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COMPARATIVE ANALYSIS OF METHODS FOR RISK ASSESSMENT - "KINNEY" AND "AUVA"

Abstract: *Individuals, entire economy and society are exposed to risks more than ever. The problem of occupational safety and health has been present from the moment of origin of labour and it has been dealt with in line with the overall development of society. For this reason, different methods and matrices for risk assessment have been developed. The subject of this study is to review the methods of risk assessment, as well as to apply these methods at the workplace where dangers and hazards occur. The aim of the study was to use KINNEY and AUVA methods for assessing risk for the workplace of Operating Engineer - Occupational Safety, Environmental Safety and Fire Protection, and to perform a comparative analysis of with the aim to state possible advantages or disadvantages of chosen methods.*

Key words: the risk assessment, methods of risk assessment, KINNEY method, AUVA method.

INTRODUCTION

The issue of safety and health at work has been present since the origin of work. It has emerged and has been dealt with in line with the overall development of society. It used to refer only to the consequences of risk because the knowledge about the risk was rather poor, while nowadays it is possible to prevent risk and reduce negative consequences.

Occupational safety and health involve working conditions in which certain measures and activities are taken to protect the life and health of employees and other people. The interest of society, all entities and each individual is to achieve highest level of safety and health at work and to avoid the consequences, such as injuries, occupational diseases and work-related diseases by reducing them to the lowest possible level; and finally, to develop conditions of work in which an employee would be satisfied while doing his job.

To realize this aim, it is necessary to carry a systematic approach for preventive actions and link all entities, holders of certain obligations on the national level and beyond. International institutions are responsible to carry out the established rules, measures and standards of working conditions as well as to comply with technological and social - economic development, to improve the safety and protect the health of employees, by adopting national regulations.

Many methods and types of matrices were developed for risk assessment. Four methods with different focus in risk assessment were developed (ISO/IEC27005) method of risk matrix with predefined values (ISO / IEC13335-3), and a method of measuring risk by ranking threats, method of assessing the impact probability and possible consequences and methods of distinction between acceptable and unacceptable risks. The case study was to check methods of risk assessment - Kinney and AUVA method - as well as to apply these methods for the chosen workplace in which dangers and hazards occur. The aim is to perform risk assessment, by applying all methods, for the workplace of Operating Engineer - Occupational Safety, Environmental Safety and Fire Protection Engineer, as well as to carry out comparative analysis of the given methods to show the possible advantages or disadvantages.

METHODS

In order to realize the primary aim, it is necessary to analyze the method that will be used in the risk assessment, to describe the workplace, then to perform risk assessment and finally to point to possible advantages or disadvantages that occur under the given methods.

The methods that will be used in risk assessment are the matrix methods - KINNEY method and AUVA method. Matrices can be used to assess the risks in the workplace, the ranking of the different risks of importance for assessing, the acceptability of risk for assessing residual risk and priority ranking [11]. The advantage of the matrix is that they can be understood by the staff in charge of occupational safety.

Risk assessment is possible if we know the nature of harms and dangers and the factors that define the intensity [5]. The data obtained by risk assessment are combined with data from other sources (such as data obtained by monitoring employees' health, matrix operations and exposure limit values, permissible levels of exposure and available statistical data).

The EU Directive suggests that each state can customize specific methodology for assessing risk according to their legislation. Some EU members have specific regulations on the way and methodology to risk assessment [12].

KINNEY METHOD

In Kinney method, the risk is seen as the emergence of dangers and hazards. Risk assessment is the product of three dimensions [1]:

- The probability of an accident or damage;
- The severity of consequences for an employee in case of dangers and hazards;
- Frequency of occurrence of dangers and hazards.

Criterion - probability (P) is ranked ranging from 0.1 - virtually impossible, to 10 - predictable (table 1).

Table 1. *Description of the criteria for assessing the probability*

Probability	Description of the criteria for assessing the probability
0,1	Virtually impossible
0,2	Practically impossible
0,5	Plausible, but unlikely
1	Improbable, but possible at boundary conditions
3	Unusual, but possible
6	Possible
10	Predictable

Criterion - consequences (C) (possible damage) is ranked ranging from 1 to 10 and that is considered catastrophic, highlighted in Table 2.

Table 2. *Description of the criteria for assessing the consequences*

Consequences (C)	Description of the criteria for assessing the consequences
1	Disease, injury which requires first aid and any other treatment
2	Medical treatment by a doctor
3	Serious - disability, serious violation with individual hospitalization and lost days
6	Very serious - individual accidents with lethal outcome
10	Catastrophic - with multiple lethal outcomes

The criterion - the frequency of occurrence of danger and harm (F) ranks of rarely - once a year, permanently - continuous 10 (table 3).

