# Web Based Application for SMEs Economic and Financial Diagnose

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**Abstract:**
Effectiveness, efficiency and profitability are examples of major aspects that must be highly considered by any Small and Medium-sized Enterprise (SME) interested in obtaining better economic results. Therefore, in order to achieve better fulfillment of SMEs economic and financial objectives, using a computerized instrument for performing the economic and financial diagnose of its activity is a high priority. The specialized market offers quite a diversity of information technologies that can be used in order to design such an instrument as that depicted above. Among those, we decided to combine the web technologies with expert systems and spreadsheets. This paper is a continuation of a former idea where we stated as a future direction the implementation of such a tool, in the web environment, making it available worldwide to those interested in performing a computerized financial diagnose. Also, we have made several improvements regarding the methods used to fulfill the economic and financial diagnose. One of the papers' major aims is to illustrate a manner of computerizing the field of economic and financial diagnoses for the case of a Romanian small and medium-sized enterprise. Thus, we will conduct the current study by implementing into a real application the theory (from the specialized literature) and expertise (collected from experts) related to the field of financial diagnose and apply, for exemplification purposes, the financial ratios that are used in the process of a financial diagnose. In author's opinion, the innovative feature of this system is its development by combining three technologies: web, spreadsheet and expert systems and also the methods used for performing the economic and financial diagnose. Thus, the computer based model is accessed throughout a webpage (hosted on an Apache virtual server), is developed using Exsys Corvid and obtains variable's values from a spreadsheet files. The web application can be accessed at the following address: http://feaa-c-24.feaa.uaic.ro/diagnose/index.html.

**Key-Words**: Financial diagnose, Web application, Expert systems, Intelligent systems in Economy, Economic and financial analysis

## 1 Introduction

Worldwide, the economic and financial phenomenon's are very dynamic and they modify its structure under the impulse of the factors that generate the changing nature of social life. In the light of this information, a system based on economic and financial ratios is extremely flexible and sensitive and those qualities allow it to appropriately observe and reflect the specific reality.
As technology progresses rapidly, there must be used specific tools for managing such a system that is made up of ratios, in order to speed up the time consumed by the ratios commensuration. At the same time, it is required to improve the quality of decision in the field of economic and financial diagnose [1]. This task can be best accomplished by human experts that acquire knowledge due to their vast experience in the field, called expertise. Through our web application we intend to capture the economic and financial expertise, related to the specific diagnose, and implement it into the computerized solution.
From a theoretical point of view, the causes and factors that lead an economic entity to bankruptcy are not only of financial nature and they can conduct to a low profitableness and solvency of the enterprise. The main information obtained from the literature, related to the field of economic and financial diagnose, is that the SMEs will encounter major difficulties in fulfilling its relationship with the contractor's if it doesn't have a minimal rate of profitableness and a satisfactory level of liquidity.
Therefore, in order to ensure its survival (if not the growth), the enterprise must conserve its financial autonomy, otherwise the investments that require supplemental financial resources cannot be fulfilled. The lack of profitableness implies an insufficient level of auto-finance capacity with respect to the required investment rate. On the other side, the lack of profitableness forces the enterprise to become indebted as a low level of profitableness doesn't allow it to attract new capital from investors. This measure will increase the enterprise expenditures, affecting its solvency and furthermore, leading to an incapacity in terms of payment.
As a result, one may notice the importance of maintaining an economic equilibrium for the enterprise functionality which mainly resides in performing a profitable activity concurrent with monetary equilibrium – all of those actions are translated into a satisfactory level of liquidity. Having in mind the importance of profitableness -liquidity correlation required for the persistence of an enterprise, the specialized literature value the "health state of an enterprise" by including them into four groups, illustrated in Table 1.

