

Z. G. Zhanbirov<sup>1</sup>,  
orcid.org/0000-0002-6444-0836,  
O. V. Deryugin<sup>\*2</sup>,  
orcid.org/0000-0002-2456-7664,  
A. B. Toktamyssova<sup>3</sup>,  
orcid.org/0000-0002-9434-7413,  
D. A. Agabekova<sup>4</sup>,  
orcid.org/0000-0003-2604-0126,  
M. M. Arkhirei<sup>2</sup>,  
orcid.org/0000-0002-6803-0703

1 – Academy of Logistics and Transport, Almaty, the Republic of Kazakhstan  
2 – Dnipro University of Technology, Dnipro, Ukraine  
3 – Kostanay Engineering and Economic University named after M. Dulatov, Kostanay, the Republic of Kazakhstan  
4 – Eurasian Technological University, Almaty, the Republic of Kazakhstan  
\* Corresponding author e-mail: [oleg.kot@meta.ua](mailto:oleg.kot@meta.ua)

## RESEARCH ON THE IMPACT OF COGNITIVE BIASES OF WORKERS ON THE SUBJECTIVE ASSESSMENT OF OCCUPATIONAL RISK

**Purpose.** When assessing occupational risks (OR) of professional activities of employees of the motor transport company (MTC), there is often a problem to determine the probability of a hazardous event and the severity of its consequences under the influence of various cognitive biases. Therefore, there arises an urgent issue of taking into account the cognitive biases and their influence on the assessment of PR. This is achieved by studying the impact of awareness and worldview of employees on the assessment of PR and developing recommendations for reducing cognitive bias in determining the likelihood of a hazardous event.

**Methodology.** The study involved 87 employees of the motor transport company of different ages, experience and level of education, who were interviewed on a specially designed checklist which provides for the ranking of harmful factors that affect the employee when performing production tasks, taking into account the impact of five cognitive biases on the value the probability of a hazardous event.

**Findings.** According to the results of the study, it can be concluded that motor transport company workers with significant professional experience were most concerned about the intensity and pace of work, as well as the number of repetitive movements, which significantly affected the level of safety when performing production tasks. Less experienced workers highlighted the intensity of work, the pace of work and the monotony of work and from the point of view of males, the greatest concern was the intensity and monotony of work, in contrast to females who are concerned about the pace of work and uncomfortable posture. It is determined that employees perceive occupational risk more optimistically if they understand that it is controlled. There has also been a deteriorating trend due to a lack of time to conduct a proper analysis of the impact of harmful factors on workers' health.

**Originality.** Relationship is established between cognitive biases that occur in employees during the assessment of OR with the determination of the probability of a hazardous situation, which increases the probability of errors from 10 to 20 % during professional activities.

**Practical value.** Recommendations are developed to reduce the impact of subjective assessment on the magnitude of PR, which is based on increasing the number of participants with different worldviews, experience, education.

**Keywords:** *cognitive bias, occupational risk, occupational safety, management decisions*

**Introduction.** The driving profession is one of the most dangerous professions. The weight of a mistake when driving a vehicle is one's own life and the lives of other road users. The sad statistics of traffic accidents (hereinafter referred to as RA) shows that approximately 1.3 million people die annually as a result of RA [1, 2]. The loss that most countries incur as a result of RA is as much as 3 % of their gross domestic product. About 1.3 million people die annually as a result of RA. Another 20 to 50 million people get non-fatal injuries, which in many cases lead to disability [3].

For the conditions of Ukraine, the total number of RA in January–July 2021 reached almost 103 thousand cases, which is 18.5 % more than in the same period of 2020 [4]. According to the data [4], the main factor of RA is the driver exceeding his/her own capabilities in various manifestations of actions when driving a vehicle: failure to comply with the speed limit, violation of manoeuvring rules, failure to comply with the rules for crossing intersections, etc. It can be argued that this results from the physical or psychological impact of the driver's condition, limiting one's own resources when making decisions about safe driving. That is, when the driver's cognitive abilities are limited, there is a mismatch of his/her competences when driving a vehicle with the degree of complexity of the problems he/she solves in the conditions of road traffic, time spent searching for information. This leads to systematic errors and, as a consequence, it results in RA [5, 6].

