Software design for professional risk evaluation

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Abstract. Professional risk evaluation represents a complex activity involving each economic operator, with important repercussion upon health and security in work. Article represents an innovative study method, regarding professional risk analyze in which cumulative working posts are evaluated. Work presents a new software that helps in putting together all the working positions from a complex organizational system and analyzing them in order to evaluate the possible risks. Using this software, a multiple analysis can be done like: risk estimation, risk evaluation, estimation of residual risks and finally searching of risk reduction measures.

1. Introduction

Presented method is specialized in work risk appreciation during working activities. It is based on on European norms that offers the legal frame for work health and security [1], [2], [4], [5],[6],[7],[8]. It can identify dangerous phenomena after a methodic "brainstorming" with experts from different specialties. Worldwide, diagnose idea of security in enterprises is relatively old, but here was not enough, only in a few cases, operational and generalizable instruments are available. The proposed method is part of the analytical methods, semiquantitative , and consists essentially in identification of all risk factors of the reviewed system (job) using checklists default and quantify the extent of the risk for each risk factor individually, based on the combination of severity and frequency of maximum foreseeable consequence.

The overall risk level, for each job is determined as the weighted average of partial risk levels so that compensation is minimal. The level of security resulting indirectly is inversely proportional to the risk.

The work can be both used for present and future designed activities. Potential dangerous phenomena are able to be finding in working posts and also in technological development processes.
The method presented in the paper was endorsed by the Ministry of Labour and Social Solidarity and its application allows:
 - Identify all risk factors at the workplace, operation required to authorize the firm's own and develop their own occupational safety instructions;
- Radiography situation at each job, resulting acceptable risks falling under the curve risk acceptability;
- Determination of the size of risk (risk levels) in every workplace and their hierarchy;
- Setting priorities concerning measures to prevent illness and accidents, and optimum use of resources for this purpose;
- Establishing a hierarchy of jobs in terms of hazards and harmfulness;

- Comparing different jobs in terms of risk of accidents and professional diseases with application in optimal use of economic instruments;
- Computerized management of risk if constitute databases with assessment results

2. Method description
Presented method can be used for working systems and also for designed systems. The PREM- MWS method helps to dangerous potential phenomenon identification from working shops, during technical processes progress. The method is based also on:
    - SUVA method specialized on risk appreciation at working shops;
    - HAZOP procedure, a systematic research procedure of dysfunctions, specialized on chemical and petrochemical industry analysis;
    - danger evaluation guide;
    - statistical analysis of danger made by assurance.
    The method steps are:
- system limit definition - system definition;
- dangerous phenomenon identification;
- risk estimation;
- risk evaluation;
- risk reducing method searching - residual risk estimation
    The base method that is used for software design uses the following principles [9], [10]:
- the HAZOP method, a systematical research procedure of the dysfunction, applied for chemical and petrochemical industry installations analyze;
- operational hazard evaluation guide;
- statistical analyses of operational hazard made by insurer.

2.1 Steps of the method
For method application, the following steps has to be followed:
    1. system limits definition – system definition;
    2. dangerous phenomenon identification;
    3. risk estimation;
    4. risk evaluation;
    5. finding methods in risk reducing – residual risk estimation.

2.2 Interdisciplinary team formation
An important condition to realize a more exact and complete risks appreciation is to form a interdisciplinary team with 3 to 5 members. The team leader has to know very good methodological knowledge. The team can be formed by very good skilled persons: plant chief, production engineer, technological engineer, design engineer, maintenance engineer, installation human operator, health and security specialist. To describe processes and activity sectors, the following documentation has to be available:
    - procedure description;
    - photos, schematics, flux diagrams of the installations;
    - raw materials characteristics;
    - printed instructions;
    - protection devices;
    - special installations;
    - security concepts;
    - conformity certificates.
    In the case of a technological process with a continuous functioning installation, this is the point to start the analysis.

2.3 Risk apreciation

2.3.1 Working sistem limits
Before starting the analysis system limits has to be defined from activity sector or analised process. In this order, it is necesaly to specify the dangerous phenomena analised and also it has to be indicate to whom or what process it refers (human operators, equipments, medium. ...). On the other hand, other interactions with nearby instalations has to be studied and also different aspects that do not require inspection [3]. For machines and instalations, at the final system limit determination, the following points has to be defined:

- considered "life period" of the process - construction, assembly, reception, working period, .etc.

