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A PROFESSIONAL RISK ASSESSMENT SCENARIO AT THE SMEs LEVEL USING KNOWLEDGE BASES

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Abstract: *Today, in the European countries more then 95% of the companies are small and medium-sized enterprises (SMEs) and majority of the European Union employees work in these companies. The SMEs research development activities, products development, new technologies implementation, etc., presupposes knowledge and assumption of multiple risks. As a result of a new product development paradigm, there is a greater need for software tools to risk estimation. In this paper we present a method to professional risk assessment (PRA) as part of risk management process (RMP.) In addition, the paper presents how can be knowledge bases built and used for PRA at the SMEs level.*

Key words: *knowledge base, professional risk assessment, small and medium-sized enterprise.*

1. INTRODUCTION

The market situation of the European countries is the following: 99% of companies in the EU are small and medium sized enterprises (SMEs) – companies with a maximum of 250 employees and a maximal turnover of € 50 million (see Fig. 1). In the European Union (Europe have 23 million SMEs and 41 000 large companies) SMEs employ more than 65% of all employees. During past years, SMEs have created 80 % of the new jobs in the EU (IP/08/1003, Brussels, 25th June 2008).

The SMEs research development activities (see Fig. 2), products development, new technologies implementation, etc., presupposes knowledge and assumption of multiple risks [1].

The SMEs play an essential role in the European economy. They are a source of entrepreneurial skills, innovation and job creation. However, they are often confronted with market imperfection. SMEs often have difficulties in obtaining capital or credit, especially start-up phase.

Their limited resources may also reduce access to new technology or innovation. Therefore, support for SMEs is one priorities of the European Commission for economic growth, job creation and economic and social cohesion.

Enterprise	Average number of employees	Turnover
Medium	< 250	≤ 50 million €
Small	< 50	≤ 10 million €
Micro	< 10	≤ 2 million €

Fig. 1. The SMEs definition.

In a single market without internal borders is essential that measures to encourage SMEs to rely on a common definition in order to improve consistency and effectiveness and to limit distortions and competition. This is especially necessary considering the interaction between national measures imposed by the EU to support SMEs in areas such as regional development and the search for funds.

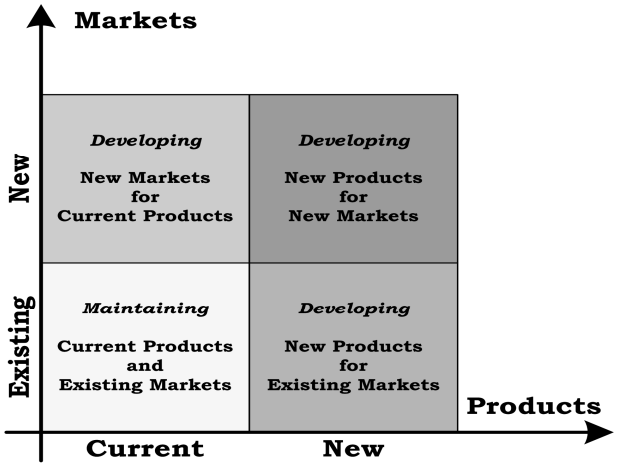

Fig. 2. The SMEs business matrix.

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As a result of a new product development paradigm, there is a greater need for software tools to risk estimation and to effectively support the formal representation, collect and exchange of product information, during the SMEs product development stage.

The risk evaluation sustains SMEs (see Fig. 3) in the uncertainties elimination in the development strategy and management policies. Estimation, evaluation and control of the occupational risk represent prerequisites for grounding and for a continual support of the decision that has been previously taken on occupational safety in a working system [2].

Risk management presumes the identification, assessment and control of risks that influence the organizations success and the efficiency of decisions making [3].

Among others we can mention that at the enterprise level, a lot of attention is paid to [4]: landslides, water, transportation work, explosive and blasting, air quality (ventilation systems), pressure equipments, elevators, lifting equipments and accessories, noise, construction sites, shipyards, illumination, electricity, individual protection equipments, extraction of fat using flammable substances, fires, fixed refrigeration systems, heat systems, machinery, flammable liquids or liquefied gases, chemical hazard, depots, air cooling towers, etc.