In the field of occupational safety, to prevent the occurrence of incidents, accidents and occupational diseases, various practices are used, associated with the assessment of the state of hazard of technological equipment, environmental conditions, and hazardous actions of employees during the performance of professional activities, etc. Their processing or interpretation is used by the management staff of the motor vehicle enterprise to determine the level of OR, which is the basis for making managerial decisions to improve occupational safety. Unfortunately, this process is often accompanied by various cognitive biases [7]. Bias in making managerial decisions is often associated with an overestimation of a person's own capabilities – self-confidence, beliefs, self-interest, limitations by certain frameworks, past experience [8]. Recent scientific studies have shown that they arise due to the accumulation of additional knowledge, the successful completion of complex tasks, which are accompanied by a deterioration of the perception of reality due to the manifestation of subjective judgments, or a subjective evaluation of one's own actions. Therefore, there is an urgent question about taking into account the presence of cognitive biases and their influence on the OR estimate.

**Literature review.** There is a significant amount of research that has been aimed at determining the influence of subjective attitude on OR estimation [9, 10]. At the initial stage, the greatest interest was shown in the determination of intercultural differences in the perception of risky types of professional activities that pose a threat to health and safety, which is caused by the processes of globalization [11, 12]. This is because people perceive OR differently due to their own experi-

ences, education, beliefs, attitudes of colleagues and culture [13, 14]. In turn, in order to ensure safety and form an appropriate work culture, it is necessary to identify dependencies between the perception of OR by employees and the cause-and-effect relationship of the hazard occurrence, variants of the development of hazardous events, which are reflected at the individual and cultural levels [15]. Also, researchers emphasize the need to take into account various social and institutional factors for the assessment of OR, which are ultimately combined with human judgments regarding the probability of the occurrence of a hazardous event [16, 17].

**Purpose.** The purpose of the study is the influence of the awareness and worldview of employees of the motor vehicle enterprise on the assessment of OR and the development of recommendations for reducing the influence of cognitive biases when determining the probability of the occurrence of a hazardous event when an employee performs professional tasks.

**Methods.** Employees of the motor vehicle enterprise were selected for the study, because this industry is one of the most trauma-hazardous, due to the high probability of getting into RA. For the sample, a certain group of employees from various structural units of the motor vehicle enterprise was randomly selected, which consisted mainly of men (67.5 %) aged 25 to 55 years. Most of the respondents had a higher education, almost 40 %. Represented professions and positions of employees are: drivers (77.5 %), managers or middle managers (9.9 %), supervisors (12.6 %). All personal data of the study participants were collected by means of a questionnaire using a developed checklist within three months with the prior consent of their processing without personalization in this study.

The survey checklist consists of three sections: personal data (age, gender, education, work experience); subjective assessment of perception of the severity of the consequences of exposure to harmful factors at the workplace (noise, presence of chemicals, dust, temperature, awkward working posture, repetition of movements, pace of work, monotony and intensity of work) and evaluation of OR (Fig. 1).

The list of HEs, which were proposed for ranking by the respondents, were determined from the analysis of scientific studies aimed at studying working conditions at the motor transport enterprise [18]. They determined that the most effective performance of production obligations by an employee is influenced by: monotony of work, intensity, repetition of movements, uncomfortable posture and high ambient temperature.

In the last section of the checklist, employees were asked to determine the value of OR as the product of the probability of the occurrence of the hazard and the severity of the consequences, based on the respondents' perception of a number of cognitive biases that affect the obtained result and are determined by the employee's awareness, in-depth knowledge, the ability to control the hazard, lack of time for production task. The rating took place on a scale from 1 to 17, where 1 is the highest probability of occurrence of a hazardous event or OR, and 17 is the lowest. In a similar way, they were ranked based on the perception of the severity of the consequences of a hazardous event. The analysis of the obtained results was carried out using the Mann-Whitney test [19], and the Bonferroni adjustment was used to take into account multiple tests [20]. Based on the obtained results, indicators of the probability and severity of the occurrence of a dangerous event were determined on a scale from 1 to 5, following the following scale: hazard rank from 1 to 3 – 5 points; from 4 to 7 – 4 points; from 8 to 10 – 3 points; from 11 to 14 – 2 points; from 15 to 17 – 1 point. The resulting score was obtained by summing the ranks established by the qualitative characteristics of each of the ten hazards as OR perception indices. For the selection of variables, the reverse exclusion procedure based on the likelihood ratio test (removal criterion of 0.05 significance level) was applied. The age of the respondents and the length of service of

