THE MINISTRY OF EDUCATION
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DOCTORAL THESIS

THE ASSESSMENT OF INJURY AND PROFESSIONAL ILLNESS, MITIGATION-ELIMINATION SYSTEMS

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Universitatea POLITEHNICA din București

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THE FACULTY OF INDUSTRIAL ENGINEERING AND ROBOTICS

SUMMARY
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ABSTRACT

The assessment of the risks of injury and professional work is the enrichment of the action by which the existing risks at the workplace are highlighted and their size is calculated according to the severity and the probability of the maximum foreseeable consequence on the human body. Risk levels are established for each risk factor, respectively risk levels for the entire work system studied both at European and national level, the basic principles of risk assessment are standardized. In my doctoral thesis I analyzed the current situation of occupational risk assessment activities - assessment methods, community and international standards, legal requirements and legislative changes, reference works in the field, etc. We also presented the measures that are taken following the identification. and the evaluation of these professional risks.

The theoretical-experimental research resulted in the development and practical application of three methods of occupational risk assessment, which respond to the current challenges in the national economy and legislative updates in the occupational health and safety sector. In the end, we chose to promote the method that would provide practical tools for the correct and complete identification and assessment of risks, along with mitigation - elimination systems. This method has benefited from promotion in conferences, articles published in scientific journals, professional risk assessment works. The method has the advantage of developing a computer application, which allows a quick evaluation process.

The results of the research and the main contributions will consist in ensuring a high quality of the prevention of occupational accidents, the implementation of the provision of specialist tools for recording and evaluating both traditional and new and emerging risks, emerging practices and innovative technologies, reducing employers' expenses. with work events and labor force stability.

Foreword

Based on a professional experience of 20 years (1999-2019) in research and development for Safety and Health at Work at the National Research and Development Institute for Labor Protection "Alexandru Darabont" in Bucharest, as scientific researcher grade III - head of of the Laboratory for Risk Assessment and OSH Management and later Occupational Safety and Health Coordinator at BRD - Groupe Societe Generale SA (since 2019), the paper presents the theoretical and practical research as a result of which I developed three methods of occupational risk assessment, which respond to the current challenges in the Romanian economy in the Occupational Safety and Health sector. From the three, I chose the optimal, accessible method, compliant with the legislative updates in the field, for which I created an EXCEL computer application, all of which have as their final goal the prevention of work events, especially accidents and illnesses. This method has been promoted in conferences and scientific journals.

I express my gratitude to the scientific supervisor Prof. univ. dr. eng. Oana - Roxana CHIVU for guidance, support and high professionalism, throughout the duration of the doctoral studies.

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I also thank my colleagues from the "Alexandru Darabont" National Research and Development Institute for Labor Protection in Bucharest, for the two decades of collaboration and expertise (1999-2019) in the field of fundamental research and that of applied research.

I express my thanks but also the support of my doctoral colleagues with whom I collaborated during the period 2019-2023, four years with major challenges (pandemic, the threat of a new world war) and surprises of all kinds.

I thank my family for their support, encouragement and trust and those who have been with me on this "journey".

Eduard M. SMÎDU

Introduction

The relevance of the research topic "Assessment of occupational injury and disease risks, mitigation-elimination systems" contains 2 directions:
- theoretical relevance: in the current theoretical and scientific context, the importance of the theme is given by the presentation of some aspects that have not been sufficiently highlighted within the professional risk assessment methods so far (e.g. the identification of new and emerging due to innovative practices and technologies, evaluation with the help of highly addressable and accessible software or computer applications, drawing up an evaluation report for each evaluated workplace, the presence of several evaluators in the evaluation team, etc.), and this research is focused precisely on filling these gaps. The theoretical data updates or necessary additions are easy to make and do not require major changes in the application; it was taken into account that the field of safety and health at work (OSH) is a dynamic one, technology evolves, some dangers disappear, new ones appear instead.
- applied relevance: the importance and actuality of the theme from an applied point of view are highlighted by the practical use of new tools for identifying and evaluating professional risks, specific to current challenges (pandemic, threat of a new world war, climate change, population aging, migration workforce, etc.) and to determine, through the mitigation-elimination systems, safe and healthy working conditions, but also the awareness of aspects related to health and safety in industrial activity, the formation of an OSH culture of the personnel who carry out their activity in industry but also in the other branches of the national economy, it offers the people who ensure the management of Safety and Health at Work the practical possibility to optimize the allocation of resources intended to avoid the occurrence of work events (accidents, diseases).

* * *

In the first part of the doctoral thesis, I studied the current situation of the professional risk assessment activity - assessment methods, community and/or international standards, legal requirements and legislative changes, reference works in the field, etc. I also presented the current situation regarding the measures taken following the identification and evaluation of these professional risks.
In the second part of the doctoral thesis, as a result of the research carried out regarding the current state, I presented the elaboration of three evaluation methods and the final choice of one, which:
• to provide practical tools for the correct and complete identification and assessment of risks, along with mitigation - elimination systems, for optimizing the allocation of resources intended to avoid work events.
• to have high applicability, to be able to be used in almost all branches of the national industry, but also in other economic activities,
• be accessible to specialists in the field.
This method has benefited from promotion in conferences, articles published in scientific journals, professional risk assessment works. The method has the advantage of developing a computer application, which allows a quick evaluation process.
The last chapter of the thesis presents the research results, the novelties and the improvements brought so that they help all those involved in risk assessment - managers, specialists in Occupational Safety and Health, workers.

Chapter 1. Study on the assessment of occupational risks and assessment methods

1.1. Introduction

Risk assessment is an action by which the existing risks at workplaces/work stations are highlighted and their size is calculated according to the severity and probability of the maximum foreseeable consequence on the human body. Risk levels are established for each risk factor, respectively risk levels for the entire work system studied [C01, E01].

On a European level, the basic principles of risk assessment are standardized [P03,R07], can be seen in table Table 1.1.

Table 1.1. European Norms [P03,R07]

Crt. No.	European Norm	Description
1.	CEI STANDARD 812/1985	risk represents the probability of producing an injury or disease to the human body with a certain severity and probability of consequences
2.	EN ISO 12100-1:2003 STANDARD	establishes the quantification of the risk as the severity and the probability of the maximum foreseeable consequence of the risk on the human body
3.	EN ISO 14121-1:2007 STANDARD	establishes the principle of risk assessment by identifying the risks in the analyzed system and quantifying their size based on the combination of severity and the probability of the maximum foreseeable consequence on the human body

At the national level, the field of risk assessment is regulated [L01,M01], can be seen in table Table 1.2.

Table 1.2. National regulations [L01,M01]

Nr. crt.	**Regulation**	Description
1.	LAW ON SAFETY AND HEALTH AT WORK NO. 319/2006: ontains provisions aimed at the obligation of risk assessment	- according to art. 7, para. 4, lit. a) the employer has the obligation to assess the risks for the safety and health of workers, including: • the choice of work equipment, • of chemical substances or preparations used, • when setting up workplaces the employer has the obligation to carry out and be in possession of a risk assessment for safety and health at work, including for those groups sensitive to specific risks, in art. 12, para. 1, lit. a).
2.	RULES FOR THE APPLICATION OF LAW NO. 319/2006	GD no. 1425/2006, with subsequent amendments.

1.2. Theoretical Premises

Specific concepts are used to identify and evaluate professional risks. Next I will present the most important concepts [C01].

1.2.1. Work system

In any economic activity, regardless of the nature of the work process, the following elements are involved, in relations of interaction and influence, in order to achieve a single goal [P01,E01]:

- the worker,
- means of production,
- work task,
- work environment.

In other words, the elements involved in a work process form a system made up of four components: worker – means of production – work load – work environment and which was called work system [P01,E01].

1.2.2. Risk factors

Risk factors represent the factors of the work system likely to interact with the state of integrity and health of workers, which can cause damage [C01,E01]. For this, it is necessary that the deviations from the optimal functioning of the work system form a sequence of causal events, with the final link being the victim's contact with the agent causing the injury. For this reason, we consider the deregulation of the elements of the work system to be the potential reasons for injury and illness, respectively risk factors for occupational injury and/or illness, that is, in short, the risk factors [C01, P01].

1.2.3. Severity

This concept, severity, refers to the consequences of the manifestation of risk factors on the physiological and psychological integrity of workers. Severity is estimated according to the following [P01,E01]:

- the severity of the injuries (mild – which is reversible, serious – which is most often irreversible, ie disability or death);
- the magnitude of the manifestation of the consequence (one or more people).
- the type of protected objective (objects, people);

The severity of the consequences is given by a qualitative scale, starting from the above definition method, and the consequences could be, as follows[C01,E01]:

- temporary inability to work, disability, death, psychological effects etc.

1.2.4. Probability

Another very important concept is the probability of damage occurring during exposure to risk factors [C01,E01]. From the MIL–STD-882 C standard, probability represents the frequency of a work event [C01,E01].

For a real determination of the probability of a damage, follow [C01,M01,P01]:

- the frequency and duration of exposure which are determined by the time spent in the dangerous area, the frequency of access, etc.
- the probability determined by the statistics regarding the frequency of accidents and occupational diseases, etc.
- the possibilities of limiting the consequence of a dangerous event depending on the worker, risk awareness, etc.

1.2.5. Risk

An important concept is that of the actual risk, i.e. the occurrence of an effect of a certain severity, depending on the exposure to the risk factor and the probability of producing a consequence during this exposure [C01,E01]. The notion of occupational risk is characterized by a ratio between the probability of occurrence and the severity of the consequences applied to a dangerous "event" in the context of a work process. If we refer to EN 292-1, the occupational risk [C01,E01] is given by the severity of the foreseeable consequence and the probability of producing this consequence.

1.2.6. Acceptable risk

Although the legislation does not specify about the acceptable risk, it mentions that it is necessary that the risk has the lowest possible value [C01,E01].

1.2.7. Prevention

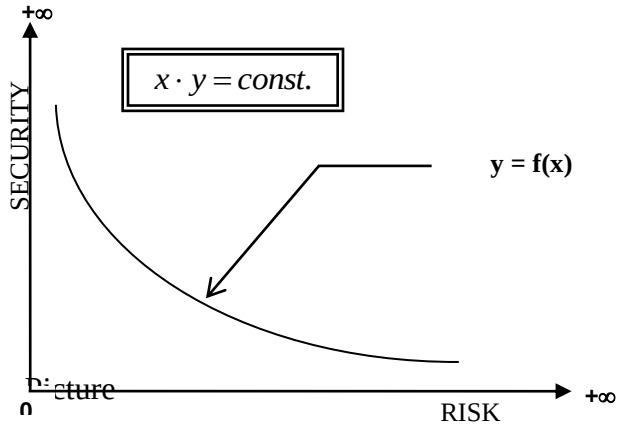
Prevention consists of measures that can eliminate the risk, reduce the severity, reduce the probability, decrease the exposure. These are technical and organizational measures [C01,E01].

1.2.8. Protection

In the absence of preventive measures, which eliminate the risk, it is necessary to resort to means of protection worn by the worker to mitigate the consequence and consist of boots, gloves, glasses, etc. [C01].

1.3. Risk, security

Taking into account the usual meanings, security is the situation of the work system in which the risk of injury is non-existent. So, security and risk are two opposite notions, which exclude each other and such absolute states cannot be achieved [C01,E01]. If security is a function of risk $y = f(x)$, where: $y = \frac{1}{x}$, then a system will be even more so sure, the lower the risk level will be and vice versa. For zero risk it follows that the security tends to the infinite plus and if the risk tends to the infinite plus, the security tends to zero according to the curve in picture 1.4 [C01,P01].



Picture 1.4. Risk, security chart [C01,P01]

In reality, the difficulty of defining the curve y=f(x), determines that the security objectives of the work system should be expressed through a grid with risk classes [C01, P01].

1.4. Risk assessment

According to the SR EN 1050 standard, the risk assessment consists of an action made up of several stages, which allow the analysis of the dangers manifested in the work processes.
The risk assessment is carried out:

- every time there is a change that affects the perception of risks,
- when using new devices, machines, etc
- when the working conditions change [C01, P01].

1.4.1. Assessment

This assessment consists in analyzing the risks of a work process, after which the risks are classified as acceptable or unacceptable [C01]. The information needed to assess the occupational risks of a work system is presented in the Table 1.3.

Table 1.3. The information necessary for the assessment of professional risks

Information	
❖ **specific to the components of the work system**	❖ **other relevant information**
• documentation for the exploitation of the means of production – technical books, operating instructions, list of dangerous substances	• statistical data of work events
• information on work environment factors - noxious, noise, radiation, microclimate determination bulletins • information about the energy supply	• statistics of technical incidents
• information on the content of the job - job description	• information regarding the impact on workers' health.
• the level of training, experience or skill of the staff;	• other data related to affecting the integrity of workers

The implementation of the security of a work process is based on the assessment of risks.

1.4.2. Method of assessment

Metodologia trebuie să ţină cont de două reguli principale:
1. evaluarea trebuie să analizeze toţi factorii potenţiali din sistemul de muncă
2. se cercetează şi stabileşte posibilitatea eliminării factorilor de risc evidenţiaţi

Conform regulilor de mai sus pot fi adoptate diferite abordări sau combinaţii, care constau în [C01]:

- studierea tipurilor de activităţi din fişa postului, observarea tipurilor de instalaţii, aparatură, utilaje, cercetarea riscurilor pentru fiecare tip de instalaţie etc
- studierea timpului de expunere la un anumit risc
- evidenţierea factorilor de microclimat, studierea măsurătorilor existente
- posibilitatea utilizării unui chestionar special pentru detalii ale riscului psihosocial
- verificarea riscurilor noi şi emergente

La final se va verifica dacă rezultatul ţine cont de toate reglementările legale modificate şi actualizate.

1.4.3. Professional risk assessment methods

The assessment of work safety can be carried out by analyzing the work events (work accidents, occupational diseases, 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.Currently, the most important existing a priori methods are:

1. Routine controls and checks [P01]: their objective is to identify through direct observation the defects of equipment, machinery, etc. They are indicated for the company, department, workplace, installation.

2. Methods using the Heinrich model, developed in the "human-centered" stage [P01] – this model aims to identify dangerous actions and dangerous conditions. The German Heinrich proposed a model of the genesis of occupational accidents in which the focus is on dangerous actions This model has good effectiveness in determining worker errors [M05].