Table 1: Profitableness, liquidity and the financial health of the enterprise

| **Ratios/ values** | | *Profitableness* | |
|---|---|---|---|
| | | *Positive* | *Negative* |
| *Liquidity* | *positive* | **1 „in shape"** | **3 „chronicle malady"** |
| | *negative* | **2 „transient malady"** | **4 „imminent ending"** |

As an interpretation of the information included in Table 1, the enterprise that suffers from „transient malady" has a

certain level of profitableness but encounters some liquidity problems. It is the case of first-years enterprises, in full growth, whose investments in assets and working capital are higher than its auto-finance capacity. These economic entities are less exposed to the risk of bankruptcy if they can overcome the liquidity problems.

Whether they are young or mature, the enterprises that belong to the third category „chronicle malady" have profitableness issues related to either the difficulties in maintaining the market share or the high weight of fixed expenses within the quantum of the total manufacturing expenses. When the total collected income covers the payment expenses and the investments are kept within a normal level, the liquidity ratio can be rated as satisfactory, allowing the enterprise to develop a profitableness activity.

An economic entity that is included in the fourth category „imminent ending" it cumulates an insufficient profitableness and a total lack of liquidity ratio. Its survival can only be attained after profound reorganization, accompanied by a reinforcement of the incoming financial resources.

As a consequence, in the Romanian economic system, in order to perform an enterprise diagnose, it is required to test the liquidity rate and profitableness of the economic entity. In the following chapters of the paper we will try to formulate and solve this matter.

## 2 Problem Formulation

As we mentioned earlier, in order to perform an economic and financial diagnose, it is required to test the profitableness and liquidity rate and of the SMEs.

### 2.1 Enterprise profitableness

SMEs activity's economic and financial performances can be measured by an N mark that is an average of five ratios. The value of each of ratio is determined by using the following pattern:

$$\frac{\text{Value of } R_i \text{ ratio}}{\text{Default value of } R_i \text{ ratio}}$$

The default value of $R_i$ ratio is determined for a population obtained from the default SMEs and represents the median of the enterprises that belongs to the same sector of activity. The general model of a score function that gives a mark for each particular case, is:

$$N = a_1R_1 + a_2R_2 + a_3R_3 + a_4R_4 + a_5R_5$$

The enterprise that has a perfect state according with a default state has a mark N computed as follows:

$$N = a_1 + a_2 + a_3 + a_4 + a_5$$

The processes of building and applying such a model in practice may look like a simple task but its relevance was acknowledged by the empiric tests which were conducted in order to verify the statistic method.

### 2.2 Bankruptcy prediction models

The pioneers of bankruptcy prediction models are Beaver (1966) [2] and Altman who, in 1968, developed the model that bears the latter's name. Almost all models that are considered in this paper are developed by using specific statistical techniques, namely univariate and multivariate approaches or step-wise multiple discriminate analysis. Step-wise multiple discriminate analysis [3] gives weight to the system of financial ratios used in order to differentiate or discriminate failed enterprises from successful ones that are being analyzed. In all cases, many ratios are used and also sufficient companies are studied in order to obtain an accurate model. For instance, the Altman model uses a system of 22 ratios and 66 companies out of which 50% were successful and 50% were bankrupted. Ultimately, after many experiments, the final model will contain a much smaller number of ratios and the most important characteristic of the model is given by its accuracy rate. To exemplify our argument, in the case of the Altman model, the final model contains 5 ratios and the rate of accuracy is considered high, namely 95%. The Fulmer model started from a set of 40 ratios based on 60 companies and the final model incorporates only 9 ratios and has an accuracy rate between 98-81%, depending on the predicted length of time.

In our application we use the Conan-Holder model which had been statistically tested and it is associated to a risk of bankruptcy probability in a score function`[4]. The functions suggested for the industrial and manufacturing sectors have the following patterns:

Manufacture sector: $Z = 0.24X_1 + 0.22X_2 + 0.16X_3 - 0.87X_4 - 0.10X_5$

Commercial sector: $Z = 0.0197X_3 + 0.0136X_2 + 0.0341X_6 + 0.0185X_7 - 0.0158X_8 - 0.01222$

The purports [5] of the parameters used in the above models are explained in Table 2.

