NATIONAL CENTER FOR PUBLIC HEALTH
AND ANALYSES

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Economic and social effects of the implementation of an innovative training model for prevention and first aid after occupational accidents in the Republic of Bulgaria

ABSTRACT

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The dissertation is presented on 175 standard typewritten pages and is illustrated with 63 figures and 17 tables. The bibliography includes 171 literary sources, of which 54 are in Cyrillic. There are 3 published scientific articles in connection with the dissertation.

The dissertation was discussed and accepted by an extended scientific board of the Public Health and Health Risk Directorate at the National Center for Public Health and Analyses and was proposed for defense in front of a scientific jury.

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LIST OF ABBREVIATIONS USED

AED	Automated external defibrillator
CPR	Cardiopulmonary resuscitation
FA	First Aid
NPB	Net present benefit
OA	Occupational accidents
OHS	Occupational health and safety

I. INTRODUCTION

Ensuring occupational health and safety (OHS) is a prerequisite for limiting occupational accidents (OA) and occupational diseases (OD), increasing labor productivity, limiting material damage from accidents and all costs for injured workers.

The strategy proposed by the World Health Organization (WHO) to improve health coverage of workers, including those working in small companies and the informal sector, is to work with countries in the following strategic directions: expanding the scope and improving the quality of specialized occupational health services in large and medium-sized enterprises and industrial zones, with a focus on the assessment and reduction of occupational risks; monitoring and improving the working environment, work organization, machinery and equipment; early detection and rehabilitation of occupational diseases; promotion of healthy living; provision of first aid in the workplace (9).

First aid (FA) training can be seen as an investment in the future or as “paying it forward”, as defined by Andreas Bohn et al. (1). Regardless of the form of training in which it is acquired, practical knowledge and skills: save lives; reduce costs and recovery time; save resources for social integration.

The topic of first aid training in the workplace is also relevant and significant in the context of national security, due to the need for effective first aid in all incidents (road accidents, domestic accidents, injuries resulting from natural disasters or conditions such as heart attacks and strokes), and not just in work accidents.

The developed and tested innovative model for training in the field of emergency preparedness is in line with modern educational standards. The created programs and the various methods used form in the trainees more knowledge and practical skills, on more topics, in the same or shorter time than the "standard" training. This knowledge and skills are applied both for accident prevention and for effective first aid after an incident, which has a positive economic and social effect.

II. PURPOSE AND OBJECTIVES

PURPOSE

To develop an innovative training model for prevention and first aid after occupational accidents in the Republic of Bulgaria, as well as to assess its effectiveness, including the economic and social effects of its implementation.

OBJECTIVES

1. To analyze the regulation and conduct of first aid training in organizations and countries outside Bulgaria.

2. To analyze the regulation and conduct of first aid training in Bulgaria.

3. To create an innovative model for conducting first aid training, which would contribute to the prevention of occupational accidents and more effective and timely provision of first aid.

4. To conduct a study on the effectiveness of the developed innovative training model.

5. To analyze the social and economic effects of the occurrence of occupational accidents, as well as the implementation of the innovative training model.

III. SETTING, CONTINGENT AND METHODS

STUDY SETTING AND CONTINGENT

The innovative first aid model was introduced, implemented and tested in 2022 in 16 economic entities with a total of 548 workers, and in 2023 in 12 economic entities with a total of 311 workers. After reviewing the questionnaires (tests), inconsistencies were found (more than one correct answer to a question; multiple corrections) or general information was not noted; therefore such tests were not included in the analysis. The final number of questionnaires for the entire period is 830. Invalid tests are 3.5% of the total number.

The participants in the study were assigned to one of the following target groups, depending on the economic sphere in which they work: production and distribution of electricity and heat (energy workers - E); extraction of metal ores (miners - M); construction of facilities (builders - B). Those who do not belong to one of the specified target groups are included in group C - "Control group". Table 1 presents summarized characteristics (age, gender, work experience at this workplace, education and sequence of first aid training), summarized and by target groups.

Table 1 - Summary characteristics of those participating in the study

	E energy workers n = 192 (23,1%)	M miners n = 305 (36,8%)	B builders n = 88 (10,6%)	C Control group n = 245 (29,5%)	TOTAL n = 830
Age, years; ($\bar{x}$ ± SD)	44,6 ± 11,3	42,3 ± 12,0	39,9 ± 11,9	40,0 ± 9,9	41,9 ± 11,4
Gender, %					
women	5,7	4,9	0,0	52,7	18,7
men	94,3	95,1	100,0	47,3	81,3
Work experience at this place, years; ($\bar{x}$ ± SD)	14,3 ± 9,8	12,2 ± 10,0	5,3 ± 5,3	7,3 ± 4,7	10,5 ± 8,9
Education, %					
Primary	0,0	0,0	28,4	0,0	3,0
Secondary	34,4	47,5	50,0	60,4	48,6
Tertiary	65,6	52,5	21,6	39,6	48,4
Sequence of training, %					
first	31,8	23,0	39,8	54,3	36,0
second	41,7	24,6	30,7	35,1	32,3
third and more	26,6	52,5	29,5	10,6	31,7

METHODS

- **Historical method**

A literature review was conducted on the regulation of workplace FA training in Bulgaria, Great Britain, Germany, Canada and the United States, using laws, regulations and data from physical and electronic literary sources. The information collected predominates from official websites of institutions and organizations related to the organization and conduct of OHS training. Scientific articles, textbooks and specialized literature were also used.

- **Sociological method with questionnaire (Test to verify theoretical knowledge)**

– ENTRY TEST for theoretical knowledge in first aid for 2022.

– INCOMING TEST for theoretical knowledge in first aid for 2023.

- There is no generally accepted single questionnaire for testing theoretical knowledge of first aid. The questionnaires compiled by the team for 2022 and 2023 use the experience of various training organizations, as we have analyzed some of the available on the websites[1][2][3][4][5][6] as well as the study by Diana Ygiyeva et al. (10), and Kostas Hatzakis et al. (6). In 2022, the questionnaire contained ten questions. In 2023, the questions in the test were reviewed and reconsidered, dropping two of them and adding four new ones. Thus, the questionnaire in 2023 contained twelve questions. In total, the trainees answered fourteen different questions for the study.

- **Documentary method**

It was applied to analyze the costs of compensation after a trade agreement.

- **Descriptive analysis**

It is used to assess the social and economic consequences of a work accident.

- **Statistical analysis**

The data were entered and processed with the statistical package SPSS 23.0. ANOVA, $\chi 2$, stepwise multiple regression analysis, and correlation analysis were applied for statistical analyses. To assess the theoretical knowledge depending on the educational qualification of the students or their order of attendance at the training, repeated measures analysis with a significance level of $p < 0.05$ was used.

[1] https://www.abertaytraining.co.uk/quiz/first-aid-quiz-questions/

[2] https://www.firstaidforfree.com/first-aid-quizzes/

[3] https://firstaidchampions.redcross.org.uk/secondary/quizzes/

[4] https://www.stdavidsfirstaid.co.uk/documents/general-first-aid-quiz.pdf

[5] https://www.mysafetysign.com/first-aid-quiz

[6] http://www.norvictraining.co.uk/first-aid-quiz/

IV. RESULTS

IV.1. Description of an innovative first aid model

The main concept of the innovative model is to prevent occupational accidents, build knowledge and form skills for effective first aid. These goals determine the structure of the three modules in which the training is conducted.