3. Methods that use the theory of system reliability, are used for uncomplicated systems, but do not take into account the human factor; among the most well-known methods is the analysis of failure modes and their effects (AMDE) [S06]. According to CEI Standard 812/85, the work tools are tables. The evaluation can also be quantitative, if the probability of producing each mode of failure is determined, and the method will be "analysis of the modes of failure, their effects and the critical level" (A.M.D.E.C.) [A01].

4. Methods based on the ergonomics of the systems, which have the advantage of a great possibility of improving the system's operating status, but analyzing the HSE aspects indirectly [P01]. The most used method at European level is the Hazop Method (Hazard Operability).

At the national level, the most used is the INCDPM "ALEXANDRU DARABONT" method. The necessary steps in risk assessment by this method are the following [E01,P01,M02]:

• identification of risks that includes: description of the system, the team that evaluates professional risks, identification of risks (with the help of the list of risks)

• the assessment itself includes: determination of severity and probability, partial risk levels, performing calculations for the system's risk level

• proposal of measures (sheet of measures). The risk assessment is completed by completing the assessment form, can notice in picture picture 1.6. [E01,P01,M02].

Unitatea: ..... **Secţia: .....**		**Fişa de Evaluare**	**Nr. Lucrători: ……....** **Durata Expunerii: .....**			
Loc de muncă:			**Echipa de Evaluare: .....**			
Componenta	Factori de Risc	Manifestarea Factorilor de Risc	Conse-cinţa Maximă Previ-zibilă	Clasa de Gra-vitate	Clasa de Frec-venţă	Nivel de Risc
0	**1**	**2**	**3**	**4**	**5**	**6**

Picture 1.6. Evaluation sheet [E01,P01,M02]

Other known methods used in Europe:

• LOPA method - Layer of Protection Analysis (LOPA) [L03], is another evaluation method. LOPA allows the analyst to make consistent decisions about the adequacy of existing or proposed layers of protection against an accident-prone scenario.

• FMEA method - Failure Mode and Effects Analysis (Analysis of Failure Modes and Effects) [F02] consists of analyzing potential failure modes in a system for severity classification or determining the effects of failures in the system. It is used very widely, the analysis of the effects refers to the consequences of these failures.

Chapter 2. Study on prevention and protection measures, mitigation-elimination systems

2.1. Occupational Health and Safety measures - the legal basis

In Law no. 319/2006 on occupational health and safety, the employer has two categories of obligations, general and specific. In order to become operational, most of the general obligations in art. 6 and 7 of the Law must be translated into specific measures [L01, D04]. Specific obligations are found in art. 12 - 13 of Law no. 319/2006, Chapter I Section 4 and does not require explanation [L01] and can be transposed as such in the programs of measures. Directive 89/391/EEC establishes the relationship between risks and measures, as well as employers' obligations in this regard. In order to achieve safety at work, two steps are taken:

• assessing risks for the safety and health of employees and identifying those who do not can be avoided;

• establishing appropriate measures for risks that cannot be avoided; the measures will ensurea high level of protection of occupational safety and health of workers and must cover all activities and organizational levels, including situations where employees from several companies work in the same unit [D05].

2.2. Prevention and protection plan

Law no. 319/2006, through the provisions of art. 13, lit. b, stipulates the obligation of managers to create and apply annually a plan of measures for the risks highlighted in the assessment [L01]. Depending on their nature, these measures are:

• preventive measures, which mitigate - eliminate risks from the work system;

• protective measures, which ensure the reduction of the possibility of exposure of the worker to the action of risk factors.

As a rule, the action of a risk factor is eliminated/diminished by several measures, one of which is mandatory of an organizational nature (OSH training). Likewise, a measure can act on several risk factors [C01, P01]. Depending on the result, the measures can be:

• organizational measures for the worker and the work load

• technical measures for the means of production and the work environment [C01].

2.2.1. The economic efficiency of the prevention and protection plan

The plan needs to contain economically efficient measures, so that their implementation does not negatively affect the profit of the organization or the negative effect is as small as possible [D04]. However important the protection of workers may be and regardless of how severe the legal regulations may be, the top management of any industrial organization aims to maximize profit. This means that for every leu invested in an action, the organization will aim to obtain the greatest possible benefit. To be as convincing as possible, such a plan must not only contain the amount of expenses that should be incurred. He must show in what sense and

to what extent they will affect the profit of the organization and demonstrate that the selection of actions that brings the greatest benefits to the company or, at least, the least loss, has been carried out [D04, P01].

2.2.2. Participatory nature of the plan

The development of the prevention and protection plan [L01] requires ensuring a significant consultation from the employees. The specialized literature in the field of OSH emphasizes the need to use as a management tool the active involvement of all employees in the adoption of decisions that directly concern them. Prevention and protection measures primarily impact workers. Therefore, a realistic plan of measures is the one based on the widest possible consultation of the employees of the respective organization [D02, D04].

2.3. Criteria for selecting measures

As a result of the evaluation, the necessary prevention plan is decided for the work system, by applying two criteria [D02, D04]: the level of risk and the economic efficiency of the application of the measure.

2.3.1. The risk level criterion

As it can be seen from what was presented in the previous chapter, achieving safety and health at work means going through three stages:

- identification of risks for each workplace;
- the actual assessment by establishing the severity and the probable frequency of occurrence a the foreseeable consequence on the worker of the action of the identified risk factors, respectively the level of risk per risk factor;
- establishment of mitigation-elimination systems through which the risks can be acted upon. After establishing the level of risk per risk factor, two rankings can be obtained: of jobs and of risk factors [C01, D04]. First, the actions will be directed towards the workplaces where the highest risk levels have been calculated. Another hierarchy of measures is as follows [E01, P01]: intrinsic prevention measures, collective protection measures, individual protection measures.

2.3.2. The criterion of economic efficiency

The selection of measures will be made not only according to the level of risks they will eliminate or reduce, but also according to the cost-benefit ratio. Risk being a function of two variables - the severity of the consequence and the frequency of its occurrence, it can be shown mathematically that the same level of risk can be obtained in various situations. For example, we consider two risk factors, whose action on the worker materializes in one case, in a work event with Temporary Incapacity for Work, and in the second - with the death of the victim, but also with massive irregularities in the process of production. The probable frequencies of occurrence of the two consequences are different, but at certain values of them, the values of the risk level for the two factors are equal. However, from the point of view of the losses suffered by the company, the first accident is very insignificant, while the second one can seriously reduce the profit, up to the bankruptcy of the organization, as for example, a fire that would destroy a large number of technical equipment, apparatus etc. [D04,P01].

Chapter 3. Conclusions regarding the current state of risk assessment and mitigation-elimination systems

From the analysis of the current stage of research and development in risk assessment and mitigation - elimination systems, the following conclusions are highlighted:

• At the European level, risk assessment is a standardized activity (see § 1.1.).

• At the national level, the risk assessment activity is regulated by:
  - Occupational health and safety law no. 319/2006, updated
  - The norms of application of the Law on safety and health at work no. 319/2006 - GD no. 1425/2006, updated.

• Specific concepts are used to identify, evaluate and prevent these professional risks. The most important concepts are: work system, risk factors, severity, probability, risk, prevention and protection (see § 1.2.).

• Risk assessment consists of a thorough investigation of a work process, after which the highlighted risks fall into a category (eg "acceptable"), specific to the evaluation method

• The assessment methodology follows two main rules:
  - the assessment identifies and analyzes all the risk factors in the chosen system
  - for each identified factor, it is monitored whether the associated risk can be eliminated

• The assessment of work security can be achieved by:
  - analysis of work events (work accidents, occupational diseases, etc.) that took place ("a posteriori" method)
  - the pre-accident/disease assessment, which analyzes the risks before they manifest in work events (see § 1.4.).

• Worldwide, due to its preventive value, the second option is used.

For the most important a priori methods, we performed the SWOT analysis (Table 3.1.)

Table 3.1. SWOT analysis

Crt No	Method	Purpose/ objective	Strengths	Weaknesses	Opportu-nities	Threat
1.	**Check-list for checks**	-highligh-ting the defects of the technical equipment	-good effectiveness for mechanical risks -for installation, job,enterprise	-design deficiencies are not taken into account - do not take into account the errors of the worker	-they can be used when the risks are obvious and major	- the analysis is general and there is the possibility of an occupational accident
2.	**The Heinrich model**	-identifi-cation of the actions and the conditions at risk	-good effectiveness in establishing the errors of the executor	-difficult quantification - methods are non-participative	- it can be done by observing the work system	-the methods focus on the analysis of the operator's actions

3.	**AMDE Method**	- the level of risk in the system is evaluated	- direct, inductive method (causes – effect) - high efficiency in the design phase	- takes into account only the technical factor -can lead to extensive tables for simple systems	- it can be an efficient means for work safety studies	- high cost, -there is a possibility of a work accident
5.	**HAZOP Method**	-making the worker-machine system more efficient	-direct observation, deduction on the system	- it is used only in the case of industrial systems	-identi-fying risks through observation and checklist	-requires special rigor for application
6.	**LOPA Method**	- quantita-tive assess-ment, through barriers to avoid important events	-each scenario is identified dangerous, generated of the associated risks process	- does not present measures necessary to avoid a possible accident	- analyze the protection barriers; -preven-tion dangerous events	- the probabi-lity of a major accident with material and human losses

• The analysis of these methods shows the need to develop a method with a wider area of application. For this you need:

- identification of all risk categories, including new and emerging risks;
- the highlighting and quantification of risks, means and specific notions of evaluation, the evaluation itself, the development of a complex evaluation form;
- drafting the evaluation method (see § 1.4.).

• From Law no. 319/2006, it appears that the employer has two categories of obligations, general and specific. In order to become operational, most of the general obligations in art. 6 and 7 of the Law must be translated into specific measures. Specific obligations are in art. 12 - 13 of Law no. 319/2006, Chapter I, Section 4 and does not require clarification and can be transposed as such in the programs of measures (see § 2.1.).

• The prevention and protection plan must include measures that are also efficient from an economic point of view, so that their implementation in practice does not negatively affect the profit of the organization or the negative effect is as small as possible (see § 2.2.).

• The selection of measures will be made not only depending on the level of risks that they will eliminate or reduce, but also on the cost-benefit ratio (see § 2.3.).

Chapter 4. Directions, main objective and research-development methodology for the assessment of occupational injury and disease risks

4.1. Research and development directions

The main directions of research and development in accordance with the current state of professional risk assessments:

• Development of professional risk assessment methods, which take into account the current working conditions and are in accordance with the updated legislation;
• Applying the new methods in practice, by identifying and evaluating professional risks at various workplaces in the national economy;
• Realization of the mitigation-elimination systems of professional risks for each method and their application in practice;
• Elaboration of the computer application in Microsoft Excel for the professional risk assessment method considered optimal, the most complete of the three;
• Comparison of the optimal method with other traditional methods of occupational risk assessment.

4.2. The main objective of the research-development activity

Knowing the data and conclusions drawn from the analysis of the current state, as well as the directions of research and development regarding the assessment of the risks of occupational accidents and diseases, the main objective of the doctoral activity is determined: the development of three methods of assessment of occupational risks, which respond to the challenges current national economy and legislative updates in the OSH sector, and one of the three methods will benefit from a computer application in Microsoft Excel and will be promoted in conferences and scientific journals, the final goal being the avoidance of work accidents and occupational diseases.

To fulfill the main objective, the following specific objectives were proposed:

• Identifying the essential requirements regarding the assessment of professional risks and mitigation-elimination systems;
• Establishing the ways of using in practice new tools for identifying and evaluating professional risks, specific to current challenges and evaluation methods;
• Research, development and implementation of new risk assessment methods professional;
• Development and testing of the IT application in Excel for the EVA-RISK Method;
• Indication of future research directions regarding the improvement of the methods of assessing the risks of occupational injury and illness, of mitigation-elimination systems.

4.3. Research and development methodology

The methodological benchmarks are as follows.
(1) The assessment of occupational risks is carried out on the components of the work system - the worker, the workload, the means of production and the work environment [L01].
(2) The assessment is based on a matrix of severity and probability for the assessed workplace. Currently, it is considered that sufficient experience has been accumulated in risk management at the national level for the use of a matrix with 5 classes of severity and 5 classes of probability illustrated in picture 4.1. [D03]. I developed and applied such a method together with colleagues from the Laboratory for Risk Assessment and OSH Management within INCDPM Alexandru Darabont, a method for assessing occupational risks called MEVA, published in 2019 [D03]. As a result, I chose that the three methods developed in the work have each matrix with 5 severity classes and 5 probability classes.

			Probability Classes				
			1	2	3	4	5
			Rarely	Rare	Infreq-uently	Frequent	Very frequentl y
Severity classes	5	Very Serious	(5,1)	(5,2)	(5,3)	(5,4)	(5,5)
	4	Serious	(4,1)	(4,2)	(4,3)	(4,4)	(4,5)
	3	Big	(3,1)	(3,2)	(3,3)	(3,4)	(3,5)
	2	Medium,	(2,1)	(2,2)	(2,3)	(2,4)	(2,5)
	1	Small	(1,1)	(1,2)	(1,3)	(1,4)	(1,5)

Picture 4.1. Severity (5 classes) and probability (5 classes) grid [D03]

The risk level for a job or workplace, for all three methods, was calculated as a weighted average of the risk levels specific to the evaluated risks [D03,E01,P01], according to the relationship (4.1.).

$$Nr = \frac{\sum_{i=1}^{n} f_i \bullet F_i}{\sum_{i=1}^{n} f_i} \quad (4.1)$$

in which:

No - the level of risk in the workplace
fi - the rank of the risk factor i
Fi - the risk level for risk factor i
n - no. risk factors in the system

Is chosen $f_i = F_i$ to avoid the effect of compensation of extremes, and the obtained result to highlight the real situation as accurately as possible [D03,E01,P01].

(3) Due to legal requirements, the basic steps of the three assessment methods are the same:

- identification of risk factors [L01], actual assessment,
- proposing preventive measures.

The elements that make the difference between the three methods are:

- identification of risk factors with specific lists [E01, P01]
- the way to determine the probability,
- the centralized evaluation form, the mitigation-elimination systems form,
- field of use.

