The 55th International October Conference on Mining and Metallurgy
15 - 17 October 2024, Kladovo, Serbia
https://ioc.irmbor.co.rs

DOI: 10.5937/IOC24053I Original Scientific Paper-Mining

STUDY OF APPLICATION THE ANOVA TEST FOR INDICATORS OF SAFETY AND HEALTH AT WORK IN THE MINING INDUSTRY

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Abstract

In this study, carried out in the underground mines in Serbia, the indicators of occupational safety and health (OSH) were investigated in relation to the parameters of production unit, age, experience and qualification. To identify the main indicators of occupational safety and health in the mining industry, a survey was conducted among the employees. The results of applied survey were analyzed using the ANOVA test to determine whether there were significant differences in the opinions of respondents. The applied test showed existing of these differences and that they are most pronounced in the age and seniority category. The differences of opinion are least pronounced in relation to the production unit of the mine and are reflected in the category of questions relating to the work equipment and training. The clearest differences between respondents were in the age and work experience, where the employees showed statistically significant differences in their opinions about the control of work equipment, competence of their colleagues, work organization and quality of training.

***Keywords**: ANOVA, mining, health and safety at work*

1. INTRODUCTION

A questionnaire was used for the purposes of this study. The formulated questionnaire contains 37 questions. The first part of the questionnaire consists of demographic questions and questions on accidents at work in order to collect the quantitative data on sample under investigation. The second part of the questionnaire is entirely geared to the purpose of the study, i.e. to identify factors of affecting the injuries at work. Questionnaires were already used in the mining research and adapted to the conditions in Serbia as the basis for formulating these questions [1, 2, 3, 4, 5, 6].

The target population of the research conducted in this dissertation are the workers employed in the underground coal mining in Serbia. This population is employed in the Public company for underground coal mining Resavica, which employs a total of 4211 workers. This figure also includes workers who are not directly involved in coal mining and who are not of interest for the survey conducted. The survey covered 2,800 workers directly involved in production. The 1400 questionnaires were distributed, a total of 1146 were collected, out of which 95 were rejected as incomplete. The 1051 questionnaires, distributed in the 11 production units, were used for further analysis.

After collecting, processing and classifying the data, obtained by interviewing the employees, the descriptive statistics methods were applied. On the basis of descriptive statistics, the basic statistical indicators were calculated, which were used to determine the dependencies between the respondents (frequencies and percentages, arithmetic mean, standard deviation, etc.) in order to create a preliminary image of the collected data. The basic statistical analysis methods, such as the analysis of variance (ANOVA), were used to analyze the differences between the surveyed employees in relation to their demographic characteristics.

2. EXPERIMENTAL

The analysis of variance is a technique that is frequently used in the experimental research. The British statistician Ronald Fisher made an important contribution to the development of this technique at the beginning of the 20th century. In the available literature, the name of this method is represented by the abbreviation ANOVA, which comes from the ANalysis Of Variance. The ANOVA is a technique that compares a variance between several groups with a variance within each group.

The ANOVA is a statistical parametric method used to study whether three or more groups have the equal arithmetic means. There are different types of analysis of variance: single factor analysis of variance, single factor analysis of variance for repeated measures, two factor analyses of variance, extended analysis of variance or multivariate analysis of variance, etc.

In order to apply this method, the sample under investigation must fulfill certain requirements:

- Dependent variable should be measured on an interval scale and be approximately normally distributed,
- Sample must contain different respondents in each group,
- There is no large deviation of the extreme values,
- The variances of the base sets should be equal.

According to Žižić, the null hypothesis is:

$$H_0: \mu_1 = \mu_2 = \ldots = \mu_i \quad (1)$$

The null hypothesis states that the arithmetic means of all observed quantities are equal, while the alternative hypothesis states:

H1: The arithmetic means of at least two groups differ from each other (Žižić et al., 1997).