The way SMEs approach the topic of risk assessment is strongly influenced by the structure and strengths of the particular SME, but there are some characteristics that are applicable to most if not all SMEs, as follows [5]:

- *Informal social dialogue:* In most SMEs, social dialogue is conducted in a very informal way. In most of them there are no formal consultation bodies or procedures. The social dialogue in SMEs is a continuous, informal interaction between employer and employees and also among employees. Many SMEs don't have, and don't need, formal consultation bodies or procedures to identify problems or pinpoint risks. The problem and the solution will be discussed on the shop floor.
- *Employer works with employees:* An enormous advantage for most SMEs is the fact that the employer works alongside the employees. This means they can see the risks in the workplace and operations first hand and will be more likely to take measures to reduce or eliminate risk. These measures can include important innovative changes or simply small changes with great effectiveness for the safety of workers and employer. With this kind of operation, risk assessment is a continuous, informal process.
- *Flexibility:* Flexibility is the key for SMEs. Employer and employees are often required to multi-task in a constantly changing environment. They are highly adaptable. This also means that workers have a good knowledge of how their company works, and most of the workplace risks. This flexibility among staff will affect the way the risk assessment is carried out.
- *Fast decision-making process:* Another advantage of SMEs is the fast decision-making process. In a larger company when one wants to introduce changes, it is usually necessary to consult several hierarchies of managers. In an SME with a flat hierarchy, the employee can go directly to the right person and make a proposal. This saves both time and energy.
- *Familiar atmosphere:* Employees are working for the company but are also ready to be mutually supportive and to help each other if necessary. The willingness to support colleagues creates a very special atmosphere in the company between workers and between employer and employees. This makes it easier for employees to correct one another and to educate one other on risk assessment.
- *Easy communication:* The traditional informal communication and the direct and personal relationships at all levels of an SME facilitate rapid adaptation of change and a better anticipation of risks. These positive elements create a sound basis for carrying out a risk assessment that is adapted to the needs of the company.

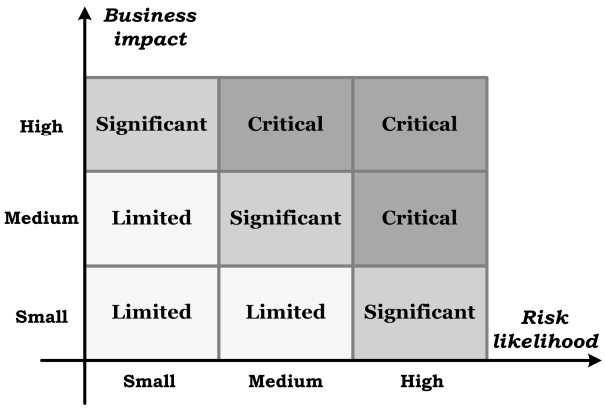

Fig. 3. The SMEs risk assessment matrix.

2. THE PROFESSIONAL RISK ASSESSMENT AS PART OF RISK MANAGEMENT PROCESS

Commonly, the risk management process includes three phases:

- the risk identification;
- risk analyses;
- risk feedback.

Risk factors are all factors that can have probability to deviate a plan.

Risk management process (RMP) is an important component of a successful project development process (see Fig. 4) with informational system support [6]. Risk is the net negative impact of the exercise of vulnerability, considering both the probability and the impact of occurrence.

In the SMEs activities risk eludes probability to not perform the establish objectives such as:

- performance – quality standards failure;
- schedule – execution terms failure;
- costs – budget exceeding.

So the risk management – see Figs 5 [7] and 6 − is the process of identifying risk, assessing risk, and taking steps to reduce risk to an acceptable level [1].

But, why is Professional safety and health an essential part of good SMEs business? Professional safety and health [8]:

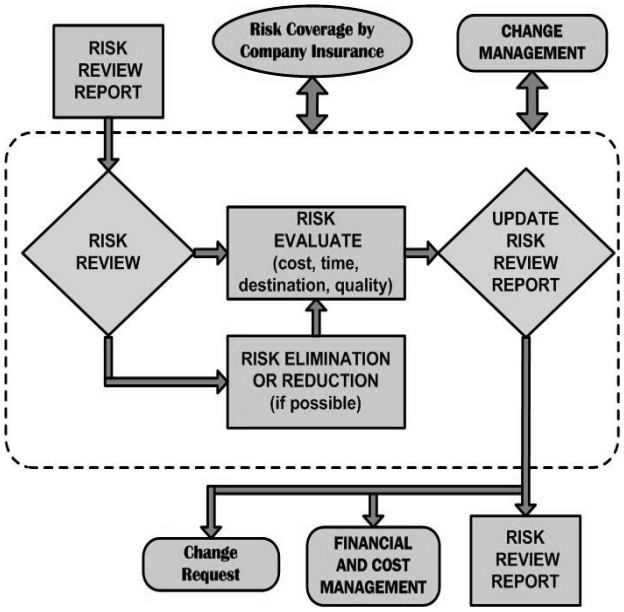

Fig. 4. The risk management process (RMP).

