

An Expert System to Detect Risk Levels in Small and Medium Enterprises (SMEs)

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Abstract

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Abstract:

Nowadays, Small and Medium Enterprises (SMEs) that hold a better competitive position have adopted technology as their key element to become competitive in a globalized market. In Mexico, 72% of the employment of the country and 52% of the GDP comes from SMEs. The importance of keeping alive and working such entities is crucial for the country and one key element is related to their first years. The following work presents a work in progress expert system for Risk Assessment based on a series of evaluations of indicators that provide an insight of the SMEs economic health. The system is based on a real-life scenario with a tailored knowledge base.

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An Expert System to detect risk levels in Small and Medium Enterprises (SMEs).

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Abstract—Nowadays, Small and Medium Enterprises (SMEs) that hold a better competitive position have adopted technology as their key element to become competitive in a globalized market. In Mexico, 72% of the employment of the country and 52% of the GDP comes from SMEs. The importance of keeping alive and working such entities is crucial for the country and one key element is related to their first years. The following work presents a work in progress expert system for Risk Assessment based on a series of evaluations of indicators that provide an insight of the SMEs economic health. The system is based on a real-life scenario with a tailored knowledge base.

Keywords- Expert system, risk assessment, SME, KB.

I. INTRODUCTION

According to the Organisation for Economic Co-operation and Development (OECD) [1] reports that 95% of enterprises in the OECD organisation are Small and Medium Enterprises (SMEs) and they account for almost 60% of the private sector employment. From such report we can see how important are SMEs to the economic and employment growth for any country. For Mexico, Figure 1 shows the SME Contribution to Employment Shares in México¹ according to the World Bank [2].

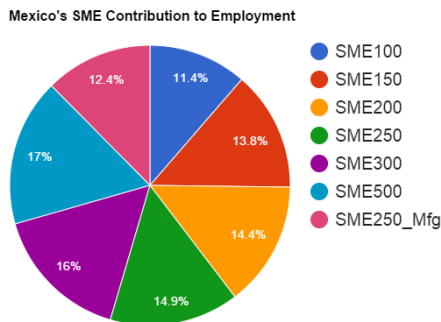


Figure 1. SME Contribution to Employment. From [2].

¹ In the dataset, the authors have constructed 6 definitions of SMEs to correspond to varying upper limits in the official country definitions of SMEs adopted around the world, the numeric component refers to the number of permanent full-time employees in a year for the establishments included in the dataset.

Research [4] shows the importance and contribution to employment in all regions as shown in Figure 2 which shows the median contribution of SMEs employment. For instance, SMEs in Latin America employing up to 500 people account for 78% in employment while in North America it hardly reaches 57%.

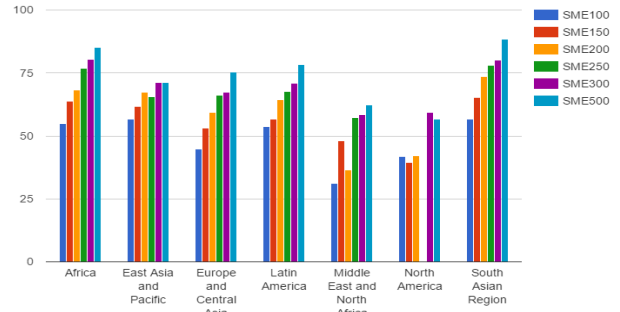


Figure 2. SME Contribution to Employment Shares by Region. From [4].

Most OECD countries have an assortment of programmes to help SMEs: “one-quarter of all public support programmes reported to the OECD primarily target SMEs”[3]. According to [4] almost 50% of the SME fund is devoted to three programmes which aims primarily to credit small firms. (National guarantee fund, SME productive project and the Seed Capital Programme) [4]. It’s clear that SMEs play an important role in a country’s economy and thus they have to be taken care of in order to preserve and promote not just the economic growth but the employment rate. Most newly created SMEs face an enormous challenge in order to receive debt and equity finance. Based on the empirical research of [5] small firms score an average of 13% less points of investment with external finance than large firms. In [6] there’s evidence on how SMEs struggle to win against their bigger competitors, also it’s shown the different financial programs to support SMEs. While there are different programs and support available in order for them to access to such financial aid SMEs need to be evaluated and comply with different regulations to prove they’re capable of paying the received help based on specific elements that show their financial strength.