The one-factorial analysis of variance can now be represented mathematically:

$$X_{ij} = \mu_i + \varepsilon_{ij} \quad (2)$$

where is:

X_{ij} – j-th observation selected from the i-th set;

μ_i – common arithmetic means of the i-th set;

ε_{ij} – random error [7].

An important indicator of ANOVA is the indicator F, which represents the quotient of variance between the groups and variance of the group. The statistical significance of the F indicator refers to the rejection or acceptance of the tested assertion. If the results of the F-test indicate the rejection of the null hypothesis, so the value of F is significantly

greater than 1, then the ANOVA indicates that there are differences in the arithmetic means of at least two groups, but not between which two. To determine between which groups there are significant differences, a multiple comparison (post hoc analysis) is carried out. In the multiple comparison, all possible sample pairs are compared with each other and tested to see whether there is a statistically significant difference between their arithmetic means [7, 8, 9, 10].

To calculate the size of the effect, the Eta-squared indicator (calculated as the quotient of the sum of the squared deviations of different groups and the sum of squares) and the Cohen criterion were used, which classifies the size of the effect: small - if the value is greater than 0.01, medium - if the value is greater than 0.06 and large – if it is 0.14 [11].

3. RESULTS AND DISCUSSION

Applying one of the basic statistical analysis techniques, the analysis of variance (ANOVA), the differences between the surveyed employees with regard to their demographic characteristics were determined.

The ANOVA test was applied to these analyzed parameters: production unit, age, total calendar work experience and qualification, i.e. vocational training of the worker. The results of the ANOVA test applied are presented in the following tables, only those results where a statistically significant difference was found between the groups, i.e. where the probability $p \leq 0.05$.

3.1 ANOVA test for the production unit parameter

Single factor analysis of variance was used to examine the differences in the answers of respondents in relation to the unit of production. The statistically significant results of the ANOVA test are shown in Table 1.

Table 1. *Statistically significant results of the ANOVA test based on the production unit parameter*

Question	Production unit	Number of respondents	Arithmetic mean	Standard deviation	Standard error	Parameter F	Probability p	Eta-squared
WE_2 The colleagues I work with are professional and do their work safely (I feel safe working with them)	Aleksinac	107	4.51	0.769	0.074	2.692	0.003	0.0252
	Lubnica	128	4.66	0.704	0.062			
	Bogovina	98	4.34	0.930	0.094			
	Sokobanja	73	4.52	0.852	0.100			
	Ibarski	180	4.56	0.778	0.058			
	Jasenovac	92	4.57	0.731	0.076			
	Štavalj	119	4.66	0.858	0.079			
	Vrška Čuka	52	4.54	0.828	0.115			
	Senjski	42	4.31	1.070	0.165			
	Vodna	48	4.35	1.082	0.156			
	Resavica	112	4.22	1.206	0.114			
	Total	1051	4.50	0.886	0.027			

T_1 I think that job training is necessary to work in my workplace	Aleksinac	107	4.72	0.595	0.058	3.286	0.000	0.2250
	Lubnica	128	4.59	0.892	0.079			
	Bogovina	98	4.41	1.120	0.113			
	Sokobanja	73	4.62	0.844	0.099			
	Ibarski	180	4.68	0.751	0.056			
	Jasenovac	92	4.48	1.064	0.111			
	Štavalj	119	4.85	0.498	0.046			
	Vrska Čuka	52	4.67	0.760	0.105			
	Senjski	42	4.36	1.340	0.207			
	Vodna	48	4.85	0.618	0.089			
	Resavica	112	4.39	1.157	0.109			
	Total	1051	4.61	0.895	0.028			
T_2 I believe that the work training, procedures and work instructions are adequate, i.e. adapted to work at my workplace	Aleksinac	107	4.36	1.013	0.098	2.653	0.003	0.2480
	Lubnica	128	4.42	0.919	0.081			
	Bogovina	98	4.13	1.273	0.129			
	Sokobanja	73	4.53	0.899	0.105			
	Ibarski	180	4.28	1.015	0.076			
	Jasenovac	92	4.39	0.925	0.096			
	Štavalj	119	4.56	0.732	0.067			
	Vrska Čuka	52	4.52	0.896	0.124			
	Senjski	42	4.17	1.305	0.201			
	Vodna	48	4.35	1.062	0.153			
	Resavica	112	4.04	1.252	0.118			
	Total	1051	4.34	1.034	0.032			