Gender identity  male  female  Prefer not to say

Age  < 35 years  > 35 years

Education  Secondary  Vocational  Higher

Experience  < 5 years  > 5 years

Harmful factor	Subjective assessment of the perception of the importance of consequences taking into account the effect of cognitive bias				
	Loss reduction	Lack of time	Pessimism bias	Optimism bias	Illusions of control
<b>Harmful physical factors</b>					
1. Increased temperature					
2. Noise					
3. Vibration					
4. Dust					
5. Chemical pollution					
6. Awkward posture					
7. Repetitive movements					
<b>Harmful psychological factors</b>					
<b>Intensity of the labor process</b>					
8. Nervous and mental overload					
9. Responsibility for the safety of employees					
10. Problems of compatibility of members of the production chain					
<b>Difficulty of the labor process</b>					
11. Physical overload					
12. Monotony of work					
13. Labor intensity					
14. Response in the event of an emergency					
15. Uncertainty and/or conflict of functions					
16. High requirements					
17. Low level of control over work					

Fig. 1. Checklist form for conducting questionnaires

the employees of the motor vehicle enterprise were included in each stage of the hazard ranking procedure and in the final model, regardless of their level of significance. Also, for each of the ten occupational hazards, a score was obtained by summing the ranks as an OR perception index.

Moreover, the scale for determining OR is presented as an equivalent from 1 to 5 (Fig. 2), according to which the criteria for evaluating OR are established using the formula [3]

$$R = S \cdot P,$$

where  $R$  is risk;  $S$  is severity of consequences;  $P$  is the probability of hazard.

OR is determined in points and varies from a minimum value of 1 point (insignificant risk) to a maximum value of 25 points (critical risk).

**Results.** The characteristics of the respondents who participated in the study are shown in Table 1. The total number of participants was 87 people; almost half of them are young workers under 35 years of age with professional experience of up to 5 years, which indicates a lack of significant work experience. At the same time, more than half of the respondents did not have a higher education, that is, they lack conceptual and methodological knowledge of professional activity.

At the same time, all research participants underwent briefings, special training and knowledge testing on labour protection, fire safety and traffic safety, which indicates that they have certain basic knowledge of safe behaviour at work. The result of a subjective assessment of the probability of the

Consequences	Probability					Risk
	Exceptional	Insignificant	Moderate	Significant	High	
No	1	2	3	4	5	1-4 Insignificant
Insignificant	2	4	6	8	10	5-8 Low
Moderate	3	6	9	12	15	9-12 Moderate
Significant	4	8	12	16	20	13-20 High
Catastrophic	5	10	15	20	25	20-25 Critical

Fig. 2. Matrix for determining OR by the "Risk score" method [3]

Table 1

## Personal characteristics of employees

Indicators	Age, years		Gender identity		Education			Experience, years	
	<35	>35	male	female	secondary	vocational	higher	<5	>5
Number of employees	49	38	76	11	23	30	34	64	23
%	56.3	47.7	87.4	12.3	26.4	34.4	39.2	73.6	26.4

occurrence of a hazardous event due to the influence of a number of harmful factors, taking into account experience and work experience, is shown in the Table 2.

From the obtained calculation data (Table 2), it can be concluded that the employees of the motor transport enterprise with significant professional work experience put intensity and pace of work in the first place, as well as repetitive movements, which significantly influenced their opinion on the level of safety, while the less experienced employees highlighted stress, pace of work and monotony of work. If we look at the results from the point of view of males, then they identified the greatest concern in the intensity and monotony of work, in contrast to females, who are concerned about the pace of work and uncomfortable posture. We note that in both cases the respondents underestimated the influence of the following factors: chemical pollution, noise, dust, although the action of these factors can lead to the development of serious occupational diseases.

Also, workers ranked the identified hazards in terms of minimizing losses to their health, lack of time to assess OR at the workplace, pessimistic or optimistic views on their lives, and availability of sufficient safety information from the management of the transport company. It is these factors that characterize five relevant cognitive biases, according to which the probability of occurrence of a hazardous event was ranked (Fig. 3). As a result, the corresponding value of OR was determined (Table 3).

Fig. 4 clearly shows that the majority of experiment participants associated the greatest hazard with the psychological

factors of the production environment, which depends on the level of perception of hazard.