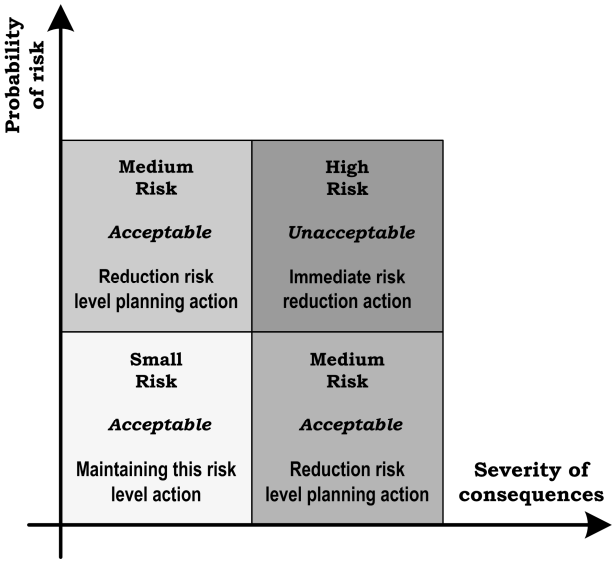

Fig. 6. The risk matrix.

- Helps demonstrate that a business is socially responsible.
- Protects and enhances brand image and brand value.
- Helps maximize the productivity of workers.
- Enhances employees' commitment to the business.
- Builds a more competent, healthier workforce.
- Reduces business costs and disruption.
- Enables enterprises to meet customers' OSH expectations.
- Encourages the workforce to stay longer in active life.

Under health and safety laws, all employers must carry out regular risk assessment [9].

To assess professional risk at the workplace we need to know [10]:

- What work equipment, materials, and processes are used.
- Where the workplace and/or the jobs performed are located and who works there: pay particular attention to those for whom occupational hazard may be more severe than usual, such as pregnant women, young workers or workers with disabilities; remember also about part-time workers, subcontractors and visitors, and employees who work off-site (including drivers, those visiting clients' or customers' homes etc.).
- What tasks are performed.
- What the potential consequences of existing hazards are and what protective measures are used.
- What accidents, occupational diseases and other occurrences of ill health have been reported.
- What legal and other requirements are related to the workplace, etc.

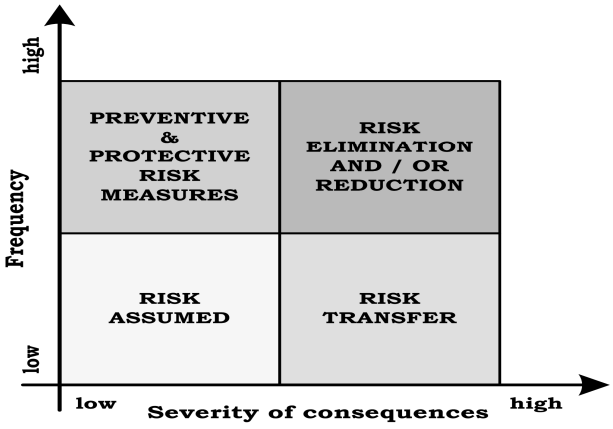

Fig. 5. The risk management matrix.

3. A KNOWLEDGE BASE MODEL TO PROFESSIONAL RISK ASSESSMENT IN SMEs

At PREMINV Research Center, University "Politehnica" of Bucharest, we implemented some of the KBS modules for risk assessment in various professional fields, system able to provide at the SMEs level the original KM framework (proposed in Fig. 7) implementation.

A first KBS module is focused on professional risk assessment for a *Cars Repair Workshop*. To identify hazards at the workplace we prepared a General Hazard Checklist (see Table 1).

This list can be extended according to specific facilities. Note that, correct identification of hazards involves active involvement of all employees in the process of gathering information. For each YES answer in the general list is given 0 points and for each answers NO is given 1 point. Depending on the total score obtained and taking into account the probability and severity of consequences risk arising from hazards are evaluated – it may be *small*, *medium* or *high*. We considered the risk level depending on probability and severity of consequences as follows: small risk, medium risk and high risk and high risk are *unacceptabl*e and small and medium risks are *acceptable.*

Using expert systems generator VP-Expert (we used the expert system generator - VP-Expert version 2.1, by Brian Sawyer, Educational Version, distributed by Paperback Software International) and based on General Hazard Checklist we built the knowledge base *CARREP.KBS* (see Fig. 7).

