous studies. Accordingly, the GMDH neural network and different variables were used to execute the modeling process in several phases. Based on the results, the multi purposes of this study are as follows:

1. Selecting the objective function: in other words, the dependent variable or output variable, which can be selected out input variables (used in the conventional method), are determined with respect to modeling.
2. Determining the variables influencing the target variable and ranking them in the order of priority influencing the dependent variable
3. Determining the optimal model to predict the output variable (objective function)

The Indicators for Evaluating Insurance Companies by the Central Insurance Company

The current criteria for ranking and scoring branches are mainly about the attitude towards the governing institution (Central Insurance). They are annually announced in a statistical yearbook. Accordingly, the first and most important criteria for ranking insurance companies are the rate of sales or production premium from the perspective of Central Insurance. Preferably, insurance companies can regard the production premium of policies, which are issued by each branch during the report period, as their objective function.

Criteria for Evaluating the Branches of Insurance Companies

The approach and strategy of senior executives at insurance companies are changing in different periods. In other words, the sales and position maintenance were significantly important in the industry in a period, and the portfolio-oriented approach was prominent. In another period, the economic sales or profitability were the head of affairs in organizations, or a certain percentage of damages was determined by the objective function. Therefore, the objective function can be different based on organizational conditions and approaches in different periods. All of the abovementioned changes can be clarified as changes in the weights of variables. However, the evaluation method is based on the total weights of variables regarded as the total weight. The following table shows the variables which are weighted in the evaluation of Dana Insurance Company branches.

Table 3: Variables Used to Validate the Branches of Dana Insurance Company

Rank	Variable	2013	2012	2011	2010	2009
1	The number of policies	5.00%	4.85%	4.85%	4.79%	4.85%
2	Geographical Location[1]	3.00%	3.64%	3.64%	3.59%	3.64%
3	The Number of Representatives	9.50%	4.85%	4.85%	4.79%	4.85%
4	The Ratio of Other Sales Except for Treatment and Third Party	4.50%	5.45%	5.45%	5.39%	5.45%
5	The Issued Premium (Production Premium)	7.00%	8.48%	8.48%	8.38%	8.48%
6	The number of Staff	4.00%	4.85%	4.85%	4.79%	4.85%
7	Plan Achievement	20.00%	24.24%	24.24%	23.95%	24.24%
8	Collected Growth Percentage	2.50%	3.03%	3.03%	2.40%	3.03%

1. According to the expert opinion, a geographical location refers to the company branches with respect to economic and insurance potentials in provinces divided into three areas (1, 2, and 3).

Table 3: Variables Used to Validate the Branches of Dana Insurance Company

Rank	Variable	2013	2012	2011	2010	2009
9	Combination of Portfolio	11.00%	9.70%	9.70%	9.58%	9.70%
10	The Number of Damages	4.00%	4.85%	4.85%	4.79%	4.85%
11	The Ratio of Collected Items to Issued Items	4.00%	4.85%	4.85%	7.19%	4.85%
12	The Growth Percentage of Premium	2.50%	3.03%	3.03%	2.40%	3.03%
13	Production Per Capita	12.00%	9.70%	9.70%	9.58%	9.70%
14	Damage Ratio	11.00%	8.48%	8.48%	8.38%	8.48%
-	Total Score	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Research Findings

It is observed that the weights and criteria for making decisions are different in different periods. Moreover, the total score is obtained from the summation of weights.

Therefore, the following steps were implemented in order to achieve research goals by executing a systematic process and using the GMDH neural network.

The First Step: determining the target variable and ranking the variables based on modeling with and without the total score

This step is meant to find the target variable based on the highest effectiveness. In other words, the aim of this step is to specify what variables have the greatest effects on the modeling process. Therefore, each of the 14 variables, shown on Table (3), is regarded as the output variable (dependent variable) in two models, one of which includes the total score, and the other one excludes it as the input variable. Thus, the model is executed 28 times. The data are on the performance of Dana Insurance Company branches from 2009 to 2013. Table (4) shows the results of the 14 models by setting aside each variable of the total model and putting it as the output variable (dependent variable). Then it is ranked according to the ratio of RMSE which is the very F statistic.

