RISK ASSESSMENT METHODS

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ABSTRACT

Risk assessment is an integral part of a broader risk management strategy for introducing control measures in order to eliminate or reduce all potential consequences associated with risk. By confronting probability and consequences, and when necessary, through additional factors, we assess the risks to which workers are exposed. The identification of risks that arise as an integral part of every work process is of crucial importance for defining appropriate occupational safety measures. After identifying risks, it is necessary to evaluate them using appropriate methods. In both theory and practice, there are multiple methods, and in most cases, in neighbouring countries, no mandatory method for risk assessment is defined. When choosing a method, it is necessary to take into account the fact that the method must be systematic, easy to understand and applicable. The subject of this paper will be an analysis of the most commonly used methods. Throughout the paper, we will also provide some reflections on the existing methods and their positive and negative characteristics. The starting hypothesis is the view that without an appropriate method, there can be no adequate risk evaluation. The descriptive method was used in this paper, along with the study of available literature, both domestic and foreign.

Keywords: risk identification, risk assessment methods, occupational safety

INTRODUCTION

We live in turbulent times where rapid changes are taking place in every economic sector. Any form of "standing still" in the process of intensive changes is not merely "standing still", but rather falling behind. We are witnessing that these changes bring about improvements in the overall business and living environment. On the other hand, we are also confronted with the fact that such changes, as an integral part of this environment, contribute to numerous challenges that affect our lives to a greater or lesser extent. Many of these challenges are very difficult to quantify or even recognise (for example, stress, which has become an inseparable part of our lives). Nevertheless, each of these challenges, in one way or another, poses a demand on modern man. Workplace accidents and injuries represent a significant issue for all countries—both developing and industrially underdeveloped nations. Considering that occupational injuries, occupational diseases and disabilities constitute a serious social, economic and psychological problem, they remain at the centre of attention for numerous social organisations. (1) In such an environment, concern for human health and worker well-being is becoming increasingly complex and requires a multidisciplinary approach through which a legal and institutional framework for a safer environment can be established. When we refer to the "legal framework", we primarily mean the adoption of specific laws and by-laws that should adequately regulate the relationship between employees and employers within an organisation. The law, as the fundamental act, cannot function without certain by-laws that more precisely define the manner and scope of its application. The foundation of this definition and concept lies in preventive measures.

If prevention is the basis of the system, then it is clear from the very definitions that occupational safety, in its essence, represents a preventive activity which, as a system, can and must include elements of occupational health and safety. (2) In most countries in the immediate region, legal regulations are based on the EU Directive 89/391. However, can a legal norm from 1989 provide answers to the challenges of today's time? Certainly not. That is why countries adopt appropriate legal acts and regulations that should recognise the need for clear legal regulation of today's challenges. Unfortunately, in the vast majority of countries in the region, we are still dealing with fundamental principles that stem from the need for basic risk assessment. Issues arising from the use of artificial intelligence, modern technologies (such as the effects of electromagnetic radiation in electric vehicles as well as fire suppression in electric cars) are still far from being legally regulated, and in this segment, serious work still lies ahead of us. It is clear that the legal framework, which represents the responsibility of states, must be much clearer, more transparent and faster. When we speak of institutional adaptation to changes that are an integral part of our environment, we primarily refer to the way today's employers recognise these challenges and how they address them. Unfortunately, based on the author's own experience in operational