The results in Table 1 show there is a statistically significant difference in these questions: WE_2 - The colleagues I work with are professional and perform their work safely (I feel safe when I work with them), T_1 - I think that induction training is necessary for the work at my workplace, T_2 - I think that the work training, procedures and work instructions are adequate, i.e. suitable for the work at my workplace.

The post hoc analysis shows that in relation to the question WE_2 - The colleagues I work with are professional and do their work safely (I feel safe when I work with them), the answers of workers employed in the Lubnica ($p = 0.007$) and Štavalj ($p = 0.009$) mines compared to the answers of workers working in the Resavica production unit. The calculation of the effect size using the Eta square results in a value of 0.0252, which according to the Cohen criterion shows that the effect of this difference is small. For the question T_1 - I think that further vocational training is necessary for the work at my workplace, the answers of the employees at the Štavalj mine differ statistically significantly from those of the employees in Bogovina ($p = 0.012$) and Resavica ($p = 0.005$). The Eta-square has a value of 0.225, which indicates that the effect is small. For the question T_2 - I consider the training for the work, procedures and work instructions to be adequate, i.e. adapted to the work at my workplace, the answers of the Resavica mine workers are statistically significantly different from those

of the employees in Sokobanja (p = 0.049) and Štavlje (p = 0.005). The Eta square has a value of 0.248, which indicates that the effect is small.

3.2 ANOVA test for the age parameter

Looking at the results of the ANOVA test for the parameter age of the respondent, it can be seen that of 25 statements, there is a statistically significant difference in the answers for 17 statements, which are shown in Table 2.

Table 2. *Statistically significant results of the ANOVA test based on the age parameter*

Question	Age	Number of respondents	Arithmetic mean	Standard deviation	Standard error	Parameter F	Probability p	Eta-squared
PPE_2 Personal protective equipment is comfortable and does not bother me while I work	18–25	82	3.70	1.108	0.122	11.013	0.000	0.040
	26–35	278	3.82	1.298	0.078			
	36–45	307	3.92	1.320	0.075			
	46–55	265	4.22	0.893	0.055			
	56–65	119	4.48	0.757	0.069			
	Total	1051	4.01	1.169	0.036			
PPE_3 Personal protective equipment is available to me (in case I lose or tear it, I can get another one)	18–25	82	3.17	1.706	0.188	11.042	0.000	0.029
	26–35	278	3.95	1.448	0.087			
	36–45	307	3.90	1.513	0.086			
	46–55	265	3.58	1.516	0.093			
	56–65	119	4.39	1.091	0.100			
	Total	1051	3.83	1.499	0.046			
PPE_4 Collective protective equipment (fire extinguishers, gas detectors and ventilation meters...) are correct and present at my workplace	18–25	82	4.32	0.718	0.079	9.405	0.000	0.022
	26–35	278	4.04	1.362	0.082			
	36–45	307	4.35	1.182	0.067			
	46–55	265	4.41	0.808	0.050			
	56–65	119	4.72	0.596	0.055			
	Total	1051	4.32	1.087	0.034			
WEM_1 The work equipment I use is correct, safe and modern	18–25	82	3.94	1.518	0.168	4.919	0.001	0.040
	26–35	278	4.31	1.138	0.068			
	36–45	307	4.09	1.449	0.083			
	46–55	265	4.23	1.020	0.063			
	56–65	119	4.58	0.742	0.068			
	Total	1051	4.23	1.217	0.038			
WEM_2 Work equipment and work machines are appropriate for the work operations I perform at my workplace	18–25	82	4.23	0.998	0.110	3.797	0.005	0.034
	26–35	278	4.35	1.197	0.072			
	36–45	307	4.15	1.254	0.072			
	46–55	265	4.24	1.027	0.063			
	I56–65	119	4.60	0.740	0.068			
	Total	1051	4.28	1.121	0.035			
WEM_3 Work equipment and work machines are regularly controlled and inspected by the authorities	18–25	82	3.71	1.486	0.164	6.680	0.000	0.014
	26–35	278	4.21	1.173	0.070			
	36–45	307	4.30	1.243	0.071			
	46–55	265	4.14	1.120	0.069			
	I56–65	119	4.52	0.662	0.061			
	Total	1051	4.21	1.176	0.036			