Table 2: The parameters used in the Conan-Holder model

| Para-meter | Formulas | Explanations |
|---|---|---|
| $X_1$ | $=EBE/Dt$ | *EBE* = Gross operating excess; *Dt* = Total liabilities; *Cperm* = Permanent capital; *At* = Total asset; *Disp* = Money liquidity *Chfin* = Financial expense; *CA* = Turnover (except VAT); *Chpers* = Employment expenses; *Vad* = Added value; *Autofin* = Auto-financing; *Bt* = Total Balance sheet; *NFR* = Operating capital |
| $X_2$ | $=Cperm/At$ | |
| $X_3$ | $=Disp/At$ | |
| $X_4$ | $=Chfin/CA$ | |
| $X_5$ | $=Chpers/Vad$ | |
| $X_6$ | $=Autofin/Bt$ | |
| $X_7$ | $=EBE/Bt$ | |
| $X_8$ | $=NFR/CA$ | |

The obtained score value can be explained by using the interpretations showed in Table 3.

Table 3: Score functions value interpretation for different activity sectors

| *Value interpretation* | Manufacture | Commerce |
|---|---|---|
| *Good shape* | Z >= 4 | Z >= 20 |
| *Danger* | Z < 4 | Z < 20 |

In order to test enterprise's liquidity and profitableness ratios, the input data will be taken over from a spreadsheet file that has the structure shown in Fig 1.

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 4 | | | | | | | |
| 5 | Parameter | Ac | Dts | St | FTE | A | Div |
| 6 | Value | 73492284 | 79840528 | 40522862 | 100000 | 20000 | 132450 |
| 7 | | | | | | | |
| 8 | Parameter | Inv | Disp | Rec | At | Rnet | Cpr |
| 9 | Value | 500000 | 6166480 | 17057763 | 1064528882 | 5213587 | 25669712 |
| 10 | | | | | | | |
| 11 | Parameter | d | CA | EBE | Dt | CP | Chfin |
| 12 | Value | 10,5 | 172907428 | 9050306 | 942642 | 26612354 | 10851112 |
| 13 | | | | | | | |
| 14 | Parameter | Chpers | Vad | AF | Bt | NFR | |
| 15 | Value | 10995878 | 20466383 | 12762482 | 2129057764 | 73492284 | |

*Fig 1. External spreadsheet file that contains the variable's values*

### 2.3 Enterprise liquidity ratio

For testing the enterprise liquidity level there is used a ratio system illustrated in Table 4; the best rate of the liquidity ratios will be attained when an enterprise fulfills all the conditions imposed by the ratios (Table 5).

Table 4: The Liquidity ratios system

| Ratios name | Formulas | Explanations |
|---|---|---|
| General liquidity rate (***RLG***) | *=Ac/Dts* | *Ac* = Current assets; Dts = Short term liabilities; |
| Low liquidity ratio (***RLR***) | *=(Ac-St) /Dts* | *St=Reserves;* |
| Immediate liquidity ratio (***RLI***) | *=Disp/Dts* | *Disp* = Liquidness; |
| The rate of covering the payment engagements (***Ro***) | *= FTE/ (A+ $Div_{plătite}$ +Inv)* | *FTE* = Cash flows; *A* = Annuity; $Div_{plătite}$ = Paid dividends; *Inv* = Investment payments; |

Table 5: Interpretations for the ratios values

| Liquidity ratios | Obtained values | |
|---|---|---|
| | Favourable | Un-favourable |
| *RLG* | *RLG* >= 1 | *RLG* < 1 |
| *RLR* | *RLR* >= 0.8 | *RLR* < 0.8 |
| *RLI* | *RLI* >= 0.2 | *RLI* < 0.2 |
| *Ro* | *Ro* >= 1 | *Ro* < 1 |

### 2.4 The recommendations

When the SMEs activity is diagnosed as being „in shape", the user will be prompted to choose whether he wants to obtain the recommendations and solutions he has in order to maintain and improve the SMEs performances. In this case, the ratios whose values are near to the normal limit are tested in order to identify the actions that can be undertaken so that the ratios don't run over their normal limits.

