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**STUDY OF THE EFFECTIVENESS OF TRAINING
OCCUPATIONAL SAFETY WORKERS**

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Abstract

The training of competent workers should adequately respond to the needs of employers. Trained workers must fully meet all the demands of the labor market for the quality and safe performance of labor functions. This is very important and necessary for employers to implement production processes. A variety of forms and types of production activity requires the adoption of various security measures and continuous training of workers. Therefore, training should be massive, short-term, accessible to workers, easily implemented for employers, and uniformly organized by training organizations and authorities. In this case, the whole system of training in occupational safety is based on a system of differentiation of types of training for various groups of workers based on state requirements for the content, duration, and forms of training organization. Improving the quality of education is possible with the inclusion of modern learning tools. In this article, the authors attempt to answer problematic questions and show how do various forms, methods, and means of education influence the quality of the formation of workers' knowledge in the field of occupational safety (FOS) and what pedagogical conditions will ensure the introduction of a model of training workers in safety and occupational safety in the system of additional education. The importance of solving this problem to improve the professional literacy and culture of employees of enterprises and determines the relevance of our study.

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Keywords: Occupational Safety Workers, Pedagogical conditions, model of training, Industrial safety.



1. Introduction

Occupational safety and health (OHS) issues are an integral part of the strategies of the European Union countries, the USA, and Canada. The most interesting is the experience of Finland, the USA and the UK. In 2004, the United Kingdom adopted the Occupational Health Safety Strategy for the period up to 2010 and longer. Industrial safety is the strategic policies, plans or measures put in place to forestall accidents to workers, people around and break down materials, tools and equipment (Anaele, Adelokun, & Olumoko, 2014).

This paper traces in particular the processes and results of comparisons of OHS specialists' roles, functions and knowledge and skills requirements.

The training of competent workers must adequately respond to the needs of employers, and the trained workers themselves fully meet all the demands of the labor market for the quality and safe performance of the labor functions necessary for employers to implement their production processes. This determines the main characteristic of the employee - professional competence (Alexankov, Trostinskaya, & Pokrovskaya, 2018; Bolotov & Serikov, 2003; Carr & Skinner, 2009; Boulet, Reid, Emery, & Hill, 2015; Day, 1994; Razinkina, et al., 2018; Stankevich, Abramova, & Boyarov, 2016; Zimnyaya, 2006).

In this regard, the solution of the problem of intensifying the learning process based on the use of combinations of various educational methods that can increase the level of competence of all categories of insured citizens in the FOS is relevant and timely. These provisions determine the relevance of our study.

2. Problem Statement

According to statistics from the International Labor Organization (ILO), the number of accidents at work in the world in recent years has increased and is 125 million people annually; about 220 thousand of them die. The dynamics of accidents in different countries varies.

At first, a survey conducted by a safety agency in the UK showed that a third of all accidents in the chemical industry were maintenance-related, the largest single cause being a lack of, or deficiency in, safe work permit systems (Zimmerman & Haywood, 2017). Then, safety is concerned with hazards to humans that result from sudden severe conditions; health deals with adverse reactions to exposure to toxic or otherwise dangerous hazards (Goetsch, 2010).

The role of OHS representatives has accordingly changed to focus on solving specific problems in the workplace as an integrated part of daily operations. Both management and colleagues consider the OHS representatives as a resource that can be utilized to manage the work environment (Hasle, Seim, & Refslund, 2016).

At the same time, training in occupational safety of managers and specialists is carried out under the relevant OHS programs directly by the organization itself or by educational institutions of vocational education, training centres, and other institutions and organizations engaged in educational activities (Friend & Ferry, 2017).

The development of effective methods of training in the FOS is devoted to the work of a large number of researchers. Some recommendations for OHS "core competencies" that all postsecondary

construction students should achieve and “essential elements” for OHS education in construction training programs was developed (Bush, Chang, Rauscher, & Myers, 2019).

Others review an Evaluation of the contribution of the OHS Body of Knowledge and program accreditation to the capability outcomes of the Australian Work Health and Safety Strategy for 2012–22 with an extrapolation to potential lessons for other countries (Pryor, 2016)

The strategies for preventing industrial accidents in technical education workshops in technical colleges are determined (Oviawe, 2018).