WEM_4 The conditions of the working environment (temperature, humidity, dust...) are satisfactory (I feel comfortable while working)	18–25	82	3.30	1.119	0.124	7.904	0.000	0.034
	26–35	278	3.53	1.400	0.084			
	36–45	307	3.41	1.487	0.085			
	46–55	265	3.14	1.512	0.093			
	I56–65	119	3.98	1.142	0.105			
	Total	1051	3.43	1.428	0.044			
WE_1 At my workplace, I am exposed to the risk of sudden collapse, gas, water...	18–25	82	4.32	0.718	0.079	9.405	0.000	0.039
	26–35	278	4.04	1.362	0.082			
	36–45	307	4.35	1.182	0.067			
	46–55	265	4.41	0.808	0.050			
	I56–65	119	4.72	0.596	0.055			
	Total	1051	4.32	1.087	0.034			
WE_2 The colleagues I work with are professional and do their work safely (I feel safe working with them)	18–25	82	4.66	0.773	0.085	10.858	0.000	0.024
	26–35	278	4.62	0.668	0.040			
	36–45	307	4.24	1.203	0.069			
	46–55	265	4.51	0.749	0.046			
	I56–65	119	4.74	0.495	0.045			
	Ukupno	1051	4.50	0.886	0.027			
WE_3 Work experience affects safe work at my workplace	18–25	82	4.32	0.718	0.079	9.405	0.000	0.018
	26–35	278	4.04	1.362	0.082			
	36–45	307	4.35	1.182	0.067			
	46–55	265	4.41	0.808	0.050			
	I56–65	119	4.72	0.596	0.055			
	Total	1051	4.32	1.087	0.034			
WE_4 It happens that sometimes due to the accelerated pace of work, I skip the safety procedures	18–25	82	4.32	0.718	0.079	7.897	0.000	0.034
	26–35	278	4.02	1.358	0.081			
	36–45	307	4.33	1.182	0.067			
	46–55	265	4..34	0.891	0.055			
	I56–65	119	4.66	0.694	0.064			
	Total	1051	4.29	1.106	0.034			
WE_5 Night work and shift work exhausts me	18–25	82	2.99	1.622	0.179	8.161	0.000	0.020
	26–35	278	3.52	1.594	0.096			
	36–45	307	3.63	1.508	0.086			
	46–55	265	3.97	1.321	0.081			
	I56–65	119	3.82	1.300	0.119			
	Total	1051	3.66	1.494	0.046			
M_2 Management believes that safety is at least as important as production	18–25	82	4.63	1.710	0.189	6.010	0.000	0.014
	26–35	278	4.32	1.091	0.065			
	36–45	307	4.43	1.296	0.074			
	46–55	265	4.37	1.195	0.073			
	I56–65	119	4.66	0.937	0.086			
	Total	1051	4.43	1.234	0.038			
M_4 I am free to present my work-related problems to my superiors	18–25	82	4.39	0.949	0.105	3.725	0.005	0.029
	26–35	278	4.42	1.044	0.063			
	36–45	307	4.09	1.031	0.059			
	46–55	265	4.26	0.933	0.057			
	I56–65	119	4.52	0.805	0.074			
	Total	1051	4.29	0.986	0.030			