When the SMEs activity is diagnose with any of the other states („transient malady", „chronicle malady" or „imminent ending") (view Table 1), the situation is consider to be critical. In this case, the user will be prompted to choose wheather he wants to discover the causes that leaded to this dangerous situation. This action allows the analyst to identify the threats and weaknesses that generated the abnormal functionality of the enterprise (view the results in Fig 8).

## 3 Problem Solution

Exsys Corvid provides a powerful environment for developing Web-enabled Knowledge Automation Systems for a wide range of decision-making problems. This software allows the logical rules and procedural steps used by an expert to reach a decision, to be efficiently described in a manner that is easy to read, understand and maintain. Corvid converts logic to a form that the underlying Runtime Inference Engine can process in order to emulate the questions, process, and recommendations of the expert in an interactive session, allowing the end users to interact with the system as if they were talking to the expert, to produce situation-specific recommendations and advice on a wide range of subjects [6].

The computerized solution, implemented with Exsys Corvid, takes advantage of all the above features of the software that, throughout its rule base, queries an external spreadsheet file by using a friendly interface. Thus, the main aim of the solution is to help the financial analyst run a financial diagnose on an enterprise only knowing the values of certain financial parameters (shown in Fig 1). The computerized solution has at least two goals:

1. to establish, based on the input information, the financial state of the enterprise (one of the four category illustrated in Table 1);
2. to reveal the causes that generated the particular financial state of enterprise.
3. to integrate the final prototype into a web page and make expertise worldwide available.

All the information included in Tables 1 to 5 was implemented into Corvid under the form of variables, logic and command blocks, all of them forming the rule base of the system.

### 3.1. Web integration and development of the prototype

The first step in developing the system consisted in installing the Appache2TRIAD[8] software, which is a distribution of some of the most popular open-source servers that allows one to develop and provide web content by using Windows as the operating system. Once the Appache web server was installed, we developed the webpage which is currently available at *http://feaa-c-24.feaa.uaic.ro/ diagnose*. The web server hosts the Corvid systems and makes it available via the options

displayed on the left pane, namely the link to the systems (Fig 2).

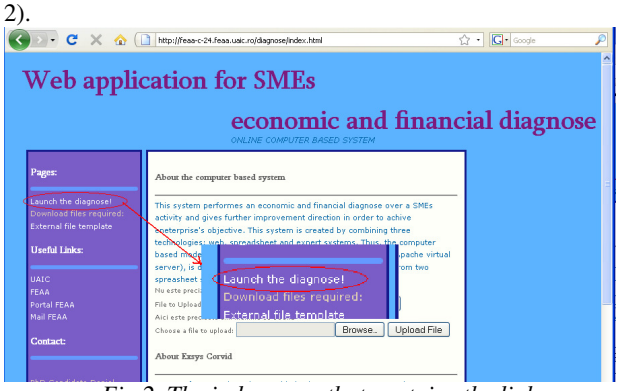
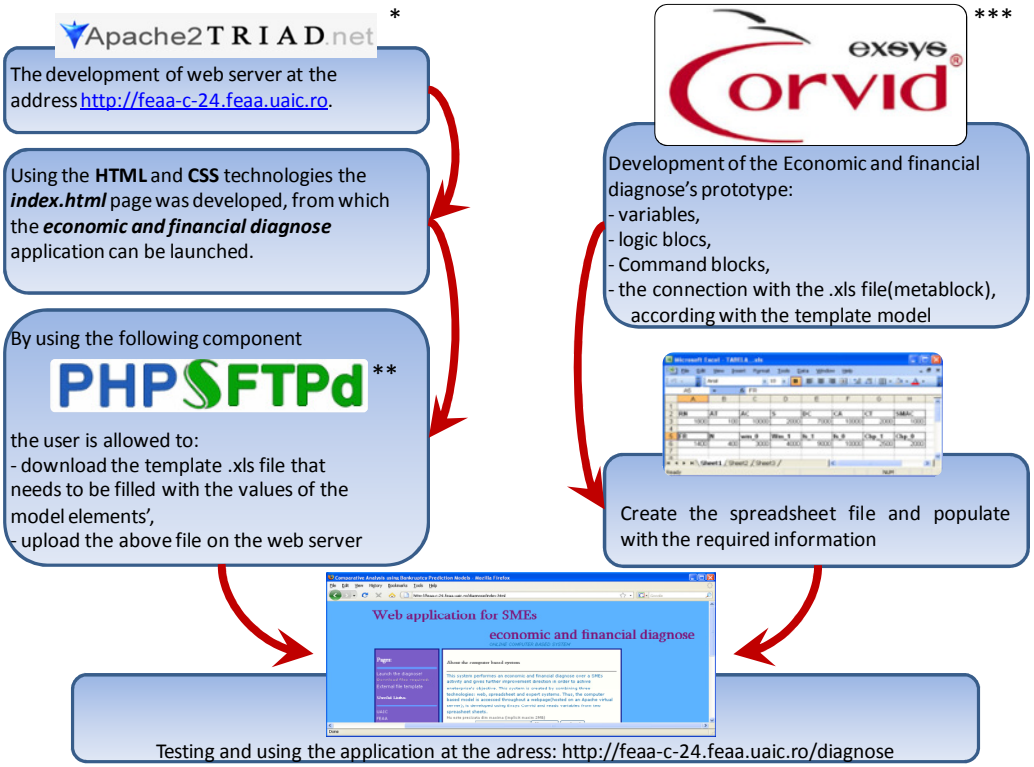