- the considered functioning mode - normal functioning, cleaning period, repair period, instalation, ...etc

- considered machine limit for a normal using;

- complete study of machine functioning mode - industrial, comercial, domestic;

- preparing (formation) of potential users.

2.3.2 Injuries definition
For each dangerous phenomenon, possible injuries evaluation has to be done and registrate it [151].

2.4 Risk estimation by probability estimation of injury gravity
Risk represents the quantified value of a dangerous phenomenon. This value is composed by - injury gravity (G) and injury produceing probability (P). This probability (P) is defined in the following equation:

$$P = f_{(e,po,L)} \qquad\qquad (1)$$

where e is frequency or duration of considered dangerous phenomenon, po - apparition probability of considered dangerous phenomenon, L - injury limitation or avoiding possibility by a adequate behaviour (of organization, involved people):

$$P = e + 2po + L \qquad\qquad (2)$$

where: po has a double number of points because probability of dangerous event evolving is more important comparing with the other two elements. This formula is based on probability presentation in EN 1050 " machines security - principles on risk apreciation'

2.5 Risk evaluation
For risk evaluation a specified matrix will be used splitted in three zones. This solution corresponds to a situation in a plant but not available for all organisations. According to presented table, risks are appreciated by probability estimation and injury gravity. The three zone matrix splitted is based on personal conception (of organisation, according to resque team, established by health and security politics, ...) and depends on established security objectives. In the case of higher demands, money resources has to be afforded or lower demands, according to economic situation, but minimal health and security requirements are compulsory according to law. In the zone 1 important risks are presented where security is not insured, medium risks are presented in the zone 2, where security is not insured also and in the zone 3 lower risks appears with generally security assured.

High priority treated is for the zone 1 risks, second rank is for the risks on zone 2 and last are treated zone 3 risks. First, priority definition has to be done, before risks treatment (risk analysis, which components will be treated and technical assistance measures elaboration). Security objectives

are according to exploitation interest of the installation but also users interests, neighbor and third parties interests in the condition of minimal health and security legislation requirements.

probabilitate	A	3	2	1	1	1
	B	3	2	1	1	1
	C	3	2	2	1	1
	D	3	2	2	2	1
	E	3	3	3	2	2
		V	IV	III	II	I
		Damage severity				

Figure 1. Risk matrix

On risks profile establishment, risk estimation for each dangerous phenomenon is done. Damage probability and severity are estimated. Each established risk is compared with security objective. If the objective is not reachable, adequate protection measures have to be finding. If possible, risks have to be eliminated. If not, at least the probability to happen will be lowered. When security measures are available, risks have to be situated in the matrix inferior left side where risks are lower and security almost assured.

3. Software description
The presented "Professional risks evaluation method-multiple working shop" (PREM-MWS) application was written in PHP language, oriented on internet zone but not only. The PREM software was designed to be very easy transformed in a centralized system, exclusive on-line. Subsequently development is permitted as a function of identified requirements at the plant level. The PREM software was tested with the study data took place at DOOSAN IMGB SA organization, foundry shop.

The main software screen contains a logo with project title and a seven buttons group. The logo is a link to main menu.
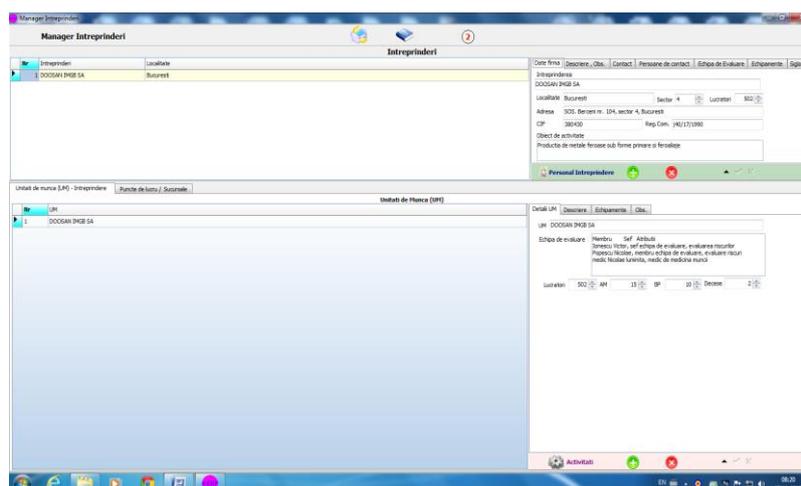

