A METHOD FOR IDENTIFYING
THE POSSIBLE CAUSES OF FAILURE
IN THE CASE OF SERVICE COMPANIES

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Abstract

The core of our paperwork consists in determining a classification of qualitative and quantitative causes that are influencing service companies’ performance and financial health based on grey systems theory and fuzzy sub-sets. The quantitative causes of firms’ performance are mainly financial causes and can be represented by the financial changes, structural changes and by macroeconomic changes. All of these are objectively measurable. Instead, the qualitative causes are subjectively measurable and in most of the cases they are quantified using some experts’ opinion. For a better representation of reality, we will consider that those values are intervals and not numbers, situated in [0; 1]. In order to reduce the degree of subjectivity, we took advantage of the methods offered by fuzzy systems, mainly in construction of the expertons. Expertons are in fact intervals built using the $\phi$-fuzzy sub-set and the opinion of several experts over a certain problem. Furthermore, after constructing the expertons, we use the methods offered by grey systems theory and grey arithmetic to determine the degree of influence of each qualitative and quantitative cause on company’s performance. By classifying the causes and acting on the most important of them, the activity of the analyst can be really improved and the company’s performance will rise. The first part of our paper describes the evolutions of the methods used for establishing the companies’ financial health and some related works regarding the causes that affects it. After that, we focus on the methods offered by grey systems theory, on grey arithmetic, and on the steps that should be done to classify the causes, including also a numerical example. We conclude our paper with some remarks over the role and the utility of the grey systems theory and fuzzy in establishing the service companies’ performance and financial health.

Keywords: Failure, Bankruptcy, Service Companies, Grey systems theory, Fuzzy sub-sets theory, Expertons, Diagnosis

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Introduction

The economic environment in which companies carry out their activities is dynamic and faces permanent changes (Delcea, Dacălu, Dascălu, Lică, Coman, 2010). In the context of the new economy, an economy in which the intangible capital is at least as important as the tangible capital, and in which an important part of the value of tangible capital is in fact based on intangible inputs, the importance of services in any economic activity is vital.
As it is known, the term of “new economy” refers basically to a set of quantitative and qualitative changes, which appeared over the past few years and which succeeded in modifying the structure, the functions and the rules that guided the economy. A contribution to these changes that occur in global economy has been made by the service companies.

As the OECD reports show, the service sector now accounts for over 70% of OECD aggregate GDP and employment, and continues to grow.

Stockholders, creditors, auditors and senior management all have a mighty interest in utilizing and developing a methodology that will allow them to monitor and to regulate the financial performance of a firm (Delcea & Dascălu, 2009). By identifying different elements that influence their financial health and performance, firms can increase positive effects, thus facilitating the achievement of the firm’s goals.

Prediction of firm’s financial health is a relatively new field in the economic and financial analysis.

This paper contains the way we can establish which of the qualitative or quantitative variables that influence the firm’s financial health and performance are the most important. Knowing these variables, managers can act on them, in the benefit of their service firm. Because the analyzed variables, the qualitative and the quantitative ones, are influencing the firm’s output, we will refer them as “causes”.

The causes of the firm’s financial health and performance are objectively and subjectively measurable. Their occurrence allows certain methods to be used for establishing which one of them have the higher impact on firm’s financial health. That is what makes this field suitable for tools taken from fuzzy and grey systems theory. This relatively new approach using the mentioned theories allows us to properly model the variables taken into consideration.

1. Methods and theories used in diagnosis and prediction of firm’s financial health

1.1. Statistical methods and theories

Early studies realized in bankruptcy prediction field are based on the statistical approaches applied to empirical data. The first paper belong to Fitz Patrick (1932) who take into consideration a set of 19 bankrupt firms and another set of 19 non-bankrupt firms. Based on this research, he concluded that with three years before the bankruptcy installed, the financial ratios showed significant changes. Another study on this field was the one made by Winakor and Smith (1935) who realized a ten years’ research on the bankruptcy of a specific set of firms and it was noticed that the rates deteriorated more and more, as the companies headed toward bankruptcy. Similar conclusions were reached by Mervin (1942) in his research.

However, it is considered that the scientific research started in this field once with the Beaver’s research (1966). His work was meant to be a benchmark for future
research to finding alternatives to bankruptcy prediction using data of company accounts. Beaver performed a univariate discriminate analysis model, taking into account two sets of firms, bankrupt and non-bankrupt, and their different rates for a period equal to one year before the inauguration bankruptcy. Those rates were selected after performing a test of dichotomous classification. These models are now part of the category of classical models of bankruptcy prediction.