The evaluation methodology, in addition to the basic stages, also contains the operations below:

- observing the work environment (temperature, lighting, noise, gases, dusts, etc.);
- analysis of the way workers perform work tasks;
- analysis of external factors (meteorological factors for working outside);
- analysis of psycho-social factors, etc

It should be specified that the evaluation methodology contains two essential rules [C01]:

- the analysis is performed on all potential risk factors;
- mitigation-elimination systems are proposed for each identified factor.

In the research process of other studies and methodologies related to occupational risk assessment, I used The Preferred Reporting Items for Systematic Reviews and Meta-Analyses - PRISMA, performing Google searches in Romanian and English in the Science Direct Freedom Collection, the Web of Science, Clarivate Analytics, Scopus, Springer Link Journals [T01]. I used keywords like: occupational safety, risk assessment, risk assessment methods,

risk mitigation, to see relevant studies on occupational risk assessment. Articles were reviewed if risk assessment methods and mitigation - elimination systems were mentioned. Although initially the searches identified a large number of articles (2700), which apparently corresponded to the established requirements, following the flow of the PRISMA diagram (identification - verification - eligibility - final selection of articles), these articles were screened step by step and only 32 articles, which gave a real outline of the current situation in the analyzed field. PRISMA systematic reviews are essential for both researchers and students, who without them would be faced with a huge volume of analysis, study and investigation on which to base their papers [T01].

Chapter 5. Elaboration and practical application of Method 1 of professional risk assessment

The development of Occupational Risk Assessment Method 1, which also includes published elements of the author [B06,D03,T01], is as follows.

5.1. Elaboration of Method 1

Considering:
• professional experience with the authors of the INCDPM Method Alexandru Darabont, Dr. Eng. Ştefan Pece and Dr. ec. Aurelia Dascălescu, within the Institute's Risk Assessment and OSH Management Laboratory,
• the research carried out in the Science Direct Freedom Collection, the Web of Science database, Clarivate Analytics, Scopus, Springer Link Journals with the help of PRISMA - The Preferred Reporting Items for Systematic reviews and Meta-Analyses - [T01,B06], I have developed Method 1 for evaluating professional risks, starting from the INCDPM Alexandru Darabont Method, known and widely used at national level.

5.1.1. Assessment stages by Method 1

In accordance with the OSH legislation, the assessment of occupational risks at workplaces in our country is carried out on the elements of the work system [E01,P01] - the worker, the work load, the means of production and the work environment. Although the main stages:

• identifying risks, assessing risks, proposing preventive measures,

are the same for such methods, there are also elements that make the difference between them. Thus, the proposed Method 1 has the following characteristics, compared to the INCDPM Method:

• applies only to jobs for which there is a statistic of work events (accidents, illnesses),
• has 2 lists to identify risk factors, list 2 from Method 1 completes the list of risks from the INCDPM Method,
• the risk matrix is defined by 5 severity classes and 5 probability classes, resulting in 5 risk levels [D03],
• mitigation - elimination systems are contained in a form with technical and organizational measures.

For Method 1, the steps are as follows:

- formation of the evaluation team,
- job description on its components,
- identification of risk factors,
- actual assessment of professional risks,
- establishing preventive measures,
- the final report.

The evaluation is centralized in a form that contains, in addition to the identified risks, the risk level of each risk determined based on the gravity-probability couple.
The application of the method contains the final report which, simply and succinctly, will highlight the following aspects:

• analysis of risks and levels on important factors

• results obtained, with the level of risk determined at the workplace [E01,P01] analyzed and references to the two evaluation forms and with the proposed measures of Method 1.

5.1.2. The professional risk assessment tools by Method 1

The evaluation stages by Method 1, presented above, are carried out using the following work tools:

- two lists for identifying risks;
- the severity and probability of damage to the body;
- scale of risk levels, job evaluation form;
- the mitigation-elimination systems form (preventive measures).

I detail the tools:
• List 1 contains common risks, found in other methods (eg INCDPM Method, MEVA Method, etc.) [E01, D03, P01, B06], as presented in Table 5.1.

Table 5.1.List 1 [E01,B06,D03,P01]

CRT. No.	LIST 1 - FOR THE IDENTIFICATION OF RISKS
MEANS OF PRODUCTION	
1.	moving subassemblies [E01]
2.	motor vehicles [E01]
3.	self-triggering, self-locking of technical equipment [E01]
4.	sliding materials, parts, etc.
5.	rolling materials, subassemblies, etc.
6.	overturning technical equipment [B06]
7.	rolling on wheels
8.	free fall parts, materials [B06]
9.	free flow
10.	surprise, collapse
11.	design [P01]
12.	recoil deflection [P01]
13.	dangerous contours [P01]
14.	pipeline routes under pressure
15.	excessive temperature of some objects [P01]
16.	flames, fire [E01]
17.	electrocution – shock [E01,B06]
18.	working with dangerous substances [E01]
19.	cultures with microorganisms - viruses, etc. [E01]
WORKING ENVIRONMENT	
20.	excessive air temperature
21.	air currents [E01]
22.	noise
23.	vibration

24.	inadequate lighting
25.	non-ionizing/ionizing radiation [D03]
26.	earthquake, tornadoes, falling trees, flood
27.	pneumoconiogenic powders [E01]
28.	toxic/caustic/flammable gases, vapors, aerosols [E01]
29.	dangerous microorganisms [E01]
30.	harmful flora and fauna
31.	dangerous people - verbal and physical aggression
WORK TASK	
32.	wrong working methods
33.	physical overload [E01]
34.	mental overload – rhythm, responsibility, quick decisions [D03]
WORKER	
35.	wrong positioning / fixations [B06]
36.	assembly
37.	wrong settings
38.	delays
39.	demotions
40.	synchronizations
41.	accidental communications [E01]
42.	falls on the same level [E01]
43.	falls from heights [D03]
44.	skip work operations [P01]
45.	non-use of protective equipment [P01]

• List 2 for identification of risk factors completes List 1 as presented in Table 5.2. The completion of List 2 is also based on research with PRISMA [T01, B06, E01].

Table 5.2. List 2 [T01,B06,E01]

CRT. No.	**LIST 2 FOR IDENTIFICATION OF RISKS**
MEANS OF PRODUCTION	
1.	accidents with electric scooters/scooters/bicycles
2.	accidents with agricultural attachments/agricultural machinery
3.	aviation accidents [T01]
4.	electric shock - shock due to damage to cables when installing, commissioning, using and maintaining computers[B06]
WORKING ENVIRONMENT	
5.	work at high altitudes
6.	working in isolation [E01]
7.	working in an environment with low oxygen content
WORK TASK	
8.	admission to work without OSH training
9.	working with inadequate production tools [T01]
10.	incorrect placement of technical equipment [B06]
11.	tolerating deviations from technological discipline
WORKER	
12.	improper use of protective equipment

13.	performing work duties differently from valid regulations or work procedures
14.	spontaneous intervention to remedy a state of danger with destructive consequences [B06]
15.	falling from a low height - from a chair, steps, etc.

• Consequence severity grid. The damage caused to the worker's body is classified into 5 categories, as shown in Table 5.3 [E01].

Table 5.3. Consequence severity grid [E01]

Severity Classes / Consequence		**SEVERITY**
1	Small	• TIW <3 calendar days
2	Media	• TIW between 3 – 45 days
3	Big	• TIW between 45 – 90 days
4	Gravity	• Disability degree I, II, III
5	Maxim	• Death

• The probability grid - the consequences are classified according to their frequency into 5 probability classes, as presented in Table 5.4, below:

Table 5.4. The probability grid

Probability Classes / Event		**PROBABILITY**
1	Very rare	• the work event is not expected to take place (no accident in 5-10 years)
2	Rarely	• the work event takes place in exceptional situations (min. one accident between 2-5 years)
3	Infrequent	• the work event occurs occasionally (min. one accident between 1-2 years)
4	Frequently	• the work event happens frequently (min. one accident between 1 month - 1 year)
5	Very frequently	• permanent problem (min. one event per month)

• Assessment grid - picture 5.1, contains the possible combinations between severity classes and probability classes, which according to the principle of risk assessment determine the level of risk.

		Probability (classes)				
		1	**2**	**3**	**4**	**5**
Severity (classes)	**5**	**(5,1)**	**(5,2)**	**(5,3)**	**(5,4)**	**(5,5)**
	4	**(4,1)**	**(4,2)**	**(4,3)**	**(4,4)**	**(4,5)**
	3	**(3,1)**	**(3,2)**	**(3,3)**	**(3,4)**	**(3,5)**
	2	**(2,1)**	**(2,2)**	**(2,3)**	**(2,4)**	**(2,5)**
	1	**(1,1)**	**(1,2)**	**(1,3)**	**(1,4)**	**(1,5)**

Picture 5.1. Assessment grid

• The scale of risk levels, respectively security [E01] is a form - see Table 5.5, which allows the establishment of risk levels in the following categories:

Table 5.5 Risk/security levels

Risk Level		**Security Level**	
1	Very reduced	5	Very high
2	Little	4	High
3	Medium	3	Medium
4	High	2	Little
5	Very high	1	Very reduced

The job assessment form (picture 5.2.) [E01] constitutes the centralization sheet of the evaluation and includes:

- work system data
- evaluation team: evaluators, occupational medicine doctor, technologists, worker, etc
- number of workers and working time
- the identified risks, the concrete form of manifestation of the identified risks
- the maximum consequence, [severity classes / probability E01]
- the risk level of the identified factor [E01]

The mitigation-elimination systems form (measures to be proposed) is a document (picture 5.3.), which includes the preventive measures - technical and organizational, proposed to be implemented to eliminate or reduce the action of risks on workers.

Economic Unit		**Sheet of Assessment**	**No. workers Exposure time**			
Workplace			**The assessment team**			
Components system	Factor of risk	Manifestation of Risk	Maximum Foreseeable Consequence	Severity Class	Probability Class	Risk level of factor
0	**1**	**2**	**3**	**4**	**5**	**6**
Means of production						
Worker						
Work task						
Work environment						

Picture 5.2. Assessment form [E01]

Technical measures refer in particular to design and construction measures, protectors and Security devices. Technical measures are preferable to organizational measures because they do not depend on the behavior of the worker. It is important that the technical measures do not result in hindering or preventing the work that the worker is going to carry out. This can lead to situations where workers disable safety devices, exposing themselves to the risk of injury.
Organizational measures consist in the use of individual protective equipment, employee training, and the use of safe work methods.
Organizational measures rarely work in the long term if they are perceived as complicated.

WORKPLACE				
crt. no.	**Identified factors**	**Risk level**	**Mitigation-elimination systems**	**Observation**

Picture 5.3. Mitigation-elimination systems form

5.2. Experimental research on Method 1 of occupational risk assessment

Method 1 applies to the Wind Turbine Maintenance Mechanic job - this job will be evaluated by all three developed methods.
• Results obtained by applying Method 1:
The risks identified on the 4 components: Means of production

Means of production

- the active parts of the nacelle
- car accidents on the wind farm routes, collisions with agricultural hitches and agricultural machinery, etc
- self-triggering of the active parts of the turbine
- materials in unstable equilibrium
- free fall of objects, tools when working in the wind turbine tower
- malfunction of the elevator - the door opens during going up/down
- direct contact of the epidermis with unburred surfaces, sharp edges, etc.
- methane gas pipes, air compressor - danger of explosion
- negative temperature of some metal objects touched in winter
- electric shock, accidental contact with worn cables
- use of petroleum jelly, etc.

Work environment

- very hot air in the summer time in the wind tower (Taer tower=35ºC)
- negative air temperatures - winter
- strong wind in winter
- natural disasters - earthquake, blizzard, etc
- noise generated by work equipment
- eye fatigue when working with video terminals (decrease)
- dust particles when traveling on the field, in the construction site
- wasps at the base of the tower, on the inside.
- physical aggression from some people when traveling on the field

Work task

- dynamic effort, during interventions in the wind turbine tower
- requesting attention during some interventions

Worker

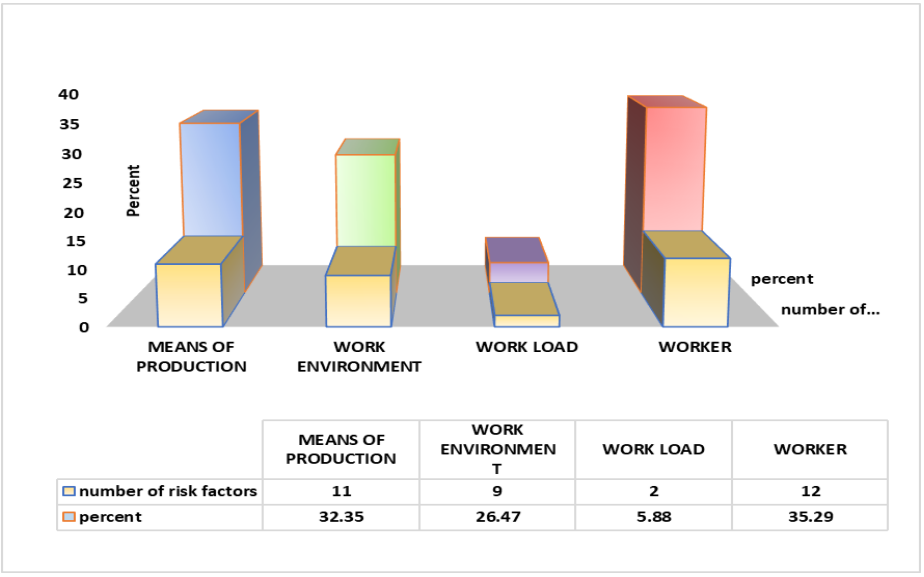
- performing tasks that are not in the job description
- interventions at elevations in adverse weather conditions (strong wind v>15m/s, lightning, etc.)
- performing some inspections during the operation of the wind turbine
- special areas, with risk of injury: installations under voltage, in the construction site, etc.
- imbalance, hindrance when moving through the wind farm
- falls from certain elevations where intervention points are established
- using the vehicle in an improper technical condition
- car use in an altered state of health
- driving the vehicle with risk of accident - prohibited maneuvers
- car speed not adapted to traffic and weather conditions
- failure to perform operations in complete safety
- interventions without wearing protective equipment

The risk level for Wind turbine maintenance mechanic is the weighted average of the levels on the identified factors and by substitution in relation (5.1) we obtain:

$$Nr = \frac{1(4x4) + 9(3x3) + 24(2x2)}{1x4 + 9x3 + 24x2} = \frac{268}{94} = \mathbf{2,85} \qquad (5.2.)$$

In picture 5.4. the weights of the factors on the components are presented, as follows:

1. 32.35% for factors of the MEANS OF PRODUCTION
2. 26.47% for factors specific to the WORKING ENVIRONMENT
3. 05.88% for factors WORK TASKS
4. 35.29% for factors of the WORKER



	MEANS OF PRODUCTION	WORK ENVIRONMENT	WORK LOAD	WORKER
number of risk factors	11	9	2	12
percent	32.35	26.47	5.88	35.29

Picture. 5.4. The weights of the four components of the work system

5.3. Conclusions

The new method developed, presented and applied in this chapter, called Method 1, contains work tools known to users of the INCDPM Alexandru Darabont evaluation method. Mastered by occupational risk assessors and implemented correctly, this method can help reduce the number of work events and maintain the health of the workforce. The risks were highlighted in two identification lists, preventive measures are presented to each described risk, which constitute the mitigation - elimination systems. Knowing the existing risk factors and their size resulting from the assessment of professional risks, the measures necessary to eliminate

or reduce the risks were established. The socio-economic effects expected to be obtained by the users of this method:
• creating safe working environments, reducing professional risks, ensuring a high quality level of activity to avoid work events (accidents, etc.);
• awareness of aspects related to health and safety in industrial activity;
• the appropriate education of the personnel from the industry but also from the other branches of the national economy.