Figure 2. Organization data input

3.1 Data input
Any PREM section selection a window is opened with checkbox type text field, tables and buttons. For example, when click on "Organization manager" follows "Plants" and finally on section about

"Plant data", "Description", "Observations", "Contact persons", "Evaluation Team", "Equipments". All data can be introduced, deleted, or modified and finally saved. Fig. 3 presents the team evaluation and involved activities corresponding window.
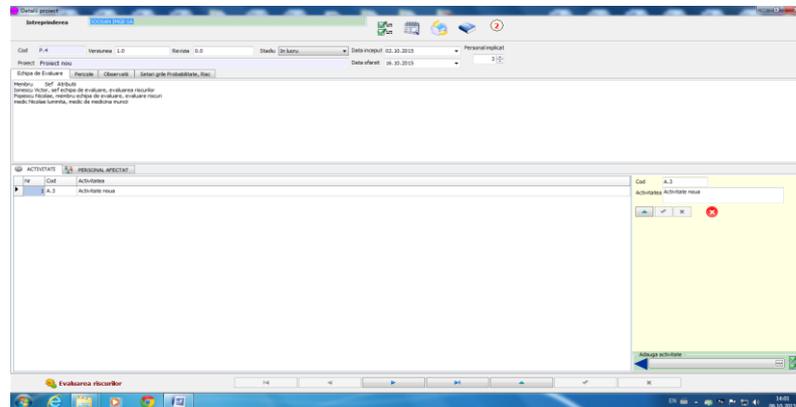

Figure 3. Team evaluation and involved activities corresponding window.

3.2 How "PREM"software works
Managing the data about organizations that performs risk evaluation represents the main aim of the software. Selecting Plant (Intreprinderi) table is the first step of working, validated than with CTRL + INS combination. In the same time, different organization specific data has to be input. To achieve the "PREM" software objectives, the following steps will be followed:

- create a new "project" by data input window;
- specify organization data like: data about, description-observations, contact data, evaluation team, equipments;
- working units input (shops, working points): details, description, equipments, observations;
- real activities input data: activity description, used equipment, raw materials, photos, observations;
- risk evaluation as a function of worker, objectives, tools and working environment by input data: dangerous activities identification, nature of risk, injury gravity, potential risk level, corrective actions, observations;
- residual risk evaluation (RRA);
- elimination measures for accident risks and professional disease.

Figure 4 presents risk evaluation as a function of worker, objectives, tools and working environment.

3.3 Working units adding for selected organization
To do this job the table UM will be selected and then the combination CTRL + INS. Once a unit added, specific data can be input in edit windows placed on the right side of the table. Window also permits registration configuration of the work unit equipment that are used during activities.

Also, the "Evaluation team" table contains: position, prerogative, competences and responsibilities of the evaluation team. This data will be automated imported from organization "Evaluation team" when a new working unit is added. For each member team, the corresponding data will be input. From this window, also, it is a link to "Personnel" and to "Activities" window.

3.4 Processes and activity sectors adding and description.
The following documents are needed for processes and activity sectors:
- procedure description;
- photos, schematics, graphs of the installations;

- raw materials characteristics;
- utilization instruction;
- protection devices;
- special installation;
- security concepts;
- conformity concepts.
The window for procedure description will contain complete detailed working method description.
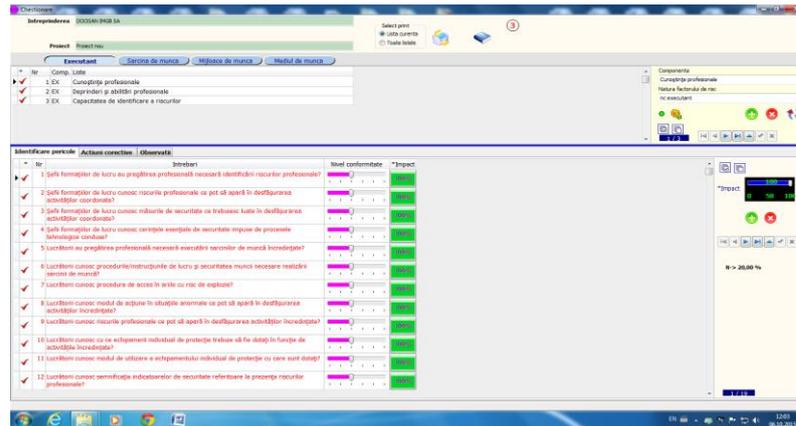
Figure 4. Risk evaluation as a function of worker, objectives, tools and working environment