Table 4: Ranking the 14 Models Resulting from Regarding Each Variable as the Target Variable

Rank	Variable	RMSE with Total Score	RMSE without Total Score	F-Test
1	Production Per Capita	12113291733	24671822698	0.490976767
2	The Growth Percentage of Premium	0.350254177	0.517320933	0.677053942
3	The Ratio of Collected Items to Issued Items	14.28538251	18.68554173	0.764515299
4	The Number of Damages	8698.955278	9582.702132	0.907776863
5	Combination of Portfolio	10.11960376	10.92153744	0.926573188
6	Collected Growth Percentage	0.082222288	0.086643633	0.948970926
7	The number of Staff	5.255902087	5.372670773	0.978266175
8	The Ratio of Other Sales Except for Treatment and Third Party	0.317620574	0.317062157	1.001761222
9	The Issued Premium (Production Premium)	32416436141	32115138240	1.009381803
10	The Number of Representatives	13.47315203	13.32407777	1.011188336
11	Damage Ratio	0.136929846	0.132848582	1.030721167
12	Plan Achievement	0.225682546	0.218820451	1.031359477
13	Geographical Location	7.163179788	6.877638306	1.041517374
14	The number of policies	19244.42445	18339.31916	1.049353266

Source: Research Findings

This table shows that regarding the number of policies, geographical location, plan achievement, damage ratio, the number of representatives, the issued premium (production premium), and the ratio of other sales except for treatment and third party (output variable) as dependent variables (output variables) decreased the prediction error of the model with total score. However, the numerical values of the test statistic were not significantly greater than the critical value of the table ($F_{0.05}(40,40,0.05)=1.69$) compared with RMSE of models with or without the total score for each of the 14 variables. Variables 1-7 increased the prediction error, something which indicates the ineffectiveness of these variables. Therefore, the importance of each variable was compared with the target variable (dependent variable) with or without the total score. Table (5) shows the ranking.

Table 5: Ranking Variables Based on the Highest Level of Effectiveness

Rank	Variable
1	The number of policies
2	Geographical Location
3	Plan Achievement
4	Damage Ratio
5	The Number of Representatives
6	The Issued Premium (Production Premium)
7	The Ratio of Other Sales Except for Treatment and Third Party
8	The Number of Staff
9	Collected Growth Percentage
10	Combination of Portfolio
11	The Number of Damages
12	The Ratio of Collected Items to Issued Items
13	The Growth Percentage of Premium
14	Production Per Capita

Source: Research Findings

Although Variables 8-14 cannot be investigated in the modeling process based on the error criterion, the results of this method can be sufficed to determine the importance of variables due to the lack of a comprehensive fundamental model resulting from the absence of the target variable (dependent variable).

The Second Step: determining the target variable (dependent variable) through the expert opinion

In this step, five important variables which experts think can be regarded as the output variable (the target variable) at insurance companies (Iran, Asia, Alborz and Dana) are determined. In this step, the total score is deleted from the set of input variables, too. Table (6) shows the results of implementing the five models based on the error criteria for RMSE.

Table 6: Ranking the Models Selected by the Experts of Insurance Companies

Rank	Growth Variable	RMSE	F(m, 5)	F(m, 4)	F(m, 3)	F(m, 2)
1	Premium Production Per Capita	0.16	3.599969157	2.262588615	2.051916	1.43021542
2	Plan Achievement	0.23	2.517081761	1.58199148	1.43469	-
3	The Number of Damages	0.33	1.754442897	1.102671259	-	-
4	The Issued Premium (Production Premium)	0.37	1.591084271	-	-	-
5	The Ratio of Other Sales Except for Treatment and Third Party	0.59	-	-	-	-

Source: Research Findings

The F statistic was calculated for the ratio of RMSE in the five models. On first column, F (m, 5) is equal to the ratio of RMSE of Row 5 divided by the RMSE values of Rows 1-4. Likewise, F (m, 4) is equal to the ratio of RMSE of Row 4 divided by the RMSE values of Rows 1-3, and F (m, 3) is the ratio of RMSE of Row 3 divided by the RMSE values of Rows 1 and 2. Finally, F (m, 2) is the ratio of RMSE values of Row 2 to Row 1.

It is observed the model of dependent variable *production premium per capita* has a significantly better performance compared with the other three models of dependent variables including *the number of* *damages, the issued premium (sales),* and *the ratio of sales*. However, it has better results compared with the model of target variable with *plan achievement*. There is no significant difference between these two models. The model of dependent variable with *plan achievement and the number of damages* had significantly better performances that the model of dependent variable with *the ratio of sales*.