A variety of forms and types of production activity requires the adoption of various security measures and continuous training of workers. In addition, the Development in the field of science and technology affects the interest of the elements of educational innovations (Richmond, & Tattoo, 2016). The application of information technologies (IT) is associated with their dynamic usage on not only in real life, but also in the education. It is necessary to take advantage of the younger generation interest in working with information technologies (Feszterová, 2015).

Given the importance of OHS Education & Training, this study attempts to fill the gap in the literature, which is associated with the need for the informed use of effective tools and training methods.

3. Research Questions

1. How do various forms, methods, and means of education influence the quality of the formation of workers' knowledge in the field of occupational safety?
2. What pedagogical conditions will ensure the introduction of a model of training workers in safety and occupational safety in the system of additional education?

4. Purpose of the Study

The objective of this study is to justify the necessity to modernize the contents and technologies of OHS Education & Training in order to ensure the successful development of their professional competences.

5. Research Methods

Theoretical and empirical methods of research were used in the study. In this study, the following methods were applied: theoretical and methodological, system and structural analysis of scientific, normative, educational and methodical documents; the analysis, generalization and interpretation of innovative pedagogical experiment on the organization of OHS Education & Training; the analysis of regulative and legal documents, the analysis of the experience of innovative pedagogical methods introduction in institutions of the general and professional education; pedagogical experiment; surveys of employees, employers and teachers; the analysis of results of educational and independent activity of students, as well as the methods of mathematical statistics.

As a result, certain sets of instructions emerge that gradually develop in some knowledge in OHS (Skinner, 2016).

6. Findings

Study results have shown that OHS Education & Training to a degree improved their professional results.

6.1. Study Question 1:

In the field of additional education, training, and testing of knowledge and requirements of occupational safety is one of the most important areas in the complex of preventive measures that contribute to the reduction of industrial injuries and occupational morbidity of employees of enterprises and institutions.

A prerequisite for achieving safe working conditions is the competence of people in the framework of existing production and ways to protect against possible occupational risks. Therefore, competence-oriented training of trainees in occupational safety courses in training organizations is not a tribute to fashion, but an objective phenomenon in education, brought to life by socio-economic, political-educational, and pedagogical prerequisites; it is the reaction of vocational education to the changed socio-economic conditions, to the processes that have emerged along with the market economy. The solution of the actual problem of increasing the efficiency of the educational process of additional education on occupational safety requires a deep analysis of the existing forms, methods, and means of its organization. At the same time, the use of innovative teaching methods for all categories of insured citizens in occupational safety in the context of the implementation of additional educational programs allows to involve them in the learning process.

Modern learning technologies are characterized by the following positions:

- training technology is developed for the implementation of specific goals that have the form of a specific expected result;
- the technology provides for the interrelated activities of the teacher and students on a contractual basis, taking into account the principles of individualization and differentiation, the optimal realization of human and technical capabilities, as well as the use of dialogue and communication;
- phased planning and consistent implementation of the elements of pedagogical technology should be reproduced by the teacher and ensure the achievement of planned results by all students;
- an organic part of the pedagogical technology are diagnostic procedures containing criteria, indicators and tools for measuring performance.

Analysis of the practice of conducting classes in additional educational programs in Sakhalin State University (SakhSU) during 2005–2018 showed that the following set of teaching methods is mainly used in their implementation:

At lectures:

- explanation of the main provisions;
- a story with thematic tables;
- a story with a presentation;

- an explanation of the main provisions using multimedia;
- video demonstration.

At workshops:

- demonstration of visual aids (DPI);
- work with a simulator;
- filling in reports, tables, and forms;
- independent work on the module.

The specificity of training determines the importance of the application of practice-oriented methods. However, for one reason or another, many teachers do not use these methods in their work.

Based on these data, it should be emphasized that more modern teaching methods are used in occupational safety training to a lesser extent than traditional ones. Most likely, this is both due to the lack of competence of teachers, and the lack of properly equipped training places. Thus, the analysis of the results of using various educational technologies has shown that the most effective is the use of various forms, methods and means of training in combination with a modular system of education.