work in the field of occupational safety, a large number of employers are not aware of the need to address even the most basic issues regarding the safety of their workers (such as the provision of personal protective equipment and risk assessment). In such an environment, we cannot but conclude that while the legal framework is necessary, it is not a sufficient condition for improving occupational safety. One of the key reasons that misleads employers lies in the belief that financial resources allocated to occupational safety represent an expense. According to research conducted by the International Labour Organisation (ILO), it has been established that for every monetary unit that can be measured as a direct consequence of a workplace injury, there are an additional four monetary units that cannot be easily measured or expressed in financial terms. (3)As long as this problem is approached from such a perspective, no significant progress can be expected in the process of creating a safe environment. When employers realise that a safe worker is more productive, that as a result of such productivity the conditions are created for increasing their profits, and that consequently the overall profitability of all activities is improved, only then will occupational safety be given the place it deserves by a large number of employers. Based on the situation in the neighbouring countries, each employer organises and implements occupational safety measures in a relatively similar manner. However, even though all legal acts in the field of occupational safety are adopted on the basis of a European standard, different interpretations of these regulations still exist, which results in different solutions across countries. For example, in the Federation of Bosnia and Herzegovina, there is a clear insistence on a specific risk assessment matrix, while in most neighbouring countries such positions do not exist. (4) Risk assessment represents the most important feature of EU Directive 89/391, and its implementation into the national legislation of countries in the immediate region constitutes the first step in the process of improving working conditions and the safety of workers themselves. When discussing working conditions, all legal acts of the neighbouring countries clearly define the obligation of periodic testing of the work environment and equipment. When safe conditions and reliable work equipment are ensured, the likelihood of worker injuries is significantly reduced. However, despite safe equipment and appropriate working conditions, the possibility of workplace injuries still exists. One of the essential factors that should contribute to the creation of a safe environment is the development of an appropriate safety culture. In this paper, however, we will place emphasis on analysing the work process itself and examining the extent to which potential hazards and harmful factors that ultimately result in workplace injuries have actually been identified.

RISK AND EVALUATION

In everyday life, for a certain action or an expected outcome, we often use the term "risky". The concept of risk was originally associated primarily with maritime navigation. Today, however, there are various definitions of what constitutes risk, and it is difficult to select a single one that would be acceptable to the majority of authors. One of the definitions describes risk "as the possibility of injury or exposure to such a condition.". (5) We are all, to a greater or lesser extent, exposed to a certain number of risks. Some of these risks are beyond our control (for example, when another person causes a traffic accident). However, a large number of risky situations arise as a direct consequence of our own inappropriate actions (for instance, when we cause a traffic accident or fail to follow workplace procedures). Thus, risk is something that forms an integral part of our lives, and the only question is the extent to which we are exposed to risky situations and the scope they actually encompass. It is evident that a construction worker faces a wide range of different risks, compared to an employee working as a programmer. Starting from the fact that every worker is exposed to certain hazards and harmful factors, it is essential to analyse the very work process and, by examining the technological workflow, attempt to identify, as precisely as possible, all the risks to which a worker at a given workplace is exposed. According to the author's view, risk identification represents a crucial turning point in the process of determining appropriate occupational safety measures. If a specific risky situation is not recognised, the likelihood of defining adequate safety measures is very low. The outcome of such circumstances inevitably results in workplace injuries. At this point, we will not go into further detail regarding risk identification and the potential methods that can be used for these activities. Instead, we want to emphasise the importance of identification itself, since everything that follows risk identification will be more or less successful depending on that phase. In the continuation, we will discuss various risk assessment methods and highlight their significance. Nevertheless, without clear risk identification, even the best method will not produce the desired results. When discussing risk assessment methods, it is important to emphasise from the outset that there is no ideal method for risk assessment. Each method has its own advantages and disadvantages and may provide better results in a particular environment or sector. For this reason, we believe it is unnecessary to insist on the use of a single methodology as mandatory, since there are generally no simple solutions. Every method should be systematic, scientifically validated, and easy to use and understand. Broadly speaking, all methods can be classified into three main categories: quantitative, qualitative and combined. Each of these has its own strengths and weaknesses. Quantitative methods of risk assessment are based on the use of precise numerical indicators. The first step involves analysing the event itself and determining the probability of its occurrence, based on experience and past data. After that, the process proceeds to the quantification of the potential consequences that may arise from the occurrence of the risky event. The value of risk is ultimately obtained by combining the recognised probability with the potential consequence, and the resulting risk value is expressed through numerical indicators. Although the quantitative approach provides precise, or absolute, risk values, this approach is not ideal for risk assessment. The main challenge with this

method is the accurate determination of exposure factors, which in most cases is practically impossible to define—even approximately—along with the probability of an undesirable event. Even in cases where statistical data are available, their use can introduce additional errors into the risk assessment process. Qualitative methods of risk assessment do not rely on quantitative values of parameters; instead, they evaluate risk based on qualitative data. In this approach, the experience, expertise and ability of those conducting the risk assessment are of great importance, as well as their knowledge and adherence to criteria defined by standards, laws, regulations, and norms related to the systems under investigation.