The Third Step: investigating the effects of input variables by considering the number and rate of effectiveness

In this step, the variables are ranked with respect to the weight combination resulting from the number of presences as the excessive or effective variable in the 28 models. In other words, 2 scores are

Table 7: Ranking and the Effectiveness Percentage of Indicators Influencing the Modeling Process

Row	Variable	Estimation with Two Layers		Effectiveness Percentage
		Excessive Number	Effective Number	
1	The number of damages	3	2	12%
2	The number of representatives	2	4	12%
3	The ratio of collected items to issued items	2	3	10%
4	The ratio of damages	2	3	10%
5	Production or sales per capita	1	5	10%
6	The issued premium (production premium)	2	1	7%
7	Collected growth percentage	1	3	7%
8	The geographical location of a branch	2	0	6%
9	The number of policies	1	2	6%
10	The number of staff	1	1	4%
11	The ratio of other sales except for treatment and third party	0	3	4%
12	Plan achievement	1	0	3%
13	The growth percentage of premium	0	2	3%
14	Combination of portfolio	0	1	1%

Source: Research Findings

considered for each presence as the excessive variable, and one score is regarded for the effective variable. The share or percentage of effectiveness of variables is obtained from the ratio of total scores to the score of each variable. In this regard, the importance of each variable can be seen in Table (7) with respect to the modeling process.

The results indicate that the greatest effectiveness came from *the number of damages, the number of representatives, the ratio of collected items to the issued items*, and *the ratio of damages.* The final 7 variables were allocated less than 30% of the effectiveness.

The GMDH neural network can be applied to process information and data and to determine the importance of variables involved in the modeling process in order to select the best evaluation criteria. Therefore, policymakers including the board of directors of insurance companies and the Central Insurance of Iran will select more upgraded, accurate and detailed procedures for ranking and rating insurance branches and companies.

6. Conclusion and Suggestions

The aim of this study is present a systematic process for ranking and scoring the branches of insurance companies by using the GMDH neural network to extract the indicators influencing this process. The evaluation method is based on the total weights of variables which is showed in table 3 regarded as the total weight. The data which are weighted in the evaluation of Dana Insurance Company branches is used from 2009 to 2013. It is observed that the weights and criteria for making decisions are different in different periods. Moreover, the total score is obtained from the summation of weights.

Accordingly, various modeling techniques were employed to extract the variables affecting this process, and the effectiveness of each of them in different models. Based on the proposed model, *the number of damages* had the greatest effect compared with other variables because the insurance activity of Dana Insurance Company was concentrated on treatment insurances presented in a specialized way throughout Iran. Therefore, the size of operations and the number of damages are very important. Thus, the effectiveness of these variables can be different in other insurance companies with respect to the type of their insurance activities.

On the other hand, *plan achievement* is the final aim of evaluating insurance companies. Determining and defining the budget in insurance companies is due to the fact that the minimum expected sales can be obtained from the branches of the company. Therefore, the important aspect of each sales strategy is that the plan should be achieved. The form and combination of the strategy are of the secondary importance. The point is that the superior strategies and policies of board of directors of insurance companies are clarified in the type and dimensions of the plan without making any differences in the decision-making process, the evaluation objective function, and ranking of the branches. The indicator of *plan achievement* shows the homogeneity which is the comparability of all the branches, something which means two branches with the same premiums and other heterogeneous variables can have the same percentage of plan achievement. Therefore, although the complementary and internal goals of insurance companies include the reduction of the ratio of damages and increase in the collectibles and reduction of demands, *plan achievement* can be the real and specific objective function (dependent variable) in scoring and ranking the branches of insurance companies. It is obvious that the general goals of insurance companies and the insurance industry is to increase sales. This goal can be reached through plan achievement. Therefore, selecting *plan achievement* as the dependent variable (target variable) is reasonable in ranking and scoring the branches of insurance companies.

The second point is that the objective function is *profit* at the superior level (board of directors) at insurance companies because it is the criterion for evaluating stockholders. The most important difference between *profit* and *plan achievement* is that *profit* is a combination of factors; however, *plan achievement* depends on sales.

According to the implementation of all the possible models, the appropriate model can be selected by combining the outputs of modeling and the objective functions of the insurance companies. Then predictions can be made accordingly.

7. Suggestions

1. The variables including the share of each branch from the

provincial insurance industry, the issued premium of the sales market of each branch, the ratio of damage, the coefficient of damage, the growth percentage of plan achievement, customer loyalty, and applying the expert opinion were regarded as the input variables in the modeling process.

2. Many outsourcing variables such as economic conditions and the institutional environment were put into the modeling process.
3. A double-purpose model can be designed to model the sales or plan achievement and profit at the same time and select the optimal balance of these functions as the optimal model.

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