*Fig 2. The index page that contains the link to the application*

The development scheme of the application is presented in Fig 3.

### 3.2 The system's variables

All the elements that are used in the formulas presented in Table 2 and 3 were implemented as Corvid numeric type variables. Their values were obtained by querying the spreadsheet file shown in Fig 1. From the specialized literature and also from the domain expertise, all the possible recommendations were implemented as Corvid confidence type variables. Some information was required from the user and thus, several variables were inputted as static list type variables. The system has a total of sixty four variables of the three types mentioned above.




Note: * Apache2TRIAD is a Trademark of Appache, ** PHPSFTPd is a Trademark of Appache, *** Corvid is a Trademark of Exsys

*Fig 3. The economic and financial diagnoses' development scheme*

When working with numeric type variables, for best results, it is required an integration of the expert system with an external database that contains the elements that the ratios system uses. This action can be best accomplished by using a spreadsheet file as an external database. Among the reasons that brought us to the above statement we only stress out two of them: the ease of working with this type of database and also the availability of the spreadsheet programs among computer users. In this manner, the "raw" data provided by the spreadsheet file would be processed by expert systems prototype.

### 3.3 Logic blocks

The reasoning base of the system is formed, in Corvid, by the logic blocks. A logic block will contain a certain combination of variables and it must obey the IF-THEN-ELSE reasoning control. For instance, in Fig 4, we illustrate the logic block that contains the reasoning attached to the profitableness ratio specific to the commerce activity. On the first line it is defined that the logic block applies only when the sector of activity is commerce; on the second line the formula is implemented – the values for the parameters are take from the external spreadsheet file; the third line contains the recommendation: good level of profitableness. The fourth line contains the

specifications for the case when the profitableness has an inadequate value (line five).

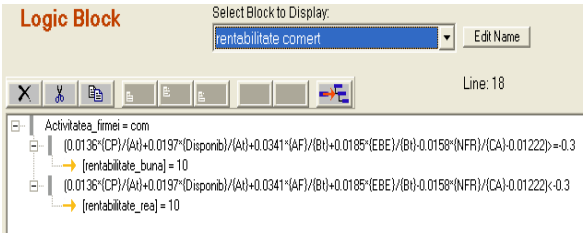



*Fig 4. The logic block containing the profitableness ratio specific to the commerce sector*

In the same manner were implemented all the required blocks containing the reasoning system. In Corvid, any logic block can be viewed as a rule view.