Where does the potential problem of this approach lie? In the subjectivity of the assessor. Are all assessors within organisations dealing with risk assessment sufficiently experienced, and at the same time objective enough, in the process of validating risks? We believe the answer to this dilemma is clear to everyone. As a response to these dilemmas, combined methods have emerged. These methods use both precise and relative numerical values obtained through quantitative and qualitative analysis, which are then evaluated and ranked using expert judgement methods. Since it is often not possible to accurately assess the probability or the magnitude of consequences—which may vary under different conditions—these values are estimated and ranked by experts. It is important to emphasise that there are numerous methodological variations that may provide answers in specific situations. In this sense, we can distinguish between: methods for assessing technological system risks, methods for assessing occupational risks, methods for assessing managerial/organisational risks, and accident analysis methods. Each of these methodological variations addresses the risk assessment process in a more detailed and comprehensive way, thus creating the basis for a clearer understanding of work processes, risks and the need to apply appropriate occupational safety measures. It should be highlighted that the identified values of risk mean nothing if they are not managed and if solutions are not sought to create safe working conditions. Risk management in both living and working environments is based on the continuous application of an analytical-synthetic methodological approach, as it ensures the possibility of maintaining a stable balance within a system exposed to constant environmental changes. It should also be noted that certain methods, tools and procedures can be used for different aspects of risk assessment (e.g., Fault Tree Analysis, Hazard and Operability Studies (HAZOP), Job Safety Analysis, and Change Analysis). Additionally, it should be emphasised that within risk assessment methods, some preliminary hazard analysis tools and procedures are frequently used, such as checklists, "What-if" analysis, and similar techniques.

RISK ASSESSMENT METHODS

In the continuation of this paper, we will present the basic characteristics of the Kinney method, which is very often used in risk assessment, as well as the 5×5 matrix, which is applied in risk assessment within the Federation of Bosnia and Herzegovina. Both methods can be regarded as quantitative methods, where the values of consequences and probabilities (as well as frequency in the case of the Kinney method) are expressed through numerical indicators. On the other hand, there are relatively significant differences in the very process of validating the risks of identified hazards and harmful factors. The Kinney methodology is based on the correlation of probability, consequence and frequency of occurrence of a given event.

Probability of an Event - P	
0.1	Hardly conceivable
0.2	Practically impossible
0.5	Unlikely
1	Unlikely but possible in certain cases
3	Slightly possible
6	Likely
10	Predictable and expected
Consequences – Severity of Injuries or Illnesses - C	
1	Minor injuries or illnesses requiring first aid only, with no further treatment needed
2	Significant – medical treatment by a doctor
3	Serious – disability, individual illnesses requiring hospitalisation
6	Very serious – individual accidents resulting in death
10	Catastrophic – multiple fatalities
Frequency of Exposure to Hazards and Harmful Factors – P	
1	Exposed rarely (annually)
2	Exposed monthly
3	Exposed weekly
6	Exposed daily
10	Exposed continuously/permanently

Figure 1 – Author's own source

The approach to determining the risk value for identified hazards can be seen in the following table:

Level	Risk Rank
I	R ≤ Acceptable
II	20 ≤ R ≤ 70 Minor – caution required, to be addressed through proper procedures and work instructions.
III	70 ≤ R ≤ 200 Moderate – measures required, management responsibilities must be defined.
IV	200 ≤ R ≤ 400 High – immediate management response required, improvement measures demanded by the direct supervisor.
V	R ≥ 400 Extreme risk – activity must be stopped, immediate action required by direct management.