In this article we present the implementation of an expert system for Risk Assessment analysis to get an insight of the SME's economic health based on a real-life scenario with a tailored knowledge base. The article is organized as follows: Section 2 presents related work of Risk Assessment experts systems for SMEs. In Section 3 we present the problem description and the aspects considered to build the expert system. Section 4 presents our approach and details regarding our system; and finally in Section 5 we discuss the current findings and future work.

II. STATE OF THE ART

Companies have to be prepared for today's changing business world and risk underlies under all those volatile conditions. Risk assessment provides companies a series of elements and tools to properly identify situations and elements that might bring a negative impact for them. In combination with Risk Management, SMEs can become competitive and succeed in the market. In order for SMEs to properly identify and monitor potential risks there's a need of systems that are able to integrate and store knowledge that helps managers and decision makers avoid such pitfalls.

In [7] the authors propose 9 main categories for Risk Management (RM) applications which correctly describe the current trends in RM solutions. The work presented by [8] presents a hybrid system based on fuzzy reasoning to diagnose risk based on factors like vagueness and unexpectedness, the solution created considers 36 laws due to the number of fuzzy sets used and include a cost associated with a threat and its risk level. IPO-Srisk expert system [9], an expert system of risk management on internal audit was created around an audit regulation based on the Composite Risk Index (CRI) and determined the probability of risk occurrence based on the scale of importance considered 5 risk levels and 54 indicators, the system needed as input of certain variables and based on them risk level assessment is conducted along with the generation of recommendations for each risk group variable. Finally, The DPG (Performance, Development, and Growth) prototype system [10] present an expert diagnosis system to benchmark SMEs performance based on the evaluation of 7 factors (human resources, production systems, production management, sales/marketing, management and control, effectiveness, and vulnerability). The system considers an expert diagnosis system that creates reports with textual comments based on natural language processing created derived from the report for each SME considering their practices and results. From the analyzed approaches the solutions presented consider the inclusion of an expert system to help and ease the process of risk identification and assessment to later generate recommendations based on the automatic analysis performed on the input data. There's no evidence of expert systems developed specifically for SMEs to assess their risk levels in order to avoid their failure at early stages considering aspects such as Taxes, Labor and Management data.

III. PROBLEM DESCRIPTION

Risk's definition has evolved from what Chapman and Cooper stated in [12] *"risk is the possibility of suffering economic and financial losses or physical material damages, as a result of an inherent uncertainty associated with the action taken"* to *"...the magnitude and likelihood of unanticipated changes that have an impact on a firm's cash flows, value or profitability"* [13]. We can clearly see a common reference to how a company might be affected financially (both losses and profitability). To help all businesses in order to properly define what risk is and how to deal with it there are a series of standards [14] but the most important among them are the ones created by the International Organization for Standardization (ISO) have created a series of standards. The ISO 31000 Standard [15] contains a series of principles and guidelines on risk management providing companies a common ground, also the ISO/IEC 31010:2009 [16] offers a collection of tools used for Risk Assessment (Risk assessment concepts, process and selection of risk assessment techniques).

SMEs hardly implement such standards mainly to misinformation and the lack of access to those information sources. Based on such lack of knowledge SMEs tend to fall back when trying to grow since they don't properly identify risk and hence don't prevent the adverse effects on their financial health. Most governments around the globe provide annually billions of dollars to help small businesses [17], but in order for them to access such aid they have to effectively deal with risk as big firms do. In [18] there's evidence that banks *"give credit only to firms with sufficient collaterals and credit history, which are more likely to be large and consolidated businesses"* even though small businesses rely more on bank credits than large businesses [19]. The volume of business credit provided by commercial banks to private companies has increased since 2002 [17].