Module "Basic Knowledge and Skills" (basic) - BKS

It is applied to the training of workers and employees who are being trained for the first time under this model or whose previous training occurred more than 24 months ago, as knowledge and skills are assumed to decay relatively quickly, which is confirmed by the research of the teams of Minna Sihvo (8), Kostas Hatzakis (6), Diana Ygiyeva (10) and others. The program is divided into two parts:

- 50% accident prevention and consequence assessment;
- 50% determining the condition of the injured, recognizing the main injuries and their treatment.

Module "Upgrading Knowledge and Skills" (upgrading) – UKS

It applies to workers and employees who have completed training under the innovative model for a period of up to 24 months. The upgrading training aims to check the level of knowledge and add new knowledge and skills. The distribution of training topics is structured as follows:

– the first part of the training lasts from 1/8 to 1/4 and is intended for conducting an entrance test. The results can also be analyzed in groups, which allows assessing the analytical abilities of the trainees, to determine whether the results are random or due to real knowledge, etc., but also personal qualities of the workers such as leadership. This part may not be included in the program, in the case of: training with a short duration; in monolithic teams that are trained regularly and in other cases.

- the second part of the training lasts 1/8. The workers and employees aim to identify risks in the workplace by determining: "P" – the probability of a certain event occurring; "F" – how often it can happen and "C" – the consequences of the work accident.

- the third part is intended for drawing up scenarios for typical OA at the specific workplace and a first aid plan. This part lasts about 1/8 of the training program.

- the fourth part is theoretical, lasting between 1/4 and 1/2 of the curriculum. Here new topics are considered such as: treatment of bone and joint injuries; treatment of weak bleeding or large wound areas; burns (chemical, thermal, cryogenic, solar), organ injuries and internal bleeding, etc.

- the fifth part lasts up to 1/2 and is intended for practical individual or group exercises.

- the sixth part is used relatively rarely. It lasts up to 1/8 and is intended for an exit test.

Module "Specialized Knowledge and Skills" (specialized) – SKS

It applies to workers and employees who have completed at least one refresher training. The specialized module follows the training structure of the refresher training, but the focus is on incidents that:

- occur rarely, but the consequences are mainly long-term treatment, disability or death of the affected workers;
- represent a risk specific to the work position (chemicals, technical gases, electrical installations with voltages above 1000 V, etc.);
- aim for more in-depth knowledge and skills (for mine rescuers, disaster and accident response units, volunteer formations, etc.);
- the application of techniques that require more time for theory and practice to master (performing CPR and working with an automated external defibrillator AED/EAD, techniques for moving a victim with specialized or improvised equipment, etc.).

This module often compares and updates knowledge and skills acquired in training for driving licenses (driving a motor vehicle, driving a forklift, etc.), acquiring a qualification group in electrical safety, training for working at heights or in confined spaces, etc.

The application of an innovative learning model has many advantages that improve the effectiveness of the educational process and adapt training to the modern needs of learners and trainees. Innovative learning models transform traditional education, making it more effective, interactive and accessible. Through them, learners not only acquire knowledge, but also develop key skills necessary for success in the modern world. Betina A Lankard (7) describes the main advantages and applications of an innovative learning model, which the current innovative model for workplace learning in the field of vocational training responds to:

1. Better engagement of learners – interactive methods, gamification, practical exercises and simulations;
2. Personalized learning – adapting the content according to the individual needs, level of preparation and pace of learning of each learner, different approaches (adaptive learning, blended learning) allow for more effective learning of the material;

3. Development of practical skills – more practical tasks, case studies and simulations, which facilitates the application of knowledge in real situations, emphasizes critical thinking, problem solving and teamwork;

4. Accessibility and flexibility – blended learning (face-to-face and online) provides greater flexibility;

5. More effective feedback and assessment – automated assessment and adaptive tests facilitate the process of verification and correction, the inclusion of artificial intelligence and data analysis allows for tracking progress and providing personalized feedback;

6. Stimulating creativity and innovation – the use of project-based learning encourages a creative approach to problem solving;

7. Preparing for the future – develops skills in working with technology, critical thinking and adaptability – key competencies for the modern labor market.

IV.2. Summary results of the study on the effectiveness of the developed innovative training model

The summarized data from the processed questionnaires show the following results:

The percentage of correct answers in relation to the order of appearance is presented in Figure 1.

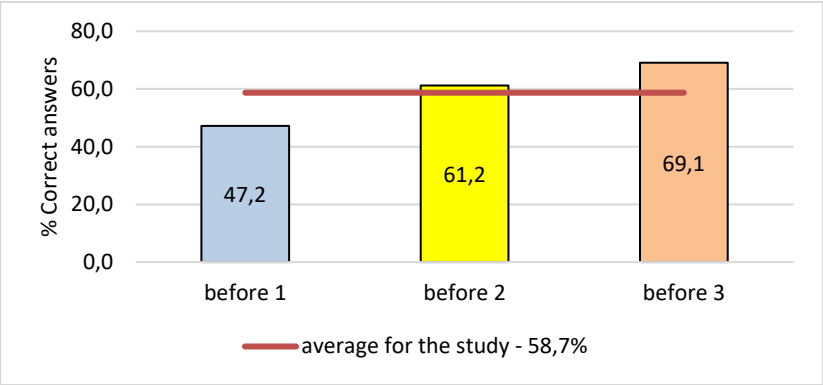


Figure 1 - Correct answers from the survey in order of appearance

The effect of training order on correct responses is statistically significant. The correlation coefficient (r) between correct responses and training order is 0.497, which corresponds to a "moderate, positive relationship." Increasing the training order by one would increase the number of correct responses by one. The validity of the study (P) is 0.000.

The percentage of correct answers by educational qualification is presented in Figure 2.

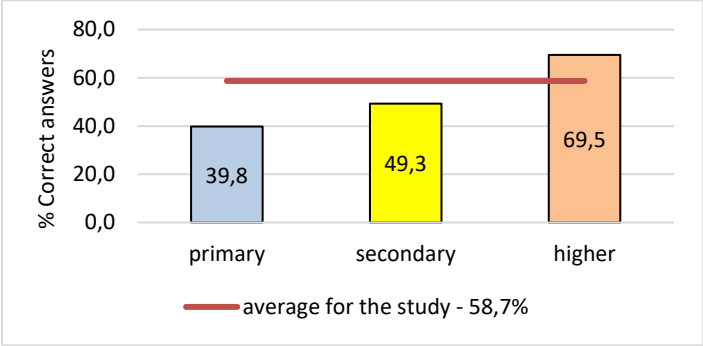


Figure 2 - Correct answers from the survey by educational level

The influence of educational qualification on correct answers was also studied through statistical analysis. The correlation coefficient r = 0.570, which corresponds to a "significant positive relationship". Also, the statistical data show that if the educational qualification increases by one grade, the number of correct answers will increase by two correct answers. The validity of the study (P) is 0.000.

The percentage of correct answers by target groups is presented in Figure 3.