6.2. Study Question 2:

The study revealed that it is advisable to conduct occupational safety training in small groups followed by discussion (the teacher's comments are also possible). This model is called *learning in cooperation*. Learning tasks are structured in such a way that all team members are interconnected and interdependent, but at the same time sufficiently independent in mastering the material and solving problems. Participants should be given tasks to solve problems that may arise in real production. After finding a consensus, each group arranges a presentation of its own problem-solving algorithm. The developed algorithm is discussed and subjected to constructive criticism from other groups and the teacher.

In the course of the study, we found that the implementation of the methodology model for training all categories of insured citizens under the additional training OHS programs depends on the following methodological conditions:

1. Substantive, determined by the specifics of the content of the subject area "Occupational Safety," which are aimed at the implementation of the learning process and the formation of professional and educational knowledge and skills in the field of occupational safety.

When drawing up the content of work programs, the didactic possibilities and potential of modular training were taken into account, which made it possible to expand the content of educational topics by increasing the volume of educational material with additional educational, scientific, and reference information.

2. Methods, instructional techniques, forms, and means of organizing modular training, implemented in the process of teaching occupational safety issues comprise the educational and methodological conditions.

The organization of modular training in occupational safety for students requires the integration of various training methods (information-receptive, reproductive, heuristic, and research), teaching methods, means, and forms of organizing training for students with the active use of logical methods of thinking (analysis, synthesis, comparison, identification of cause-effect relationships, abstraction, synthesis, etc.) in

the organization of their cognitive activity.

3. The evaluation and performance conditions Evaluation and performance conditions are represented by various operations for diagnosing the results of studying OHS program as part of additional training.

4. The material and technical conditions for the implementation of modular training in occupational safety for students require the use of modern information and communication technology, multimedia, etc., which, as a consequence, reflected in the effectiveness of the formation of subject knowledge of security and occupational safety.

Special training in OHS is carried out using innovative educational technologies (educational materials and e-learning courses, testing, exchange of information between students and a teacher, computer testing, etc.). All of the above positions are trying to find reflection in progressive forms of training students in OHS programs at the Center for Educational Services of the Sakhalin State University FSBEI HPE. The training center has a set of interrelated elements:

- equipped classrooms;
- qualified teaching staff;
- logistical and methodological support;
- modular training systems;
- the automated system of training and examination Ekzaminator.

More than 1,000 people study at the Center annually, of whom managers make up on average 17% and specialists 83% (Table 1):

Table 01. Number of People Who Completed Training in 2018

Total trained		Managers and specialists		Teachers of educational institutions of vocational education		Persons replacing civil service positions	
Total	Heads of Departments	Total	Heads of Departments	Total	Heads of Departments	Total	Heads of Departments
1 138	197	1 053	175	4	1	81	21

Training of students under the OHS program is conducted in specially equipped classrooms and classrooms. Lecture halls are equipped with multimedia equipment connected to the Internet, and classrooms have special equipment for laboratory and practical classes in the field of occupational safety.

The teaching staff of the Center consists of faculty members of the departments of life safety and civil defense, technical disciplines, management organizations and the department of theory and methods of teaching technology and entrepreneurship, as well as employees of research institutes and laboratories specializing in occupational safety and industrial safety issues, labor inspection of the Sakhalin region, etc. The choice of teaching staff is determined by the content of the relevant training program in occupational safety, focused on solving specific problems and tasks in occupational safety.

Two computer rooms with a total of 35 computers are used when teaching occupational safety students at the Center. The classrooms are equipped with stationary projectors and other multimedia equipment. They allow for remote training of students, as there is a special program for this. The computers have an electronic database on all sections of the OHS program. Practicing of rendering first medical and

intensive care aid to a person in extreme situations using simulation models like “Maxim” and “Gosha” are held in the classrooms. Considering the current trends in the development of pedagogical activity associated with the use of innovative teaching methods, teachers in the occupational safety classes use separate interactive forms and teaching methods. These include training in small groups, questionnaires, observations and interviews, modular training, and business games.