Beaver (1966) used financial rates on profitability, liquidity and solvency to predict the failure of a firm to pay its maturing financial obligations, and bankruptcy. His research focuses on calculating a value for each financial ratio to classify firms into two groups. These tests were followed by linear statistical models, which were applied to the problem of corporate bankruptcy prediction.

Studies continued with models that have attempted to improve decision making through a variety of statistical methodologies.

1966 is the year of birth risk index models. In these models, each company under analysis is assigned a number between 0 and 100 points in line with the rates involved in the model. The company manages to collect a large number of points, the financial situation is better. Points are allocated so that the most important rates to have more weight. Allocation is still a subjective weighting. These models were introduced by Tamari (1966) and later extended by Moses and Liao (1987).

An important stage in the development of bankruptcy prediction models it were empirical research conducted by Altman (1968) which made the separation between the univariate and multivariate methods (which were based on discriminate analysis). The author is the one who first applied the discriminate analysis and introduces a rating system (scores method) to discriminate between healthy firms and those showing abnormalities, using this statistical function.

Altman is the one who discovered a new class of models based discriminate analysis used to characterize a company's financial performance using five financial variables: working capital / total assets, retained earnings / total assets, earnings before interest and taxes / total assets, market value of equity / total debt and sales / total assets. Model performance was superior for the analysis conducted two years before bankruptcy, but then deteriorates substantially. Classification accuracy of this model range from 96% in tests conducted one year before bankruptcy to 70% in tests carried out five years before the actual installation of bankruptcy. Zeta model has managed to overcome the existing alternatives in terms of expected costs.

After 1968, studies conducted have developed generally Altman's method. Many are focused on verifying and assessing the results of the above mentioned model (Halderman, Narayanan -1977, Deakin - 1972, Edminster - 1972 -1982 Taffler).
1.2. Artificial intelligence methods and techniques

The next step was the prediction problems companies use artificial intelligence methods. Scholars who have embraced these methods were many and the contribution made by them was valuable. Some of the most popular theories are based on artificial intelligence: decision trees, fuzzy systems theory, CBR (case based reasoning), GA (genetic algorithms), SVM (support vector machine), DEA (data envelopment analysis), RST (rough sets theory - the theory of rough sets of data), NN (neural network) as: BPNN (back propagation neural networks), ANN (Artificial Neural Networks - Artificial Neural Networks), PNN (probabilistic neural networks), SOM (self organizing map), CASCOR (cascade correlation neural networks).

The „hybrid-intelligent” methods succeeded to combine the „pure intelligent” theories by taking into account all the benefits these could give.

Usually, integrative strategy varies by a data set to another. This is one of the reasons why a lot of studies are trying to combine different methods applied in problems regarding the prediction of bankruptcy.

Trying to improve the methodology for selection the characteristics of data subset and for optimization of the used parameters, Min & Lee (2005) have combined genetic algorithms with SVM. GA are used in the same time for the optimization of the characteristics of data subset and also for the SVM parameters. The proposed model was used for the bankruptcy’s prediction. Another study that combines GA with SVM belongs to Wu, Tzeng, Goo and Fang (2007).

Genetic algorithms were also used along with the neural networks for examining the cost of misclassification of the bankrupt firms compared to the one involved by the applying of the multi discriminate analysis and back propagation neural networks. A study that used neural networks and genetic algorithms was proposed by Pendharkar (2005) and Tsakona, Dounias, Doumpos and Zopoundis (2006) in their researches regarding the bankruptcy’s prediction.

Many hybrid models were created by using neural networks along with other theories such as: discriminate analysis (Lee, Booth, Alam 2005; Ong, Huang, Tzeng, 2005), fuzzy logic (Malhotra, Malhotra, 2002), self organizing maps (Huysmans, Baesens, Vanthienen, van Gestel, 2006).

Even thou, beside the hybrid models presented above, the literature that deals with the firms’ bankruptcy is vast, there can also be made some improvements and can be constructed other models using the best these theories can offer. Even the proposed model is a hybrid one by using two intelligent theories: grey systems theory and fuzzy logic.