M_5 My superiors emphasize the importance of security and we openly discuss it	18–25	82	4.61	0.997	0.110	6.529	0.000	0.017
	26–35	278	4.63	1.221	0.073			
	36–45	307	4.59	1.425	0.081			
	46–55	265	4.41	1.107	0.068			
	I56–65	119	4.82	0.753	0.069			
	Total	1051	4.58	1.212	0.037			
OR_1 My superiors always organize the work process in accordance with OSH measures	18–25	82	4.39	0.953	0.105	5.488	0.000	0.024
	26–35	278	4.42	0.983	0.059			
	36–45	307	4.09	1.116	0.064			
	46–55	265	4.26	1.120	0.069			
	I56–65	119	4.52	0.882	0.081			
	Total	1051	4.29	1.055	0.033			
T_3 Work training is conducted by professionals	18–25	82	4.61	0.871	0.096	4.557	0.001	0.030
	26–35	278	4.63	0.747	0.045			
	36–45	307	4.59	1.010	0.058			
	46–55	265	4.41	1.062	0.065			
	I56–65	119	4.82	0.676	0.062			
	Total	1051	4.58	0.924	0.028			

The data in Table 2 show that the opinion of employees belonging to the 18-25 age group is different from the opinion of older employees, i.e. those belonging to the 46–55 and 56–65 age groups, for all statements. It is quite certain that the young population perceives the occupational health and safety differently from the older generations. Despite the different perceptions, the research has shown that the occurrence of injuries among workers in these categories is not so frequent in the mines in Serbia [12].

The results of further analysis (post hoc analysis) show there is a difference between the opinions of workers of younger age groups compared to the older age groups for most statements. However, the Eta-squared value according to the Cohen criterion shows that the effect of this difference is less than 0.06, which indicates that the actual value of the difference between the groups is small.

3.3 ANOVA test for the parameter work experience

The ANOVA tests in relation to the total calendar work experience showed there was a statistically significant difference in 11 statements. A more detailed analysis shows that the opinion of employees who belong to the group with 0-10 years of professional experience differs from the opinion of employees with longer professional experience (21-25 years), and those who are about to retire (26-35 years). The statistically significant values of the ANOVA for the parameter total calendar work experience are shown in Table 3.

According to the data from Table 3, the highest value of the Eta-squared parameter (0.0634) in relation to the Cohen criterion was the question WEM_3 - Work equipment and machinery are regularly checked and inspected by the authorities. This value classifies the significance of the difference between the compared groups as medium (value greater than 0.06). The respondents with 16-20 years of professional experience gave this criterion the highest rating, while the respondents with 0-10 years of professional experience gave it the lowest rating.

Table 3 *Statistically significant results of the ANOVA test based on the parameter total calendar work experience*