Chapter 6. The development and practical application of Method 2 of professional risk assessment

The development of Evaluation Method 2 also includes published elements of the author [D03,B06] and looks as follows.

6.1. Development of Method 2

Method 2 is based on the STANDARD EN ISO 14121-1:2007 (formerly EN 1050) - Safety of machines. Principles for risk assessment [S08] – A.S.R.O. and proposes the assessment of the risks to which personnel working in industrial installations are exposed, in accordance with Law no. 319 of 2006 [L01] and HG 1425 of 2006 [G01], with subsequent updates and additions.

6.1.1. Assessment stages by Method 2

Method 2 includes the following mandatory stages, as was specified when developing Method 1: identification of risks in the system [C01, D03], risk assessment [C01, D03], proposal of preventive measures and is carried out on the 4 elements of the system - the means of production, the worker, the work load and the work environment [C01, D03].
This method of occupational risk assessment has the following specific characteristics:
• applies only to workplaces in industrial installations,
• has 2 lists of risk factors, one for identifying classic risks and another for identifying new and emerging risks,
• I defined 5 classes of severity and 5 classes of probability, resulting in 5 levels of risk [D03],
• the most important document of the method is the risk assessment form, which has, in addition to the identification data of the economic entity and the name of the assessed workplace, the designation of the identified risks, the risk level of each risk assessed based on the severity-probability couple, maximum foreseeable consequences, mitigation systems - elimination for each individual risk.
Method 2 has stages similar to Method 1, the difference appears when establishing the probability of injury, but also in the evaluation form:
- formation of the evaluation team, description of the workplace to be evaluated,
- the highlighting of professional risks, new and emerging risks are also taken into account,
- establishing the maximum foreseeable consequence (damage) on the human body,
- the severity of the consequence, the calculation of the probability of injury [S08],
- establishing the risk level of each risk,
- completing the risk assessment form, proposing preventive measures,
- the evaluation report.
In the case of each risk factor, preventive measures are proposed, i.e. mitigation systems - elimination of the risks identified for the analyzed workplace. The measures proposed here can help to complete the annual Prevention and Protection Plan [L01].

At the end, the evaluation report is drawn up, which briefly presents:

• the analysis carried out,

• results obtained: the risk level of the workplace, the risk levels of the identified risks and the proposed measures, etc.

6.1.2. Assessment tools by Method 2

Assessment method 2 uses the tools below:

- a list for classic risks, a list for identifying new and emerging risks,
- grid of severity of consequences,
- the exposure duration (frequency) table, the probability table for the dangerous event P0, the table of the possibility of limiting/reducing damage,
- the grid of the probability of injury,
- matrix of combinations of severity – probability, scale of risk/security levels,
- the actual evaluation form and mitigation-elimination systems.

These assessment tools are presented below as follows:

• L1 list of occupational risks - Table 6.1. [D03,E01,B06] is a systematized and highly compressed checklist. This list is the main tool used in the stage of identifying risks in installations.

Table 6.1. L1 list of occupational risks [D03,E01,B06]

WORKING SYSTEM COMPONENTS	RISK FACTORS		
MEANS OF PRODUCTION	**Mechanic**	• Dangerous movements	• moving objects, equipment • vehicle collisions, fixed structures • mechanical failures • CF derailers • self-locks[E01] • falling objects • material design [D03] • flipping components[B06]
		• Dangerous contours – sharp objects, surfaces	
		• Pressure equipment	
		• Exposure to excessive vibrations	
	Thermal	• Extreme temperatures – thermal contact	
		• Open flame[E01] • Explosion	
	Electric	• Electric shock [B06]	
	Chemical	• Hazardous substance [D03]	
WORKER	**Wrong actions**	• Defective performance of operations	- commands, maneuvers - positioning, fixations - adjustments - assemblies
		• Staggered, early, delayed interventions [D03]	

		• Activities outside work [E01]
		• Actions in dangerous areas [D03]
		• Falls from the same level [E01]
		• Falls from various heights
		• Accidental communications [E01]
		• Failure to perform safe operations
		• Lack of use of the protections provided
WORK TASKS	**Work load deficiencies**	• Faulty operations
		• Lack of operations
		• Improper working methods
	Physical strain by pulling/pushing/lifting/handling	
	Mental overload through decisions, the monotony of work	
WORKING ENVIRONMENT	**Physical**	• Extreme temperatures [E01]
		• Inadequate ventilation
		• Exposure to noise [E01]
		• Exposure to vibrations
		• Inadequate lighting
		• Contact with radioactive products, ionizing radiation
		• Exposure to non-ionizing radiation [E01]
		• Flood, blizzard, etc.
	Chemical	• Chemical agents – inhalation/ingestion/direct contact[D03]
	Biological	• Biological agents[D03]
		• Animal attacks, insects [D03]
		• Aggression from people

- A L2 list of factors associated with new and emerging risks, Table 6.2. [E02].

Table 6.2. L2 list for new and emerging risks [E02]

L2 LISTA RISCURILOR NOI ŞI EMERGENTE	
Nanomaterials - the potential to enter the human body	
New technologies - wind energy production - wind turbine syndrome	
Age - aging workforce	
Young people - insufficient skills and training	
Psychosocial risks	• high emotional consumption
	• non-existent harmony between professional life - private life [E02]
Digitization	• psychological pressures for performance
	• non-existent social interaction
Pandemics	• new viruses
	• viruses with mutations
Change climate	• continuously increasing temperature
	• violent storms

- Grid of severity of consequences (Table 6.3). The severity of the consequences of the impact on the performer is based on the most unfavorable situation and falls into 5 classes.

Table 6.3 Grid of severity of consequences

SEVERITY CLASS		DESCRIPTION
1	Negligible	TIW - under 3 days
2	Minors	TIW - over 3 days without hospitalization
3	Moderate	TIW - over 3 days with hospitalization
4	Majority	Disability (grade I, II, III)
5	Fatal	Death

where TIW – represents temporary incapacity for work.

- Determining the probability of the consequences
  It starts from the following relationship 6.1. [M06]:

$$\mathbf{Pv = F + 2Po + L\ ,} \qquad (6.1.)$$

relation that is based on the presentation of the probability in the EN ISO 14121-1:2007 STANDARD, used for machine security [S08].
The meaning of the quantities in the relationship:
F – frequency factor and duration of risk exposure, it is quantified in 3 classes, according to the table below (Table 6.4) [M06]

Table 6.4. F- frequency factor [M06]

frequency factor F	description
1	Low / very rare, less than 25% of working time
2	Medium/ between 25% and 50% of working time
3	High/frequent, more than 50% of working time

Establishing the exposure time class is done by studying work processes, observation and interview.
Po - the probability of occurrence of the dangerous event (Table 6.5.) [M06]

Table 6.5. P_0- probability of occurrence of the dangerous event [M06]

Po	description
1	Small – although apparently sufficient preventive measures are taken, the occurrence of the event could occur
2	Medium – the event is likely to occur – preventive measures are insufficient
3	Big – the event can happen at any time

Stabilirea acestei probabilităţi se face prin studierea măsurilor de prevenire existente în momentul evaluării. Astfel se dublează Po, pentru că probabilitatea producerii evenimentului periculos, care rezultă din documentele SSM, este mult mai important faţă de F şi L.
L - posibilitatea de limitare /evitare / diminuare a vătămării (Tabelul 6.6.) [M06]

Tabelul 6.6. L- posibilitatea de limitare /evitare /diminuare a vătămării [M06]

L	description
1	High: The danger is noticed - the protection measures are very good
2	Low: The danger is noticed but the protection measures are weak and ineffective

3	Non-existent: Unnoticed danger, non-existent protection measures, insufficiently qualified and trained personnel

Establishing this possibility is done by studying the existing protection measures at the time of the evaluation. Considering all possible combinations, this damage probability Pv can take values from 4 (when all elements are at the minimum level of 1) to 12 (when all elements are at the maximum value of 3). These values will lead to the classification in 5 classes of probability of the production of Pv damage, thus (Table 6.7.) [M06]:

Table 6.7 - Classification into 5 classes of probability of injury Pv [M06]

Values Pv	**Class of probability of injury (P)**	**description**
4	1	Rarely
5, 6	2	Rare
7, 8	3	Less Frequent
9, 10	4	Frequent
11, 12	5	Very Frequently

- The severity-probability combination matrix (Table 6.8.) includes the possible combinations between the severity classes and the probability classes that, according to the principle of risk assessment, determine the level of risk.

Table 6.8 - • The severity-probability combination matrix

Probability [M06]	**Severity**				
	1. Negligible	**2. Minors**	**3. Moderate**	**4. Majority**	**5. Fatal**
1. Rarely					
2. Rare					
3. Less Frequent					
4. Frequent					
5. Very Frequently					

- The scale of risk levels (Table 6.9.) allows establishing the specific risk levels of each individual risk in the following categories:

Table 6.9. The scale of risk levels

RISK LEVEL	**CLASS COMBINATIONS (S-P)**
1. Low risk	**(1,1) (1,2) (1,3) (2,1) (3,1)**
2. Acceptable risk	**(1,4) (1,5) (2,2) (2,3) (3,2) (4,1) (5,1)**
3. Medium risk	**(2,4) (2,5) (3,3) (3,4) (4,2) (4,3) (5,2)**
4. Very high risk	**(3,5) (4,4) (4,5) (5,3) (5,4) (5,5)**
5. Unacceptable risk	**(4,5) (5,4) (5,5)**

- The risk assessment form (Picture6.1.) is the centralizing document of the assessment and includes:
  - name of the organization, department, workplace, evaluation team;
  - the risks of occupational injury and illness identified;
  - concrete manifestation of the identified risks (description, parameters, characteristics, etc.), gravity / probability of the consequence;
  - risk level;măsuri propuse.

Organization:	**EVALUATION OF PROFESSIONAL RISKS**			**Working time:**
Department:				**Assessment team**:
Workstation:				
Risk Factors	**S**	**P**	**NR**	**Measures**
Means of production				
Working environment				
Sarcina de muncă				
Worker				

Picture 6.1. Risk assessment form

6.2. Experimental research on Method 2 of occupational risk assessment

Method 2 applies to the Wind Turbine Maintenance Mechanic job.
Results obtained following the evaluation by Method 2.
The factors identified on the four elements are:

Means of production

F1 - Organs of moving machines - the active parts of the nacelle
F2 - The functional movement of wind turbines produces the syndrome of wind turbines
F3 - Car accident on the wind park routes, etc.
F4 - Self-triggers: of the active parts of the turbine
F5 - Materials in unstable equilibrium
F6 - Free fall of objects from higher elevations when working in the wind turbine tower
F7-Elevator malfunction - door opens during ascent/descension
F8 - Direct contact of the epidermis with unburred surfaces, sharp edges, etc.
F9 - Methane gas pipelines, air compressor - danger of explosion
F10 - Cold surfaces touched during winter
F11-Electric shock - accidental contact with used cables, etc.
F12 - Use of petroleum jelly, etc.

Work environment

F13 - Very hot air in the summer time in the tower (Taer tower=35ºC)
F14 - Very cold air in winter
F15 - Strong wind in winter
F16 - Natural disasters – earthquake, blizzard, etc
F17 - Noise generated by work equipment
F18 - Vision fatigue when working with video terminals (SCADA)
F19 - Dust particles when traveling on the field, in the construction site
F20 - Wasps at the base of the tower, on the inside
F21 -Physical aggression from some people when traveling on the field

Work task

F22-Dynamic effort when performing some work
F23 - The psychological demand for complex interventions

Worker

F24 - Carrying out tasks that are not in the job description
F25-Interventions in adverse weather conditions (strong wind v>15m/s, lightning, etc.)
F26 - Carrying out some inspections during the operation of the wind turbine
F27-Using the elevator in the tower when it is not safe to operate
F28 - Special areas, with risk of injury: installations under voltage, in the construction site
F29 - Imbalance, obstruction when moving through the wind farm
F30-Falling from certain elevations where intervention points are established
F31-Using the vehicle in an improper technical condition
F32-Using a car in an altered state of health
F33- Driving the vehicle with risk of injury - prohibited maneuvers
F34 - Vehicle speed not adapted to traffic and weather conditions
F35 - Failure to perform operations in complete safety
F36 - Interventions without wearing protective equipment

Establishing the probability class of the consequence

• Determine F – the frequency factor and exposure duration (from 1-low to 3-high), according to Table 6.4.

• Establish Po - the probability of the occurrence of the dangerous event [M06] (from 1-low to 3-high), according to Table 6.5.

• Establish L – damage limitation (1-non-existent, 2-reduced, 3-high) – Table 6.6.

• I calculate Pv=F+2xPo+L (relation 6.1.) the probability of injury and we place the result in the probability class P (according to Table 6.7., from 1-very rare to 5-very frequent)

The calculation of the probability of damage Pv for each identified factor and the classification in the probability class P, according to Table 6.10 below.