On the other hand, in the case of increased control (providing a certain illusion of control), the emphasis shifted to physical factors: awkward posture, the effect of noise, increased temperature. Usually, these parameters are more easily controlled by technological solutions.

Some workers perceived OR more optimistically if they understood that it was controlled through awareness of the need to follow relevant occupational safety instructions; there

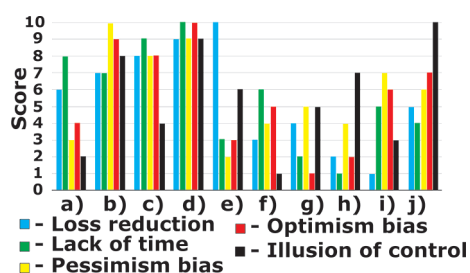


Fig. 3. The results of a subjective assessment of the perception of the probability of occurrence of OR under the influence of cognitive biases:

a – temperature; b – noise; c – vibration; d – dust; e – chemical pollution; f – awkward posture; g – repetitive movements; h – intensity; i – monotony; j – congestion

Table 2

## Subjective assessment of the severity of consequences

Harmful factor	Ranking of severity of consequences				Total score	P-value
	with experience		Gender identity			
	<5 years	>5 years	male	female		
Increased temperature	7	6	15	10	3	0.765
Noise	8	7	13	15	3	0.694
Vibration	9	8	10	9	3	0.121
Dust	10	9	7	7	3	0.012
Chemical pollution	5	10	6	3	4	0.017
Awkward posture	4	4	5	5	4	0.477
Repetitive movements	6	3	4	4	4	<0.001
Nervous and mental overload	1	2	2	6	5	<0.001
Responsibility for the safety of employees	14	13	11	10	2	0.553
Problems of compatibility of members of the production chain	16	11	8	11	3	0.426
Physical overload	11	14	3	7	3	
Labour intensity	2	1	1	2	5	<0.001
Monotony of work	3	3	3	4	5	<0.001
Response in the event of an emergency	17	17	12	16	2	0.012
Uncertainty and/or conflict of functions	15	12	17	1	3	0.017
High requirements	14	15	9	8	3	0.477
Low level of control over work	13	14	16	14	3	<0.001

Subjective assessment of perception of probability of HE and assessment of OR

Harmful factor	Ranking the probability of a hazardous event taking into account the effect of cognitive biases						Severity of HE consequences	OR
	Loss reduction	Lack of time	Pessimism bias	Optimism bias	Illusions of control	Total score		
Increased temperature	12	10	6	12	13	3	3	9
Noise	14	12	17	15	14	3	3	9
Vibration	17	15	12	14	17	2	3	6
Dust	15	13	16	16	12	3	3	9
Chemical pollution	10	11	10	17	6	3	4	12
Awkward posture	4	6	4	11	1	4	4	16
Repetitive movements	5	3	2	3	8	4	4	16
Nervous and mental overload	7	5	7	9	4	4	5	20
Responsibility for the safety of employees	8	9	8	10	11	3	2	6
Problems of compatibility of members of the production chain	9	7	9	1	9	4	3	12
Physical overload	6	4	1	2	5	4	3	12
Labour intensity	1	2	5	4	7	4	5	20
Monotony of work	3	1	3	6	6	4	5	20
Response in the event of an emergency	16	16	15	13	2	3	2	6
Uncertainty and/or conflict of functions	13	8	11	8	10	3	3	9
High requirements	2	14	4	7	8	4	3	12
Low level of control over work	11	17	10	5	3	4	3	12

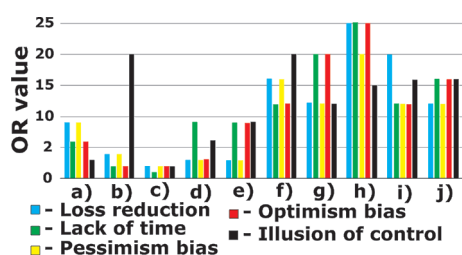


Fig. 4. The results of assessment of OR under the influence of cognitive biases:

a – temperature; b – noise; c – vibration; d – dust; e – chemical pollution; f – awkward posture; g – repetitive movements; h – intensity; i – monotony; j – congestion

were workers who considered themselves responsible for implementing safety measures to prevent workplace accidents; it is also possible to note the understanding of the influence of OR on the magnitude of the consequences for the health of workers. In addition, there was a tendency for the results to deteriorate due to the lack of time to perform the appropriate analysis.