Question	Work experience	Number of respondents	Arithmetic mean	Standard deviation	Standard error	Parameter F	Probability p	Eta-squared
PPE_2 Personal protective equipment is comfortable and does not bother me while I work	0–10	450	3.78	1.342	0.0633	8.715	0.000	0.0323
	11–15	160	4.17	1.139	0.0901			
	16–20	105	4.17	0.925	0.0902			
	21–25	124	4.07	0.973	0.0873			
	26–35	212	4.28	0.894	0.0614			
	Total	1051	4.01	1.169	0.0361			
PPE_4 Collective protective equipment (fire extinguishers, gas detectors and ventilation meters...) are correct and present at my workplace	0–10	450	4.10	1.298	0.0612	10.628	0.000	0.0391
	11–15	160	4.35	1.150	0.0909			
	16–20	105	4.45	0.635	0.0620			
	21–25	124	4.67	0.472	0.0424			
	26–35	212	4.52	0.857	0.0588			
	Total	1051	4.32	1.087	0.0335			
WEM_2 Work equipment and work machines are appropriate for the work operations I perform at my workplace	0–10	450	4.23	1.282	0.0605	3.927	0.004	0.0148
	11–15	160	4.48	0.918	0.0725			
	16–20	105	4.50	0.667	0.0651			
	21–25	124	4.03	1.126	0.1011			
	26–35	212	4.28	1.036	0.0712			
	Total	1051	4.28	1.121	0.0346			
WEM_3 Work equipment and work machines are regularly controlled and inspected by the authorities	0–10	450	4.00	1.376	0.0649	12.384	0.000	0.0634
	11–15	160	4.36	1.054	0.0833			
	16–20	105	4.74	0.501	0.0488			
	21–25	124	4.50	0.841	0.0755			
	26–35	212	4.13	1.080	0.0742			
	Total	1051	4.21	1.176	0.0363			
WEM_4 The conditions of the working environment (temperature, humidity, dust...) are satisfactory (I feel comfortable while working)	0–10	450	3.48	1381	0.0651	4.835	0.001	0.0182
	11–15	160	3.77	1.472	0.1164			
	16–20	105	3.47	1.366	0.1333			
	21–25	124	3.15	1.507	0.1353			
	26–35	212	3.22	1.425	0.0979			
	Total	1051	3.43	1.428	0.0441			
WE_1 At my workplace, I am exposed to the risk of sudden collapse, gas, water...	0–10	450	4.10	1.298	0.0612	10.628	0.000	0.0391
	11–15	160	4.35	1.150	0.0909			
	16–20	105	4.45	0.635	0.0620			
	21–25	124	4.67	0.472	0.0424			
	26–35	212	4.52	0.857	0.0588			
	Total	1051	4.32	1.087	0.0335			
WE_3 Work experience affects safe work at my workplace	0–10	450	4.10	1.298	0.0612	10.628	0.000	0.0391
	11–15	160	4.35	1.150	0.0909			
	16–20	105	4.45	0.635	0.0620			
	21–25	124	4.67	0.472	0.0424			
	26–35	212	4.52	0.857	0.0588			

WE_4 It happens that sometimes due to the accelerated pace of work, I skip the safety procedures	0–10	450	4.08	1.289	0..0608	8.065	0.000	0.0299
	11–15	160	4.33	1.152	0.0911			
	16–20	105	4.41	0.661	0.0645			
	21–25	124	4.61	0.608	0.0546			
	26–35	212	4.43	0.969	0.0665			
	Total	1051	4.29	1.106	0.0341			
M_3 My superiors will stop the work if it is done unsafely	0–10	450	4.29	1.093	0.0515	5.038	0.001	0.0147
	11–15	160	4.28	1.110	0.0878			
	16–20	105	4.42	0.852	0.0832			
	21–25	124	3.98	1.473	0.1323			
	26–35	212	3.96	1.371	0.0942			
T_3 Work training is conducted by professionals	0–10	450	4.60	0.875	0.0412	4.651	0.001	0.0175
	11–15	160	4.38	1.176	0.0929			
	16–20	105	4.83	0.448	0.0438			
	21–25	124	4.69	0.790	0.0709			
	26–35	212	4.50	1.019	0.0700			
	Total	1051	4.58	0.924	0.0285			

The question WE_3 - Work experience has an impact on safe work at my workplace also has a high Eta-squared value, with respondents with the least experience agreeing with this statement the least and those with the most experience the most. Two questions from the group of questions on PPE: PPE_2 - Personal protective equipment is comfortable and does not bother me at work and PPE_4 - Collective protective equipment (fire extinguishers, measuring devices for gas ventilation...) are correct and available at my workplace, they also have a high Eta-squared value. However, the first question has a low overall mean, indicating that respondents are not entirely satisfied with the quality of their protective equipment. In the second question, the respondents with more seniority rated the quality of collective protection measures better than those with less seniority. For all questions, with the exception of question WEM_3, there is a difference in the group comparison, but further analysis showed that the actual value of differences between these groups of questions is small.