Table 6.10 Determination of the probability class P

The identified risk factor Fn	**Frequency factor and duration of exposure**[M06] **F**	**Probability of hazardous event**[M06] **Po**	**Limitation of damage L**	**The probability of injury Pv**	**Probabi-lity class p**
F1	2	2	1	7	**3**
F2	3	2	2	9	**4**
F3	3	2	2	9	**4**
F4	2	2	1	7	**3**
F5	2	2	2	8	**3**
F6	2	2	2	8	**3**
F7	2	2	2	8	**3**
F8	2	2	2	8	**3**
F9	1	1	1	4	**1**
F10	1	1	1	4	**1**
F11	2	2	2	8	**3**
F12	2	1	1	5	**2**
F13	2	2	1	7	**3**
F14	2	2	1	7	**3**
F15	3	2	2	9	**4**
F16	2	2	2	8	**3**

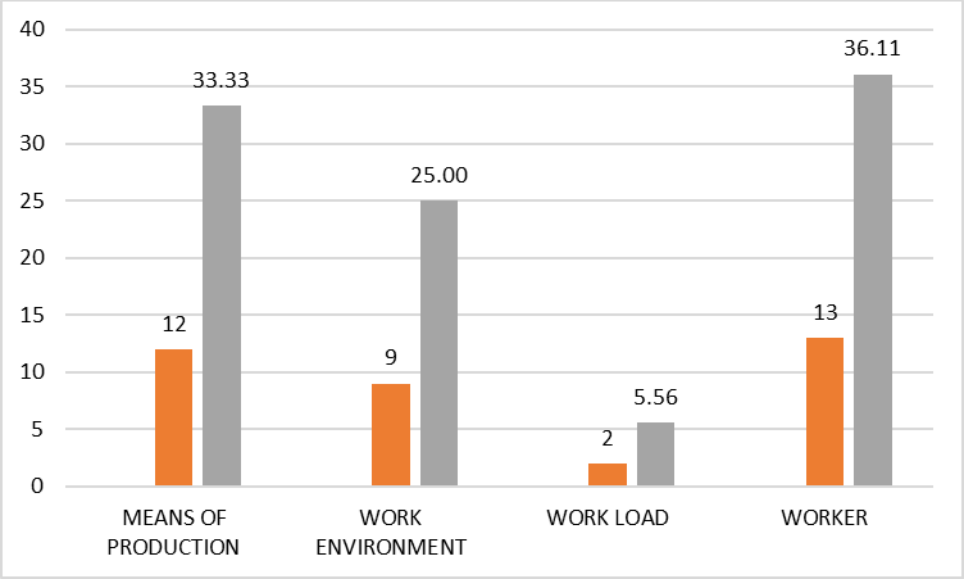
F17	3	2	2	9	**4**
F18	2	2	2	8	**3**
F19	2	2	2	8	**3**
F20	2	2	2	8	**3**
F21	2	2	2	8	**3**
F22	3	2	2	9	**4**
F23	3	2	2	9	**4**
F24	1	1	2	5	**2**
F25	1	1	1	4	**1**
F26	1	1	1	4	**1**
F27	2	2	2	8	**3**
F28	2	2	2	8	**3**
F29	2	2	2	8	**3**
F30	1	1	1	4	**1**
F31	1	1	1	4	**1**
F32	1	2	2	5	**2**
F33	2	1	1	5	**2**
F34	2	1	1	5	**2**
F35	2	1	2	6	**2**
F36	1	1	2	5	**2**

- Calculation of the risk level No. for Wind turbine maintenance mechanic - through substitution in relation (5.1) of the risk levels on the factors in the system:

$$Nr = \frac{1(4x4) + 10(3x3) + 24(2x2)}{1x4 + 10x3 + 24x2} = \frac{277}{97} = \mathbf{2,86} \qquad (6.2)$$

which falls below the medium level of risk (<3).

- Distribution of factors by components (number and percentages) in picture 6.2.



Picture 6.2. Weight of factors on components

- Table 6.11 shows the percentage value of the factors on the maximum consequences.

Table 6.11. The value of the factors on the maximum consequence

NO. FACTORS from the total of 36	VALUE [%]	MAXIMUM CONSEQUENCE
19	53	DECES
2	5	INVALIDITATE
5	14	ITM 45-90 zile
10	28	ITM 3-45 zile

6.3. Conclusions

Method 2 proposes the assessment of occupational injury and disease risks to which workers are exposed in industrial installations. This Method for evaluating the risks of occupational injury and illness elaborated contains work tools known to the users of the other evaluation methods but also new elements, compared to the INCDPM method:
• 2 lists of risk factors, one with classic risks, another completed with new and emerging risks;
• the scale of risk levels has five categories: low risk, acceptable risk, important risk, very high risk and unacceptable risk;
• the evaluation form contains both the risks and the measures for each identified risk (of course, along with the quantification of the risk level, based on the gravity-probability couple);
• the probability is classified into 5 categories, depending on the probability of injury.
The correct implementation of this method can contribute to reducing the number of work events (accidents, illnesses, etc.) and to maintaining the health of the workforce at the national, regional, local level.

Chapter 7. The development and practical application of Method 3 for the assessment of professional risks

The development of Evaluation Method 3 also includes published elements of the author [D03,S01,S02] and is presented as follows.

7.1. Development of Method 3

The evaluation method proposed in this chapter can be easily acquired and used because it contains work tools known to users of other evaluation methods (eg INCDPM, MEVA, SUVA, etc.) but also new elements.

7.1.1. Evaluation stages by Method 2

Method 3 of occupational risk assessment also contains the three main and mandatory stages [S01], as follows: risk identification in the system, the actual assessment of the identified risks, the proposal of preventive measures and is carried out by component - the worker, the task of work, the work environment and the means of production. This Method 3 differs from Method 1 and Method 2 by the following main elements:
• the central evaluation form basically has two parts: the first, on the left, presents
the assessment itself and contains the identified risks and the quantification of the risk level, based on the severity-probability couple, and the second, on the right side of the form, contains the prevention measures proposed for each risk, indicating the deadline for the implementation of the measures and the responsible workers (mitigation-elimination systems);

• the development of a highly accessible and addressable computer application in Excel for assessment that fills an existing gap in risk assessment in general, namely the lack of a computer application to simplify and speed up the assessment process;
• the evaluation grid has 5 severity classes and 5 probability classes, resulting in 5 risk levels [D03] grouped into three categories: low risk, tolerable risk and unacceptable risk [S03].

Method 3 will be called EVA-RISK and due to its main elements presented above, it will be the chosen method for promotion in conferences, scientific journals, evaluation works, online environment, etc.

7.1.2. The professional risk assessment tools by Method 3, called EVA-RISK

Method 3 or EVA-RISK uses the following tools:
- classic risk identification checklist [D03],
- checklist for identifying new and emerging risks [S01],
- grid of severity of consequences, grid of probability of consequences,
- matrix of severity-probability combinations, scale of risk levels,
- the evaluation form that also contains the mitigation-elimination systems.

The assessment tools are presented below, as follows:
• The occupational risk list is the main tool used in the risk identification stage, as shown in Table 7.1.

Table 7.1. List of occupational risks

CRT. No.	LIST OF OCCUPATIONAL RISKS
MEANS OF PRODUCTION	
	MECHANICAL RISK FACTORS [D03]
1.	vehicles, CF etc. - collisions
2.	moving machine parts of technical equipment
3.	self-triggering of technical equipment
4.	self-locking of technical equipment
5.	sliding materials, parts, etc.
6.	rolling materials, subassemblies, etc.
7.	overturning technical equipment
8.	free fall parts, materials
9.	surpare ditches, excavations
10.	collapse of stacks, trees, etc. [D03]
11.	spray particles
12.	swing [D03]
13.	recoil [D03]
14.	big shocks
15.	jet, eruption of liquids [D03]
16.	dangerous contours/surfaces: sharp/sharp/abrasive/adhesive [D03]
17.	technical equipment under pressure
18.	vibrations of technical equipment [D03]
19.	railway derailments
20.	wear or defects
	THERMAL RISK FACTORS [D03]
21.	temperatură mare a materialelor/suprafeţelor - contact direct
22.	temperatură coborâtă a materialelor/suprafeţelor - contact direct

23.	fire
	ELECTRICAL RISK FACTORS - electric current [D03]
24.	Electrocution, electric shock
	CHEMICAL RISK FACTORS [D03]
25.	working with toxic substances
26.	working with caustic substances
27.	working with flammable substances
28.	working with explosive substances
29.	working with carcinogenic substances
	BIOLOGICAL RISK FACTORS
30.	working with microorganisms: bacteria
31.	working with microorganisms: viruses
32.	working with microorganisms: rickets, spirochetes, fungi, protozoa
33.	working with animals
WORKING ENVIRONMENT	
	PHYSICAL RISK FACTORS
34.	high air temperature [D03]
35.	negative air temperature [D03]
36.	high air humidity [D03]
37.	low air humidity [D03]
38.	currents, high air ventilation
39.	high air pressure
40.	low air pressure
41.	aeroionization of air [D03]
42.	noise
43.	Ultrasound
44.	vibration
45.	low light level
46.	shine
47.	non-ionizing radiation - infrared, ultraviolet, microwave, laser [D03]
48.	ionizing radiation - alpha, beta, gamma [D03]
49.	electrostatic potential [D03]
50.	natural disasters (earthquake, landslides, lightning, tornadoes, falling trees, flood)
51.	pneumoconiogenic powders
	CHEMICAL RISK FACTORS
52.	flammable gases, vapors, toxic or caustic aerosols [D03]
	BIOLOGICAL RISK FACTORS
53.	Microorganisms - bacteria, viruses, etc. [D03]
54.	Animals, dangerous insects
55.	Dangerous people - verbal and physical aggression
	WORK IN A SPECIAL ENVIRONMENT
56.	underground/aquatic/aerial/space/ others
WORK TASK	
	WORK TASK DEFICIENCIES (OSH)
57.	wrong procedures [D03]
58.	lack of operations [D03]
	PHYSICAL REQUEST
59.	static stress / dynamic stress [D03]
60.	forced or vicious working positions [D03]

	PSYCHIC REQUEST [D03]
61.	taking responsibility [D03]
62.	checking and supervising the activities of subordinates[D03]
63.	repetitive work [D03]
64.	monotony of work [D03]
WORKER	
	WRONG ACTIONS
65.	improper execution of orders
66.	incorrect execution of some maneuvers
67.	incorrect positioning / fixings
68.	incorrect settings
69.	incorrect use of protective equipment
70.	faulty operations
71.	actions outside of work
72.	sectors with risk of injury
73.	accidental communications
74.	use of open flames (smoking, etc.) in non-permitted places
75.	equivalent level falls
76.	falls from a low height - steps, chair
77.	fall from height
	OMISSIONS
78.	skip work operations
79.	non-use of PPE and other means of protection

- List of new and emerging risks (Table 7.2), [E02,R01].

Although it does not explicitly present the concept of emerging risk, the ISO 45001 Standard includes some aspects related to new hazards, for example during the hazard identification process and the change management process [S06]. Emerging risk is any risk that is both new and growing [M04].

Table 7.2. List of new and emerging risks [E02,R01]

CRT. No.	**LIST OF NEW AND EMERGING RISKS**
MEANS OF PRODUCTION	
	NEW TECHNOLOGIES
1.	the functional movement of some equipment used in new technologies (e.g. the operation of wind turbines produces wind turbine syndrome)
	NANOMATERIALS
2.	penetration into the human body, toxicity
WORKING ENVIRONMENT	
	CLIMATIC CHANGES
3.	continuously increasing high temperature, prolonged drought, violent storms, devastating tornadoes, heavy rainfall in a short time
	pandemics
4.	new viruses / viruses that have undergone mutations
	INTERNATIONAL ARMED CONFLICT
5.	working near a war zone - accidental or intentional bombing
WORK TASK	
	PSYCHIC REQUEST
6.	working over the normal schedule / variable, unpredictable schedule
7.	professional / personal life imbalance

8.	Very high emotional demands at work
	PSYCHOSOCIAL RISKS [R01]
9.	poor organization and management of the activity
10.	inappropriate social context at work
	digitization
11.	lack of social interaction / reduction of human contact
12.	monitoring workers
13.	artificial intelligence – the takeover of leadership by super-machines
WORKER	
	VULNERABLE PERSONS
14.	disabled workers
15.	pregnant or lactating women
16.	workers with chronic diseases
	elderly
17.	the aging workforce
	YOUNG PEOPLE
18.	insufficient level of skills and training / lack of physical and emotional maturity
	IMMIGRANT WORKERS
19.	difficulties in understanding the Romanian language
	GENDER
20.	harassment / intimidation / discrimination / underestimation at work

- Consequence severity grid - as seen in Table 7.3., the severity of the consequences suffered by the worker is based on the most unfavorable situation and falls into 5 classes.

Table 7.3. Consequence severity grid

Severity (classes)	Consequence	Severity - description
1	minor	small, insignificant conditions, with TIW less than 3 days
2	medium	specific medical care and treatments, TIW in the range of 3 – 45 days
3	high	admission to the clinic, with TIW between 45 and 90 days
4	majority	disability degrees III / II / I
5	fatal	death

- Grid of probability of consequences, according to Table 7.4. (the placement in the classes of probability was based on the CEN 812/1985 standard and the MEVA Method [D03]).

Table 7.4. Consequence probability grid

Probability class	Event	Probability - description
1	very rare	It has not happened in many years (10) but a minimum of 1% is admitted as a chance of it happening; The danger is not observed in case of OH&S inspections/audits, exposure time to very little risk.
2	rare	There are quite small chances of it happening, below 30%; The hazard could be very difficult to detect during OH&S inspections/audits, short exposure time.
3	unlikely	There is a 30 to 50% chance of it happening; The hazard could be noticed during OSH inspections,

		average exposure time
4	likely	There is a 50 to 80% chance of it happening; The hazard can be easily noticed during OH&S inspections/audits, high risk exposure time
5	very likely	There are enough conditions for it to happen, over 80%; The danger is easy to notice during inspections carried out at workplace level, very long exposure time

- **The severity-probability scale** (Table 7.5.) includes the possible combinations between the severity classes and the probability classes that, according to the principle of risk assessment, determine the level of risk.