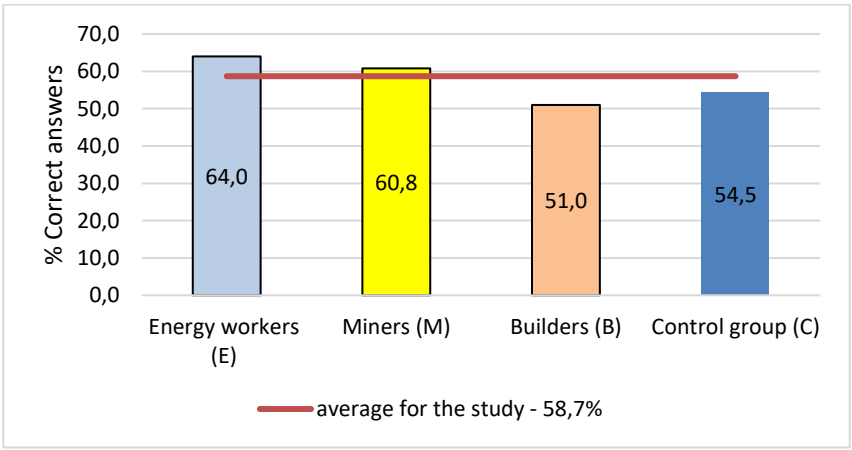


Figure 3 - Correct answers from the survey by target groups

IV.3. Results of theoretical knowledge on issues

Question: General approach to first aid (Question 1).

The basis of first aid is safety, and therefore we investigate whether workers know the generally accepted algorithm for Bulgaria ("The Rule of the Four O's").

- ✓ Securing the incident – in Bulgarian *"Обезопасяване на инцидента";*
- ✓ Assessing the condition of the victim – in Bulgarian *"Оценка състоянието на пострадалия";*
- ✓ Notifying specialized teams – in Bulgarian *"Оповестяване на специализираните екипи";*
- ✓ Providing first aid – in Bulgarian *"Оказване на първа помощ".*

Figure 4 presents the percentages of correct answers to the question, depending on the order of participation, while Figure 5 presents them according to the target group.

[38,8%; 73,1% (+34,3%); 84,0% (+10,9%)]; χ2 = 139,3; p = 0,000

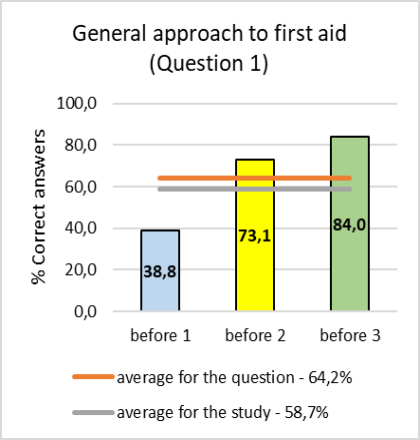


Figure 4 - Correct answers in order of appearance, to a question about: General approach to first aid

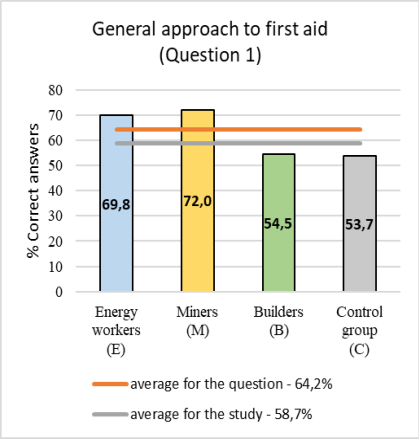


Figure 5 - Correct answers by target group to a question about: General approach to first aid

Question: Determination of immediate measures (Question 2).

The question aims to test whether trainees can prioritize their actions based on clear algorithms and objective observations or treat the first injury identified.

Figure 6 presents the percentages of correct answers to the question, depending on the order of participation, while Figure 7 presents them according to the target group.

[23,4%; 34,7% (+11,3%); 37,7% (+2,6%)]; χ2 = 14,4; p = 0,000

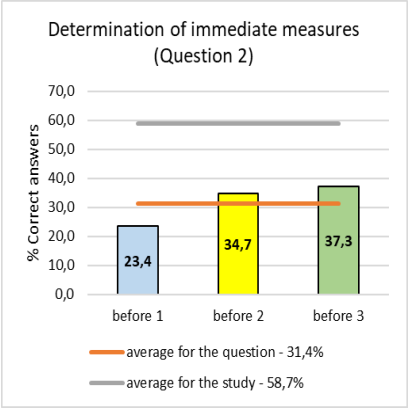


Figure 6 - Correct answers in order of appearance, to a question regarding: Determining immediate measures

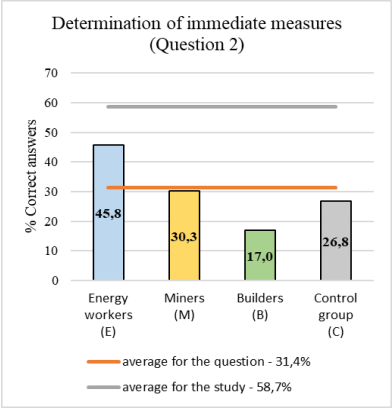


Figure 7 - Correct answers by target group to a question about: Determining immediate measures

Question: Treatment of severe external bleeding (Question 3).

Assessing and treating severe bleeding is a life-saving priority. Even in the best healthcare systems, getting specialized care takes time (more than 5 minutes), and severe bleeding can be life-threatening and requires a response within seconds.

Figure 8 presents the percentages of correct answers to the question, depending on the order of appearance, and Figure 9 by target group.

[46,3%; 59,0% (+12,7%); 69,2% (+10,2%)]; $\chi 2 = 30,7$; $p = 0,000$

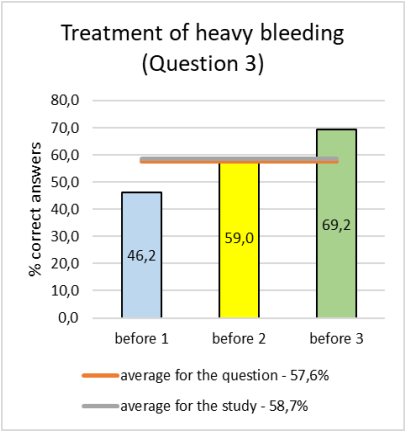


Figure 8 - Correct answers in order of appearance, to a question about: Treatment of heavy bleeding

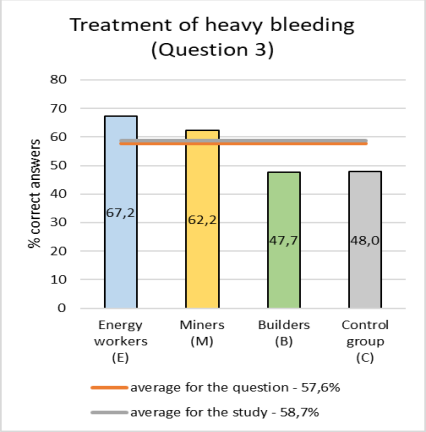


Figure 9 - Correct answers by target group to a question about: Treatment of heavy bleeding

Question: Recognizing and providing assistance to an unconscious person (Question 4).

A state of unconsciousness is common across to all industries, and results in the tongue being pulled back, obstructing the airway, colloquially referred to as “tongue-swallowing.” Due to its frequency and “elementary” technique for effective first aid, the issue is central to all first aid training.

Figure 10 presents the percentages of correct answers to the question, depending on the order of appearance, and Figure 11 by target group.

