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EXPANDING THE INSTRUMENTATION FOR OCCUPATIONAL RISK IN NATIONAL PRACTICE: A CASE STUDY ON THE APPLICATION OF SUVA METHOD

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Abstract: *The palette of methods, techniques and tools for analysis and assessment of the risks of occupational accidents and diseases that are used in the usual practice of occupational risk management in Romania is extremely limited, given the fact that the labor inspectors themselves impose the use in most cases to the INCDPM Bucharest method. This tendency and reality seriously affects the effectiveness of the process, the results obtained being - not infrequently - formal and devoid of practical purpose. Often, the approach to risk assessment becomes formal, and the assessment becomes a goal in itself, which aims exclusively at compliance in the strict sense with the provisions of the occupational health and safety legislation in force at national level. In this context, this article provides specialists with a complete case study on the application of the SUVA risk assessment method, a tool that facilitates an in-depth and integrated analysis of hazardous events that may occur at a workplace, allowing the determination of residual risks, along with appropriate preventive measures. The application of the method can considerably facilitate the exploitation of the results of the risk assessment, with immediate beneficial consequences on ensuring the safety, health and well-being of workers in various fields of industrial activity.*
Keywords: *hazardous phenomenon, SUVA, occupational risk, aggregate probability index, exposure, elevator fitter*

1. Introduction

An evaluation method for occupational risks is always welcome when it can constitute a step forward from the existing situation [1], because:

- allows establishing the current situation from the point of view of Safety and Health at Work and implicitly the working conditions - it can be a useful report for potential investors [2].
- allows the identification and assessment of specific risks from a certain area of the economic unit or from a workplace - in order to mitigate them. We know that most risks cannot be eliminated - but they can be reduced below a certain level of hazard to the human operator and to the property [3];
- provides assistance to managerial decision-making processes - especially for processes that refer to the allocation of resources; we know that there is no economic operator/company with "*too much money*" and we also know that managers will generally be very reluctant to invest in protective means and procedures as long as they are not convinced that they are not losing more than they are gaining [4];
- provides a quantification of a certain identified risk (through the evaluation operation), quantification that allows the occupational protection specialist and the manager to make decisions if the respective risk must be mitigated or if it can be survived with it in order to achieve some immediate objectives - under the conditions no one is hurt. Also, quantification offers the possibility of risk ranking - necessary for the mitigation plan and the allocation of resources [5];
- offers the hope of real safety for personnel exposed to the respective occupational risks [6];

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vol. 31, issue 4 / 2025
pp. 78-94

- offers the hope of real safety for the community of which the economic agent is a part [7].
- can provide, in certain situations, a global picture at the level of the industrial branch or even at the national level - for the launch/optimization of some protection programs - for example against the risks related to working at height.

It can be seen that among those who benefit from such an assessment are the experts/specialists in the field of OSH - they obtain the necessary and extremely important data to build risk mitigation/prevention plans. It is important to make the population largely aware of this assessment; in some industries - especially in the process industry - many important companies mention such an assessment among their performance indicators. On the other hand, it is also important for the local community to accept such an economic unit and to establish relations with it - reaching a process of mutual integration [8].

For quite a few people, occupational risk assessment seems like a simple formality, a procedure intended to fill some files. This also happens because work accidents are an exception and not a rule in the course of industrial activities. Unfortunately, this approach leads to risks that can be induced by the risk assessment itself - these risks can be a starting point in determining the performance [9].

There are enough aspects related to the "*risk*" of a wrong or incomplete assessment, influenced by various external factors - so that it is necessary to identify and define some performance parameters that such a method can fulfill. The evaluation methodology should take into account two main rules [10]:

1. the assessment must analyze all potential factors in the work system.
2. the possibility of eliminating the highlighted risk factors is investigated and established

According to the above rules, different approaches or combinations can be adopted, which consist of:

- studying the types of activities from the job description, observing the types of installations,
- equipment, machinery, risk research for each type of installation, etc.
- studying the time of exposure to a certain risk
- highlighting the microclimate factors, studying the existing measurements
- the possibility of using a special questionnaire for details of the psychosocial risk
- verification of new and emerging risks

At the end, it will be checked whether the result takes into account all the amended and updated legal regulations [11]. The SUVA method for risk assessment at workplaces describes a method of analyzing and assessing risks at workplaces in the development of work processes. Such an analysis is necessary for all organizations that present particular risks [12].

2. Description of the analyzed company and the investigated project

Elevator Services LLC is a limited liability company, based in Bucharest. The company's activity has CAEN code *4321 - Electrical installation* works, over 6 years of experience in the activity of assembling and maintaining elevators, escalators and moving sidewalks, boarding ramps, self-elevating platforms for people with disabilities having around 35 workers (for office and production activity). It is authorized at the trade register regarding the safety and health at work activity both for the registered office, workplace, as well as for work at the beneficiary's headquarters. Within the contracts obtained, the company executed large-scale works such as: Hotel complexes in Poiana Brasov, Intercontinental Hotel Bucharest, Hilton Oradea Hotel, Sun Plaza Mall, Otopeni International Airport, Basarab Passage, as well as countless company headquarters and residential complexes, etc.

Regarding the Integrated Management System, the target objective is the development, implementation, maintenance and continuous improvement of a management system *Quality & environment & safety and health at work* **in accordance with the requirements of the standards in force, the company's policy in the field of quality having as objectives:**

- the provision of quality products and services, from the organization's field of activity, based on the European and national regulatory requirements in the field (elevators and escalators/escalators respectively), as well as the principles that govern this sector;
- the identification of appropriate means of work and the continuous adaptation of the procedures, in order to satisfy the explicit or implicit demands of the clients;
- cultivating competence, responsibility and a positive partnership attitude among the own staff;
- initiating actions regarding the harmonization of national regulations with European and international regulations;
- training and continuous evaluation of the staff to ensure their qualification at the level of the required requirements;

vol. 31, issue 4 / 2025
pp. 78-94

- the adoption of a high-performance management system by adopting the total quality system that includes both the quality parameters of the works/services and the actions undertaken for quality assurance and control.
- compliance with legal provisions and other requirements regarding the **safety and health at work** of employees.