Figure 2 – Author's own source

The approach to determining the risk value for identified hazards can be seen in the following table:

No	Hazards – Harmful Factors	Probability of Occurrence	Consequence	Frequency	Risk Level
1.	Hazard due to participation in public traffic (road traffic hazard)	3	2	3	36 Low Risk (Acceptable)
2.	Possibility of slipping and tripping	6	1	6	36 Low Risk (Acceptable)

Figure 3 – Author's own source

The product of the numerical values of the identified probability, consequence and frequency defines the value of risk. Once this calculated risk value is verified against the risk ranking table, it becomes easy to determine the level of identified risk. After establishing these risk values in this way, risk assessors define occupational safety measures, thereby concluding the process of risk assessment. The general limitations of this methodological approach have already been explained in the previous section. However, in our opinion, there is one additional limitation to which assessors should pay attention. The initial part of the risk assessment is clear and leaves little room for doubt. The hazard is identified, the probability, consequence, and frequency of the event are recognised, and the product of the numerical values provides the risk level. Following this, occupational safety measures are defined. But what happens with the residual risk? For example, if a risk is assessed as medium and certain occupational safety measures are defined, does the probability of the risky event decrease as a result of the definition and application of those safety measures? This is not evident from the risk assessment itself.

The objective of risk assessment is to determine the value of risk, but it is equally important to evaluate the contribution of the defined measures in reducing the residual risk level. In our opinion, this methodological approach requires an additional column in which the residual risk remaining after the definition and application of occupational safety measures would be assessed. Of course, the implementation of such measures cannot always alter the initial risk values, but it is necessary to strive for appropriate technical or organisational measures that can reduce the level of risk. In the Federation of Bosnia and Herzegovina, only in 2020 was a Law on Occupational Safety adopted, harmonised with EU Directive 89/391. The law essentially contains all the key elements of the EU Directive, one of which is the requirement for mandatory risk assessment for every workplace across all employers. In its methodological section, the law establishes the obligation of authorised organisations to use the 5×5 matrix when conducting risk assessments.

In the following section, we will present the basis of this methodology:

Probability Category (workplace injuries, health impairments, and occupational diseases caused by hazards and harmful factors at the workplace and in the work environment).		
P1	Insignificant probability	Very low probability of occurrence, only in exceptional cases
P2	Unlikely	Possibility exists, but unlikely
P3	Moderate likelihood	Possibility exists, under certain circumstances likely to occur
P4	Likely	Increased likelihood of occurrence, very likely, expected
P5	Extremely likely	Almost certain, high likelihood of occurrence

Figure 4 – Author's own source

As can be seen from the previous table, probability is defined in five categories, and accordingly, probability values are assigned from 1 to 5.

When it comes to consequences, the legislator considers them in the following way:

Category of Severity of Consequences (workplace injuries, health impairments and occupational diseases of workers).		
P1	Very minor	Noticeable health impairment, no sick leave, or absence from work
P2	Minor	Minor and temporary health impairments that may require medical assistance and cause temporary incapacity for work
P3	Moderate	Significant health impairment requiring prolonged treatment, which may result in permanent reduction of work ability
P4	Serious	Permanent or progressive health impairment causing permanent incapacity for work
P5	Very severe (fatal)	Severe health impairment with disability – death or multiple injuries regardless of severity

Figure 5 – Author's own source

The value of an individual risk is determined by the assessor by multiplying the probability value by the consequence value and then dividing the result by two. In this way, the risk value is obtained.

The risk values are then interpreted using the corresponding table:

Level of risks		
P1	Insignificant	Risk is negligible, no protective measures are required
P2	Acceptable Risk	Improve protection if possible
P3	Moderate Risk	Protective measures required for improvement, monitor workers' health condition
P4	High Risk	Risk is high, immediate protective measures must be implemented, health monitoring required, and workers must be warned about the hazard
P5	Very High Risk	Risk is very high (unacceptable), work process must be stopped immediately and urgent measures undertaken

Figure 6 – Author's own source

In the application of this methodology, several interesting issues can be observed. For instance, if we consider a recognised hazard categorised as "unlikely" (2) and the potential consequence as "moderately severe" (3), the value of risk is calculated by adding the quantified probability and consequence values and dividing the sum by two. In this hypothetical case, the risk value would be 2.5. What, then, is the actual risk category? Category 2 – "Improve protection if possible"? Or Category 3 – "Measures to improve protection required, monitor workers' health status"? A second dilemma relates to the final risk assessment of a workplace. Namely, an employer may evaluate a workplace and, following the above methodology, identify values for each recognised risk. In determining whether a workplace is considered high-risk, the legislator prescribes that all identified risk values should be summed and divided by the total number of risks.

