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# Impact of occupational safety culture on the occurrence of accidents in a selected coal mine

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**Abstract.** Mining-related professions, accompanied by significant hazards that are difficult to eliminate, are characterized by lower occupational safety cultures and higher accident rates, as compared to professions in which the hazard levels are lower or easily eliminated. In such situation it may be assumed that the accident rates are related to the magnitude of hazards and risk and the level of occupational safety culture in each of the professional groups. The main purpose of the paper is to present the dependence between risk-taking, including risky behaviours and the causation of accidents, and, as a consequence, the occupational safety culture. An analysis of accident rates in one of the coal mines was conducted for the purposes of the paper and a questionnaire regarding the risk and risky behaviours. The study encompassed a representative, randomly selected group of people employed at underground. The thesis presents the dependence between risk-taking, including risky behaviours of the employees and the accident rate, related to the occupational safety culture. To make an assessment of the dependence between the two variables, Spearman's rank correlation coefficient was used. Also the determination coefficient was calculated. The obtained result indicates that a correlation exists between the studied variables.

## 1. Introduction

In any enterprise, the level of safety culture level has a direct impact on the employees' attitudes regarding safety and health protection. This has been confirmed by numerous studies regarding the occurrence of accidents conducted in the past decade or so. The research has shown that cultural mechanisms play a significant role in the occurrence of large-scale industrial catastrophes, are related to the accident indicators and the number of professional diseases in companies as well as in the entire society. Statistics regarding accidents at work indicate that various professions related to mining are different in terms of accident rates. This is most likely the result of performing professional duties characterized by different hazards and – possibly – a consequence of different levels of occupational safety cultures [1, 2].

A high occupational safety culture is characterized by “non-acceptance” of high risk. Such “non-acceptance” results in the withdrawal from hazardous situations or the reduction of risk. The reduction of risk may be achieved either by changing the environmental conditions or the technology, or – if the change is impossible – by underrating the level of risk. Empirical data exists, exhibiting that if no actual reduction of risk may be achieved, the employees accept risk that they had not accepted previously. The cases of reduction of risk by changes in the assessment methods or the acceptance of excessive risk are the symptoms of a low occupational safety culture. Mining-related professions, accompanied by significant hazards that are difficult to eliminate, are characterized by lower occupational safety cultures and higher accident rates, as compared to professions in which the hazard levels are lower or easily eliminated. In such situation it may be assumed that the accident rates are related to the magnitude of hazards and risk and the level of occupational safety culture in each of the professional groups.

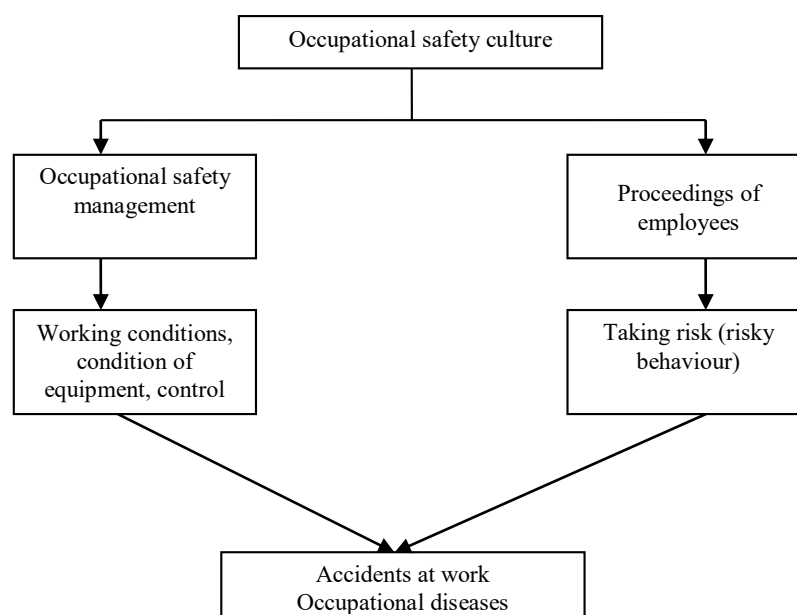


A question has thus been asked: are the presented assumptions well-founded, that is, are the professional groups within the mining industry different from each other in terms of the safety culture and is the occupational safety culture level of each of the professional groups related to the non-observance of safety standards and thus the occurrence of accidents [1]?

## 2. Materials and methods

The main purpose of the paper is to present the dependence between risk-taking, including risky behaviours and the causation of accidents, and, as a consequence, the occupational safety culture. The safety culture was operationalized as a variable shaping both the level of safety management and the behaviour of employees, measured directly as the frequency of deviations from the binding OHS standards and measured indirectly as accident rates [3].

The dependence referred to above has been presented in the diagram below (figure 1.).