2. Service companies’ financial health and performance

There are many research papers in the field of service science, service companies, service management, service operations management, performance of service companies, website design quality - as a part of service quality, etc., all of these because service firm becomes central in nowadays reality.
First of all, as Chen, Chen and Lee (2008) observe that “unlike manufacturing firms, which rely on patented technologies or unique products, service firms gain their competitive advantage primarily through their ability of combination to make use of their proprietary knowledge”. So, once with the study of service science, we can refer to the knowledge involved in their processes. Now, if we are wondering how knowledge has been able to intervene in the predominantly industrial economy, we can identify two relevant ways of action: the development of the areas whose primary output is knowledge and of the areas involved in transmission and incorporation of knowledge into the output.

Also, some of the changes that took place in the economy can be considered the result of the fact that the organizations have given greater importance to their intangible assets, which are often difficult to be measure. Some of these intangible assets are represented by the investment in research and development, the knowledge and the talent of the workers, etc.

The new economy is granting a widely interest to so-called “knowledge society”, to the employee who owns the knowledge, to the intellectual capital and to the learning organizations. Information society in which humankind is living is defined as a knowledge society and, at the same time, as a society of organizations (Drucker, 1988, 1992). Meanwhile, with the new economy, appears the idea of a new type of organization, a knowledge based organization, a service based organization.

As the figures presented by OECD show, service sector offer an important contribution to economic employment and economic growth. One of the key drivers of such development is represented by innovation.

Each new innovation leads to creating a space where some other innovations can be created. Starting from these new innovations, more new spaces of opportunity are created. On a market competition, organizational performance is positively related to the level of innovation possessed by a firm (Subramanian, Nilakanta, 1996). Verhees (2004) pointed out that the intensity of innovation is reflected in the form of product modification.

Over the last years, the analysis of innovation in service companies progressed remarkably like Den Hertog (2000) shows.

Starting from the actors that are involved in the innovations’ initiation (meaning: the clients, the suppliers and the service firm), Den Hertog (2000) identifies 5 types of innovation:

- Supplier-dominated innovation;
- Innovation within services;
- Client-led innovation;
- Innovation through services;
- Paradigmatic innovation.
The effects of innovation on service companies can be regarded in firm’s financial benefits, increasing customer value and strategic success (Tidd, Bessant, Pavitt, 2001).

Strategic success is depending on the service company’s power to provide innovative services. An example from the financial services field is provided by Dodgson and Rothwell (1995) regarding the competitive advantage that make Citibank gain the position of technology leader in 1939 when the bank was the first one that offered services through ATM.

Also, Kay (1993) argued that if in the past competitive advantage used to come from low prices and high quality, nowadays, it increasingly depends on innovative activities. In his paper, Del Valle (2009) consider the generation of human capital through training a source of competitive advantage, that gives rise to better performance by means of extraordinary income. He believe that training is “a worthwhile investment for the companies in our sector, since, as it is a service activity where the final client’s contact with the company is through the employee providing service, the training of said employee is the best standard for measuring the client’s quality perception”.

Along with the R&D, customers seem to play an important role in generating idea, the expression “customer involvement” is more and more popular. Lundkvist and Yakhlef (2004) believe that “within the evolving research, customer involvement is cast in an information-processing mould that tends to reduce it to the mere transfer of the information from where it exists (customers) to where it is dearly needed (the firm)” From that point of view, they identified four roles that these can play: customer as a “resource”, “co-producers”, “buyers” and “users”. The first two are the input side of value creation process and they are strictly related to the idea of continuous innovation. But, involving customers in the process of innovation implies several limits (e.g. a common language, customers’ motivation) that should be taken into account.

Furthermore, strategic capabilities, defined as the firm’s capacity to deploy internal resources and integrate external resources that have been coordinated purposely to achieve a firm’s creation and a desired end state (Chen, Chen, Lee, 2008) have been considered to affect firm’s performance.

Over time, diverse accounting ratios indicators have been used to measure firm’s performance: ROA and ROE (Dodgson, Rothwell, 1995), net sales per employee (Koch, McGrath, 1996), return on sales (Hitt, Bierman, Shimizu, Kochhar, 2001), average sales growth or profit margin (Lee, Phan, Chan, 2005), earnings before interest, taxes, depreciation and amortization (EBITDA) per number of employees (Del Valle, 2009). Chen and al find appropriate to use change in sales and market share expansion for measure firm’s performance (Chen, Chen, Lee, 2008).
3. **The economic causes of business failure**

Although there are many causes that could lead to financial failure, their effective and accurate identification is not as easy as it seems. Most often, failure is the result of several factors leading to appearance an event which, in turn, causes rapid installation and immediate revocation of the company. A basic cause of failure may not be at all obvious from the outset.