Considering the above - mentioned, the company:

- complies with the current legislation on environmental protection (especially pollution prevention) and any evolution thereof, regarding the activities carried out;
- is committed to the selective collection of generated waste and packaging and to their recovery through specialized centers;
- is committed to improving the ***performance related to safety and health at work***, emphasizing the identification of accident risks, the prevention of injury and illness;
- pays full attention to the needs of training and awareness of the entire staff regarding the issues related to the implementation of the requirements of Quality, Environmental protection and Safety and Health at Work.

In terms of health and safety, it is an essential part of quality management and a priority component that will ensure that all practical measures will be taken to:

- to ensure a safe and healthy work environment for all employees in the location and to keep the location in the appropriate condition, so as to avoid any hazard for these employees;
- to take into account the potential hazards and risks to people, workplace and property;
- to adopt the preventive practice of avoiding any accident, which would lead to death, injury to persons, as well as loss or destruction of property;
- to monitor the effectiveness of the actions provided in the safety and health plans;
- to take great care and involve the staff for aspects of occupational health and safety, through information and training.

In the analyzed company, a number of 35 workers carry out their activity, and the number of people exposed at the workplace studied: 4 workers as elevator installers. From the synthetic report of the occupational medicine doctor, it is evident that all employees are „*fit to work at height*”. The company signed with the FCC-ASTALDI JV Association the contract for the supply, assembly and commissioning of vertical and horizontal transport equipment at the Basarab Passage (fig. 1). In the premises of the "Passage" they mounted:

- 4 elevators;
- 4 escalators.

Located in Bucharest, this infrastructure project is one of the largest in the last 20 years. The suspended bridge is a record in terms of being the widest in Europe, having a width of 44.5 meters and crossing the railway lines from the North Station (fig. 2). 3,600 cables anchored to the two 80-meter-high pillars each will support the massive metal structure. The 6 moving sidewalks (3 pairs) make access quick and easy between the North Station and Pasaj at ground level, and from here there will be 4 elevators and 4 escalators for access on the bridge to the tram station, two for each platform.

Fig.1. Basarab Passage - overview

Fig.2. Basarab Passage - drawbridge (suspended)

vol. 31, issue 4 / 2025
pp. 78-94

Technical data Passage:
- Total length of the construction: 1900 m;
- Total length of the bridge: 1607 m;
- The width of the passage in the area of the tram station: 44.5 m;
- The area intended for the tram station: 2000 sq m;
- The entire area of the passage: 55,880 sq m.

Escalators
- • The escalators proposed by ThyssenKrupp are the Tugela model for external use conditions, manufactured by TK Norte Spain.
- Their technical characteristics consist of a level difference of 10.20 meters, 30° inclination and speed of 0.65 m /s.

Rolling sidewalks
- The rolling pavements proposed by the company are the Orinoco model, produced at the TK Norte factory in Spain, for external use conditions.
- The 6 units have a length of 80 m each, a pallet width of 1200 mm, illuminated railing.
- With this length, the company sets a new record, being the longest in Romania, after the 75-meter one, in operation at Henri Coandă-Bucharest Airport.

Lifts
- The elevators are Evolution Flexible type, without machine room, produced at the company's top factory, in Germany.
- The 4 units have a nominal capacity of 1325 kg / 17 passengers, a stroke of 10.20 meters, speed of 1.0 m/s.

3. Material and method

3.1. SUVA method

In order to assess the occupational risks of injury at the "*Elevator Fitter*" workplace within ELEVATOR Services SRL, it was decided to use the SUVA method as it represents a dynamic method of analyzing/assessing risks at the workplace during the work process [13].

The method considers the identification of uncertainties and hazards, the assessment of the risks associated with them, the application of the calculation formulas, the estimation and assessment of the results according to the calculation grids and the generation of the final reports of the professional risk assessment. The SUVA method (fig. 3) is part of the category of analytical, semi-quantitative methods and consists, in essence, in the identification of all the risk factors in the analyzed system (workplace) with the help of predetermined checklists and the quantification of the size of the risk for each risk factor risk in part, based on the combination of severity and frequency of the maximum foreseeable consequence. The level of risk is determined for each individual job [14].

The Suva method of identifying hazardous phenomena, characteristic of the analyzed system, is characterized by a methodical "*brainstorming*" (combinations of ideas) in which the members of the team of evaluators participate, who can be both external and employees of the institution. An important condition for the most accurate and complete risk assessment is the creation of an interdisciplinary team. This team must consist of 3, 5 members led by a team leader. The team leader must have good methodological knowledge. Teamwork is organized and animated by the team leader. This team can be composed, for example, of the head of the company, a production engineer, a maintenance engineer, the plant operator, the foreman, a work safety specialist, a design engineer, a technologist. We must always make sure that the team includes people with good knowledge of the sector of activity that is subject to evaluation.

This procedure can be used both for existing systems and for those in the design phase. The Suva method helps to identify potentially dangerous phenomena at workplaces, during the processes that take place in technical installations. On the other hand, this method also relies on:
- the HAZOP procedure, a procedure for systematic investigation of malfunctions, customized for the analysis of installations in the chemical and petrochemical industry;
- on the hazard assessment guide;
- on the statistical analysis of the hazards, carried out by the insurer.