Table 1

The Hazard Checklist

No.	Hazard	Yes	No
Does the hazard exist at the workplace?			
1	Are flat surfaces (floor, inspection pit, etc.) regularly cleaned?		
2	Are employees obliged to clean the workplace?		
3	Are flat surfaces (floor, inspection pit in service station, etc.) paint resistant from substances that are used (e. g., oil, diesel, petrol)?		
4	Is the inspection pit safely covered after work?		
5	Is the inspection pit suitably marked or surrounded with handrails to prevent people from falling down?		
6	Are there marked (e. g., on the floor) ways for cars to enter the service station?		
7	Are there measures implemented to avoid injuries while working on bodywork (e. g., welding, grinding, painting)?		
8	Are suitable protective measures being used to prevent or reduce exposure to dust and other small parts (e. g., during grinding, welding, painting)?		
9	Do workers wear non-slipping shoes?		
10	Are there defined safety rules for assembly work (e. g., bodywork, engine)?		
11	Are there defined safety rules for work with petrol tanks (e. g., repairing)?		
12	Are there defined safe routings or measures to avoid falling parts from a vehicle (e. g., when a car is lifted)?		
13	Are there protective guards to eliminate contact of workers with rotating parts (e. g., when balancing a dynamic wheel)?		
14	Are measures implemented to avoid workers being caught by rotating parts (e. g., when an engine set up)?		
...	**… … … … …**		
Answer sum:			

The knowledge base rules are following: rules for awarding point's variables, rules for calculation of the partial scores and total score and rules for assessment of probability and severity of consequences, and risk arising from hazards in accordance with the total score obtained. To achieve the KBS professional assessment of risk we used the method of representation of knowledge production rules.

In the *PRA.KBS* knowledge base (KB) there are *if-then* structure rules (excluding the rules for inference engine operations), such as:

```
RULE 0-1
IF      electrical<>?       AND   fire<>?          AND
        explosion<>?        AND   substances<>?    AND
        guardrails<>?       AND   oil<>?           AND
        cylinders<>?        AND   raisedcar<>?
THEN    FIND  rp9     FIND  rp10    FIND  rp11
        FIND  rp12    FIND  rp13    FIND  rp14
        FIND  rp15    FIND  rp16
        r2=(rp9+rp10+rp11+rp12+rp13+rp14+rp15+rp16);
… … … … …

RULE 3
IF      risk>12 AND
        risk<=14
THEN    prob=HIGHLY_PROBABLE
        conseq=MODERATELY_HARMFUL
        riskprof=MEDIUM
CLS
DISPLAY"
EXPLANATIONS
++++++++++++++++++++++++++++++++++++++++
Highly probable = may materialize repeatedly during the occupational career of an employee.
Moderately harmful = accidents and illnesses not causing prolonged distress (such as small nicks, eye irritations, headaches, etc.).
Medium Risk = acceptable.
Conclusion = it is recommended to plan actions to reduce its level.
++++++++++++++++++++++++++++++++++++++++";

RULE 4
IF      risk>8  AND
        risk<=12
THEN    prob=PROBABLE
        conseq=EXTREMELY_HARMFUL
        riskprof=HIGH
CLS
DISPLAY"
EXPLANATIONS
++++++++++++++++++++++++++++++++++++++++
Probable = may materialize only a few times during the occupational career of an employee.
Extremely harmful = accidents and illnesses causing grave and permanent distress and/or death (e. g., amputations, complex fractures leading to disability, cancer, second or third-degree burns on a large body
surface, etc.).
High Risk = unacceptable.
Conclusion = actions to reduce it need to be taken at once.
++++++++++++++++++++++++++++++++++++++++";
… … … … …

RULE 29-0
    IF      posture=YES
    THEN    rp20=0;
RULE 29-1
    IF      posture=NO
    THEN    rp20=1;
RULE 30-0
    IF      loads=YES
    THEN    rp21=0;
RULE 30-1
    IF      loads=NO
    THEN    rp21=1;
```

Fig. 7. The CARREP.KBS knowledge base interrogation and shows results.