A study conducted by Dun & Bradstreet (Newton, 2009) tried to establish the nature of cases which could cause an imbalance in the company. According to the study, it was found that a percentage of 47% of failures are attributed to financial reasons, of which 40% are determined by operating costs too high. A percentage of 37% of failures were attributed to economic factors, of which a percentage of only 11% being due to insufficient profits. Only 1% of failures were caused by lack of experience and 4% fraud.

Yet the question that remains is: which are the causes of financial failure? The answer to this question can be very simple or extremely complicated. Although in some cases, determining causes of failure of some business is involving only a comprehensive examination of the financial statements of said company, there are many cases where the achievement of certain financial and economic diagnosis requires an intensive investigation.

Given the large number of cases which could lead to failure, another study by Jessie Hagen of the bank identified the following possible causes (Newton, 2009)

- Lack of a sound business plan - 78%;
- Location in a light far too optimistic in terms of sales and estimating the necessary funds - 73%;
- Ignorance and complacency weaknesses in the existing situation - 70%;
- Business ownership experience inadequate or irrelevant - 63%;
- Weak managerial skills - 82%;
- Start business with insufficient financial resources - 79%;
- Incorrect price fixing - 77%;
- Promoting business failure - 64%;
- Ignoring the competition - 55%;
- Concentrates too much on the client - 47%;
- Problems in delegating tasks - 58%;
- Hiring the wrong people - 56%.

In terms of how that can be quantified, cases are divided into quantitative (based on easily measured indicators) and qualitative causes (quantified by experts, without using indicators of different values).

The most quantitative causes are represented by quantitative reasons are the same as those found in models of financial diagnosis and prediction (e.g., increases in sales volume in current assets, changes in employment costs, etc.). In the area of quantitative cases, will be also included some structural causes linked to the
number of employees, type of company, shares it, and even some macroeconomic causes related to real GDP growth, real effective exchange rate change etc..

Among the most common objectively measurable causes, we can identify:

- Credit overextension, and
- Insufficient capital.

Compared with the quantitative causes, the qualitative causes cannot be identified by the company's financial position or quantitative changes occurring at the macroeconomic level.

Qualitative causes are regarded as value judgments issued by an expert or group of experts to a specific problem. This is why they are considered to be subjective.

Some of the most important causes that can affect the quality of a firm's performance are listed below:

- Intensity of innovation in the company;
- Level of customer interaction and degree of customization of the product;
- Consumer perception of products and services company;
- Leadership type and intensity;
- Presence of knowledge-based resources;
- The competitiveness of domestic resources;
- Level of flexibility and adaptability to changes in the environment of business;
- Presence of social relations;
- Employees' professionalism, their ability to learn;
- Managerial capacity;
- Ability to identify, develop and retain certain resources to its opponents stand firm;
- Company's ability to create competitive advantage;
- Company’s ability to benefit from social relations;
- IT infrastructure architecture;
- Structure of information found on the company website.

Depending on the company, only some of these cases can occur and the specialists’ role is to determine which of these causes are most important, so that may be selected for further research.

In terms of the determinants of firm management and cases may occur following situations:

- Ineffective management;
- Lack of management;
- Lack of management training in low gears;
- Type bureaucratic management;
- Unbalanced structure of the management team;
- Lack of involvement of the board.
Other external causes can be added to the ones listed above, such as:

- Changes in competition;
- The impact of governance;
- Social change;
- Changes in technology.

4. Intelligent methods used in hybridization

We summarized in the following two theories used in hybridization.

4.1. Fuzzy sub-sets theory

Fuzzy logic gives the instruments necessarily for the treatment of uncertainty and subjectivity. Because the proposed model works with qualitative variables, we use the theory of $\varphi$-fuzzy sub-sets and fuzzy expertons-calculated according to theory.

The main feature of fuzzy sub-sets is that the membership characteristic function takes values in the interval $[0, 1]$ instead of values from the set $\{0, 1\}$.

With the idea of $\varphi$-fuzzy sub-sets emerges even the idea that the opinion of one expert is insufficient.

In essence, the expertons, calculated in this manner, are constructed using the $\varphi$-fuzzy sub-sets theory and the opinion of a of a number of experts on a particular issue.