At the end of the course, students were offered to fill out a questionnaire as one of the forms of feedback between the course instructors and the students. The questionnaire had 10 questions on various aspects of occupational safety training. The questionnaire was filled out by business leaders – 17%, chief specialists of enterprises – 57%, occupational safety engineers – 19%, and members of committees and commissions and authorized occupational safety officers – 7%. In total, 170 people participated in the survey. The questions from the questionnaire are listed below, and the results of answers to the questions are presented in the form of diagrams:

In the course of studying the questionnaires of students, the following conclusions can be drawn:

- the majority of students are motivated to attend occupational safety courses held at the Center for Educational Services of the Sakhalin State University;

- the students realize the necessity and importance of conducting the OHS program, since it is very important for the effective work of the enterprise where the students work;

- when answering “deceived expectations” to question 2, one trainee among the managers of a company indicated that the program did not suit him. A further conversation with him showed that he was dissatisfied not with the program itself, but with the timing of its execution. The rest of the students in all categories indicated that 99.4% were satisfied with the curriculum and teaching methods;

- when asked about the knowledge that students will require in their future work, respondents indicated that all the points noted in the diagram will be useful in one way or another in their further work (from 20 to 70%). The most demanded is knowledge in the field of investigation of industrial accidents and occupational diseases – 70% and rendering first aid to the victim – 60%. The specifics of work of the occupational safety service in organizations is less in demand – 20%. Such a distribution in the application of the knowledge gained suggests that many job descriptions and functional duties do not fully reflect occupational safety;

- students generally rated their level of training in various sections of occupational safety as good, which can be viewed as a positive assessment of the educational and methodological work of the course teachers;

- the level of teaching in the courses was assessed by 22% of students as excellent, good by 76% of students, and 2% as satisfactory, which indicates the high qualifications of the teachers. All students rated the set of teaching materials as worthy;

- students see increasing hours for laboratory and practical classes as an increase in the effectiveness of the training courses, while a 40-hour program is considered the optimal time for mastering the OHS program;

- to increase the effectiveness of training, students believe that the time for practical training should be increased to study the following topics: investigation of accidents at work – 23%; study of labor law – 17%; first aid – 15%; rights and obligations of a commissioner for occupational safety – 14%; PPE,

selection criteria and their application – 13%; additional duties imposed on production – 10%; industrial safety – 8%. This distribution is due to the fact that the functional responsibilities of different categories of trainees impose different degrees of responsibility for the protection of labor in the enterprise on them;

- among active learning methods, students put modular teaching method first – 72%; the method of small groups and round table was second – 52%; questionnaires in third place – 45%; followed by IT technologies – 32% and individual conversations – 28%. Of the active teaching methods, students prefer the modular teaching method, which corresponds to individual training of students on occupational safety topics, dispenses the material under study, and builds a logical chain of acquired knowledge into it;

- among the conditions required to improve the organization of the educational process, students put forward the distribution of teaching materials at the beginning of the educational process – 38%; delivery of lectures in an interactive way – 18%; holding exams on a computer – 15%; linking lectures with the specifics of a particular enterprise – 11%; use of excursions and visual teaching methods – 9%. Placing the condition of the distribution of teaching materials at the beginning of the educational process in the first place, students meant that this will help them better prepare for the final exam on their own;

- students generally rated the material and technical equipment of the courses as good and excellent, which indicates that the material and technical base complies with modern requirements for equipping the educational process;

According to the results of the training, the listeners put the use of the computer class for self-training in the first place – 35%; in the second place, there was the provision of methodological material in an interactive form and the provision of materials in electronic form – 21%; systematic training of occupational safety employees – 13%, and an increase in training time – 10%. The intensity and short term of the course requires students to maximize concentration and concentration. They understand that during the lecture-practical classes, the teachers of the Center touch upon the most important issues of teaching occupational safety while omitting the questions concerning the listeners' particular enterprise, therefore they need time for self-training and self-improvement. The widespread use of visual material (slides, educational films, dynamic teaching aids) allows students to more deeply understand the specifics of the occupational safety training program.