The application of the method is completed with two centralizing documents for each workplace: the risk assessment sheet and the proposed measures sheet. In the first sheet, the identified risk factors, their quantification parameters, the maximum foreseeable consequence, the severity and frequency classes, the

vol. 31, issue 4 / 2025
pp. 78-94

risk level for each individual risk factor and the global risk level at the workplace are entered. The second sheet contains the technical and organizational measures necessary to combat the action of each risk factor at the evaluated workplace, ranked according to the risk levels, starting with the very high levels. By applying these measures, the workplace goes from a higher risk level to lower levels. The method involves going through the following steps:

1. *Determining the limits of the system - defining the system;*
2. *Identification of hazardous phenomena;*
3. *Risk estimation;*
4. *Risk assessment;*
5. *Proposal of risk reduction measures - estimation of residual risk.*

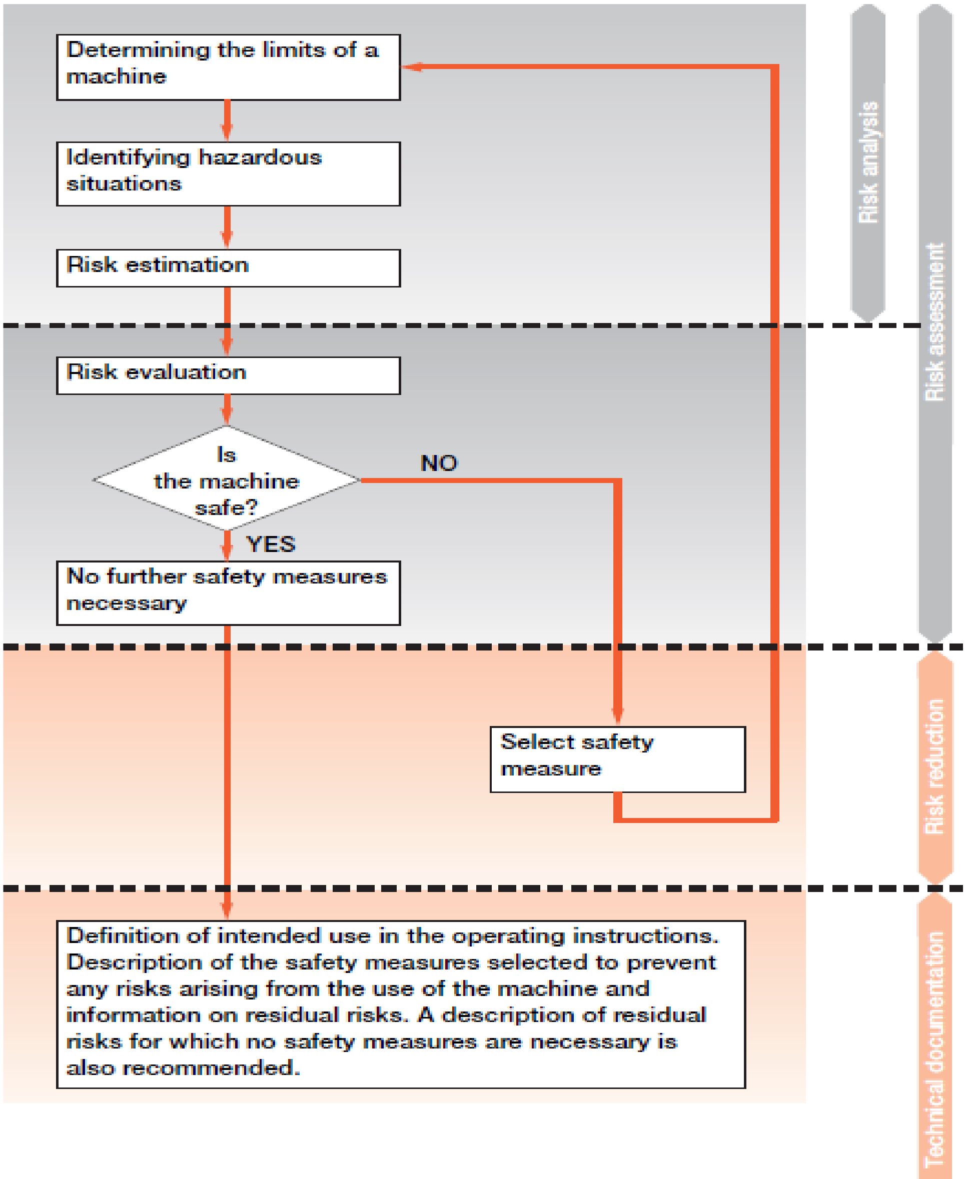

Fig. 3. Logical application scheme of the SUVA method

Every company has an organizational framework that can be structured like this:

- subdivisions (processes);
- sectors of activity;
- groups of people.

Before starting the risk assessment process, it is important to identify all other processes and sectors of activity. For organizations, which have constantly changing jobs, which employ employees (who need protection), it is recommended to list the different groups of people and groups of professions. All companies (organizations) have their activities subdivided into processes.

 vol. 31, issue 4 / 2025
pp. 78-94

The problem that must be taken into account is a process that, in turn, should be subdivided into particular processes. If the commercial company has a management system focused on processes (for example, it has implemented a quality management system according to the ISO group 9000 standard) the various processes can be represented directly.

This subdivision is recommended for companies whose employees frequently work in jobs that are not fixed, but also for companies that employ particular groups of people (people who require additional protection, such as young people with disabilities, pregnant women). An issue that must be considered is a possible combination of different subdivisions. For example, an enterprise subdivided into processes, which in the risk assessment process requires their analysis according to the sectors of activity - the requirement resulting from the classification of the sectors.

Determining the limits of the work system

Before starting the analysis, we must define the limits of the system in the activity sector or in the analyzed process. Therefore, we must define in a precise manner what is part of the system, that is, what must always be taken into account to identify hazardous phenomena, and what is located outside the system. It is advisable to divide large processes or sectors into smaller elements. If an activity sector or process contains a complex production line, composed of several activities, then the sectors or partial processes into which we have divided the activity must correspond (to the extent possible) to a phase or a process.