[67,2%; 79,1% (+11,9%); 89,4% (+10,3%;)]; $\chi 2 = 40,3$; $p = 0,000$

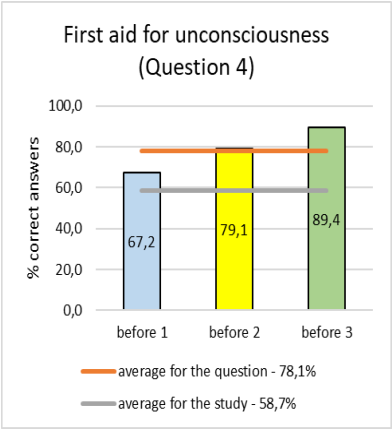


Figure 10 - Correct answers in order of appearance, to a question about: Recognizing and providing assistance to an unconscious person

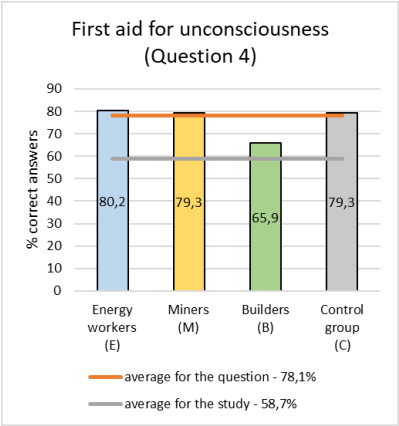


Figure 11 - Correct answers by target group to a question about: Recognizing and providing assistance to an unconscious person

Question: Recognizing clinical death (Question 5).

First aid in the event of clinical death is often identified with the concept of "first aid". Resuscitation actions are embedded in several training courses on OSH, road safety and electrical safety, etc.

Figure 12 presents the percentages of correct answers to the question, depending on the order of appearance, and Figure 13 by target group.

[62,5%; 66,0% (+3,5%); 72,2% (+6,2%)]; $\chi 2 = 6,0$; $p = 0,042$

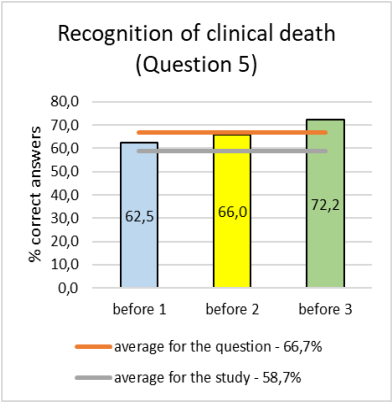


Figure 12 - Correct answers in order of appearance, to a question about: Recognizing clinical death

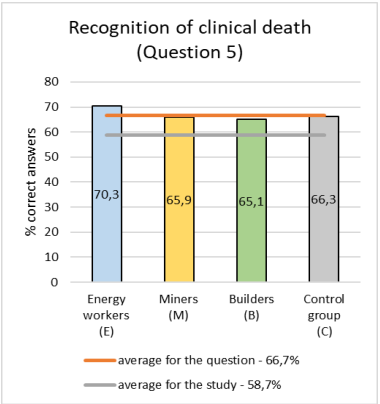


Figure 13 - Correct answers by target group to a question about: Recognition of clinical death

Question: Performing cardiopulmonary resuscitation (Question 6).

The resuscitation standards used over the years have different effectiveness, but we apply the one that we believe has the greatest effect (one cycle consists of 2 breaths and 30 chest compressions; 3 cycles are performed in one minute; and the sternum should sink about 1/3 of the chest profile or approximately 5÷6 cm.

Figure 14 presents the percentages of correct answers to the question, depending on the order of appearance, and Figure 15 by target group.

[25,1%; 45,5% (+20,4%); 70,0% (+24,5%)]; $\chi 2 = 113,5$; $p = 0,000$

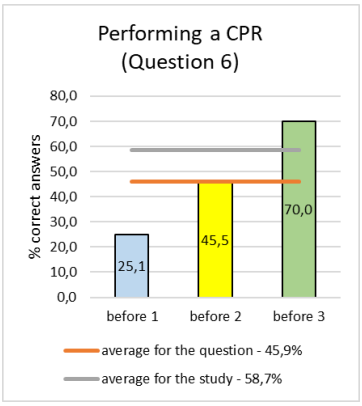


Figure 14 - Correct answers in order of appearance, to a question about: Performing cardiopulmonary resuscitation

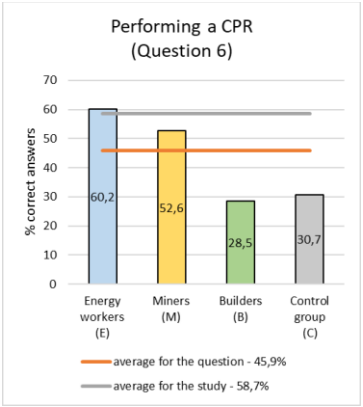


Figure 15 - Correct answers by target group to a question about: Performing cardiopulmonary resuscitation

Question: Knowledge of normal pulse and respiratory rate values (Question 7).

Recognizing atypical values of pulse and respiratory rate is a prerequisite for orienting the victim's condition, directing attention to certain injuries and planning first aid actions. In addition to the value of pulse and respiratory rate, other characteristics are also important, such as: for the pulse - strength and rhythm; for breathing - depth, cyclicity. Assessment of breathing is extremely important in case of possible chest injuries, most typical in road accidents, accidents in construction, mining and other areas.

Figure 16 presents the percentages of correct answers to the question, depending on the order of appearance, and Figure 17 by target group.

[41,1%; 48,1% (+7,0%); 57,0% (+8,9%)]; $\chi 2 = 14,2$; $p = 0,000$

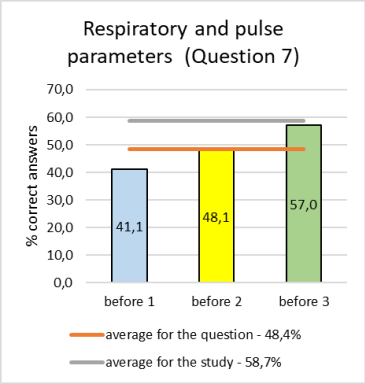


Figure 16 - Correct answers in order of appearance, to a question regarding: Knowledge of normal values of pulse and respiratory rate

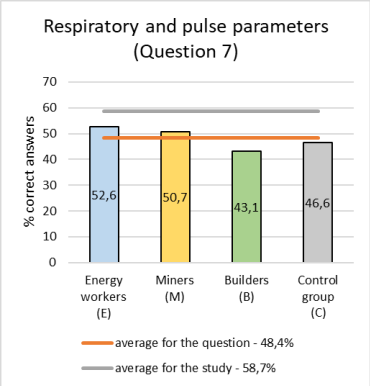


Figure 17 - Correct answers by target group to a question regarding: Knowledge of normal pulse and respiratory rate values

Question: Recognizing the signs of SHOCK (Question 8).

The state of shock is indicative of a serious disruption of normal processes in the human body, which can often be life-threatening. Identifying the cause of shock and recognizing the shock state are prerequisites for providing effective first aid.

Figure 18 presents the percentages of correct answers to the question, depending on the order of appearance, and Figure 19.