Experimental research conducted by teachers of the department of life safety and civil defense of Sakhalin State University (SakhSU) and teachers of the Center for Educational Services of the Technological Institute of SakhSU, as well as the analysis of educational programs for additional education in the field of security, occupational safety, and Federal state standards of higher professional education in the field of technospheric safety, currently implemented by SakhSU, allowed to determine the following professional competencies that are most characteristic for students attending the Center for Educational Services of the SakhSU:

- PC-1. The ability to navigate the basic methods and systems for ensuring technosphere safety and reasonably choose known devices, systems, and methods for protecting humans and the natural environment from hazards.
- PC-2. The ability to navigate the main regulatory and legal acts in the field of security;
- PC-3. The readiness to perform professional functions when working in a team;
- PC-4. The readiness to use knowledge on the organization of occupational safety,

environmental protection, and safety in emergency situations at economic facilities;

- PC-5. The ability to use knowledge of the organizational fundamentals of safety of various industrial processes in emergency situations.
- PC-6. The ability to analyze the mechanisms of the impact of hazards on humans and determine the nature of the interaction of human body with the hazards of the environment, taking into account the specifics of the mechanism of the toxic action of harmful substances,
- PC-7. The ability to identify hazardous, extremely hazardous, and acceptable risk areas;
- PC-8. The ability to monitor the status of the protective equipment used and make decisions on the replacement (regeneration) of protective equipment.

Organizationally, in order to obtain objective data during the experiment, we used the following research methods: monitoring the activities of students; conversation; testing; documentation analysis (reports, completed forms, tables); expert assessment of the development of professional competencies among students (by commission, after graduation) by teachers and involved specialists in occupational safety (Sakhalin Region Labor Agency, State Labor Inspectorate in the Sakhalin region, Sakhalin Region Department of Rospotrebnadzor, Sakhalin Engineering JSC, etc.), qualitative and quantitative data analysis.

The sample of the research included 1250 students (2011-2018).

In the course of testing, participants were asked to answer 120 questions, which were divided into a series of 10 questions on each topic studied.

During the test control, the mark “5” was issued if the listener gave 9 or more correct answers to the questions from the corresponding group; two incorrect answers resulted in “4,” four incorrect answers in “3,” five or more incorrect answers in “2.” Each professional competency was assessed based on the results of the responses.

The relative results of the research (the relative formation of each competence by year of study, 2016-2018) are presented in Figure1:

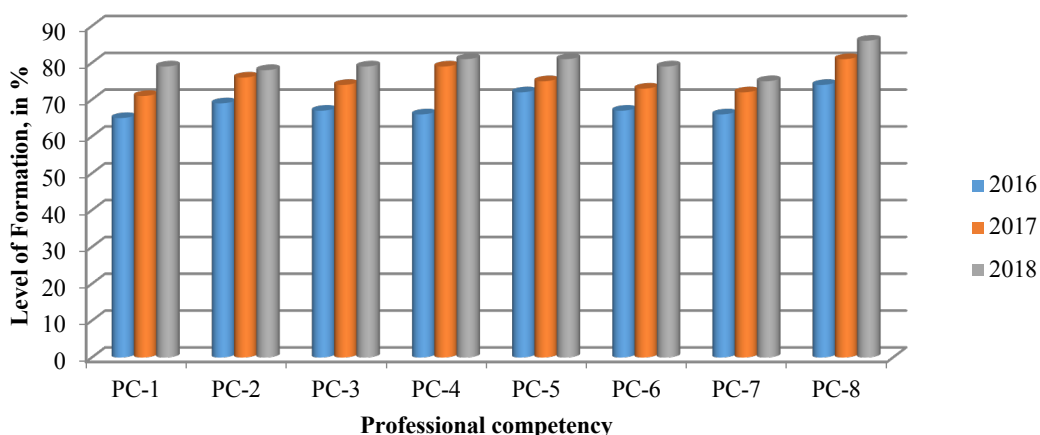


Figure 01. Generalized Results of the Formation of Professional Competence in OHS Programs

Figure 1 indicates an increase in the level of development of professional competencies among students of occupational safety courses.

To assess the development of students' professional competencies and confirm test results, the

method of group expert assessments was applied (Cherepanov, 1989). When selecting specialists participating in the expert survey, the following requirements were set for them. The experts had to know the requirements of professional activities for occupational safety specialists, in generalized form, qualification requirements, extensive experience, and relevant education and work experience in the field. The expert group was made up of eight representatives of SakhSU and experts in the FOS at the federal and municipal levels.

In the course of the expert survey, the results of the study were obtained; they were further converted in profiessograms or profiles of professional competence of each student (Table 2).