Table 7.5. Severity-probability scale

Probability	**Severity**				
	1. Minor	**2. Medium**	**3. Big**	**4. Major**	**5. Fatal**
1. Very rare					
2. Rare					
3. Unlikely					
4. Likely					
5. Very likely					

- **The scale of risk levels** (Table 7.6.) is a form that allows the establishment of risk levels in the following categories:

Table 7.6. Scale of risk levels

Risk levels		**Risk category**	**Security levels**	
1	**Minimum**	Low risk - current measures are maintained	**Very high**	**5**
2	**Small**		**High**	**4**
3	**Medium**	Tolerable risk - control measures/action plans can be introduced	**Medium**	**3**
4	**High**	Unacceptable risk - firm and immediate stop/remedial actions are required	**Small**	**2**
5	**Very high**		**Minimum**	**1**

- **The risk assessment form** (picture 7.1.) includes:

- presentation of the workplace: economic entity, department, workplace;
- the evaluation team with at least 2 experienced evaluators,
- working time;
- identified risks;
- gravity classes,
- the probability of the consequence,
- the risk level of each risk
- the measures proposed for each risk, the deadline for the implementation of the measure and the person responsible for the implementation of the measure.

ECONOMIC UNIT:	RISK ASSESSMENT FORM	WORK PROGRAM:
DEPARTMENT:		EVALUATION TEAM:
WORKPLACE:		

FACTORI DE RISC (FR)	G	P	N_f	Measures	Deadline	Responsible
MEANS OF PRODUCTION						
WORK ENVIRONMENT						
WORKLOAD						
WORKER						

Picture 7.1. Risk assessment form

N- risk level of the evaluated workplace
Nf – risk level of the assessed factor
G – the severity of the consequence
P – the probability of the consequence

The proposed measures (technical, organizational, hygienic-sanitary, others) together with the term of
achievement and the responsible person make up the mitigation-elimination systems. These measures will be taken for each identified factor. Even if all the proposed preventive measures are taken, there are risk factors that cannot be eliminated, called residual risk factors in the specialized literature. These risk factors can be kept under control through organizational measures. Statistics show that most accidents are related to non-observance of OSH instructions. As a result, there will be an emphasis on the professional training of workers for the formation of the security culture at the workplace and the awareness of occupational risks, if they do not respect the work procedures [S02].

7.2. Experimental research of the EVA-RISK method of occupational risk assessment

The EVA-RISK method applies to the following two jobs:

- Bank counter operator [S01]
- Wind turbine maintenance mechanic, which will be evaluated using the EXCEL application [S04]

The method was also applied in the case of the Occupational Medicine Doctor job evaluation [S02], but also in the case of the Research Project with an applied component, Research Performance - POCU/993/6/13/153178, from the Polytechnic University, between 2022-2023 [P05].

7.2.1. Occupational risk assessment for the job Bank Counter Operator [S01]

Results obtained following the assessent by this method:
According to the method, 23 risk factors were identified, of which the following 5 are specific to the banking activity carried out, centralized in the evaluation form in picture 7.2. [S01].

THE ECONOMIC UNITY: BANKING AGENCY	**ASSESSMENT FORM No.1**	**WORKING TIME: 8 hours**
DEPARTAMENT: F.O.		**ASSESSMENT TEAM**: Evaluators Occupational medicine doctor Agency director
WORKPLACE: Bank Counter Operator		

RISK FACTORS	S	P	N_f	MEASURES	TERM	RESPONSIBLE
F1. operation of technical equipment - money counting machines, banding machines, punching machine	3	2	3	- the provision of a medical kit - periodic OSH training	-quarterly	-counter operator -workplace manager
F2. working with money-biological contamination	3	3	3	-use of protective gel -health check	-quarterly -annual	-counter operator - workplace manager
F3. biological contamination – in contact with various people	3	3	3	- provision of masks, gloves, gel	-quarterly	- workplace manager
F4. verbal or physical aggression from some customers	3	1	2	-psychological counseling -medical kit -training on conflict prevention and resolution	- according to schedule	-counter operator - workplace manager
F5. the possibility of being the victim of an act of force committed for the purpose of robbery	3	1	2	-urgent request of qualified services	- according to schedule	-counter operator - workplace manager

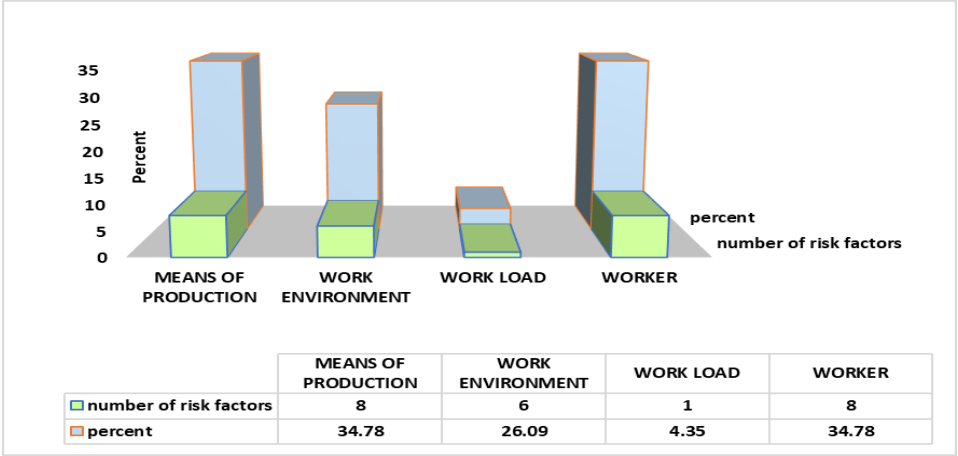
Picture 7.2. Assessment form

The following main measures were recommended:

- training workers for situations in which security events may occur;
- specialized psychological counseling;
- giving disinfectant gels to the cash handling staff;
- non-admission to work of operators who present respiratory/viral/dermatological symptoms on their palms, without the opinion of the occupational medicine doctor.

The highlighted risk distribution (picture 7.3.) [S01] is as follows:

- 34.78%, factors specific to the means of production;
- 26.09%, factors specific to the work environment;
- 04.35%, factors specific to the workload;
- 34.78%, factors specific to the worker



	MEANS OF PRODUCTION	WORK ENVIRONMENT	WORK LOAD	WORKER
number of risk factors	8	6	1	8
percent	34.78	26.09	4.35	34.78

Picture 7.3. Risk weighting [S01]

I substitute in the weighted average formula (5.1.) and obtain NR = 2.47, which is a level lower than 3 (tolerable level). In order to eliminate or reduce the identified risk factors, preventive measures were proposed in the assessment sheet.

7.3. Conclusions

7.3.1. SWOT analysis for M1, M2, EVA-RISK

In Table 7.7. below is the SWOT analysis of the three evaluation methods developed:

Table 7.7. SWOT analysis

crt no	Method	Purpose/ objective	Strengths	Weaknesses	Opportu-nities	Threat
1.	**Method 1**	- establishing the level of risk -measurable	-very high applicability in the industrial field -easy to use for those who know the INCDPM method	-insufficient updating of the risk identification list -requires accident statistics	- the measures sheet helps in risk management -reducing risks professional -the experience	-the possibility of a work accident
2.	**Method 2**	- risk presentation, risk level calculation, measures	-has 2 risk identification sheets - the assessment sheet has proposed risks and measures - the probability given by Pv = F + 2Po + L, the starting point is the EN 1050 norm on machine safety – risk assessment -adaptable for the evaluation of jobs in industry, services	- other risks also appeared, after the development of the list of risk factors	-prevention of dangerous events; - risk reduction;	- the possibility of a work accident
3.	**Method 3 EVA-RISK**	-highlighting classic risks and new and emerging risks, assessing and establishing the level of risk, elimination-mitigation systems	-it has a computer application, it has the advantage of a fast evaluation process -has 2 risk identification sheets, with most risks (plus new and emerging risks) -complex assessment sheet, with risks, with mitigation-elimination system (measures),	- the need for an antivirus -min 2 evaluators of risk experienced	-dissemination on the e-learning platform - publication of articles, presentation in conferences	- the possibility of a work accident

			deadline for implementation of measures, responsible - very high applicability			

7.3.2. Comparison of the EVA-RISK method with other evaluation methods

Next, I will compare the EVA-RISK method with two other methods [S02].
Although I.N.C.D.P.M. "Alexandru Darabont" benefits from a relatively new evaluation method, the MEVA method [D03], I will compare EVA-RISK with the best-known method here - INCDPM and a quantitative method, widely used (Spain, Portugal, Italy, Romania, etc.) - ENDESA. These 3 professional risk assessment methods are simple and can be applied to analyze and evaluate systems (installations, industrial platforms, etc.). The three methods EVA-RISK [S01], INCDPM [P01,E01] and ENDESA [M07] appear as general methods for event analysis. The AMYS methodology is used for these evaluation methods.
Below we present the evaluation stages for the three methods in comparison.
The INCDPM method has the following steps [P01,E01]:

- the presentation of the system for analysis and evaluation, the workplace is described in detail, targeted being the establishment and presentation with details of the system components and their operation; the identification of risk factors in the system: a stage that presents, according to a predetermined list, situations related to the use and improper functioning of workplace elements;
- risk assessment: quantification of severity, probability and partial level of risk; calculation of the global level of risk [P01,E01];
- presentation of measures according to the assessed risks.

The ENDESA method includes the following steps [M07]:

- workplace analysis highlighting specific elements: work load, means of production, work environment, worker.
- presentation of the factors: definition of risk agents and generation of the risk matrix;
- risk assessment: risk identified in the work area at each work station (from the applicable risk matrix), application of questionnaires in each work area (one for each factor), definition of frequency and time of exposure, definition of probability materializing the risk and defining the consequences
- application of preventive measures, intervention on positions if necessary to apply additional measures to the respective positions, reducing the risk to an acceptable level.

Compared to the 2 methods above, the EVA-RISK Method has the following stages:

- describe the workplace, the economic entity, present the identification data of the workplace, the purpose of the activity and its 4 elements; the elements of the job are presented in detail;
- with the help of the 2 checklists, classic risk factors as well as new and emerging ones are identified and entered in the evaluation sheet, which includes at least 2 experienced evaluators in the evaluation team, the working time, the severity class of the consequence and the probability class of the consequence, the level of risk on the established risks and the level of risk at the workplace; complete the measures, the deadline for the implementation of the measures and the person responsible for the implementation of the measures;
- at the end, the job evaluation report is completed.

The comparison of the three methods continues:

- in the EVA-RISK method, 5 levels of severity are quantified [S01].

- in the INCDPM method, 7 levels of gravity are quantified [P01,E01].
- in the ENDESA method, 3 levels of gravity are quantified [M07].
- in the INCDPM method, 6 levels of probability are quantified [P01,E01].
- in the ENDESA method, 3 levels of probability are quantified [M07].în metoda EVA-RISK sunt cuantificate 5 niveluri de **probabilitate** [S01].

The situation on risk levels in the case of the three methods to be compared, EVA-RISK, INCDPM "Alexandru Darabont", ENDESA is presented in Table 7.14. [S02].

Table 7.14. The level of risk on the three methods compared [S02]

EVA-RISK risk level		**INCDPM risk level**		**ENDESA risk level**	
1	Minimum	1	Minimum	5	Insignificant
2	Small	2	Very small	4	Tolerable
3	Medium	3	Small	3	Moderate
4	High	4	Medium	2	Important
5	Very high	5	Big	1	Intolerable
		6	Very big		
		7	Maximum		

In conclusion, although they are so different, the three methods have the following points in common:

- hey are based on a matrix that includes the place/installation where the activity is carried out;
- take into account the elements of the work system
- the basic stages are the same: identification of risk factors, actual evaluation, proposal of preventive measures.

However, one of the major differences is the application in EXCEL that the EVA-RISK method benefits from.

Chapter 8. Development of the IT application in Excel for the EVA-RISK Method for assessing the risks of occupational injury and illness

The development of the IT application for Evaluation Method 3, called EVA-RISK, also includes published elements of the author [S01,S02,S03,S04] and looks as follows.

8.1. Development of the IT application in EXCEL

I developed the computer application for the EVA-RISK method in Microsoft Excel, which belongs to the Microsoft Office group of programs. The tools of the EVA-RISK method developed in Chapter 7 will have to be defined and automated as much as possible in Excel. These are entered into Excel and used to generate the identified risks as the assessment sheet. Also, the possible consequences of the action of the risks on the human body are defined. The severity-probability combination matrix is used by the application to establish the risk level for each identified risk [C01] and generate measures to mitigate - eliminate the action of occupational risks. The evaluation form is the main document of the application and contains [S01,E01]:

• data related to: economic entity, department, workplace,
• the composition of the evaluation team, with at least 2 evaluators, the working time,
• the identified occupational risks, the severity and probability of the consequence,
• the risk level determined based on the severity-probability couple for each risk factor,

• mitigation systems, elimination (measures), term for the implementation of the measures, responsible for the implementation of the measures.

8.1.1. The main buttons and functions used in the computer application

The most used functions and buttons specific to the Excel program for developing the application are presented below [S04]:
• the SHEET function presents a sheet/worksheet – a single page containing cells for organizing data.
• the DATA VALIDATION function is used to present a vertical menu with predefined options.
• the FILTER function is used to filter data based on established criteria and automatically distributes the results vertically or horizontally in the worksheet, depending on how the data is organized.
• the AVERAGE function performs the arithmetic mean of a group of numbers.
• the ROUNDUP function rounds a number by addition.
• the SUM function performs the sum of numbers, cells.
• the PRODUCT function is used to multiply numbers, area cells.
• the VLOOKUP function looks for a specified value and returns a matching value from another column.
• The IF function allows making logical comparisons between a value and the expected value, it can have two results: True, False.
• the SAVE command from the menu bar saves the data, remaining in the same worksheet.
• the INSERT command from the main menu is used to insert a row, columns, graphs, as appropriate.

8.1.2. Completing worksheets

The Excel application has 5 worksheets:
1. job description,
2. identification of risks,
3. actual risk assessment,
4. graphics,
5. the evaluation report.

The order of entering information in the application is as follows:
• Completing the first worksheet - job description, which contains:
- data about the economic entity where the professional risk assessment is carried out;
- the presentation of the job on the specific components [C01, P01].