This approach raises two questions. First, when the result is a decimal value, how should it be "rounded"? If the calculated risk value falls into Category 3, monitoring of workers' health is required. But should this also apply when the value is, for example, 2.5? Second, and more importantly, a dilemma arises with respect to the classification of a workplace as high-risk. At certain workplaces, the majority of hazards and harmful factors may fall into Categories 1 and 2, while only one hazard may be in Category 4 (e.g., working at heights, operating forklifts, or handling construction machinery).

When risk evaluation is approached in this way, the overall risk is reduced to an average value, which, in our view, is not a satisfactory solution. If there is even a single hazard assessed as Category 4 (for example, working at an unsecured height), that workplace MUST be classified as a high-risk workplace. However, under this methodology, due to the influence of other hazards and harmful factors rated as Categories 1 and 2, the overall value of risk is "reduced", leading to the conclusion that the workplace does not qualify as high-risk. We believe it is important to emphasise that classifying a workplace as high-risk should be the exception, not the rule. The broad spectrum of available methodologies should provide a framework for a more accurate evaluation of risk values. Accordingly, the selection of appropriate methodologies contributes to the improvement of the quality of risk assessment itself and creates the conditions for a clearer understanding of the current state, as well as for the implementation of corrective measures.

CONCLUSION

A safe environment is a fundamental prerequisite for safe workplaces. The essential elements of every safe environment are work equipment, raw materials, energy, and people. Each work environment generates certain hazards and harmful factors that may endanger human life and health. Therefore, the process of identifying all potential risks to which workers are exposed in specific workplaces is of great importance. Risk assessment methods themselves are highly significant, as they provide a way to evaluate risk values and, on that basis, determine and implement corrective actions. Through the comparative presentation of the two methods, we have sought to provide a broader perspective and emphasise that no method is ideal. Each has its own advantages and disadvantages. It is the responsibility of authorised organisations and professionals to select the method that best suits the employer, depending on the nature of their activity. Furthermore, risk assessment is not something that is conducted once in order to fulfil a legal obligation and then concluded. Rather, risk assessment is a process that must be carried out continuously, and only in that way does it have real meaning.

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METODE ZA PROCJENU RIZIKA

SAŽETAK

Procjena rizika predstavlja sastavni dio šire strategije upravljanja rizicima s ciljem uvođenja kontrolnih mjera radi uklanjanja ili smanjenja svih mogućih posljedica povezanih s rizikom. Suočavanjem vjerovatnoće i posljedica, te po potrebi uključivanjem dodatnih faktora, procjenjuju se rizici kojima su radnici izloženi. Identifikacija rizika koji nastaju kao sastavni dio svakog radnog procesa od ključnog je značaja za definisanje odgovarajućih mjera zaštite na radu. Nakon identifikacije rizika, potrebno ih je procijeniti korištenjem odgovarajućih metoda. U teoriji i praksi postoji više metoda, a u većini susjednih zemalja nije propisana obavezna metoda procjene rizika. Prilikom odabira metode, potrebno je uzeti u obzir da ona mora biti sistematična, lako razumljiva i primjenjiva. Predmet ovog rada će biti analiza najčešće korištenih metoda. U radu će se također dati osvrt na postojeće metode, kao i na njihove pozitivne i negativne karakteristike. Polazna hipoteza rada jeste stav da bez odgovarajuće metode ne može postojati adekvatna procjena rizika. U radu je primijenjena deskriptivna metoda, kao i analiza dostupne domaće i strane literature.

Ključne riječi: identifikacija rizika, metode procjene rizika, zaštita na radu

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