[48,5%; 72,4% (+23,9%); 80,6% (+8,2%)]; $\chi 2 = 71,4$; $p = 0,000$

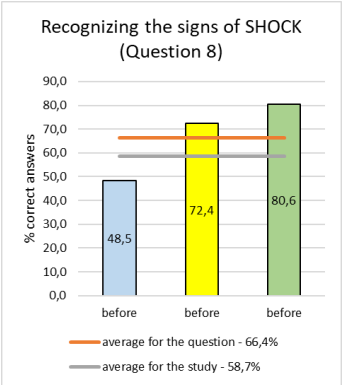


Figure 18 - Correct answers in order of appearance, to a question about: Recognizing the signs of SHOCK

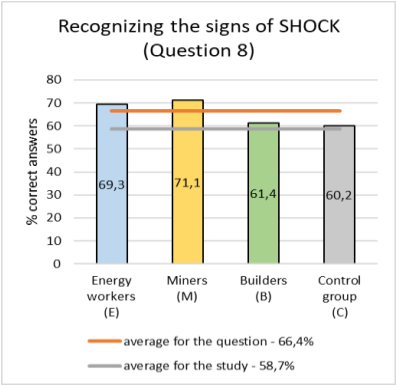


Figure 19 - Correct answers by target group to a question about: Recognizing the signs of SHOCK

Question: Recognizing chest trauma (Question 9).

Chest injuries are often life-threatening. In severe chest injuries, there are techniques that should be applied in the first few minutes. These situations are very rare and are characteristic mainly of the areas with the most severe trauma.

Figure 20 shows the percentages of correct answers to the question depending on the order of participation, while Figure 21 presents them according to the target group.

[69,6%; 71,4 (NB); 80,8% (+11,2%)]; $\chi 2 = 6$; $p = 0,049$

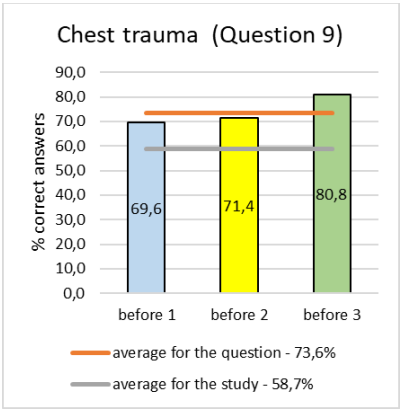


Figure 20 - Correct answers in order of appearance, to a question about: Recognizing chest trauma

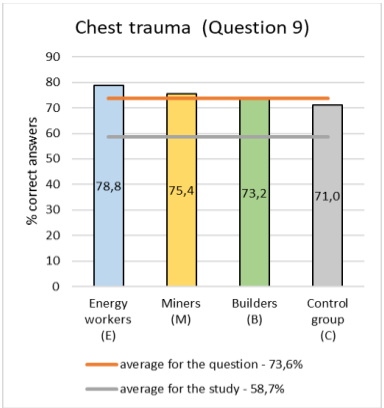


Figure 21 - Correct answers by target group to a question about: Recognizing chest trauma

Question: Treatment of a large foreign body (Question 10).

Occupational accidents involving a large foreign body are a very rare injury, yet a significant number of workers have the knowledge to help in such a situation.

Figure 22 shows the percentages of correct answers to the question depending on the order of participation, while Figure 23 presents them according to the target group.

[71,8%; 83,9% (+12,1%); 87,2% (+3,3%)]; $\chi 2 = 15,3$; $p = 0,000$

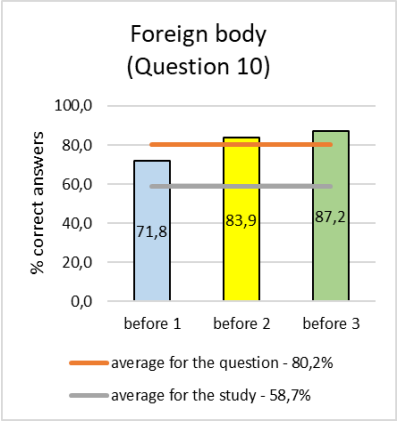


Figure 22 - Correct answers by target group to a question about: Treatment of a large foreign body

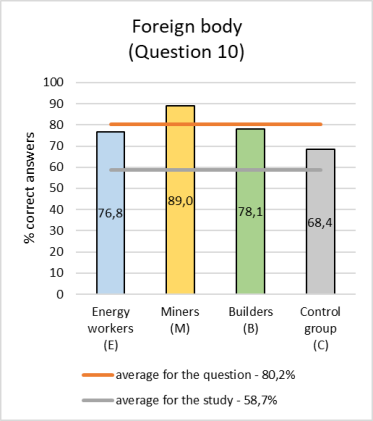


Figure 23 - Correct answers by target group to a question about: Treatment of a large foreign body

Question: Recognizing traumatic brain injury (TBI) (Question 11).

Head injuries account for about 15% of declared occupational injuries in Bulgaria, and traumatic brain injuries (TBI) are possible in most of them.

Figure 24 presents the percentages of correct answers to the question depending on the order of participation, while Figure 25 presents them according to the target group.

[52,7%; 64,0% (+11,3%); 64,5% (+0,5%)]; $\chi 2 = 3,6$; $p = 0,016$

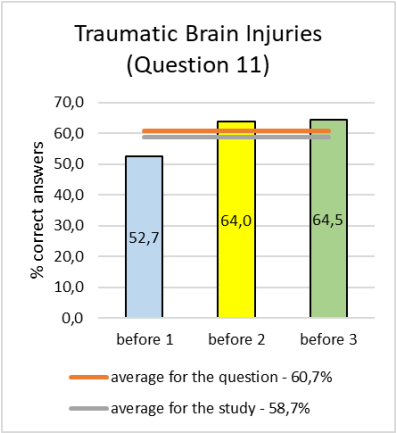


Figure 24 - Correct answers by target group to a question about: Recognizing traumatic brain injury (TBI)

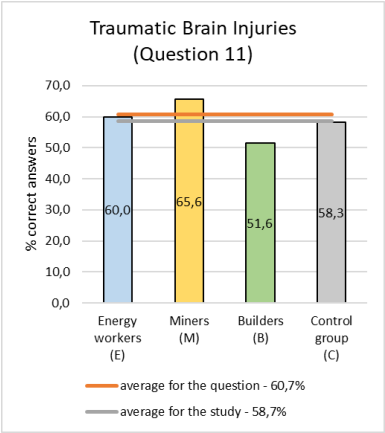


Figure 25 - Correct answers by target group to a question about: Recognizing traumatic brain injury (TBI)

Question: Recognition and treatment of injured bones (Question 12).

Recognizing and treating bone injuries is among the most common injuries addressed in first aid (about 40%).

Figure 26 shows the percentages of correct answers to the question depending on the order of participation, while Figure 27 presents them according to the target group.

[30,1%; 39,3% (+9,2%); 43,0% (+3,7%)]; $\chi 2 = 3,6$; $p = 0,026$

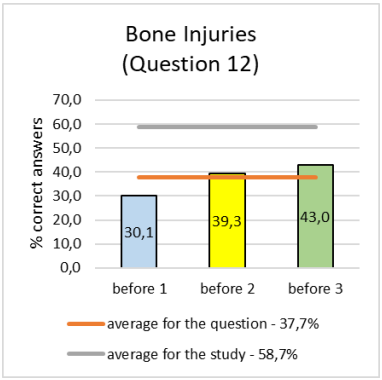


Figure 26 - Correct answers by target group to a question about: Recognition and treatment of injured bones

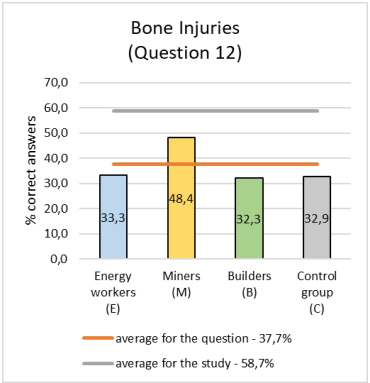


Figure 27 - Correct answers by target group to a question about: Recognition and treatment of injured bones

Question: Recognition and treatment of injured joints (Question 13).