After querying the knowledge base will be displayed to evaluate the outcome of risk assessment conclusion and explanations on the likelihood and severity of injury in terms of consequences (see Fig. 7).

We considered the risk level depending on probability and severity of consequences as follows: *small risk*, *medium risk* and *high risk* and high risk are *unacceptable* and small and medium risks are *acceptable* (see figure 8). In general, if the risk is assessed as unacceptable (height) reduction actions must be taken immediately. If risk is assessed as acceptable (average) is recommended plan of action to reduce or necessary to ensure that it will remain at the same level (in case of risk assessed as small).

Measures of prevention and protection to be implemented in the organization are to eliminate or reduce to a minimum the danger by organizational measures, or use of collective protection equipment suitable for individual protection. To reduce the risk it is necessary to take preventive measures [10], such as:

- Maintaining flat surfaces, floor, inspection pit, etc., safe and non-slippery; cleaning work area regularly.
- Cleaning thoroughly after grinding, painting, etc.
- Using appropriate material (non-absorbing liquid substances) for flat surfaces.
- Using correct procedures when pouring oil from a storage barrel and collecting used oil into appropriate barrel; cleaning oil off the floor.
- Wearing protective non-slipping shoes.
- Covering the steps into the inspection pit with non-slipping material.
- Never stepping under raised vehicles.

- Never stepping into a closed inspection pit in a service station.
- Keeping inspection pits in service station covered after work.
- Keeping electrical, hydraulic and pneumatic lines out of people's way.
- Indicating fixed places for working tools, to be used during work and after work.
- Marking (e. g., on the floor) ways for cars and transport routes.
- Ensuring correct control and placement of lifting mechanism arms; not putting hands into moving parts.
- Ensuring that all activities are performed by well-trained staff; respecting all required safety procedures.
- Using only recommended safe tools for work with batteries.
- Ensuring proper ventilation to avoid creation of explosive mixtures of various vapours and liquids. Never smoching in dangerous areas.
- Protecting all electrical equipment from humidity, moisture and water.
- Providing workers with necessary personal protective equipment (gloves, masks, safety shoes).
- Using effective ventilation and exhaust systems to eliminate hazardous vapours or fumes; where these are not fully effective, using appropriate personal protective equipment.
- Performing regular medical examinations, etc.

We suggest a reassessment of activity sector after the implementation of these measures and to compare this result with that obtained at first evaluation in order to verify the effectiveness of measures for prevention and protection implemented. General idea that shows the importance of this system of occupational risks assessment consists in the fact that nothing can be achieved without a motivated/interested staff. The new methods, technologies, tools, techniques can be implemented only with the people and for people. According to legislation in safety and health, all employers should periodically assess the occupational risks.

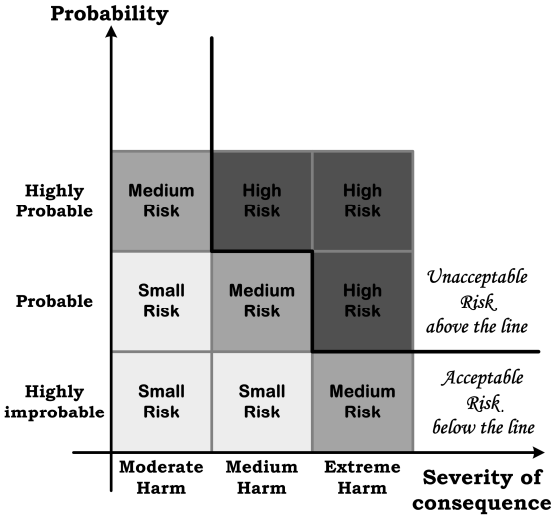

Fig. 8. The risk evaluation matrix.

It is particularly important that any technique or method to be presented by such a way as to appear in the eyes of the staff as a useful tool, and not as a tool for monitoring employee activity or suppressing it.

The main goal of the occupational risk assessment is to protect workers, helping to maintain competitiveness and enterprise productivity.

4. CONCLUSIONS

In this paper we describe the PRA as part of RMP, how can be establish the risk level depending on probability and severity of consequences an present a method to knowledge bases built and used for PRA at the SMEs level. This work realized at the UPB - PREMINV Research Centre, is focusing on a university – small and medium-sized enterprise partnership. The validation of this methodology by a case study in the PROGPROC project (CNMP 11014/2007 – 2007-2010) is to create a support system for resources planning and programming activities according to manufacturing processes management in virtual organizations.

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