Table 3. *Description of the criteria for frequency*

Probability	Description of the criteria for frequency
1	Rare (yearly)
2	Monthly
3	Occasional (weekly)
6	Regular (daily)
10	Permanent

Evaluation of risk R is performed by the formula:

R = P x C x F

Table 4 gives a tabular presentation risk assessment.

Table 4. *Table of risk assessment*

Identified risk or harm	Evaluation of risk				Measures to control risk assessment
	P- probability	C- consequences	F- frequency	R- the risk level	

The level of risk (R) is ranking from acceptable, negligible levels RI, to extreme, impermissible, which requires interruption of work activities and the instantaneous preventive actions which is defined as the risk level RV (Table 5).

Table 5. *Description of risk classification*

Total rating	Level of risk	The classification of the level of risk	Description of the classification level of risk
0,1 – 20	R I	**Negligible risk**	No action is required.
21 – 70	R II	**Low risk**	There is no need for additional activities in the management of the operation. More cost-effective solution or improvement without additional investment should be considered. It is necessary to monitor the situation in order to obtain information on the implementation of prescribed activities.
71 – 200	R III	**Medium risk**	Efforts are needed to reduce the risk or cost of prevention. Costs must be carefully planned and limited to a certain level. It is necessary to define a deadline for the implementation of improvement. For those events which may have extremely dangerous consequences, it is necessary to further examine the probability of occurrence of such an event so as to define the required level of activity and to mitigate risks.
201–400	R IV	**High risk**	An activity cannot start unless the level of risk is reduced. Additional resources may be required in order to reduce risks. Considerable resources may be required, in order to reduce the risk. If the risk applies to all started activities, it is necessary to take urgent action to reduce the level of risk.
Over 400	R V	**Extreme risk**	The operation cannot be started nor continued until the risk is reduced. It s not possible to reduce the risk by additional investments, and therefore the ativity should stay idle.

AUVA METHOD

For the assessment of the risks in the workplace in the working environment, a modified AUVA method can be used.

Elements of the assessment and evaluation of risks to AUVA method are Probability of danger or harm and severity of possible consequences. Accordingly, the level of risk (LR) was defined as the product of the probability an unwanted event (RP) and rank as possible severity of the violation (RV):

LR = RP x RV

Probability of dangers or harms depends on employees' exposure to risks and hazards in the working environment (existing state of health and safety at work). Employees' exposures to dangers and hazards are ranked as follows (table 6):

Table 6. *Ranking of the dangers and harmfulness*

Exposure hazards and harmfulness during the working day (week, month, year) %	Qualitatively ranking of exposure dangers and harmfulness	Quantitative ranking of exposure dangers and harmfulness
< 20%	Very rarely	1
21% - 40%	periodically	2
41% - 60%	often	3
61% - 80%	The most of work hours	4
> 80%	Through all workday	5

The environmental condition or the current state of occupational health and safety has been determined by the following elements (table 7):

Table 7. *Elements for assessing the condition of the environment*

Nº	Elements for assessing the condition of the working environment	Document/ base	Compatibility with the requirements / satisfies	
			YES	NO
1.	Workspace and work surface			
2.	Tools and equipment for work			
3.	Protection from electric shock			
4.	Heating and ventilation			
5.	Microclimate			
6.	Light			
7.	Electromagnetic radiation			
8.	Noise and vibration			
9.	Atmospheric and climatic influences			
10.	Fire and explosion protection			
11.	Passage, access and evacuation routes			
12.	Raw materials, basic and additional material			
13.	Organizational of occupational safety and health			
14.	Personal protective equipment			
15.	Training for safe work			
16.	Information on safety and health at work			
17.	First aid			
18.	Protection of nonsmokers, the ban on alcohol and other addiction			
19.	The maintenance of premises			
20.	Condition of facilities for personal hygiene			
21.	The inspection about supervision			
22.	Injuries and occupational diseases			

On the basis of the level of compliance with the requirements of health and safety at work is determined by the rank condition of the working environment as follows (table 8):

Table 8. *The ranking of dangers and harmfulness*

occupational health and safety demands are fulfilled (OHS) in%	Qualitative ranking of condition in the working environment	Quantitative ranking of condition in the working environment
OHS>80%	Satisfying	1
60%< OHS ≤80%	Medium term necessary measures	2
40%< OHS ≤60%	Short term measures necessary	3
20%< OHS ≤40%	Currently necessary measures	4
OHS ≤ 20%	Measures for instant termination of work processes	5

Description of the workplace – Operating Engineer for occupational safety, environmental protection and fire safety

According to the systematization within a certain company, this person is responsible to:

1. Apply and implement legal regulations and internal acts in the field of occupational safety, the environmental protection and fire protection.
2. Control work equipment, devices and means of personal protective equipment and devices and systems with harmful radiation or hazardous emissions.
3. Follow and control the working conditions of the working environment and control the handling of hazardous materials.
4. Perform training for safe work and fire protection.
5. Perform professional duties.