**Discussion.** The obtained results from the calculation of OR showed (Table 3) that its largest value was recorded from work intensity, repetitive movements and monotony of work. It should be noted that the value of the overall OR, regardless of the difference in the ranking of the presented hazards, is in line with the recognized causes of RA in the analytical analyses of patrol police [4] and accidents that are mostly caused by human factors. It is the psychological component of drivers' work that increases the probability of making a mistake while driving a vehicle, which leads to RA. The greatest increase in the value of OR to almost 20 % of the average value is the presence of pessimism bias, under the influence of which a person overestimates the probability of negative events (Fig. 5).

This is caused primarily by the psychological state of the participants (depression, outlook, character). It is believed that

in order to carry out a detailed analysis, it is necessary to, first of all, assess one's psychological state, since it significantly affects the probability of error when forming judgments about the probability of the occurrence of a dangerous event [9, 10].

Optimism and illusions of control biases also lead to an underestimation of the OR value by almost 15 %, which is explained by the distortion of the causal relationship between successful decision-making and the presence of real hazard caused by the tendency of people to overestimate their ability to control events/beliefs in their own capabilities. In this case, in order to avoid such errors, it is necessary to use the base percentage of negative events provided that there is no reliable data when forecasting unlikely events. On the other hand, the larger the amount of data used to predict the probability of an event is, the higher the probability of the prediction being wrong is. This shows the bias of the illusion of loss control, which greatly increases the magnitude of the OR.

Work experience, education/training can also be the reason for some differences in OR estimates (Fig. 6).

Education/training influences hazard attitudes and perceptions. Employees who had a secondary education and not much work experience often did not understand the hazard posed by one or another harmful factor. In turn, employees

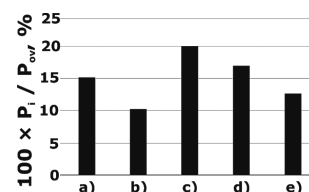


Fig. 5. The change in the relative OR due to the influence of cognitive biases ( $P_i$  is value of OR under the influence of the  $i^{\text{th}}$  cognitive bias;  $P_{ov}$  is the total value of OR under the influence of all biases together):

a – losses reduction; b – lack of time; c – pessimism; d – optimism; e – illusion of control



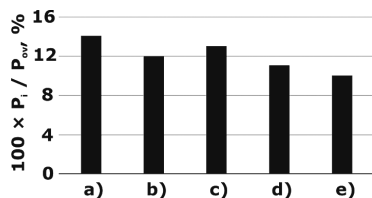


Fig. 6. The change in the relative OR due to the influence of experience and educational level of employees ( $P_i$  is value of OR under the influence of the  $i^{\text{th}}$  cognitive bias;  $P_{ov}$  is the total value of OR under the influence of all biases together): a – experience < 5 years; b – experience > 5 years; c – secondary education; d – vocational education; e – higher education

with higher education slightly overestimated the hazard, overestimating the risk to almost 10 %. It should be noted that among all participants there is a certain group who, despite their knowledge or experience, are afraid of receiving a negative result due to insecurity in their actions. Thus, one can draw an important conclusion about the need for continuous training of employees. It can also be noted that employees with considerable work experience more pragmatically estimated the value of OR, despite the effect of certain biases.

The study suggests that differences in the experience of risky activities can explain individual variability in OR scores, but their relationship depends on what the OR experience was.

The perception of OR is difficult to understand. Several factors are known to influence this, but how people characterize OR is still not fully understood. This study sought to highlight the views of employees and their assessment of OR in the context of a trucking company. Our results provide clues about cultural differences in risk perception of occupational hazards. Combined with education/training, these differences account for differences in OR perception. In order to explain individual, group or cultural influences, in-depth psychological research is needed on model-based prediction of occupational hygiene behaviour [8]. Motivation, beliefs and values are important elements of health and safety activities. Effective measures at both the organizational and political levels should take into account the motivation, satisfaction and effectiveness of employees based on knowledge of individual and situational characteristics [12].