3.5 Risk evaluation
For this activity, accidents and professional diseases will be treated as a function of: performer, work load, means work, work environment. All these will be input in destination section of risk evaluation from "PREM" software (figure 5).
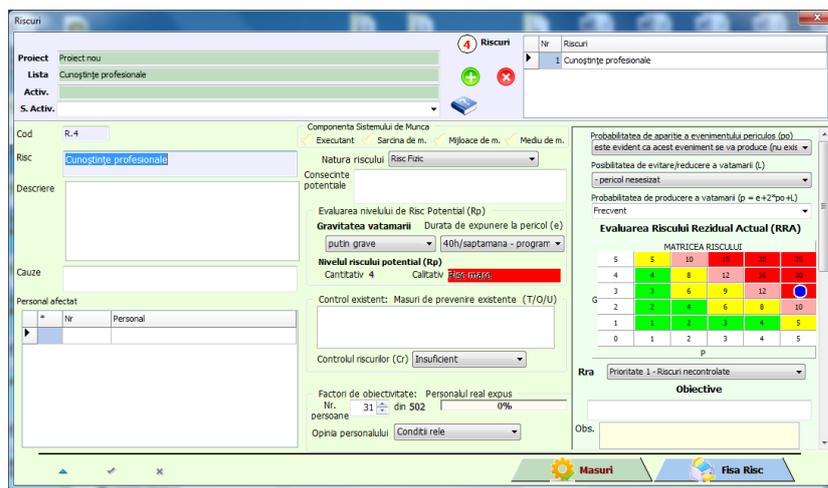
Figure 5. Residual risk evaluation

3.6 Input of risk removal measures
For this job, according to injury and occupational diseases risk evaluation, risk removal measures will be identified and will be input in corresponding window destined to risk removal measures from "PREM" software (figure 6).
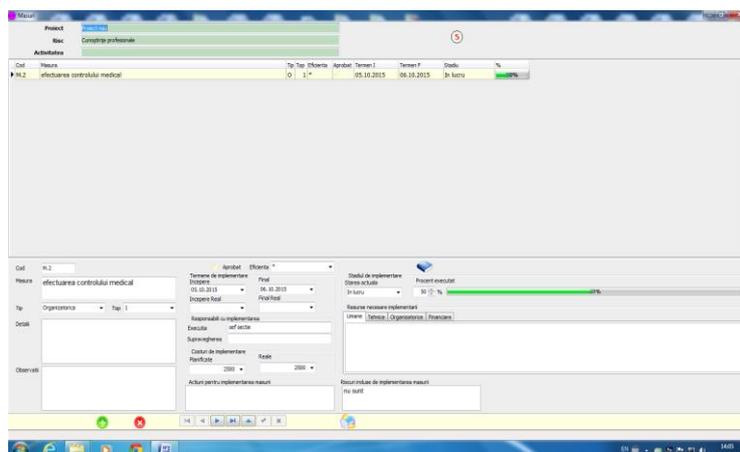
Figure 6. Risk removal measures input

4. Conclusions

Professional risk evaluation method (PREM- MWS) is specialized in working place risk evaluation during working activities. The PREM- MWS method, applied to analyzed system, is characterized by a methodic "brainstorming" planned by an experts team from different specialities.

Using PREM- MWS proposed method the following advantages will arise:
- common risk estimation for different working posts in the frame of one work unit;
- common risk evaluation for different working posts in the frame of one work unit;
- searching reducing measures and residual risk estimation is rapidly done because risk reducing method list is contained in software data base;
- residual risk elimination can be immediately done because of technical, organizational, health measures application available on measures list of data base;
- because of MERP facilities, risk estimation, risk evaluation, residual risk reducing and preventive plan design are able in the shortest time;
- thousands work units evaluation can be stocked in MERP software data base;
- method has the advantage of five steps gravity instead seven of PECE method and five frequency steps instead of PECE method;
- method is available on continuous metallurgical activities;
- method permits critical work place identification in the context of global evaluation of work conditions;
- method allows definition and ranking of human solicitations in a certain work place and allows incompatibility definition between worker activity and technical and organizational conditions.

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