In Mexico, according to a study by Nacional Financiera SNC (NAFIN) the most common causes that contribute to the failure of SMEs are as follows [20]:

- Incompetence or lack of experience managers
- Inadequate controls that allow to anticipate problems.
- Capital Financial insufficient, because of adequate planning of resource requirements.
- Identification of risks

The Risk Management Process is defined by [7] be defined as follows:

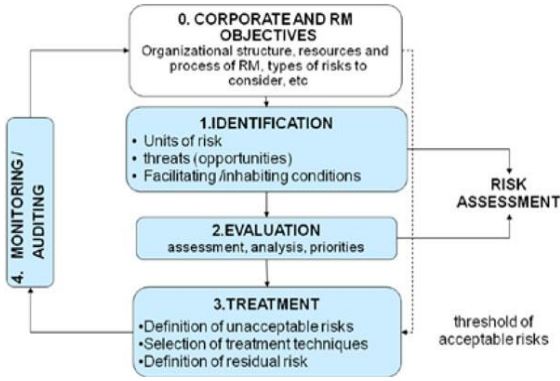


Figure 3. Risk Management Process is Based on 4 Main Steps [7].

In the first step the main goal is to identify the risks that the company may face whilst the second stage focuses mainly in the assessment and risk analysis. In this second stage an estimated probability and magnitude is associated with the threats identified. And it is here where the proposed solution aims at helping decision takers.

As presented in the previous section there aren't currently targeted solutions to help SMEs determine their risk level based on their current situation. The main target for the developed tool are SMEs located in Hidalgo, Mexico. The main goal is to provide those SMEs with a tool that will provide them the possibility to analyze and interpret their current situation and make a recommendation, to help improve their performance and maturity. That's achieved by a series of queries in a Prolog inference engine and knowledge base. Such Knowledge base is divided on three main areas:

- Tax
- Labor aspects
- Management aspects

Which in term are evaluated using the Committee of Sponsoring Organizations of the Treadway Commission (COSO) Enterprise Risk Management (ERM) Methodology [21][22].

IV. AN EXPERT SYSTEM TO DETECT RISK LEVELS IN SMALL AND MEDIUM ENTERPRISES (SMEs)

The Committee of Sponsoring Organizations of the Treadway Commission (COSO) assesses risks in companies to improve their internal control systems. In [23] the authors discuss the importance of knowledge management systems as an important part of the creation of any warning system to identify critical developments on time. Companies need to carefully monitor their financial situation (current expenses) as well as successfully forecast potential costs that may derive from risky decisions.

Whether the people in charge of planning know how to identify such risks in the end it all relies on the knowledge

they possess and thus they are able to attribute a value based on a priority scale. Such scale sometimes is off the limit due to a lack of knowledge in terms of risk identification and hence the actions and mechanisms to minimize such risks are not properly created and implemented.

Based on such conditions we developed an Expert system that will aid in the process of identification and monitoring of risks for SMEs based on three critical indicators as described in the previous section.

The evaluation consists of 5 components, as shown in the following figure 4:



Figure 4. Risk Assessment from the COSO Framework.

Therefore, the proposed expert system would help the internal auditor at the stage of identifying the level of risk considering an appreciation for assessing tax, labor and administrative aspects. (Figure 5)

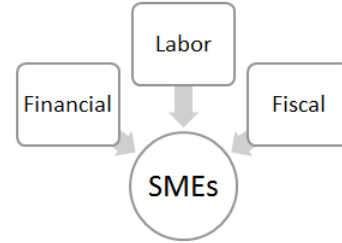


Figure 5. Aspects to Evaluate by the Expert System.

The evaluation is aims at assigning a risk level for each aspect and it can range from "Very high" to "no risk."

Table 1, shows the measuring scale:

TABLE I. RISK MEASUREMENT SCALE.