The interface of the system assembly with the environment, as well as the interface of the different sectors or processes in which it is divided, must be highlighted and defined. It is necessary to specify the type of hazardous phenomena analyzed, it must be indicated to whom or what the products refer to (operators, equipment, environment). On the other hand, the interactions with the neighboring installations that must be retained, as well as the aspects that do not require inspection, must be clarified and highlighted.

At the end of determining the limits of the system, for installations and machines/working systems, the following points must be clarified:

- "*life phase*" taken into account (construction, assembly, reception, use, scrapping);
- mode of operation taken into account (normal operation, cleaning, repairs, adjustment, installation);
- the limits of the machine considered for normal use (both in use and in correct operation of the machine, but also in case of malfunction or foreseeable misuse.
- the complete inventory of the ways of foreseeable use of the car (industrial, commercial, domestic);
- preparation (training) of potential users of the surroundings (environment) including: neighboring installations and the interactions between them, all potentially exposed persons;
- the type of hazardous phenomena highlighted, to whom and/or what they refer to (operators, installations, environment);
- aspects that must be taken into account, but which do not require additional control or inspections (statics of constructions, type of chemical processes).

Considering the above, when defining the system, the mode of operation analyzed must be declared, i.e. in normal, specific or maintenance operation. These three modes of exploitation are defined below.

Normal operation - the installation/machine fulfills the function for which it was designed.

Specific exploitation - refers to the preparation, transformation, installation, adjustment, verification, elimination of errors, cleaning of the installation.

Maintenance

- ✓ control (measurement, control, recording), determination (comparison) of the actual operating parameters with those provided;
- ✓ maintenance (cleaning and maintenance), measures to keep the operation of the installation at the provided (designed) parameters;
- ✓ returning the operating parameters of the installation to those foreseen in its design phase (replacing some components or sub-assemblies, improving the operation or improving it).

An important step in the SUVA method is the description of the activities (man / machine / environment). At the beginning, the different stages of the activity must be determined by activity sectors and/or manufacturing processes. All stages must be recorded in chronological order, as well as the operative ones.

The necessary steps for installing a machine, for example transporting it from point A to point B, cannot be omitted, even if the collaborators or third parties performing this operation do not constitute a direct or obvious threat (hazard). In certain situations, some activities can be regrouped. Proceeding in this way, we can reduce the time needed to assess the risks, but the accuracy of the assessment will also be reduced. Such

vol. 31, issue 4 / 2025
pp. 78-94

regrouping is indicated in the absence of major risks or when we do not analyze a certain particular configuration to highlight the main hazardous phenomena of the sector, because we use a branch solution and we will highlight only the risks specific to the company. The activities must be formulated for the three modes of exploitation listed above, namely: normal, particular, maintenance.

Hazardous phenomena identification

During this stage, we must identify the hazardous phenomena that may appear in the course of the activities described. A member of the team is in charge of drafting the minutes. The team leader chooses the first partial process, highlights the activities for all team members (can even use a flip-chart). The team starts the analysis with the first activity. Using a structured brainstorming, the team looks for hazardous phenomena that may occur in the described activity. In the appendix, we have a repertoire of hazardous phenomena that must be taken into account during the analysis. It is important to also review those hazardous phenomena for which, at this moment, it seems unlikely, or even impossible, that they will lead to an event.

The team leader must supervise that the examined process or sector is analyzed in the most complete manner. One must also choose a work rhythm that does not bore or stress the team. In the event that a discussion between two experts is prolonged, it is advisable to propose that they write down each of their points of view in the minutes, and that these be clarified outside the meeting. If we need, we can use other lists of hazardous phenomena.

3.2. Hazard identification and risk estimation at the "elevator fitter" workplace at the "Basarab Passage" construction site

The job "***Elevator fitter***" code 724112, according to the Classification of occupations in Romania, has the following characteristics:

- ***Work environment***: the activity performed takes place under normal conditions, both indoors and outdoors, in an 8-hour/day schedule; the temperature varies depending on the season and location; drafts due to working outdoors, elevator shafts.
- ***Work task***: the main work task of the job is the installation of elevators; the job holder carries out assembly activity of new installations, with strict compliance with the national and European legal provisions in force; the operations are performed "*at ground level*", as well as on ladders, platforms, scaffolding that can be classified as "*working at height*".
- ***Work equipment***: electric hand tools (flex, drill); manual hand tools - specific tool kits; stairs; mobile scaffolding;
- The ***worker (human factor):*** the fitters are organized in teams of approximately 2-3 people; the composition of a team is as follows: 1 team leader, 2 qualified fitters; each person engaged in the development of the Project has the mandatory duty to take care of both their own protection and that of the persons who may be affected by their actions or omissions at the workplace; no person must interfere, intentionally or accidentally, with an improper use of any object (equipment, device, etc.) provided for occupational safety and health; all employees will wear and use the appropriate protective equipment as well as the appropriate work tools; employees will report any accident or damage to property or equipment to the supervisor or responsible person in question; workers are encouraged to make proposals to supervisors and inspectors, regarding the improvement of labor protection.