Joint injuries account for about 10% of declared OA in Bulgaria, so the issue is of interest. Adequate first aid in these conditions ensures a reduction in the victim's pain and limits the consequences of the injury, including recovery, which in turn is associated with fewer financial resources for disability benefits, rehabilitation, etc. The economic effect of these injuries (treatment of fractures and dislocations) is the most visible and easier to assess.

Figure 28 shows the percentages of correct answers to the question depending on the order of participation, while Figure 29 presents them according to the target group.

[40,9%; 61,7% (+20,8%); 65,0% (+3,3%)]; $\chi 2 = 13,3$; $p = 0,001$

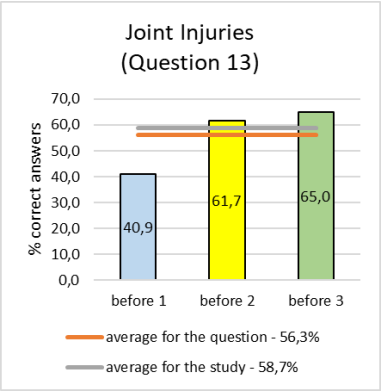


Figure 28 - Correct answers by target group to a question about: Recognition and treatment of injured joints

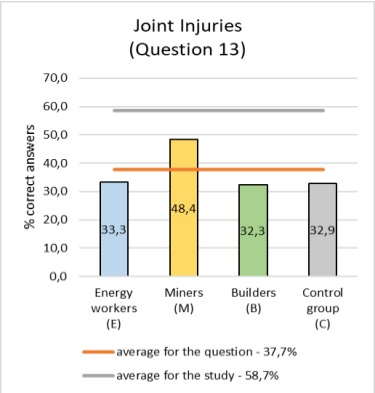


Figure 29 - Correct answers by target group to a question about: Recognition and treatment of injured joints

Question: Determining the general condition of a thermal burn and first aid (Question 14)

Burns account for only 5% of declared occupational injuries in Bulgaria. They are often not life-threatening, but they have lasting consequences, cause pain for a long period of time, and require prolonged treatment.

Figure 30 shows the percentages of correct answers to the question depending on the order of participation, while Figure 31 presents them according to the target group.

[36,6%; 49,5% (+12,9%); 52,0% (+2,5%)]; $\chi 2 = 5,3$ и $p = 0,040$

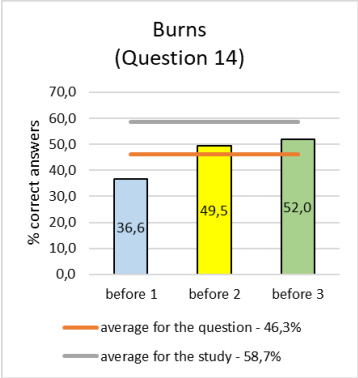


Figure 30 - Correct answers by target group to a question regarding: Determining the general condition in case of thermal burn and first aid

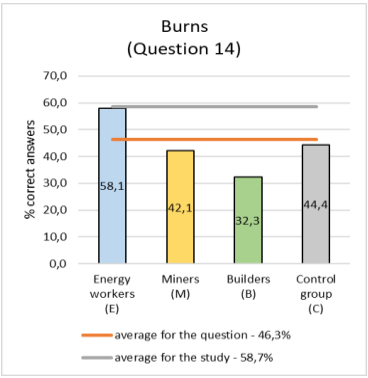


Figure 31 - Correct answers by target group to a question regarding: Determining the general condition in case of thermal burn and first aid

IV.4. Evaluation of the developed model

The analysis of the summarized data on correct answers from the survey by order of appearance was presented in Figure 1. The trend is an increase in correct answers, by order of training [47.2%; 61.2% (+14.0%); 69.1% (+7.9%)], within the set goals (baseline; + 15%; +5%). The correlation coefficient (r) between correct answers and order of training is 0.498 and the validity of the study P = 0.000.

The possibility of rapid change in the structure and content of the curricula, at any time when necessary, according to the set goals, target group, risk assessment and other factors, makes the model effective (permanent knowledge within one year - 58.7%). This indicator is acceptable in view of the scope of the training and its duration. The model has better results than those presented at the conference on "Development of a roadmap for the implementation of an early defibrillation program on the territory of Sofia Municipality" for the period 2022 -2050 by Dr. Bonev - *"On the third month after the training, 50% of the knowledge remains, and on the sixth month 30%."* (2).

IV.5. Social and economic effects of the implementation of the developed model

Training in safety has important social effects for working people, by limiting the negative health consequences for a worker who has suffered an accident, and by forming a proactive safety culture and creating the skills necessary to respond to incidents of various nature (disaster, accident, attacks, etc.) occurring in the workplace or outside it. Training in safety can

also be considered in the context of corporate social responsibility and as support for the teams of the unified rescue system (ESS) in cases of events with a large number of victims.

To assess the economic effects of the implementation of the innovative model, the Cost–Benefit Analysis (CBA) was used, in which all benefits are monetized, and the result is expressed in terms of Net Present Benefit (NPB). The alternatives compared are a standard training model under the PP and an innovative training model. The following were identified and assessed: direct costs – the cost of training, indirect costs – the lost benefits and at the same time additional costs incurred by the employer; probable costs of compensation because of the OA. The specific calculations were made for a 3 (three) year period, and the costs were discounted by 3%.

$$NPB = \sum \frac{\text{Ползи}_t - \text{Разходи}_t}{(1+r)^t}$$

where „r“ is the discount rate and „t“ is the time.

Official statistical data for 2025 were used: gross domestic product; employed persons in 3 quarters; working days and hours; average gross salary. We have assumed that:

1. The training has an optimal program over the years (8/4/4 school hours).

2. The result of the work-related injury is "average bodily injury - fracture of the lower leg (tibia and/or fibula)", the worker is incapacitated for more than 60 days and one of the scenarios has occurred:

- **scenario 1** - for the period under consideration, no work-related injury is allowed (compensation costs after work-related injury - 0.00 BGN);
- **scenario 2** - for the period, 1 (one) work-related injury is allowed, without permanent incapacity for work, but only with temporary for the minimum period of 60 days (2 months) (compensation costs after work-related injury - 43114.00 BGN);
- **scenario 3** - for the period, 1 (one) OA is allowed, with permanent incapacity for work from 50% to 70.99% (compensation costs after OA - 67432.00 BGN);
- **scenario 4** - for the period, 1 (one) OA is allowed, with permanent incapacity for work over 90% (compensation costs after OA - 80550 BGN).

Other data from the dissertation were also used in the valuation of the scenarios. The net present benefit under an assumed OA with the outcome described in scenario 2 is calculated in Table 2.

Table 2 - NPB in case of non-admission of OA under scenario 2

year	Benefits (BGN)	Expenses (BGN)	net flow (benefit – cost) (BGN)	discount factor $1/(1+0,03)^n$	Discounted flow (BGN)
1	14 371,33	8 000	6 371,33	0,9709	6 184,79
2	14 371,33	4 100	10 271,33	0,9426	9 681,22
3	14 371,33	4 100	10 271,33	0,9151	9 401,20
				ННП	25 267,21

As a result of the calculations we have also established:

1. Indirect costs exceed the value of direct costs many times over (Figure 32), with the economic sphere having a significant impact due to the large differences in the cost of labor and productivity.