**Figure 1.** Hypothetic dependence among the culture of the safety of the work and causing the incidents [3].

The impact of the safety culture on the causation of accidents proceeds indirectly through an intermediate variable, which was assumed to be taking up risky behaviours by the employees. The safety culture was assumed as the independent variable, while the causation of accidents was assumed as the dependent variable.

An analysis of accident rates in one of the coal mines was conducted for the purposes of the paper and a questionnaire regarding the risk and risky behaviours taken up by employees was filled in [4, 5]. The form of the questionnaire was open and it was anonymous. The respondents could select from one or several answers among the provided ones or could express their own opinion. The study encompassed a representative, randomly selected group of people employed at underground positions of the coal mine in concern (154 persons) and were conducted during the periodical OHS trainings.

## 3. Results and conclusions

### 3.1. Risky behaviours most often taken up by the mine employees

The term „risky” pertained to behaviours against the binding formal standards of occupational safety – provisions, procedures and instructions [3].

A list of most commonly observed risky behaviours, expressed as percentages:

- 1) Walking on transport ways in a manner violating the provisions (61.3% of employees);
- 2) Travel using a conveyor unfit for transport of humans (59.5%);
- 3) Standing or walking on transport ways during transport (56.5%);
- 4) Improper behaviour while ascending the shafts (56.0%);
- 5) Using devices or tools in inappropriate technical condition (53.1%);
- 6) Failure to use personal protective equipment (49.6%);
- 7) Using incorrect tools (48.2%);
- 8) Failure to use safety equipment during work at heights (46.1%);
- 9) Cleaning the belt conveyor during its operation (44.8%);
- 10) Passing over belt conveyors and scraper conveyors where it is prohibited (42.2%);
- 11) Non-observance of OHS regulations binding at the area of the mine (33.6%);
- 12) Exchange of rollers during the operation of the belt conveyor (33.5%);
- 13) Failure to use anti-dust masks (32.7%);
- 14) Jumping on or off the passenger train during its movement (29.5%);
- 15) Failure to carry an absorber (27.4%);
- 16) Work under the influence of alcohol (23.6%);
- 17) Jumping on or off of the locomotive operator during movement (18.8%);
- 18) Non-observance of safety signs placed underground in the mine (17.9%);
- 19) Smoking underground in the mine (16.1%);
- 20) Travelling with man cars while the door is open (14.9%);
- 21) Simultaneous operation of passenger and freight trains (14.8%);
- 22) Not keeping a safe distance during blasting works (14.4%);
- 23) Performing live works without turning off the power (13.5%);
- 24) Entering one-way, non-ventilated headings (13.1%);
- 25) Failure to protect the devices before repair works (12.7%);
- 26) Travel of persons by mine carts (7.5%);
- 27) Welding in cross headings without supervision and protection (6.5%);
- 28) Excessive speed of passenger trains, which may lead to derailment (5.7%).

The above list exhibits that risky behaviours are most often undertaken during transport of goods and persons. Moreover, the risky behaviours are also related to inadequate or malfunctioning devices or tools (which may be related to the economic condition of the mine and insufficient organization of work), and non-observance of OHS regulations binding at the area of the mine, including failure to apply personal protective equipment or working under the influence of alcohol.

Table 1 presents a list of the most common risky behaviours at different workplaces, expressed as percentages.

Based on the data in the table, one may note that the risky behaviours are most often taken up at positions such as: miners and junior miners (31.0%), fitters, timberers and mechanics (32.5%) as well as electricians, machine operators (26.1%) and other underground workers (27.0%).

**Table 1.** Proportional composition of undertaken the most often risky behaviours on the individual positions of the work.

Risky behaviours	Type of workplace			
	Miners and junior miners	Locksmiths, mechanics, carpenters	Electricians, machinery and equipment operators, electricians	Others physical worker
1	64.3	63.2	39.7	67.6
2	53.7	56.6	41.4	50.3
3	52.5	55.8	44.1	83.3
4	57.4	44.3	48.4	50.1
5	59.0	56.4	48.4	67.6
6	48.4	55.8	39.7	50.1
7	41.3	36.9	30.1	33.2
8	44.1	42.7	39.7	50.1
9	59.1	42.7	39.7	67.6
10	45.0	47.2	37.9	50.1
11	33.5	36.9	35.4	17.6
12	34.8	30.4	12.7	17.6
13	34.8	44.3	27.1	33.2
14	26.6	26.2	26.7	16.7
15	23.3	36.9	18.3	33.2
16	23.3	44.3	22.7	17.6
17	27.1	12.3	18.3	33.2
18	15.8	25.4	20.7	-
19	19.2	12.3	9.6	-
20	11.8	25.4	18.3	17.6
21	21.1	19.8	9.6	-
22	12.4	19.8	13.1	-
23	11.3	19.8	31.0	-
24	15.2	7.5	13.1	-
25	12.4	24.6	27.2	-
26	6.2	7.6	9.6	-
27	8.7	8.4	4.3	-
28	6.5	5.4	4.3	-

### 3.2. Analysis of accident rates in a selected coal mine in the years 2015 - 2016

To perform further analyses, it is necessary to bring up the statistical data pertaining to accident rates in the coal mine in concern [4].