The organization has no registered accidents/incidents. Following the analysis and direct observation of the work process and the work performed by the employee (elevator fitter), the dangerous phenomena summarized in table 1 were identified:

Table 1. Identified hazardous phenomena and potential consequences

No.	Hazardous phenomena		Hazardous events/consequences
1.	Mechanical hazardous phenomena	By contact with unprotected moving elements - rollers, couplings, gears	Crushing, crushing, cutting, shock, Sectioning, perforating, Drive, lock, grip, wrap, stab, Overturning and collision with a person, crushing, Crushing; Free fall from higher elevations; Particle design; Hitting by means of lifting and transport within the construction sites

		By contact with means of transport or work equipment in motion	
2.	Slip, wrong step, obstruction, collapse		Falling
3.	Hazardous electrical phenomena	By direct/indirect contact with electrical elements	Electrocution by direct or indirect contact
4.	Hazardous thermal phenomena	By contact with metal surfaces to be handled in the cold season.	Frostbite
5.	Constraints related to the work environment	Climate (air temperature, air currents,) Inadequate lighting	Diseases, indisposition Rapid fatigue
6.	Non-compliance with ergonomic principles	Lifting, carrying heavy loads in an inadequate posture, vicious positions	Injuries of the locomotor system (spine, joints of the limbs)
7.	Inadequate organization of the activity	Inadequate performance of the activity (organization, execution) Insufficient qualification, Insufficient training, Competences and responsibilities are not clearly defined	Different consequences

Every hazardous phenomenon can lead to a susceptible event that causes harm (a physical injury, a worsening of the state of health and/or death). For each hazardous phenomenon identified, we must evaluate the possible injury and record (through notaries in tables or grids) this. The assessment team does this.

Risk estimation

Risk represents the quantified value of a dangerous phenomenon. This value is composed of: the severity of the injury (**G**) and the probability (**P**) of this injury occurring.

$$R = f\,(G; P)$$

The probability P of injury occurrence is defined as follows:

$$P = f\,(e, p_o, L)$$

where:

- **(e)** represents the frequency and/or duration of exposure to the hazardous phenomenon considered;
- **(po)** represents the probability of occurrence of the considered hazardous event;
- **(L)** represents the possibility of avoiding or limiting harm through appropriate behavior (of the organization, the people involved or the existing measures).

As a general rule, the probability that a hazardous event occurs and the severity associated with the corresponding injury cannot always be precisely specified. It is advisable to proceed in a prudent manner, for example: “*we expect a high probability of production and significant injuries*”.

Severity of potential harm

The severity of the injury can be subdivided into 5 categories (table 2):

Table 2. Definition of severity classes

Category	**Severity of the injury**	**Defining consequences**
I	Very serious	Death
II	Serious	Serious disability
III	Less serious	Light disability
IV	Low	Injury with stoppage of activity
V	Very low	Injury without stopping the activity

vol. 31, issue 4 / 2025
pp. 78-94

- ✓ ***Serious disability*** – inability to work for the profession in question or for an equivalent profession, great influence on the quality of life;
- ✓ ***Light disability*** – reduction of work capacity for the profession in question or for an equivalent profession, reduced influence on the quality of life.

The probability of injury (likelihood)

In the following, two qualitative methods are presented for estimating the probability of injury occurrence, namely:

Statistics: the procedure to be followed for a collective risk assessment (e.g. for a branch with similar activities);

The probability P is subdivided into 5 categories, according to table 3. The estimate refers to 1000 employees performing the same activity. As helpful means, we will use (to the extent that they exist) the statistical data of the analyzed branch, regarding work accidents and occupational diseases. The figures in table 3 are only indicative values.

Table 3. Definition of probability classes

Category	**Definition of probability P**	
A	Frequent	> Once a month
B	Occasional	< Once a month > Once a year
C	Rare	< Once a year > Once in 5 years
D	Unlikely	< Once in 5 years > Once in 20 years
E	Almost impossible	< Once in 20 years > Once in 100 years

An organization may have frequent accidents and related costs higher or lower than these values, depending on its facilities, its activities, its culture for the health and safety of workers.

Based on a formula: to evaluate the probability in an organization or sector that has particular jobs, we can start from the current state, that is, we take into account the facilities and the organization of activities as they are found at the time of the evaluation. There are two possibilities for evaluating the probabilities.

We will proceed to a qualitative assessment. The probability P is subdivided into 5 categories, as we indicated for option 1 (table 4). We will define a probability index P, which is determined by three individually evaluated elements.

$$P = e + 2po + L$$

We assigned a double score to the "po" element, because the probability of a dangerous event, which results from the technical safety and activity norms, has a more important place than the other two elements.

Table 4. Definition of probability according to the aggregate probability index

Category	**Definition of probability P**	**Probability index** **P = e + 2po + L**
A	Frequent	19, 20
B	Occasional	17, 18
C	Rare	14, 15, 16
D	Unlikely	11, 12, 13
E	Almost impossible	1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Revista Minelor – Mining Revue vol. 31, issue 4 / 2025
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Index of frequency and duration of exposure to the hazardous phenomenon (e), (table 5)

Table 5. Explanation of the values of the frequency index and duration of exposure to the hazardous phenomenon

e	Exposure length
5	40h/week - full schedule
4	20h/week - schedule 50%
3	8 hours/ week – 1 day/ week
2	4h/week – ½ days/week
1	2h/week 1 – 1 day/month

The probability of occurrence of a hazardous event (po), *(table 6)*

Table 6. The probability of occurrence of a hazardousous event

p_o	The probability of occurrence of a hazardousous event po	
	5	it is obvious that this event will occur (there are no preventive measures)
	4	this event is expected to occur (weak preventive measures)
	3	the event is likely to occur (there are measures, but it is obvious that they are not enough)
	2	imaginable event, but its occurrence is not impossible (there are measures)
	1	it is difficult to imagine the occurrence of the event (measures are taken in accordance with technical progress)

The possibility of avoiding or limiting harm (L), (table 7)

Table 7. Possibility of avoiding or limiting harm

L	Possibility of avoiding or limiting harm L	
	5	• unnoticeable hazard • lack of measures, instructions • insufficiently qualified, trained, trained personnel
	3	• the existence of one or two of the criteria from point 1 (below), but which are not sufficient
	1	• hazard identified, notified • there are instructions carried out and periodically updated • good qualification, training, staff training

The probability **P** (index) of producing an injury **G** results from the summation of the values of its component elements:

$$P = e + 2po + L$$

The result of this summation can be evaluated with the help of table 4. The relationship between the different numerical values and their classification in categories from A to E has been thoroughly verified in practice.