Table 02. Expert Evaluation of the Professional Competencies of OHS Program (for UNITA01 Petrova I.I.*)

Expert	PC-1	PC-2	PC-3	PC-4	PC-5	PC-6	PC-7	PC-8
A.S.V.	4	4	4	4	4	4	5	5
B.E.N.	4	5	3	4	4	4	5	5
G.I.E.	4	5	3	4	3	4	4	5
M.V.V.	4	5	4	3	4	5	4	4
M.V.P.	3	4	5	4	4	5	4	4
S.G.V.	4	4	4	4	5	4	4	4
A.A.V.	3	4	3	3	5	4	4	4
...others								

* Person Name is changed

The evaluation was given in the form of points: 5 points – the listener has the full competence of the study; 4 points – the listener’s competence is quite well-formed; 3 points – the level of the listener’s competence is satisfactory; 2 points - the listener’s competence is insufficient.

Each expert gave a score. Then the results of a survey of all experts were summed up, and the average score was calculated for the formation of each competence B_{cp} :

$$B_{cp} \cong \frac{\sum_{n=1}^N B_n}{N}, (n = 1, \dots, N),$$

B_n – is a score given by n th expert, N – number of experts interviewed.

At $B_{cp} < 3$, the listener was considered “conditionally unfit” in the framework of the activities determined by a specific competence, and the program organizers had to implement measures to develop the missing qualities.

Comparison of the results of expert evaluation with the results of testing allowed us to identify the degree of formation of a particular competence in a student, the totality of which represented professional competence.

As an example, Table 3 shows the results of evaluation of the professional competencies of occupational safety course students.

Table 03. Evaluation of the Professional Competencies of Occupational Safety Course Students (2018)

Professional Competencies	Test Result (%)	Expert Evaluation (%)
PC-1	82.10	89.60
PC-2	79.00	78.20
PC-3	85.00	88.00
PC-4	77.20	81.00
PC-5	92.30	91.40
PC-6	81.40	77.00
PC-7	93.60	92.20
PC-8	85.00	89.60

To date, the Center for Educational Services uses a variety of forms and methods of organizing classes in the educational process. As a rule, their spectrum is directly proportional to the effectiveness of training, and the learning process itself becomes more attractive and interesting in terms of content, allowing creating conditions for increasing the interest of students and their active participation in the learning process, striving to use the knowledge gained in their practical activities. But the forms and methods of organizing classes should be tested in practice and show their effectiveness. Therefore, conducting a survey among students allows adjusting both the content of the course program and the most effective forms and methods of conducting classes.

7. Conclusion

Analysis of the results of the application of various educational technologies has shown that the most effective is the use of various forms, methods and means of education in combination with a modular system of education, the distinctive features of which are flexibility and the ability to quickly create various modifications on training topics and the greatest intensity and individualization of the educational process.

The introduction of pedagogical innovations in the FOS is possible when performing a number of preparatory works:

- development of innovative technologies with reference to specific topics on occupational safety issues;
- organizing training centers for occupational safety teachers;
- ensuring the variability of content of occupational safety training in accordance with the requests of various student groups;
- introduction of a differentiated approach to occupational safety training, taking into account not only the position of the trainee, but also the degree of their training;
- improvement of material and technical base;
- development and implementation of a teacher motivation system that encourages them to introduce innovative forms of occupational safety training;
- further improvement of the regulatory framework governing the occupational safety training;
- development and implementation (with systematic monitoring) of the occupational safety training effectiveness assessment system.

Scientific Novelty

1. A model of training for workers in security and occupational safety in the system of supplementary education has been developed and implemented, which ensures an increase in the level of knowledge.

2. Pedagogical conditions for the implementation of a model of training workers in security and occupational safety in the system of additional education have been developed.

3. Scientific and methodological support has been developed, creating conditions for effective training of workers in security and occupational safety in the system of additional education.

Practical Significance

The findings and provisions of the research can be used in the development of educational programs for additional education to improve the system of safety and occupational safety of employees of the Sakhalin region enterprises.

Scope of Implementation

The methodological and software for training employees of enterprises of the Sakhalin region on occupational safety has been developed.

Resource Base

Center for Educational Services of the SakhsU FSBEI HPE

Organizations Supporting the Innovative Development:

Sakhalin Region Government Labor Agency, Sakhalin Region Labor Inspectorate, Sakhalin-Engineering JSC

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