These data vary depending on the work system and will be entered each time the assessment is made.
• Adding a new worksheet - risk identification:
- this will initially contain all the risks from the theory of the EVA-RISK method;
- with DATA VALIDATION (yes/no column) we identify each risk
- we apply FILTER to the yes/no column to filter from the total risks only the risks specific to the job being evaluated (yes column)

• Adding the worksheet - risk assessment, represents the actual assessment:
- the risk assessment form is created with INSERT – TABLE
- complete the evaluation form with the risks already identified (COPY-PASTE);
- using DATA VALIDATION, complete and select the columns and values specific to severity (from 1 to 5), respectively probability (from 1 to 5), then automatically generating the level of risk specific to each factor; it was calculated as the arithmetic mean of the two values G and P, with rounding by addition, using the ROUNDUP function: =ROUNDUP((D11+E11)/2.0 enter the formula for calculating the risk level

at the workplace depending on the risk level determined on each factor [P01], using the * option and the / option.
- with DATA VALIDATION, each column with measures in the frame is automatically generated mitigation - elimination systems, then selecting the proposed measure; the same is generated in the columns with the term of the measure, respectively the person responsible for the implementation of the measure, and during the evaluation only the proposed option will be selected

• Adding the worksheet - graphics, which presents the graphic analysis of the risk assessment:
- the weight of risks on the components of a job
- the graph with the distribution of risk levels can be seen in the following figure
- the weighting of risks depending on the maximum foreseeable consequence is presented as follows, in the figure below

• Adding the worksheet containing the analysis and evaluation report

The assessment report concludes the risk assessment for the analyzed workplace and briefly presents the results of the workplace assessment.
Completing the spreadsheets will be done in the next chapter.

8.2. Experimental research in EXCEL for the evaluation of occupational risks by the EVA-RISK method

The field of green technologies is in full development and I believe that an update of the occupational risk analysis in this sector is welcome [S03]. The classic risks of occupational injury and illness are evaluated alongside the new and emerging ones, and the necessary systems to mitigate and/or eliminate these risks under current conditions are proposed [S02, S04].
We performed the assessment of occupational risks using the EVA-RISK method [S01] for a job in a wind farm in Dobrogea, namely WIND TURBINE MAINTENANCE MECHANIC. The evaluation was carried out in Microsoft EXCEL and the 5 worksheets were taken over in Word.

1. The first worksheet – description of the work system to be evaluated (selection), picture 8.19.

<table>
<tr><td>  </td><td colspan="3">ASSESSMENT OF ACCIDENT AND OCCUPATIONAL DISEASE RISKS FOR THE WORKPLACE - WIND TURBINE MAINTENANCE MECHANIC</td><td>Assessment date: 2022/05/12</td></tr>
<tr><td>WIND FARM</td><td>Doc code ER01</td><td>Doc type. Professional risk assessment</td><td>Versions no. 1.0</td><td>Printable Excel version</td></tr>
<tr><td colspan="5">1. DESCRIPTION OF THE UNIT
The Wind Park, located in Dobrogea, Constanta county, was designed for a power of 300 MW, with a total of 100 turbines grouped in 3 areas: A, B, C, contains overhead and underground cables, transmission station, switchboards distribution and a control building. This park consists of wind turbines with a capacity of 3 MW each and a maximum turbine height of 150 m (with blade blade). A 110/33kV transformer station equipped with an 80MVA transformer is built in each of the three zones A, B, C</td></tr>
<tr><td colspan="5">2. THE PURPOSE OF THE WORKPLACE ACTIVITY
The wind turbine maintenance mechanic performs maintenance operations, supervision, SCADA monitoring and inspection of the wind farm turbines.</td></tr>
</table>

3. MEANS OF PRODUCTION Wind farm: - 100 wind turbines, with an installed capacity of 3 MW each - 400kV Main Transformation Station - The 400KV national network for the transport of electricity by Transelectrica - Substations A, B, C of 110/33KV each - Specific intervention kit, spare parts, subassemblies - Flammable substances: oil, petroleum jelly - PC system, SCADA monitoring system, service vehicle
4. WORKING ENVIRONMENT The activity of the wind turbine maintenance mechanic takes place in the premises of the SCADA monitoring office and in the field during the inspection of the wind turbines. The work environment is characterized by: - mixed lighting - strong wind when traveling on land, variable temperatures, depending on the season; dust when traveling in the field
5. WORK TASK The worker's workload consists of specific operations: - online monitoring of the turbine, the substation and the main transformation station; - prepares studies, analyzes and surveys for the operating department and maintenance, using SCADA systems; - prepares diagnoses, surveys and inspects wind turbines; - administers the resources allocated for maintenance, defines the requirements related to the operation of the wind farm after commissioning phase and during production; - supervises and coordinates the intervention teams; - supervises the performance, quality of maintenance and the reports received from the maintenance teams; - takes care of the maintenance works according to the technical specifications; - provides support, supervises and takes care of meter reading at substations and the main transformation station; - supervises and provides support regarding the performance of external service works; - inspects and produces reports related to the availability of internal roads
6. WORKER The HSE preparation and training of the workers is done according to the legal provisions by the own staff employed with management functions in the organization and coordination of the work process. The worker is equipped with specific equipment: gloves, helmet, boots, belt.

Picture 8.19. Job description

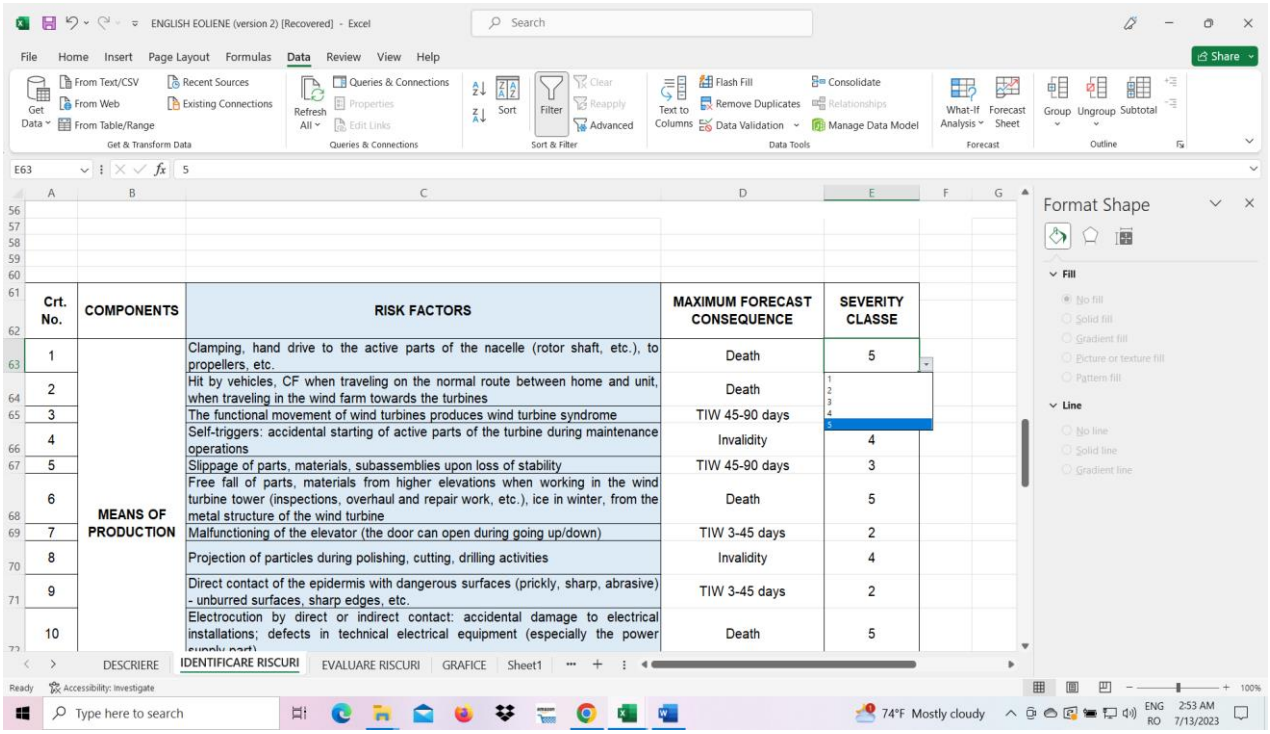
1. Second worksheet – identification of risk factors, according to Picture

LIST OF PROFESSIONAL RISKS			
0	**1**	**2**	
Crt. No.	**WORKING SYSTEM COMPONENTS**	**RISK FACTORS**	
F1	**MEANS OF PRODUCTION**	Clamping, hand drive to the active parts of the nacelle (rotor shaft, etc.), to propellers, etc.	Yes
F2		Collisions when traveling in the wind farm towards the turbines	Yes
F3		The functional movement of wind turbines produces wind turbine syndrome	Yes
F4		Self-triggers: accidental starting of active parts of the turbine during maintenance operations	Yes
F5		Slippage of parts, materials, when losing stability	Yes
F13	**WORKING ENVIRONMENT**	High air temperature in the hot season (Tair tower=35ºC)	Yes
F14		Negative temperatures in winter	Yes
F15		Noise produced by the operation of wind turbines	Yes
F16		Strong wind, especially in winter, in the wind farm	Yes
F17		Natural calamities – earthquake, lightning, blizzard	Yes
..		……..	…
F24	**WORK TASK**	Dynamic effort during interventions and inspections in the turbine - the space between the turbine wall and the elevator is narrow,	Yes

		forcing the staff to pass (crouch) under the electrical cables.	
F25		Demanding attention when driving, etc.	Yes
F26	**WORKER**	Activities performed outside of work	Yes
F27		Interventions in the turbine in adverse weather conditions (strong wind, lightning, etc.)	Yes
…		…….	…
F38		Interventions and inspections in the wind tower without means of protection	Yes

Picture 8.20. Identification of risk factors (selection)

Establishing the severity class according to the consequence – one of the 5 classes is selected, as seen in Picture 8.21.



Crt. No.	COMPONENTS	RISK FACTORS	MAXIMUM FORECAST CONSEQUENCE	SEVERITY CLASSE
1	MEANS OF PRODUCTION	Clamping, hand drive to the active parts of the nacelle (rotor shaft, etc.), to propellers, etc.	Death	5
2		Hit by vehicles, CF when traveling on the normal route between home and unit, when traveling in the wind farm towards the turbines	Death	
3		The functional movement of wind turbines produces wind turbine syndrome	TIW 45-90 days	
4		Self-triggers: accidental starting of active parts of the turbine during maintenance operations	Invalidity	4
5		Slippage of parts, materials, subassemblies upon loss of stability	TIW 45-90 days	3
6		Free fall of parts, materials from higher elevations when working in the wind turbine tower (inspections, overhaul and repair work, etc.), ice in winter, from the metal structure of the wind turbine	Death	5
7		Malfunctioning of the elevator (the door can open during going up/down)	TIW 3-45 days	2
8		Projection of particles during polishing, cutting, drilling activities	Invalidity	4
9		Direct contact of the epidermis with dangerous surfaces (prickly, sharp, abrasive) - unburred surfaces, sharp edges, etc.	TIW 3-45 days	2
10		Electrocution by direct or indirect contact: accidental damage to electrical installations; defects in technical electrical equipment (especially the power	Death	5

Picture 8.21. Severity class selection (selection)

The third worksheet – the assessment itself, picture 8.22.

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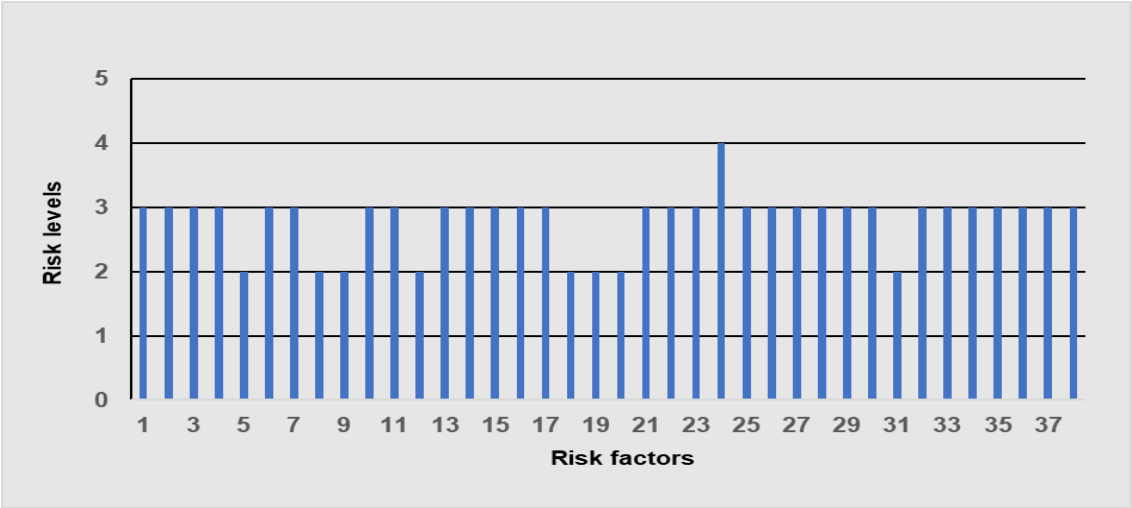
ECONOMIC UNIT: WIND PARK		ASSESSMENT FORM Nr = 2,89			WORKING TIME: 8 hours/shift					
DEPARTMENT: MAINTENANCE					ASSESSMENT TEAM: Risk Assessors OSH Responsible Worker Occupational Medicine Doctor					
WORK PLACE: WIND TURBINE MECHANIC										
1	2	3	4	5	6	7	8	9	10	11
COMPONENTS OF THE WORK SYSTEM	RISK FACTORS	S	P	N	PROPOSED MEASURES				DEADLINE	RESPONSIBLE
					technical measures	organizational measures	sanitary measures	other measures		
MEANS OF PRODUCTIONS	1. Grasping, driving the hand to the active parts of the nacelle (rotor shaft, etc.), to the propellers, etc.	5	1	3	equipping and using appropriate PPE	risk signaling	equipped with a medical kit	verification compliance OSH instructions	quarterly	manager and worker
	2. Hit by vehicles, CF when traveling on the normal route between home and unit, when traveling in the wind farm towards the turbines	5	1	3	carrying out technical inspections	periodic training and testing	periodic medical check-up	verification compliance OSH instructions	quarterly	manager
	3. The functional movement of the wind turbines produces the wind turbine syndrome	3	3	3	equipping and using appropriate PPE	periodic training and testing	periodic medical check-up	risk awareness	semester	manager
	4. Self-triggers: accidental starting of active parts of the turbine during maintenance operations	4	2	3	carrying out technical inspections	risk signaling	training, providing first aid	risk awareness	quarterly	manager and worker
	5. Slippage of parts, materials, subassemblies upon loss of stability	3	1	2	equipping and using appropriate PPE	periodic training and testing	equipped with a medical kit	risk awareness	quarterly	manager and worker
	6. Free fall of parts, materials from higher elevations when working in the wind turbine tower (inspections, overhaul and repair work, etc.), ice in winter, from the metal structure of the wind turbine.	5	1	3	the use of appropriate technical equipment	risk signaling	equipped with a medical kit	risk awareness	semester	manager
	7.7. Projection of particles during polishing, cutting, drilling activities	2	5	4	the use of appropriate technical equipment	periodic training and testing	periodic medical check-up	verification compliance OSH instructions	according to schedule	worker
	27.Interventions in the turbine in adverse weather conditions (strong wind, lightning)	5	1	3	equipping and using PPE for working at height	periodic training and testing	equipped with a medical kit	verification compliance OSH instructions	according to schedule	manager