Risk evaluation

To assess the risks we will use a risk matrix. Figure 4 shows a matrix of risks subdivided into three areas. This solution corresponds to the situation in one enterprise, but this does not mean that it is valid for all enterprises. The risks are assessed by estimating the probability and severity of the injury, in accordance with the tables presented previously. The risk matrix is defined by:

- members of the interdisciplinary assessment team,
- the employer (company manager).

Probability						
	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
	Severity					

Fig.4. The risk matrix

In the present case, it is decided that the risks included in different areas of the matrix (hierarchized) in three areas (table 8):
1. high risk level,
2. average risk level,
3. low risk level.

Table 8. The risk acceptability assessment grid used

Area 1	important risks safety is not guaranteed
Area 2	medium risks safety is not guaranteed
Area3	low risks safety is mostly ensured

The risks from area 1 are treated with priority, the risks from area two are treated next, and the risks from area three are treated last. Defining the priorities must be done before starting to treat the risks (analyzing them, determining which components we will act on and developing preventive measures). The subdivision of the matrix into the three areas is based on the personal concept (of the organization, the one agreed with the evaluation team, the one established by the safety and health policy) and it depends on the safety objectives we have established.

At the same time as establishing priorities, the applicable legislative provisions, ordinances and directives must be respected. The safety objectives must take into account, at the same time, the operating interests of the installation, but also the interests of users, collaborators, etc.

For an enterprise that operates the same installations, but in another location, the safety objectives may differ. It can set higher requirements, to which it will have to allocate adequate resources, or lower ones (correlated with the economic situation), but these must at least comply with the minimum health and safety requirements provided in the applicable legislation.

In order to be able to establish the ranking of risks and the allocation of areas in the matrix, for each risk, the organization must define its priorities in the action to protect the health and safety of workers. For this, specific prevention and protection objectives must be defined for each hazardous event identified. In this sense, we will establish, even for events that seem unlikely to occur, the conditions under which they can take place, as well as the appropriate prevention and protection measures.

4. Results and discussion

A risk assessment is carried out for each hazardous phenomenon. Both the probability that the damage will occur and its severity are estimated. The different risks are then entered in the risk matrix. The risk profile is the basis of risk management. Each identified risk is compared with the safety objective. If this objective is not achieved, appropriate protective measures must be sought again. To the extent possible, the risks must be eliminated. If the risks cannot be eliminated, then at least the probability of them happening must be reduced. Once the measures have been taken, the risks must be located in the lower left corner of the matrix. The residual risks existing in areas 1 and 2 after the implementation of the measures are noted according to the SUVA method on a form. In this form, care will be taken to indicate why the additional risk reduction was carried out. The management must be informed about the residual risks and give their consent by signing the form.

The brief description of the activities related to the work load for the job "*elevator fitter*" is summarized in table 10, and the particularities of the risk assessment are highlighted in fig. 5.

vol. 31, issue 4 / 2025
pp. 78-94

Table 9. Activity description for the assessed work position "elevator fitter"

Activity	**Remarks**
1. Picks up from the central warehouse the materials and equipment that must be installed on the respective day, after consulting the installation manual	Moving around the warehouse to pick up materials and equipment; Movements with the risk of falling due to slipping and obstruction Object manipulation Use the PPE provided
2. Checking work equipment, parts and materials	The operator moves to all technical equipment that enter the elevator component to check their technical condition. Lack of specific instructions
3. Checking the workplace - elevator shaft	Lack of signaling indicators (warning, prohibition, mandatory) Movements with the risk of falling due to slipping and obstruction Use the PPE provided
4. Assembles the components on the elevator shaft	The operator assembles the elevator components Make adjustments in case of improper operation Movements with the risk of falling due to slipping and obstruction Maintains and cleans the workplace Use the PPE provided