**Table 2.** The composition of incidents the totality in years 2015- 2016 [4].

Type of accidents	Number of accidents		
	Year 2015	Year 2016	Difference
Death accident	2	1	-1
Heavy accident	1	0	-1
Other	44	43	-1
Total	47	44	-3

**Table 3.** The composition of incidents according to the injured contest [4].

Type of workplace	2015	2016
Miner	15	13
Face foreman	2	1
Suspended railway operator	0	1
Junior miner	2	0
Carpenter-miner	2	3
Electrician	8	6
Borer	0	1
Timberer	7	8
Washer operator	0	2
Shaft carpenter	2	1
Mine rescuer	1	2
Technical and engineering employees	3	2
Sorters	1	0
Processing plant machine maintenance serviceman	1	1
Gasman miner	0	1
Miner performing measurements	0	0
Boring dept. overman	0	1
Physical worker – filling preparation building	0	0
Ventilation measurement dept.	0	0
Underground transportation worker	1	1
Underground transportation dispatcher	1	0
Miner – prop drawer	1	0
Total	47	44

**Table 4.** Coefficient of frequency of incidents on 1000 workers (WZ) for individual professional groups persons undergrounds workers [4].

Type of workplace	Coefficient W <sub>Z</sub>	
	2015	2016
Miners and junior miners	56.7	54.1
Locksmiths, mechanics, carpenters	48.1	51.7
Electricians, machinery and equipment operators, electricians	24.5	22.3
Others physical worker	43.6	37.5

### 3.3. Statistical analysis of the obtained results

This section presents the dependence between risk-taking, including risky behaviours of the employees and the accident rate, related to the occupational safety culture. To make an assessment of the dependence between the two variables, Spearman's rank correlation coefficient was used. Also the determination coefficient was calculated [6].

The rank correlation coefficient was calculated based on the following formula:

$$r_s = 1 - \frac{6 \cdot \sum_{i=1}^n d_i^2}{n(n^2 - 1)} \quad (1)$$

where:  $d_i$  – denote the differences between ranks of the corresponding values of  $x_i$  and  $y_i$  ( $i=1, 2, \dots, n$ )

Using the above formula, we obtain:

$$r_s = 0.8$$

$$r_s^2 = 0.64$$

The obtained result indicates that a correlation exists between the studied variables. A positive sign of the rank correlation coefficient indicates the existence of positive interdependence. The determination coefficient of both the variables is 64.0%, which may indicate a considerable dependence of the accident rate and the propensity to take up risky behaviours.

#### 4. Conclusions

Studying the occupational safety culture is one of the methods to assess the OHS conditions and the engagement of the employees. It also constitutes an occasion to promote certain ideas and values in places of employment. A positive safety culture of the staff is a necessary condition of maintaining safety and – which is empirically verified – it may be decisive for the safety level of the staff's behaviour, contributing to the limitation of accident rates and number of cases of professional diseases.

In view of the current analyses of the causes and circumstances of accidents, humans are the weakest link of the social and technical system. As the data of the State Mining Authority provide, over 90% of injuries registered in the recent years in mining took place due to mistakes of the employees, negligence of duties or risky behaviours. The causes of the observed accident rates formulated in that way indicate a serious deficiency of the current process of training people to work in a safe manner.

In the conducted study, respondents have specified the frequency of their risky behaviours. While analyzing the results, the conclusion may be reached that usually risky behaviours are taken up during transport of goods and persons. Moreover, the risky behaviours are also related to inadequate or malfunctioning devices or tools (which may be related to the economic condition of the mine and insufficient organization of work), as well as neglecting OHS provisions binding at the mining plant, including the failure to apply personal protective equipment or working under the influence of alcohol.

The risk level expressed through the employees' behaviours is considerable, which was reflected in the number of accidents noted in the analysed hard coal mine. This fact may exhibit that the occupational safety culture has a significant influence on the accident rate. The higher the level of safety culture, the more probable a lower number of accidents.

The conducted studies and analyses allow the conclusion that the professions related to mining vary in terms of exposure to professional hazards and the number of occupational accidents.

To summarize, it may be stated that the accident rate is strictly related to the level of hazards and risk that is taken up and – as a consequence – to the occupational safety culture level.

#### 5. References

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