The conducted research leaves open the question of the adequacy of the sample for studying the influence of the presented prejudices. The sample is relatively small, so the obtained result rather weakly characterizes the established dependencies for spreading the conclusions to other organizations and companies. However, the proposed approaches provide an understanding of the development trends of the identified differences, which can characterize identical situations and carry out refinements in other conditions.

### Conclusions.

1. Based on the results of the research, it can be noted that the employees of the motor transport company with significant professional experience were most concerned about the intensity and pace of work, as well as the number of repetitive movements, which significantly influenced their opinion on the level of safety. In contrast, less experienced workers highlighted stress, work pace and monotony of work, with males being most concerned about work stress and monotony, in contrast to females who were concerned about work pace and awkward posture.

2. Workers were found to be more optimistic about OR when they perceived it to be controlled, and a tendency to worsen outcomes due to lack of time to adequately analyse the impact of harmful factors on workers' health was also observed.

3. The relationship between the cognitive biases manifested by employees during the OR assessment and the determination of the probability of a dangerous situation, which increases

the probability of errors from 10 to 20 %, has been established.

4. Recommendations have been developed to reduce the influence of subjective assessment on the value of OR, which is based on increasing the number of participants with diverse worldviews, work experience and education before the OR assessment process.

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## Дослідження впливу когнітивних упереджень робітників на суб'єктивну оцінку професійного ризику

Ж. Г. Жанбіров<sup>1</sup>, О. В. Дерюгін\*<sup>2</sup>, А. Б. Токтамисова<sup>3</sup>,  
Д. А. Агабекова<sup>4</sup>, М. М. Архірей<sup>2</sup>

1 – Академія логістики і транспорту, м. Алмати, Республіка Казахстан

2 – Національний технічний університет «Дніпровська політехніка», м. Дніпро, Україна

3 – Костанайський інженерно-економічний університет імені М. Дулатова, м. Костанай, Республіка Казахстан

4 – Євразійський технологічний університет, м. Алмати, Республіка Казахстан

\* Автор-кореспондент e-mail: [oleg.kot@meta.ua](mailto:oleg.kot@meta.ua)

**Мета.** При оцінці професійних ризиків (ПР) професійної діяльності працівників виникає проблема з визначення ймовірності настання небезпечної події й важкості її наслідків під дією різних когнітивних упереджень. Тому виникає актуальне питання стосовно врахування наявності когнітивних упереджень і їх впливу на оцінку ПР. Це досягається за рахунок дослідження впливу обізнаності та світогляду працівників на оцінку ПР і розробки рекомендацій щодо зменшення когнітивних уперед-

жень під час установлення ймовірності настання небезпечної події.

**Методика.** Для проведення дослідження були залучені 87 працівників автотранспортного підприємства різного віку, стажу й рівня освіти, які проходили анкетування за спеціально розробленим чек-листом, в якому передбачено ранжування шкідливих факторів, що впливають на працівника під час виконання виробничих завдань з урахуванням впливу п'яти когнітивних упереджень на величину ймовірності виникнення небезпечної події.

**Результати.** За результатами проведеного дослідження можна зробити висновки, що працівники автотранспортного підприємства зі значним професійним досвідом роботи найбільше переймалися напруженістю й темпами роботи, а також кількістю повторювальних рухів, що значно впливали на рівень безпеки при виконанні виробничих завдань. Працівники, менш досвідчені – виділили напруженість виробничого процесу, темпи роботи й монотонність праці, при чому, з точки зору чоловіків найбільше занепокоєння викликала напруженість і монотонність праці, на відміну від жінок, які стурбовані темпами роботи й незручною позою. Визначено, що працівники сприймають ПР більш оптимістично, якщо розуміють, що він контрольований. Також була помічена тенденція щодо погіршення результатів роботи через нестачу часу для проведення відповідного аналізу впливу шкідливих факторів на здоров'я працівників.

**Наукова новизна.** Полягає у встановленні взаємозв'язку когнітивних упереджень, що проявляються у працівників під час оцінки ПР, з визначенням ймовірності виникнення небезпечної події, що збільшує ймовірність виникнення помилок від 10 до 20 % під час виконання професійної діяльності.

**Практична значимість.** Полягає в розробці рекомендацій зі зменшення впливу суб'єктивної оцінки величини ПР, яка базується на збільшенні кількості учасників із різноманітним світоглядом, стажем роботи, освітою.

**Ключові слова:** когнітивні упередження, професійний ризик, безпека праці, управлінські рішення

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