Each expert will express their opinion through a number or a range between 0 and 1. For example, if an expert is sure the level of a certain variable will note that prints at a number between 0 and 1. If not absolutely sure, the expert will record the causes value through an interval placed between the same limits. It may happen even a third case, namely that the expert has no clue regarding the variable, it will record the entire interval $[0, 1]$. All experts’ opinions expressed in this manner will be placed in tables, the number of these tables is equal to the number of years considered in the analysis. For each of these tables, using the theory of $\varphi$-fuzzy sub-sets, we will build an experton. Gil-Lafuente (2005) presents the steps required to build these expertons.

4.2. Grey systems theory

Grey system theory, unlike other interdisciplinary theories, has found and managed to keep a special place within them, especially through the success of applications made using these theory on real systems. The theory managed to overcome drawbacks encountered in using probability theory and statistical methods (need the existence of reasonable sample size and the determination of certain distributions to be able to make inferences) and those of fuzzy mathematics (which deals with the study of phenomena problems with uncertainty cognitive, using so-called "membership functions" based on experience).

The name derives from the grey system nature of the subject under investigation. In the control theory, colors were indicating the clarity of information. One of the
classic examples is the "black box". Objects were called black if their internal structure and relations between them were completely unknown to those who investigate them. In information, black was used to express all unknown information white was used when facing with the complete information case. Grey systems are considered to be a mix of information, partly known and partly unknown, a combination of black and white, namely grey (Liu, Lin 2005).

From this broad theory will be used only elements related to: grey arithmetic and grey degree of incidence, used to identify the most important causes that are affecting firm’s performance.

5. Identifying the causes

The figure presented above underlines the way the model works:

![Figure 1. The identification of causes](image)

6. Experiment

There can be considered the following quantitative and qualitative causes:

- $X_1$: Labour force expressed through the number of employees
- $X_2$: Sales volume
- $X_3$: Investments
- $X_4$: Customers’ influence on products
- $X_5$: Efforts in improvement and innovation
- $X_6$: Professionalism of the employees

As a performance indicator we used service revenue, noted $X_0$. 
After gathering the values of those indicators at firm’s level, for a period of time equal to three years and after applying the proposed model, the degree of incidence are determined, and based on them, the causes were arranged according to their influence on firm’s performance.

Using the formulas for the relative degree of grey incidence, the output values of the model are the following:

<table>
<thead>
<tr>
<th>( r_{0j} )</th>
<th>( r_{01} )</th>
<th>( r_{02} )</th>
<th>( r_{03} )</th>
<th>( r_{04} )</th>
<th>( r_{05} )</th>
<th>( r_{06} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.654458</td>
<td>0.998634</td>
<td>0.618598</td>
<td>0.615626</td>
<td>0.600717</td>
<td>0.630147</td>
<td></td>
</tr>
</tbody>
</table>

From: \( r_{02} > r_{01} > r_{06} > r_{03} > r_{04} > r_{05} \), it can be seen that:

\( X_2 \succ X_1 \succ X_6 \succ X_3 \succ X_4 \succ X_5 \).

The most influencing factor is \( X_2 \), followed by \( X_1 \), \( X_6 \), ... \( X_4 \), and the factor with the less influence on the financial performance of the analyzed firm is \( X_5 \). This is equivalent to say that sales volume have the greatest effect on firm’s performance, labor force (number of employees) have the second greatest effect, and the efforts in improvement and innovation have the smallest effect on the firm’s performance.

As it can be seen, the quantitative and qualitative causes are been interposed. Among the qualitative causes, the professionalism of the employees, the efforts in improvement and innovation, and customers’ influence on product seem to be the most influencing causes.

On the purpose of increasing the performance of the analyzed firm, managers can try to find ways to act upon the most “important” causes.
Concluding remarks and future work

Many theories have been developed since the research begun in this economic analysis field and their purposes are convergent: to find a way to establish the main causes that are affecting service firm’s performance.

In classifying the firms’ causes, a peculiar attention must be shown to the qualitative causes manifested by the firms under analysis and their quantification. Also, some “expertons” are being used, to the purpose of quantify them better.

As we have seen in this article, the classification of causes is based on facilities offered by the grey systems theory, being designed to find a way of determining the rank to which individual cause affects the final status of a firm.

The research can be extended to include facilities offered by other theories. Also, a soft procedure can be created for aggregate easier the qualitative causes and for the construction of expertons. In order to bring future improvements to the proposed model, we intend to consider into analysis several issues, such as: the way of choosing the ratios and the absence of some figures for a specific period of time; all of them deserving further investigations and explorations.

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