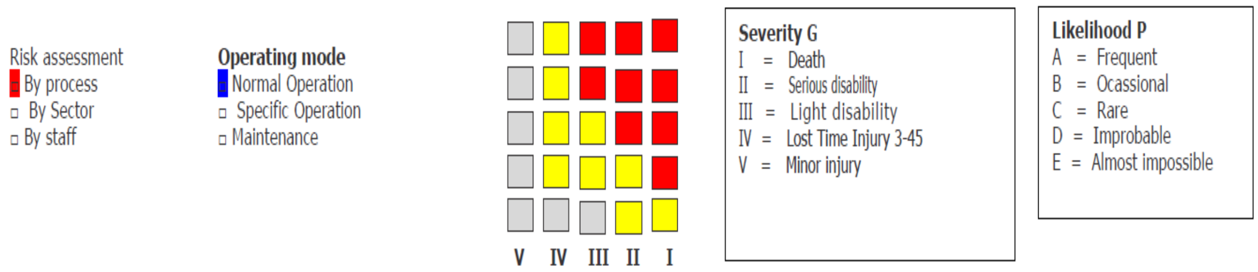

Fig.5. The particularities of the risk assessment for the "elevator fitter" job

Table 10. Synthesis of hazardous phenomena by specific activities

Task	**Specific activity**	**No**	**Hazard / Hazardous phenomenon**	**Injury**	**Risk**		**Area**
					G	P	1-3
1. Picks up from the central warehouse the materials and equipment that must be installed on the respective day, after consulting the installation manual	Moving on the access ways to the workplace - wet floors	1.1	Slipping, hindering, falling from the same level	dislocations, fractures P1.1.= e+2po+L= 5+2x3+1=12	IV	D	2
	Moving on access paths blocked by various objects on the floor or at floor level	1.2	Slipping, obstruction	dislocations, fractures P1.2.= e+2po+L= 5+2x4+3=16	II	C	2
	Object manipulation	1.3	Physical demand through work positions vicious and dynamic effort on body in handling procedures	Osteo-musculo-articular diseases due to manipulation of masses P1.3.= e+2po+L= 5+2x3+1=12	II	D	2
2. Checking work equipment, parts and materials	Moving on access paths blocked by various objects on the floor or at floor level	2.1	Slipping, falling from the same level by obstruction	dislocations, fractures P2.1.= e+2po+L= 5+2x4+3=16	II	C	2
	Contact with mobile moving elements of technical equipment	2.2	Grasping, crushing	crushes P2.2.= e+2po+L= 5+2x3+1=12	II	D	2
3. Checking the workplace - elevator shaft	Work at height	3.1	Falls from a height under the effect of gravity	crushes P3.1.= e+2po+L= 5+2x4+5=18	I	B	1
4. Assembles the components on the elevator shaft	Moving on the access ways to the workplace – wet floors	4.1	Falling from the same level by sliding	dislocations, fractures P4.1.= e+2po+L= 5+2x3+1=12	IV	D	2

	Moving on access paths blocked by various objects on the floor or at floor level	4.2	Falling from the same level by obstruction due to various objects on the floor	dislocations, fractures P4.2.= e+2po+L= 5+2x4+3=16	II	C	2
	Use of defective cables and extension cords	4.3	Contact with live elements (uninsulated cables), short circuit	Electric shock, skin burns, skin cancer, lesions of cornea P4.3.= e+2po+L= 5+2x3+1=12	I	D	1
	Checking the order and protections before the intervention	4.4	Free fall of materials from higher elevations - self-triggering of the elevators during the intervention	crushes P4.4.= e+2po+L= 5+2x3+1=12	II	D	2
	Contact with parts with edges or contours dangerously	4.5	Cutting, stabbing	Injuries, cuts P4.5= e+2po+L= 5+2x3+1=12	IV	D	2
	Contact with particles when the disc from the angle grinder accidentally breaks	4.6	Cutting, stabbing, hanging, catching	Injuries, cuts P4.6= e+2po+L= 5+2x3+1=12	IV	D	2
	Faulty handling procedures	4.7	Physical demand through vicious working positions and dynamic effort on body	Osteo-musculo-articular diseases due to manipulation of masses P4.7.= e+2po+L= 5+2x3+1=12	II	D	2

The probability **P** (index) of producing an injury **G** results from the summation of the values of its component elements:

$$P = e + 2po + L$$

The method of calculating the probability values related to the identified dangerous phenomena and defining the probability class is centralized in table 11.

Table 11. Calculation of the probabilities associated with the identified hazardous phenomena

Nr	**Hazard / hazardous phenomenon**	**e**	**po**	**L**	**P**	**Defining probability**
1.1	Falling from the same level by sliding due to the wet floor	5	3	1	12	D-unlikely
1.2	Falling from the same level by obstruction due to various objects on the floor or at floor level	5	4	3	16	C- rare
1.3.	Physical demand through vicious working positions and dynamic effort on the body in handling procedures	5	3	1	12	D-unlikely
2.1	Falling from the same level by obstruction due to various objects on the floor or at floor level	5	4	3	16	C-rare
2.2	Contact with moving parts of technical equipment	5	3	1	12	D-unlikely
3.1	Falls from a height under the effect of gravity	5	4	5	18	B-occasional
4.1	Falling from the same level by sliding	5	3	1	12	D-unlikely
4.2	Falling from the same level by obstruction due to various objects on the floor	5	4	3	16	C -rare
4.3	Contact with live elements (uninsulated cables), short circuit	5	3	1	12	D-unlikely
4.4	Free fall of materials from higher elevations - self-triggering of the elevators during the intervention	5	3	1	12	D-unlikely
4.5.	Contact with parts with hazardous edges or contours	5	3	1	12	D-unlikely
4.6.	Contact with particles when the disc from the angle grinder accidentally breaks	5	3	1	12	D-unlikely
4.7.	Physical demand through vicious working positions and dynamic effort on the body in handling procedures	5	3	1	12	D-unlikely

vol. 31, issue 4 / 2025
pp. 78-94

The final results of the risk assessment for the "elevator fitter" job, including the prevention-protection measures that need to be implemented, as well as the level of residual risks, remaining after the implementation of the measures, are systematized in table 12.

Table 12. Centralizer of residual risks and prevention / protection measures of the dangerous phenomena analyzed

No. Haz Phen	**Cause**	**Objective**	**Measures**	**Residual risk**		**Area**	**Details *(accepted measures)***	**Person in charge**
				G	**P**			
1.1	Falling from the same level by sliding due to the wet floor	Protection of the worker who moves or works in the area	Keeping the floor clean and dry The use of indicators of warning (beware wet floor)	IV IV	D E	2 3	The personnel serving the warehouse will be trained in order to maintain order and cleanliness in the warehouse premises	Warehouse manager
1.2	Falling from the same level by obstruction due to various objects on the floor or at floor level	Protection of the worker who moves or works in the area	Issuance, marking and permanent maintenance of access roads Clearing access areas of objects on the floor The use of warning indicators	II II	C D	1 2	The personnel serving the warehouse will be trained in order to maintain order and cleanliness in the warehouse premises	Workplace manager OHS officer
1.3.	Physical demand through vicious working positions and dynamic effort on the body in handling procedures	Protection of the worker	Training of workers	II III	D E	2 3	Staff will be trained	Workplace manager OHS officer
2.1	Falling from the same level by obstruction due to various objects on the floor or at floor level	Issuance, marking and maintenance in permanently free access roads Clearance of areas of access to the objects on the floor Use of warning signs	Release, marking and maintaining in permanently free of access roads Clearance of areas of access by the objects on floor Formation of operators	II III	C D	2 2	Staff will be trained	Workplace manager OHS officer
2.2	Contact with the mobile elements in movement of technic equipment	Protecting operators at the intervention at organs in movement of equipment	Personal Training Equipment PPE	II III	D E	2 3	The measures are sufficient	Manager
3.1	Falls from a height under the effect of gravity	Fall prevention from the height of workers	Training	I II	B D	1 2	Elaboration of instructions Additional personal training	Workplace manager OHS officer
4.1	Falling from the same level by sliding	Protection of the worker who moves or works in the area	Training	IV III	D D	2 3	Staff will be trained Measures are sufficient	Workplace manager OHS officer