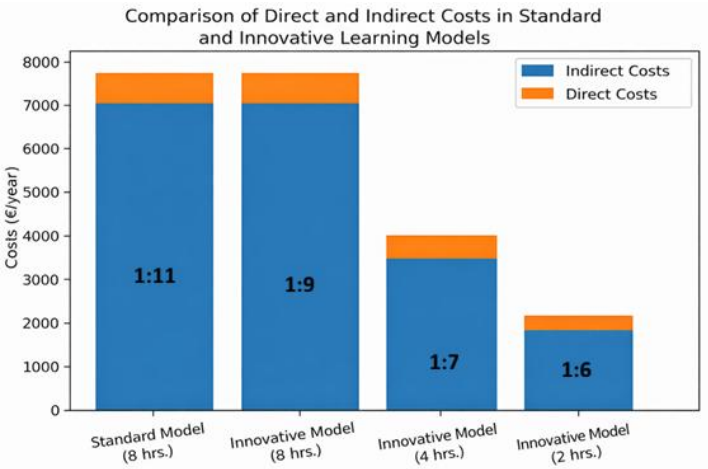


Figure 32 - Comparison of direct and indirect costs in a standard and innovative model

2. Reducing or limiting the effect of work accidents. Assumptions: Conservative - as a result of the training conducted, we aim to allow at least one less accident that would cause a moderate bodily injury - a fracture of the lower leg, or for the consequences to be more limited (at least one degree milder, compared to cases where first aid was not provided).

- scenario 4 (80,550 BGN) to scenario 3 (67,432 BGN) – 13,118 BGN;
- scenario 3 (67,432 BGN) to scenario 2 (43,114 BGN) – 24,318 BGN;
- scenario 2 (43,114 BGN) to scenario 1 (0.00 BGN) – 43,114 BGN.

3. The data in Table 3 were used for the analysis of “prevention costs (training) / costs for OA”. In the selected “scenario 2”, the costs for prevention are from 1.8 times to 12.8 times, according to the selected curriculum. The most often applied optimal option, which considers a ratio between OA costs and those for training of 5.0 times, which is significantly better than the generally accepted ratio of 1:3 (or 2.2 times according to a study by DGUV (4)), which confirms that the innovative model has excellent results.

Table 3 - Cost-benefit ratio of implementing an innovative first aid model

For a period of 3 years		Standard	Innovative Model			
		3 * 8 h	3 * 8 h	3 * 4 h	3 * 2 h	8 / 4 / 4 h
	Prevention costs	23 550 BGN	24 000 BNG	12 300 BGN	6 300 BGN	16 200 BGN
Scenario 1	For occupational accident	0				
	Occupational accident / prevention	-				
Scenario 2	For occupational accident	43 114 BGN				
	Occupational accident / prevention	1,8	1,8	3,5	6,8	2,7
Scenario 3	For occupational accident	67 432 BGN				
	Occupational accident / prevention	2,9	2,8	5,5	10,7	4,2
Scenario 4	For occupational accident	80 550 BGN				
	Occupational accident / prevention	3,4	3,4	6,5	12,8	5,0

V. DISCUSSION

First aid in the workplace is a topical topic, which can be addressed within the scope of the EU Strategic Framework for Health and Safety at Work 2021-2027 (5) and the National Program for Safety and Health at Work 2025-2027 (3).

Among the leading reasons for the relevance of the topic are:

1. Occupational accidents continue to pose a risk to the health of workers, to varying degrees depending on the economic sector.
2. Untimely or ineffective assistance, and sometimes incorrect action, can pose an additional risk to the health of the injured person or contribute to death.
3. Regulatory regulation of first aid training, because trained individuals are more likely to take initiative and responsibility for their actions, thereby limiting the harmful impact and limiting the consequences of an occupational accident.
4. Realizing the risk to their life and health, trained first aiders are more vigilant and do not take risky actions, which has a preventive role.

Our experience in organizing and conducting first aid trainings within the scope of this study and beyond shows that it is necessary to first emphasize the need for these trainings and to illustrate their application in order to form interest and active participation in the learning process in the trainees. This is possible under the following circumstances:

1. The training is conducted according to a curriculum adapted to the respective sector.
2. The training is conducted using interactive tools.
3. The training contains a practical part including both individual practical exercises (bandages, working on a mannequin, etc.) and group exercises (situational) to illustrate teamwork.
4. Analysis of the training and discussion of the causes, reaction and consequences of occupational accidents that occurred in the enterprise.

In the economic analysis, we examined a hypothesis that proves the economic benefit of conducting training on PP. The payback period is 1.46 years (approximately one and a half years), which shows that after this period we will make a greater profit than the costs. Due to the same values, we can assume that, keeping all other parameters, if we conduct not one but two training courses according to the same model, at the end of the three-year period, in the worst case, the money invested in prevention will be comparable to the costs of compensation due to an occupational accident.

In some of the companies where we tested the model, no training had been conducted before or “standard training” had been conducted, which did not arouse serious interest among the trainees and employers underestimated the effect. After the introduction of the training according to the innovative model, a change in the attitudes of both workers and employers was observed, as evident from what was shared in the employers’ questionnaires about the innovative model applied. Many employers apply the ALARA model (As Low As Reasonably Achievable) as a fundamental principle in risk management, which can also be used in the field of occupational health and safety. It shows what the optimal level of safety is, at which the risk is reduced to the lowest possible level without unjustified costs, with the interpretation often being that 10% of trained workers provide the necessary prevention and an acceptable resource for providing first aid. These indicators are comparable to the German DGUV standards (4).

All variations of the innovative model have more benefits compared to "standard training" (though the price may occasionally be higher), but we consider the most essential:

1. Developing skills to identify risks and take measures to prevent/reduce/limit occupational accidents;
2. Developing lasting theoretical knowledge and practical skills to provide effective first aid in the event of a real incident.

Returning to the economic analysis and the assumptions made, we can argue that even if 100% of workers are trained, with a maximum duration of the training process according to the innovative model, as well as conducting it even for 6 months, it is not a guarantee for 100% prevention of occupational accidents. Therefore, any training expense may turn out to be a “loss” for the employer, but most likely the following options will also have to be considered:

1. As a result of the training, the workers have identified all risks and potential incidents and as a result, there are no OA and damages. Are the costs incurred considered 100% lost funds?!
2. The worker has prevented a domestic incident, a traffic accident, which is not directly related to his work activity. His employer has no direct interest in the limited consequences of the incident, but public resources for compensation will be reduced or avoided. What is the benefit to the employer from the training conducted and are the invested funds considered 100% lost funds?!
3. An employer with 45 workers (identical to an employer from our study in the group - Energy), trains everyone (100%), organizing 3 groups of 15 people. Due to the high levels of risk, in accordance with the developed risk

assessment at the workplace, the training courses are annual, lasting 8 teaching hours. Each training is worth 1000 (one thousand) leva. If calculations are made for this employer under the hypothesis of the economic analysis in this dissertation, the net present benefit would be negative, that is, the model would not be economically justified. But can economic indicators alone compensate or completely replace social effects?!