Picture 8.22. Assessment form (selection)

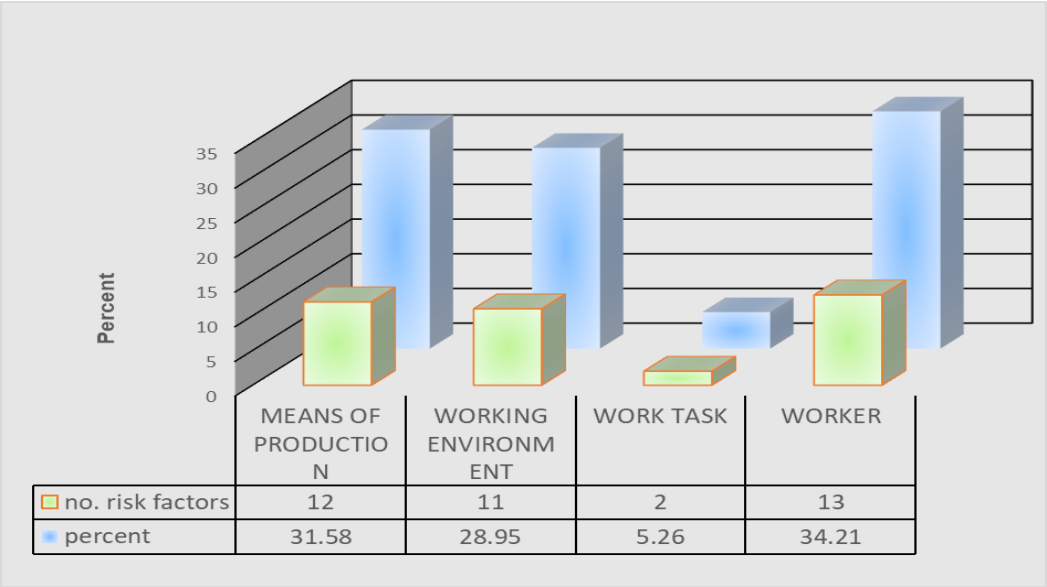
Table8.1– Determining the level of risk for Wind Turbine Mechanic

GENERAL RISK LEVEL	2.89								
	Total number of risks	Total number of risks value 5	Total number of risks value 4				Total number of risks value 3	Total number of risks value 2	Total number of risks value 1
	38	0	1				29	8	0
		0	1				29	8	0

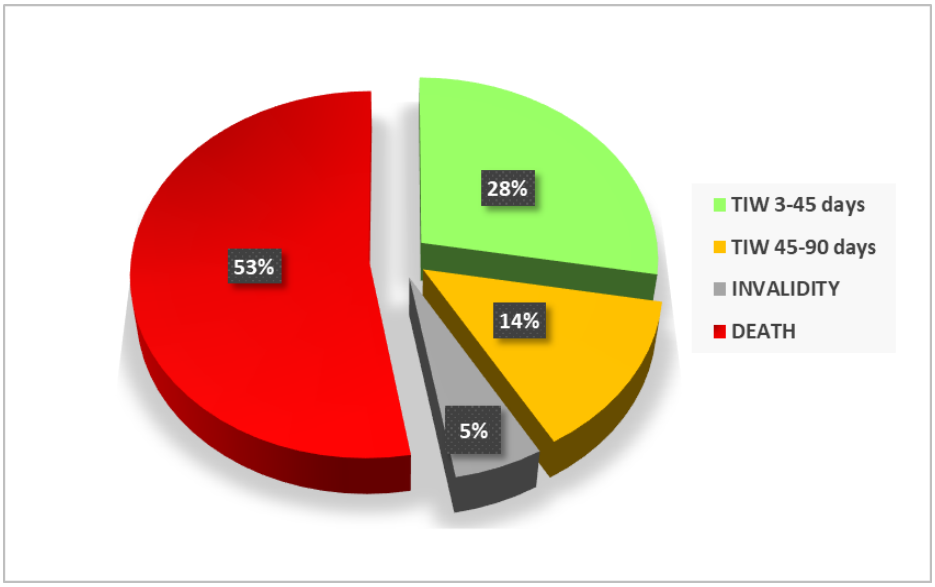
1. Fourth worksheet with Graphs (Pictures 8.23-8.25).



Picture 8.23. Risk level and risk factor



Picture 8.24. Distribution of factors by job component



Picture 8.25. Risk distribution according to consequence

	**ASSESSMENT OF THE RISKS OF ACCIDENTS AND PROFESSIONAL ILLNESS FOR THE WORKPLACE - WIND TURBINE MECHANIC**			**Date of assessment: 2022/05/12**
Wind Park	**Doc Code: ER01**	**Doc Type: Report of Assessment**	**Versions nr.: 1.0**	**Printable version: Excel**

1. The job evaluated: Wind turbine mechanic
2. The general risk level of the workplace: 2.89
3. The number of identified risk factors - 38 and the level of risk for each (picture 8.23): - no. risk factors with risk level 1: 0 - no. risk factors with risk level 2: 8 - no. risk factors with risk level 3: 28 - no. risk factors with risk level 4: 2

4. F21 - Dynamic effort, forced, vicious working positions during interventions and inspections in the turbine - the space between the turbine wall and the elevator is narrow, forcing the personnel to pass (crouch) under the electrical cables. The preventive measures for this risk are presented in the assessment sheet.
5. Distribution of risk factors on the components of the work system (picture 8.25): - means of production: 12 - work environment: 11 - work task: 2 - worker: 13
6. Distribution of risk factors according to the maximum foreseeable consequence: - TIW 3-45 days - TIW 45-90 days - Invalidity - Death
7. Conclusions: In order to eliminate or reduce the identified risk factors, preventive measures were proposed in the assessment sheet. The risk factors that cannot be eliminated, named in the specialized literature and residual risk factors, will be kept under control through organizational measures. Although the general risk level at the workplace is below level 3 (tolerable), the assessment of the Wind Turbine Mechanic workplace shows that more than 60% of the total risk factors identified are factors with irreversible consequences (death or disability).

Picture 8.26. Evaluation report (fifth spreadsheet)

Chapter 9. Final conclusions and main contributions to analysis and evaluation of occupational injury and illness risks

(1) From the analysis of the current state of risk assessment in the industrial field, important conclusions emerged, which are presented in chapter 3.
(2) Taking into account the data and conclusions from the analysis of the current state regarding the methods of assessing occupational risks in the industrial field, research and development directions as presented in § 4.1 were considered to be current.
(3) In relation to the current state and directions of research and development regarding the assessment of occupational injury and disease risks in the industrial field, it was determined as the main objective of the research and development activities within the doctorate (see also § 4.2): the elaboration of three evaluation methods and their mitigation-elimination systems, selecting one to benefit from an application in Excel and to be promoted in conferences, scientific articles, etc.
(4) The relevant conclusions regarding the doctoral research and development activity to achieve its main objective (see § 4.3), are as follows.
○ The three risk assessment methods were developed on the 4 components of the work system - the worker, the work load, the means of production and the work environment.
○ Due to legal requirements, the basic steps of the three assessment methods are common: the identification of risk factors, the actual risk assessment and the proposal of preventive measures. The elements that make the difference between the three methods are (see § 4.3): the risk identification lists, the probability determination method, the centralized assessment form, the mitigation-elimination systems form.
(5) To the main objective, this doctoral thesis brings a series of contributions, the most important of which are as follows.
• The new EVA-RISK risk assessment method contains 2 lists for identifying risk factors: one with "classic" risks and the second with new and emerging risks (see § 7.1).
• Risk levels are grouped into three categories: low risk, tolerable risk and unacceptable risk

• The evaluation sheet has two parts: the first, on the left side, presents the actual evaluation (contains the identified risks and the quantification of the risk level, based on the gravity-probability couple) and the second, on the right side, contains the proposed preventive measures for each risk, indicating the deadline for implementing the measures and those responsible for implementing the measures (see § 7.1).
• The assessment team consists of several experienced professional risk assessors (minimum 2 people) (see § 7.1).
• The proposed measures (technical, organizational, hygienic-sanitary, others) together with the deadline and the responsible persons form the mitigation-elimination systems. After taking the measures, it is found that priority are the measures for the factors whose value decreases. For risk factors that cannot be eliminated, also called residual risk factors, organizational measures are needed through which workers must be taught to form strategies to adapt to the respective factors and problems, strategies that help them to cope with various dangerous situations that they may encounter during the performance of their duties (see § 7.1).
• I developed a computer application in Microsoft EXCEL for the EVA-RISK method, which fills a gap in risk assessment, due to the lack of a computer program, which would simplify and accelerate the assessment process (regardless of the chosen method) (see § 8.1). It will be carried out at O.R.D.A. an approach for the EVA-RISK application in Excel.
• The new EVA-RISK method is an adaptable and highly accessible method through the content and application in Microsoft EXCEL elaborated (see § 8.1).

*** * ***

The scientific importance of this thesis is given by the presentation of some aspects that have not been sufficiently highlighted in the professional risk assessment methods so far (e.g. the identification based on a list of new and emerging risks arising due to innovative practices and technologies, the assessment with the help of highly addressable and accessible software or computer applications, the preparation of an evaluation report for each evaluated job, the presence of several evaluators in the evaluation team, etc.), and this research is focused precisely on filling these gaps. The practical importance of the thesis lies in the fact that the new tools developed, for identifying and evaluating professional risks, take into account the current challenges (pandemic, the threat of a new world war, climate change, population aging, labor migration, etc.) and determine through mitigation-elimination systems, safe and healthy working conditions and the formation of an OSH culture of personnel working in the industry. Perspectives - through content and application in Microsoft Excel, the developed and presented EVA-RISK evaluation method can be used by companies from different industrial branches to significantly improve their OSH management system.
The technological impact of the elaborated EVA-RISK method is given precisely by this application developed in the Microsoft Excel program, which has the following advantages:
- can be installed on any computer, laptop, smartphone that uses Microsoft Office;
- there is no need for administration, logging, additional expenses, etc.;
- the necessary changes or additions are easy to make and do not require major changes in the Excel application.
The socio-economic impact expected to be obtained by using this new method is given by:
- ensuring a high quality level of occupational accident prevention;
- reducing expenses with work events, ensuring the stability of the workforce;
- providing tools for highlighting and evaluating both traditional risks as well as the new and emerging ones, which appeared due to innovative practices and technologies.
From the research experience and the effective evaluation of jobs in the national economy, I can say with certainty that the adaptability of the EVA-RISK method makes it usable successfully in most branches of the national economy, but also in agriculture, in the financial-banking field, that of medical services, etc., in accordance with Law no. 319/2006 and HG no. 1425/2006 amended and updated.

Bibliografie

B

[B06] Badea D.O., Darabont D.C., Bucerzan D., Trifu Alina, **Smîdu E.,** Bulboacă Eugenia, Haralambie V., Occupational safety issues related to computer equipment installation, maintenance and use, 2022, MATEC Web of Conferences 354, 00001 (2022) – lucrare susţinută la 10th International Symposium on Occupational Health and Safety, SESAM 2021.

D

[D03] Darabont D., **Smîdu E.**, Trifu Alina, Ciocîrlea V., Ivan I., Bejinariu C., Baciu C., Bernevig-Sava M.A., MEVA - a new method of risk assessment of injury and professional illness MSE SIBIU 2019 - lucrare susţinută https://doi.org/10.1051/matecconf/201929012008.

S

[S01] **Smidu E**., Chivu Oana Roxana, Suciu Oana, Dumitrescu S., EVA-RISK - method of risk assessment of injury and professional illness, Acta Technica Napocensis, Series: Applied Mathematics, Mechanics and Engineering - Vol.66, nr.1, pag. 141-148, 2023 – lucrare susţinută la International Conference on Ergonomics and Workplace Management, 16-18 June 2022, Timișoara, ErgoWork.

[S02] **Smidu E.**, Chivu Oana Roxana, Darabont D.C., Gheorghe Marilena, Nițoi D., Radu C., Dumitrescu S., Enache Ioana Cătălina, Considerations on Prevention and Protections Measures Against Occupational Risks, Journal of Research and Innovation for Sustainable Society (JRISS), Volum 5, Issue 1, ISSN: 2668-0416, pag.44-50, 2023 - lucrare susţinută, martie 2023, Tg. Jiu.

[S03] **Smidu E.**, Chivu Oana Roxana, Nitoi D., Gheorghe Marinela, Butu Larisa, Borda Claudia, Bujor C., Considerations on professional risks and preventive measures in the green technologies sector, in Innovative Manufacturing Engineering & Energy International Conference, 2023 – lucrare depusă la IManEE23.

[S04] **Smidu E**., Chivu Oana Roxana, Darabont D.C., Suciu Oana, Dumitrescu S., Teleanu Raluca Ioana, Teleanu D.M., Marinescu Marinela, Identification and assessment of new and emerging occupational risks, 2023 – lucrare depusa la MDPI.

T

[T01] Trifu Alina, **Smidu E.,** Badea D. O., Bulboacă Eugenia, Haralambie V., Applying the PRISMA method for obtaining Systematic reviews of occupational safety issues in literature search, MATEC Web Conf., 354 (2022) 00052 , 2022 – lucrare susţinută la 10th International Symposium OHS Safety, SESAM 2021.