Another logic block, very important, that contains the reasoning for all the Liquidity ratios (illustrated in Table 5) can be viewed in Fig 5.

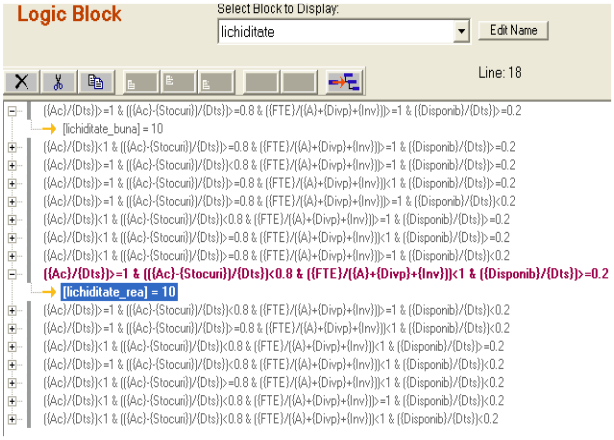



*Fig 5 The Liquidity ratios logic block*

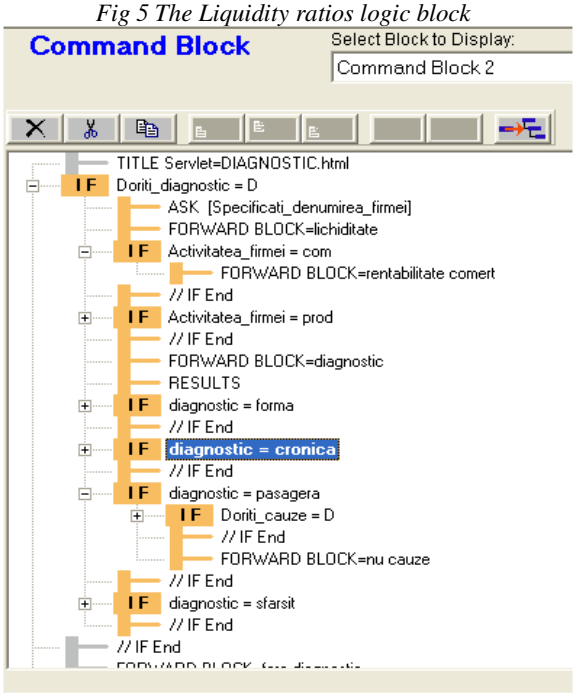



*Fig 6 The main command block of the system*

### 3.4 Command blocks

The Corvid inference engine runs the logic blocks in the ordered specified in the command block and infer the recommendations, namely the financial diagnose. Corvid allows both the backward and forward chaining, when it comes to setting up the inference strategy.

For exemplification reason, in Fig 6, it is illustrated the main command block of the system that sets up the strategy applied for the functionality of the system.

### 3.5 Testing the computerized solution and displaying the results

Once launched from the index page, the system displays the main screen (Fig 7) containing the name of the system and the OK button.


*Fig 7 The main screen of the system*

The action of pressing the OK button allows the computerized solution to commence the financial investigations that will end up with displaying the financial state of the enterprise (Fig 8).

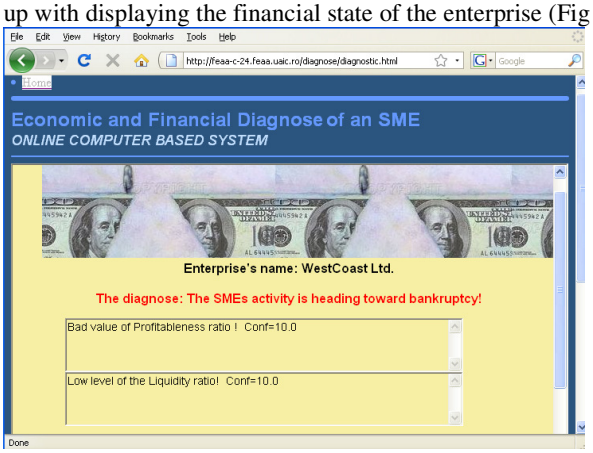



*Fig 8 The screen containing the economic and financial state of the diagnosed enterprise*

Also, based on user's choice, the system will display the diagnose and the causes that leaded to the current financial state of the enterprise (Fig 9).