Application of Kinney methods for the workplace Operating engineer for occupational safety, environmental protection and fire protection

In Table 9 presents the application of Kinney methods for the workplace Operating engineer for occupational safety, the environmental protection and the fire protection.

Table 9. *Application of Kinney methods for the workplace operating engineer for occupational safety, the environmental protection and the fire protection*

Nº	Work activities	P- probability	C- consequences	F- frequency	Level of risk
1.	Working in the field and in the facility	0.1	3	1	**0.3**
2.	Using computer and other electrical devices	0.1	10	1	**1**
3.	Working in the open	0.1	1	1	**0.1**
4.	Working on a computer – using a monitor	0.1	2	2	**0.4**
5.	Using a computer and other administrative office duties	0.2	2	3	**1.2**
6.	Performing the work in OHS and fire protection, direct communication with employees and inspection and other state bodies, it is possible crisis situations.	0.1	2	2	**0.4**
7.	Performance of regular work activities	0.2	3	3	**1.8**

Based on the conducted workplace Operating engineer for occupational safety, the environmental protection and the fire protection, is workplace with an acceptable risk, given that the level of risk for all work activities does not exceed 20 chapters R <20.

Application of AUVA methods for the workplace Operating engineer for occupational safety, environmental protection and fire protection

Table 10 presents the existing condition of health and safety at work.

Table 10. *The existing condition of health and safety at work*

Nº	Elements for assessing the condition of the working environment	Document/ base	Compatibility with the requirements / satisfies	
			YES	NO
1.	Workspace and work surface	Regulations on Safety Measures for Auxiliary Facilities, ("Official Gazette of SRS", No. 29/87) Inspection	●	▲
2.	Tools and equipment for work	Regulations on the procedure of inspection and test equipment for the operation and testing of working environment ("Official Gazette of RS" No.94 / 06 and 108/06) Instructions for inspection, testing and maintenance of assets. Records of the inspections and tests of work equipment	●▲	
3.	Protection from electric shock	Regulation on technical norms for low voltage electrical installations ("Official Gazette of SFRY", no. 53/88 and Official Gazette No. 28/95) Instructions for inspection, testing and maintenance of assets.	●	
4.	Heating and ventilation	Inspection	●	
5.	Microclimate	Report on the measurement / inspection	●	
6.	Light	Report on the measurement / inspection		●
7.	Electromagnetic radiation	Report on the measurement / inspection	●	
8.	Noise and vibration	Report on the measurement / inspection	●	
9.	Atmospheric and climatic influences	Inspection		▲
10.	Fire protection and explosion	Law on fire protection ("Official Gazette of SRS", No.37 / 88) Regulations for fire protection.	●▲	
11.	Passage, access and evacuation routes	Regulations on Safety Measures for Auxiliary Facilities, ("Official Gazette of SRS", no. 29/87) / Inspection		

12.	Raw materials, basic and additional material	Do not use hazardous materials, or Instructions for inspection, testing and maintenance of assets. Records of hazardous substances used in the course of work	●▲	
13.	Organizational of occupational safety and health	Collective agreement Regulations on safety and health at work.	●▲	
14.	Means and equipment for personal protection	The norm means and equipment for personal protection at work. Records of the inspections and tests of means and equipment for personal protection at work	●▲	
15.	Training for the safe operation	Law on Safety and Health at Work ("Official Gazette of RS", No.101 / 05) Regulations on safety and health at work. Records of employees trained for safe and healthy work	●▲	
16.	Information on safety and health at work	Law on safety and health at work ("Official Gazette of RS", No.101 / 05) Directive 92/58 / EEC on the minimum requirement for ensuring label for safety or health of workers at work		
17.	First aid	Regulations on safety and health at work. Ordinance on equipment and procedures for the provision of first aid and rescue service organization in case of an accident at work ("Official Gazette of the SFRY", No.21 / 71)		●▲
18.	Protection of nonsmokers, the ban on alcohol and other addiction	Smoking ban. Ban on the use alcohol and other psychoactive substances in companu's buildings and premises.	●▲	
19.	The maintenance work premises	Inspection	●	
20.	Condition of facilities for personal hygiene	Inspection	●	
21.	The inspection about of supervision	The inspection about supervision		
22.	Injuries and occupational diseases	Records of injuries, occupational illnesses and diseases related to work	●▲	