vol. 31, issue 4 / 2025
pp. 78-94

4.2.	Falling from the same level by obstruction due to various objects on the floor	Protection of the worker who moves or works in the area	Release, marking and maintaining in permanently free of access roads Clearance of areas of access to the objects on the floor Use of warning signs	II III	C D	1 2	Elaboration of instructions Additional personal training	Workplace manager OHS officer
4.3	Contact with live elements (uninsulated cables), short circuit	Protecting operators at the intervention at electrical parts of the technical equipment Medical kits	Annual check of electrical installation by authorized companies Check at the beginning integrity exchange command and control elements	I II	D D	1 2	The measures are sufficient	Manager
4.4	Free fall of materials from higher elevations - self-triggering of the elevators during the intervention	Staff supervision Wearing PPE	Operator training Indicators of warning	II III	D E	2 3	Additional training	OHS officer
4.5.	Contact with parts with hazardous edges or contours	Protection of the worker Supervision of the activity	Equipment with PPE Operator training	IV III	D D	2 3	The measures are sufficient	OHS officer
4.6.	Contact with particles when the disc from the angle grinder accidentally breaks	Staff supervision	Wearing PPE - protective glasses; Work equipment check	IV III	D D	2 3	Additional measures are required	Workplace manager OHS officer
4.7.	Physical demand through vicious working positions and dynamic effort on the body in handling procedures	Protection of workers	Training of workers	II III	D E	2 3	The measures are sufficient	Manager

It is important to respect the following principle in choosing safety measures: ***Workers must be involved in finding solutions***. If a solution or a measure has been chosen, it must be specified in writing, if it changes, and additional clarifications related to the change. The details must also be fixed well. For certain events, it is necessary to do a thorough research on the possible causes. In practice, in general, it is impossible to eliminate the risks as a whole. Due to cost and capacity considerations, it is often difficult to put into practice, simultaneously, all the measures necessary to reduce risks. The practical implementation of these measures is done gradually, in stages, because the residual risks exist. The employer is obliged to inform the employees about the residual risks and the types of these risks.

5. Conclusions

The assessment of work safety can be carried out by analyzing the work events (work accidents, occupational diseases, nearmisses, etc.) that have taken place ("a posteriori" method) and by the pre-accident/illness assessment, which analyzes the risks before they manifest themselves in work events. Worldwide, due to the preventive value, the second option is used. Organizations can use various OHS risk assessment methods as part of their overall strategy for dealing with various hazards or activities. The method and complexity of the assessment does not depend on the size of the organization, but on the hazards associated with the organization's activities, the approach must be based on processes, hazard identification and OHS risk assessment. The frequently used methods of occupational risk assessment have a general character, they are insufficiently detailed for industrial fields with specific risks. The calculation tools required for professional evaluations are expensive, require periodic updates established by the manufacturer's policies, have difficult instructions for use, and do not present details about the meanings of the results.

OSH risk assessment criteria in the SUVA method are defined according to their scope, nature and timing, to ensure that they are proactive rather than reactive and that they are used in a systematic way.

 vol. 31, issue 4 / 2025
pp. 78-94

Carrying out occupational risk assessments is a professional activity that is regulated by legislative requirements regarding the need to ensure them and the quality of specialists. However, their application is different from specialist to specialist depending on:

- experience-own professional training (evaluation course, specialization courses, master's, doctorate);
- the environment and nature of the workplace;
- contractual requirements (employee/collaborator company, corporation, service provider).

The appearance of some changes, even specific ones, in the characteristics of the elements of the work system (human factor, work load, means of work and work environment) can lead to changes in the partial risk levels of the identified risk factors (both in the direction of increase and decrease) as well as the appearance of new risk factors. The proposed measures are of a recommendation nature, their purpose being the provision of an information base for the establishment of prevention and protection measures by the employer, within the Prevention Plan and protection, the employer's obligation in accordance with the provisions of the Occupational Health and Safety Law no. 319/2006

If it is found, during a risk assessment, that the work system is not safe enough or that the risk is too high for the group of people examined, then the appropriate measures must be reconsidered to eliminate or reduce the risks. Evaluating once again the risk with the chosen measure, it is checked if the measure effectively reduces the risk. It must also be checked on this occasion if the implementation of the new protective measures involves additional hazardous phenomena and if in this case these hazardous phenomena must be added to the existing list and a new risk assessment must be carried out.

Finding a suitable solution for safety problems qualifies first if the hazardous phenomena can be suppressed by rethinking the activity. If it is not possible to suppress the hazardous phenomenon, proceed as follows:

- elimination or reduction of hazardous phenomena by improving the activity, technical protection measures against hazardous phenomena that cannot be suppressed (decreasing the probability that the event will occur and reducing the size of the hazard);
- organizational measures (modification of work organization, arrangement of working time, training, work instructions, information about residual risks and the way of administration);
- measures relative to the personnel (PPE, training).

In general, measures must be combined to obtain the required/imposed safety level. It is important that each safety measure allows reducing the frequency and/or severity of hazardous events. To do this, we must not only take into account short-term expenses, but also long-term profitability calculations. Often a relatively expensive measure is cost-effective, as it allows reducing the number of days of long-term absence and producing savings on multiple levels.

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 vol. 31, issue 4 / 2025
pp. 78-94

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