Risk level	Linguistic Value	Numerical Value
1	Risk Free	10
2	Low	9
3	Moderate	8
4	High	7 - 6
5	Very High	Less than 6

There's also a value assigned to each priority level of the evaluated aspects as shown in Table 2:

TABLE II. SCALE PRIORITY, AS ASSESSED INDICATOR.

Priority Level	Linguistic Value	Numerical Value
1	Very High	3
2	High	2
3	Average	1
4	Low	0.5

Figure 6, presents the development process conducted to develop the expert system. It's important to note that the last two stages repeat as the system is fine-tuned when analyzing new SMEs.

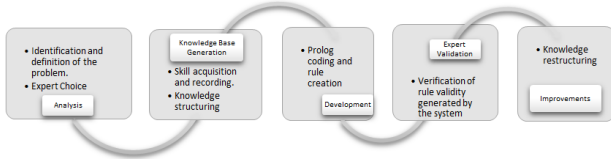


Figure 6. Expert System Development Process.

Based on a series of questions tailored by an audit expert key indicators were identified: 10 indicators for the fiscal aspect, 5 for the Labor and 5 for Fiscal aspects.

For each evaluated aspect there's a priority level calculated which is in accordance to the importance it represents to comply it in order to avoid jeopardizing the company's operations. A total of 20 evaluations are performed which allows us to determine the risk and its impact in a company (Figure 7).



Figure 7. Evaluation Cycle Indicators

Figure 8, presents an overall look of the system process in order to calculate and specify the risk level considering the 20 evaluations from the 3 main aspects to consider.

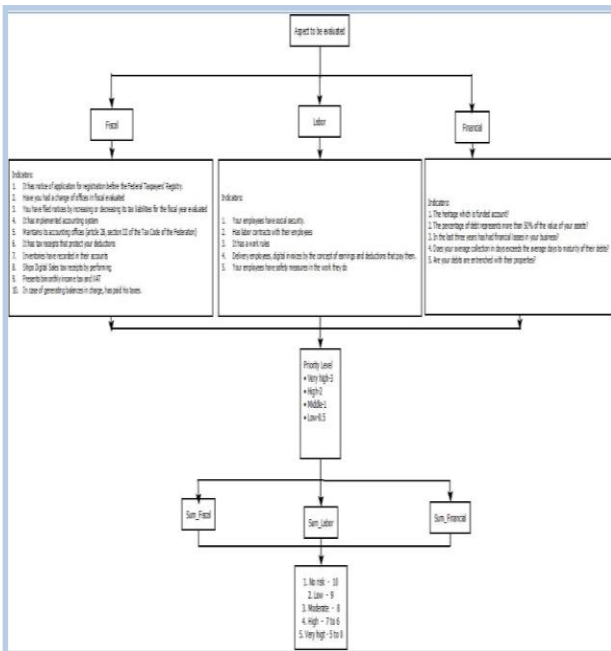


Figure 8. General Diagram of the Expert System

V. CURRENT FINDINGS AND FUTURE WORK

Finally, the work presents an expert system to help expert auditors properly assess risk under the COSO standard. The system applies two levels of measurement to determine the situation of SMEs, considering for evaluation: 10 indicators for the fiscal side, 5 indicators for the labor aspect and 5 more indicators for the financial aspect.

The first prototype of the expert system is to assess the priority level indicator and considering the valuation of each of the audited points.

It is working on assessing the level of irrigation and general diagnostic aspect of the company to be tested with a real case by the expert auditor, so that, the expert system warns of recommendations to avoid risks, as shown in the following Table 3:

TABLE III. EXAMPLE OF RECOMMENDATIONS FOR EACH ASPECT.

Aspect	Linguistic Value	Recommendation
Fiscal	Very High	Meet omissions fiscal spontaneously in order to avoid fines, according to the current tax code.
Labor	Very High	Assure employees, to avoid risks of work, fines and penalties. You can implement a plan for staff contracts such as: • Contracts for a definite • indefinite contracts
Financial	Very High	To analyze the cash flow of the company, to restructure their debts, reducing delays and minimizing the risk of the assets of the business.

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