● RANK OF THE CONDITION OF THE WORKING ENVIRONMENT - OFFICE	1
▲ RANK OF THE CONDITION OF THE WORKING ENVIRONMENT - GROUNDS	2

Table 11. *Identification of dangers and threats on the workplace and working environment and possible consequences*

Nº	**Work activities**	**Possible danger and harmfulness**	**Possible consequences**
1.	Working in the field and in the facility	Slipping and tripping when moving on the ground and inside on buildings	The fracture of bone and soft tissue injuries
2.	Using a computer other electrical devices	Indirect contact	The burns, injuries caused by electric shock
3.	Working in the open	Low temperatures in winter (wind, rain, snow) High temperatures in summer	Colds, respiratory system diseases, sunstroke
4.	Working on a computer - monitor	Long term eyestrain	Malfunctions disorders and vision,
5.	Using a computer and office work	Long term sitting	Headache, a stiff neck, pain in the shoulders and back, disorders of the digestive system
6.	OHS and fire protection, direct communication with employees and inspection and other state bodies, it is possible crisis situations.	The psychological burden	Psychosomatic disorders
7.	Regular work activities	The responsibility for receiving and transferring information, the use of appropriate knowledge and skills	Psychosomatic disorders and diseases (high blood pressure and other diseases of the cardiovascular system and digestive system)

Table 12. *Ranking of risk*

Nº	Code of danger or harmfulness	Rank exposure	Rank of the working environment	Rank of probability	Severity rank of possible consequences	The measure of risk	Rank of risk	
							Five degrees scale	Three degrees scale
1.	10	1	2	1	3	3	I	A
2.	16	1	1	1	5	5	I	A
3.	27	1	2	1	1	1	I	A
4.	30	2	1	1	2	2	I	A
5.	31	3	1	2	2	4	I	A
6.	32	2	1	1	2	2	I	A
7.	33	3	1	2	3	6	II	A

On the basis of the recording process of the organization of work, applied measures of health and safety occupational, dangers and threats in the workplace and working environment, and risk ranking, it has been estimated that the workplace Operating Engineer for occupational safety, environmental protection and fire protection is a workplace with an increased risk.

Comparative analysis of the results of the risk assessment for the workplace Operating engineer for occupational safety, the environmental protection and the fire protection with Kinney and AUVA methods

While conducting risk assessment for the workplace Operating engineer for occupational safety, the environmental protection and the fire protection used Kinney and AUVA methods. Both of methods use a five-degree scale ranking of risk. The analysis shows that rank of risk for all activities were given position 1 when it comes to KINNEY method. At AUVA method last, seventh activity has rank of risk 2.

CONCLUSION

There are several methods for risk assessment and health risk assessment. The methods are divided by areas for which they are intended. They differ by the matrices and the ranking scale they use, according to which they can be three degrees, five degrees and multi degrees. Matrices that are used can be 3x3, 4x4, 5x5, 4x6, 9x9 and others, which have been defined by certain standards. Accordingly, the methods can be more precise or less precise.

This paper investigates one workplace with KINNEY and AUVA methods. Using both methods to assess the workplace of an Operating Engineer for occupational safety, environmental protection and fire protection, it has been assessed as a workplace with acceptable risk. However, AUVA method besides taking into account possible dangers and harmful effects, possible consequences and exposures also considers the condition of the working environment, unlike KINNEY methods which is based only on probability, consequences and frequency. The results showed that the AUVA method is a bit more precise because it uses many factors for risk analysis unlike KINNEY methods. Therefore, AUVA method is more precise and reliable than KINNEY method.

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BIOGRAPHY

Milena Stanković was born in Nis, Serbia, 1987. She graduated from the Faculty of Occupational Safety, University of Nis, department of Environmental Protection.
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UPOREDNA ANALIZA METODA ZA PROCENU RIZIKA „KINNY“ I „AUVA“

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Rezime: *Pojedinci, privredni subjekti i čitavo društvo, izloženi su rizicima više nego ikada. Problem bezbednosti i zdravlja na radu je prisutan od kada postoji rad, nastajao je i rešavao se u skladu sa celokupnim razvojem društva. Iz tog razloga, za procenu rizika razvijene su različite metode i matrice. Predmet rada je prikaz metoda za procenu rizika, kao i primena tih metoda za radno mesto u kome se javljaju povećane opasnosti i štetnosti. Cilj rada je da se kroz izabrane metodeza procenu rizika - Kinny i AUVA, za radno mesto - operativni inženjer za BZNR, ZŽS i ZOP, izvrši procena rizika, kao i da se izvrši uporedna analiza datih metoda kako bi se ukazalo na moguće prednosti ili nedostatke izabranih metoda.*

Ključne reči: procena rizika, metode za procenu rizika, Kinny metod, AUVA metod.