We should also take into account the following circumstances:

- When determining the consequences, it was not taken into account that the worker who suffered an accident had invested funds for training and qualifications, which can be significant;
- The worker who suffered an accident cannot always be replaced by an equivalent worker in terms of productivity, therefore there will be additional lost benefits;
- The net present benefit may be a negative value in the case of an average bodily injury, but in the case of death or permanent incapacity for work of over 90% and the need for assisted care, the possible funds for expenses would increase many times over and, accordingly, the NPP will become positive. However, if OA is not allowed or they are mild, can we consider the training costs as a loss?!
- From the data in the dissertation on "Coefficient of frequency of occupational accidents by age groups, for the period from 2018 to 2022." we see that these are young workers aged 18 ÷ 19. If we assume that as a result of the TC the person has permanent incapacity for work and cannot participate in the labor process, the person consumes a public resource (minimum pension for life) for a period of more than 30 years. The calculations would be too conditional, but most likely the economic indicators would show that training that could prevent such an incident would be economically feasible.

We believe that in addition to the economic and social indicators that we have considered so far, we should also take into account the change in human relationships, which can again be linked to economic indicators:

- A victim of a disability needs assisted care. As a result, a member of the household leaves the labor market (stop producing GDP), while receiving benefits for the care provided;
- A victim of disability may lose their reproductive functions, which reduces the population;
- The family of a victim of disability allocates significant funds for care for the victim of disability, as a result of which they are deprived of education, rest, clothing, food and other normal needs;

- Pain and suffering are not only for the person directly affected by disability, but also for their relatives and colleagues;

- Often the physical environment is unsuitable for people with disabilities and limits them.

Due to the above, we believe that the two main advantages of the model (prevention and adequate first aid) contribute more than standard training to prevent and limit the consequences of disability.

The innovative model allows, through role-playing tasks in practical exercises, the trainees to experience the state of a victim and a first aid provider. Disguise, scenarios compiled based on hypothetically possible incidents for the specific workplace, acting tasks that the trainees perform, bring the trainees as close as possible to a real situation and test not only the theoretical knowledge and practical skills for providing first aid but also their mental resilience, teamwork and adaptability.

We establish a significant advantage of the innovative model compared to mass training that it allows its program to be adapted, taking into account all the specifics of the client and the goals set for the training. We believe that, regardless of the economic sphere, the innovative model of first aid training would be preferable to "standard training" mainly because of: its individual approach, the linking of training with prevention activities, in most cases the lower price with comparable or better theoretical knowledge and practical skills.

VI. CONCLUSIONS

1. The dissertation analyzes the regulation and implementation of first aid training in Bulgaria and around the world, justifying the need to refine the regulations for organizing and conducting first aid training in the workplace.

2. After the study, the main topics of first aid training in the workplace were identified, based on an analysis of the frequency and severity of OA in Bulgaria, which would have the most significant preventive function for preventing OA or would have the most positive health effect for employees who have suffered OA.

3. The analysis of data from the testing of the innovative model for first aid training in the workplace shows a significant increase in the readiness to provide OA in the workplace with each subsequent training and with an increase in the educational qualification of the trainees.

4. Compared to “standard training”, the innovative model has similar or better educational outcomes, can be conducted in a shorter time, be conducted in different modules to meet specific needs and its implementation is less expensive.

5. The developed innovative model has undeniable social effects by forming a proactive safety culture, characterized by increased awareness, preparedness and shared responsibility for health and accident prevention; acquisition of basic skills for first aid and emergency response in the workplace and elsewhere.

6. The economic analysis for the implementation of the innovative model shows that the project is economically very profitable, with a profitability index (PI) of at least 2.7, with the selected optimal option, for employers and for the whole society.

VII. CONTRIBUTIONS

CONTRIBUTIONS OF A SCIENTIFIC, THEORETICAL AND METHODOLOGICAL NATURE

1. The need to regulate first aid training in the workplace is justified based on an analysis of the regulation and conduct of first aid training in our country and in the world, an analysis of the frequency and severity of occupational injuries, the social and economic effects of occupational injuries.

2. An analysis of the necessary topics for first aid training has been carried out, based on the frequency and severity of occupational injuries and the most frequently necessary actions when providing first aid in the workplace.

3. An innovative model for first aid training has been developed, which will contribute to the prevention of occupational injuries and prepare workers for timely and adequate provision of first aid.

CONTRIBUTIONS OF A SCIENTIFIC AND APPLIED NATURE

4. The innovative first aid training model is based on interactive training, including presentations, educational films, documentaries, videos from previous trainings, scenarios for potential work accidents, a response plan, situational exercises, etc., which allows for better engagement of the trainees, personalized training, development of practical skills, accessibility and flexibility, more effective feedback, etc.

5. The innovative first aid training model has been introduced in three economic sectors with a high risk of occupational injuries: mining, construction and energy. The model has also been introduced in state administration, where occupational injuries have average levels.

6. A questionnaire has been developed and implemented to assess the theoretical knowledge of the trainees and monitor the effectiveness of the training in the covered groups of workers.

7. The analysis of the social and economic effects of the OA provides guidance on the necessary share of workers who need to undergo first aid training after the OA.

8. The dissertation is a strong argument for regulatory changes in national legislation with a view to improving the quality of first aid training.

VIII. LIST OF PUBLICATIONS on the topic of the dissertation

1. Pachalov S. – "First aid training at the workplace – necessity, organization and implementation", Journal "Health and Safety at Work", 2023, vol. 9, pp. 44-49. (ISSN 2367-7171)

2. Pachalov S. – "Presentation of the results of the application of an innovative model for conducting first aid training in mining enterprises in Bulgaria", Journal "Mining and Geology", 2025, no. 3-4, pp. 47-51. (ISSN 0861–5713)

3. Pachalov S., Vangelova K., Grigorov E. – "Innovative model for conducting first aid training at the workplace in Bulgaria", Bulgarian Journal of Public Health, 2025, vol. 17, no. 4, pp. 104-115. (ISSN 1313-860X)

IX. PARTICIPATION IN SCIENTIFIC EVENTS in connection with the dissertation

1. Pachalov S. – "Provision of first aid", "59th Summer Seminar in Bulgarian Studies for Foreign Bulgarian and Slavic Studies", 11.07.2022, Lozen village, Bulgarian Red Cross National Center, Bulgaria

2. Pachalov S., Grigorov E. - "Current Bulgarian legislation regulating first aid training in the workplace, as part of occupational safety and health activities", Eighth Pharmaceutical Business Forum and Scientific and Practical Conference "Pharmacists and Doctors – United in Support of the Patient", from 28.10.2022 to 29.10.2022, Medical University – Varna, Varna, Bulgaria

3. Pachalov S., Grigorov E. – "Provision of first aid by and to foreign workers", Conference "OSH without borders", 27-29.09.2023, Hotel Drim, Struga, N. Macedonia.

4. Pachalov S., Vangelova K., Grigorov E. - "Survey results of an applied innovative model for workplace first aid training in Bulgaria", 12th International Conference Working on Safety (WOS), 22–25 September 2024, Dresden, Germany

5. Pachalov S., Grigorov E. - "Innovative model for first aid training at the workplace in Bulgaria", "50 years of medical education and science in Pleven", Jubilee scientific conference with international participation, 01-03 November 2024, Medical University - Pleven, Pleven, Bulgaria

6. Pachalov S. - "First medical aid", XXIX conference of the "Heart-Lung" Association, 7-9.11.2025, r.c. Albena, Bulgaria

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