3.4 ANOVA test for the parameter qualification/professional education

The qualification/professional training parameter was analyzed using the ANOVA tests to identify 12 statements with a statistically significant difference in the answers of respondents, shown in Table 4.

Table 4 shows the Eta-squared value of the extracted statements in the last column. In the opinion of the respondents, based on Cohen's importance criterion, the question WEM_3 - Work equipment and machinery are regularly checked and inspected by the authorities - stands out as the only one with medium importance.

Table 4. *Statistically significant results of the ANOVA test based on the qualification/professional education parameter*

Question	Qualification / Professional education	Number of respondents	Arithmetic mean	Standard deviation	Standard error	Parameter F	Probability p	Eta-squared
PPE_1 I think that personal protective equipment is necessary to work at my workplace	NK – non-qualified	308	4.88	0.497	0.028	7.221	0.000	0.027
	KV – qualified	473	4.65	0.873	0.040			
	SSS – secondary education	225	4.81	0.690	0.046			
	VS – higher education	39	4.56	0.754	0.121			
	Dr/Ms – PhD/MSc	6	4.00	0.000	0.000			
	Total	1051	4.75	0.743	0.023			
PPE_3 Personal protective equipment is available to me (in case I lose or tear it, I can get another one)	NK – non-qualified	308	4.15	1.298	0.074	9.458	0.000	0.035
	KV – qualified	473	3.72	1.565	0.072			
	SSS – secondary education	225	3.51	1.593	0.106			
	VS – higher education	39	4.41	0.966	0.155			
	Dr/Ms – PhD/MSc	6	5.00	0.000	0.000			
	Total	1051	3.83	1.499	0.046			
PPE_4 Collective protective equipment (fire extinguisher parameters...) are correct and present at my workplace	NK – non-qualified	308	4.45	0.945	0.054	4.266	0.002	0.016
	KV – qualified	473	4.24	1.185	0.054			
	SSS – secondary education	225	4.32	1.050	0.070			
	VS – higher education	39	4.49	0.970	0.155			
	Dr/Ms – PhD/MSc	6	3.00	0.000	0.000			
	Total	1051	4.32	1.087	0.034			
PPE_5 I know how to properly and purposefully use collective and personal protective equipment	NK – non-qualified	308	4.57	0.790	0.045	3.767	0.005	0.014
	KV – qualified	473	4.69	0.797	0.037			
	SSS – secondary education	225	4.76	0.573	0.038			
	VS – higher education	39	4.38	0.963	0.154			
	Dr/Ms – PhD/MSc	6	5.00	0.000	0.000			
	Total	1051	4.66	0.761	0.023			
WEM_1 The work equipment I use is correct, safe and modern	NK – non-qualified	308	4.44	1.109	0.063	4.554	0.001	0.017
	KV – qualified	473	4.09	1.353	0.062			
	SSS – secondary education	225	4.18	1.079	0.072			
	VS – higher education	39	4.36	0.843	0.135			
	Dr/Ms – PhD/MSc	6	500	0.000	0.000			
	Total	1051	4.23	1.217	0.038			
WEM_3 Work equipment and work machines are regularly controlled and inspected by the authorities	NK – non-qualified	308	4.53	0.893	0.051	9.930	0.000	0.064
	KV – qualified	473	4.00	1.299	0.060			
	SSS – secondary education	225	4.20	1.193	0.080			
	VS – higher education	39	431	1.004	0.161			
	Dr/Ms – PhD/MSc	6	4.00	0.000	0.000			
	Total	1051	4.21	1.176	0.036			
WE_1 At my workplace, I am exposed to the risk of sudden collapse, gas, water...	NK – non-qualified	308	4.45	0.945	0.054	4.266	0.002	0.016
	KV – qualified	473	4.24	1.185	0.054			
	SSS – secondaryeducation	225	4.32	1.050	0.070			
	VS – higher education	39	4.49	0.970	0.155			
	Dr/Ms – PhD/MSc	6	3.00	0.000	0.000			
	Total	1051	4.32	1.087	0.034			