## 4 Discussions and Conclusion

To conclude, we may say that Corvid is a competitive Expert System Shell that incorporates up-to-date technology and allows the developer to design and implement sophisticated expert system solutions for a variety of domains, including the economic field.

With powerful integration abilities (external data access), Java delivery through Applets and Servlets and strong interface design, Corvid stands for a leading software when it comes to developing prototypes for local or web environment. Therefore, one of the future directions for the development of the current research would be to incorporate it into a web page and make it available throughout the Internet. In this way, the current solution could be widely use by a variety of firms to test their financial performances.

The field of financial analysis and diagnose can be very easily computerized with the Expert system technology due to its abilities to interpret, analyze and infer recommendation and not just determine the value for a certain ratio.

Unlike multinationals and other large corporations, small and medium-sized enterprises do not have sufficient funds to implement sophisticated systems such as Enterprise Resource Planning and others that could signal out when their economic and financial situation is far from normal. Therefore, we have considered it relevant to propose such an online computer-based system that would allow any SME to check its economic and financial state.

In order to develop the online system, we have combined three technologies: web, expert systems and spreadsheet (view Fig 3). We used Appache to create the web server and via HTML code, we have developed all pages of the website, including the pages that contain the Exsys Corvid Java Applet. Exsys software and its services enable businesses, government and organizations to distribute a company's most valuable asset, namely its expert knowledge to the people that call for it. All of these Exsys features are made available through powerful interactive Web-enabled expert systems that can solve numerous problems and assist in the process of decision making.

As further research directions, we plan to improve the current system in the following manner:

- to allow a three year comparative analysis based on the data upload on the web server by the SMEs users;
- to improve the diagnose, by adding more ratios;
- to perfect the upload option in order to restrict the user to upload only the necessary file type(.xls) and implement other security triggers.

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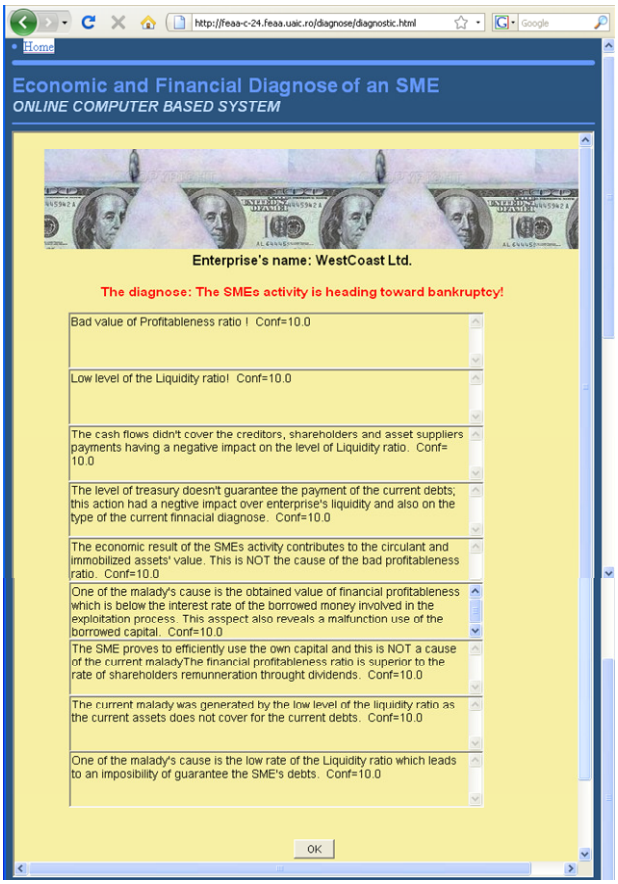


*Fig 9 The results screen containing both the financial diagnose and the causes*