WE_3 Work experience affects safe work at my workplace	NK – non-qualified	308	4.45	0.945	0.054	4.266	0.002	0.016
	KV – qualified	473	4.24	1.185	0.054			
	SSS – secondary education	225	4.32	1.050	0.070			
	VS – higher education	39	4.49	0.970	0.155			
	Dr/Ms – PhD/MSc	6	3.00	0.000	0.000			
	Total	1051	4.32	1.087	0.034			
WE_4 It happens that sometimes I skip safety procedures due to accelerated work	NK – non-qualified	308	4.43	0.964	0.055	4.152	0.002	0.016
	KV – qualified	473	4.22	1.183	0.054			
	SSS – secondary education	225	4.22	1.120	0.075			
	VS – higher education	39	4.44	0.995	0.159			
	Dr/Ms – PhD/MSc	6	3.00	0.000	0.000			
	Total	1051	4.29	1.106	0.034			
WE_5 Night work and shift work exhausts me	NK – non-qualified	308	3.90	1.410	0.080	7.372	0.000	0.027
	KV – qualified	473	3.39	1.569	0.072			
	SSS – secondary education	225	3.83	1.407	0.094			
	VS – higher education	39	4.00	1.277	0.205			
	Dr/Ms – PhD/MSc	6	4.00	0.000	0.000			
	Total	1051	3.66	1.494	0.046			
M_4 I am free to present my work-related problems to my superiors	NK – non-qualified	308	4.54	0.921	0.052	5.285	0.000	0.020
	KV – qualified	473	4.42	0.952	0.044			
	SSS – secondary education	225	4.36	1.039	0.069			
	VS – higher education	39	3.85	1.368	0.219			
	Dr/Ms – PhD/MSc	6	5.00	0.000	0.000			
	Total	1051	4.43	0.986	0.030			
OR_2 The organization of work is such that workers do not endanger each other (i.e. the jobs I perform do not endanger my colleagues)	NK – non-qualified	308	4.52	0.904	0.052	3.977	0.003	0.015
	KV – qualified	473	4.25	1.153	0.053			
	SSS – secondary education	225	4.40	0.978	0.065			
	VS – higher education	39	4.62	0.782	0.125			
	Dr/Ms – PhD/MSc	6	4.00	0.000	0.000			
	Total	1051	4.38	1.039	0.032			

The NK employees rated this question the highest, while KV employees and employees with the highest level of training rated it the lowest. Significant Eta-square values also have questions related to the PPE: PPE_2 - Personal protective equipment is comfortable and does not interfere with my work and PPE_4 - Collective protective equipment (fire extinguishers, gas ventilation parameter meters...) are correct and available at my workplace. Question WE_5 - Night and shift work exhausts me, because the disadvantages of night work are certainly recognized by those who work in shifts, namely NK and KV workers. Another question stood out, M_4 - I am free to bring my work-related problems to the attention of my superiors. Here it is noted that communication with superiors is characterized by the highest rating from the point of view of the best educated, which is logical, since they occupy the highest management positions. However, the employees who are only one level below them in the hierarchy gave this criterion the lowest rating, so the communication between managers is poor.

4. CONCLUSION

When completing the questionnaire, the respondents showed considerable differences in their opinions on health and safety at work in the mining industry. The differences in opinion are the smallest in relation to the production unit of the mine and are reflected in the category of questions related to the work equipment and training. The

most significant difference between respondents was in the category of age and overall work experience, where workers showed the statistically significant differences of opinion in relation to the control of work equipment, knowledge of their colleagues, work organization and in relation to the quality of training.

ACKNOWLEDGEMENTS

The research presented in this paper was done with the financial support of the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, within the funding of the scientific research work at the University of Belgrade, Technical Faculty in Bor, according to the Contract with registration number 451-03-65/2024-03/200131.

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