Analysis of the optimization of labor protection measures in engineering work

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Abstract. The paper is devoted to the analysis of the extent of injury in the coal mine by age categories of employees. Different age groups of employees are studied. Measures taken to protect workers by types of productive activities in coal mines aimed at improving working conditions in the workplace are proposed. Due to the proposed measures the decrease of level of injury and occupational diseases of workers was achieved.

1 Introduction

Occupational safety measures should be planned on the basis of management theory, which uses a systematic approach for goals, criteria, methods and management tools. The methodology of the system approach allows us to reveal the internal connections of the process under study, to determine the main management functions.

For optimal planning of labor protection measures in order to effectively use available resources, it is necessary to create a management system that provides mathematical methods and information analysis, adoption and implementation of management decisions [1].

2 Materials and methods

If we take into account the statistics of our Republic when planning labor protection measures, it shows that at the beginning of 2023, there were 18.13 million men out of the total population, and 17.89 million women. The urban population was 18.33 million people, the rural population was 17.69 million. People younger than working age make up 31.7%, able-bodied - 56.8% and older than working age - 11.5%. The number of live births in 2022 amounted to 932.2 thousand people, including 482.4 thousand boys and 449.8 thousand girls. 473.4 thousand people were born in cities, 458.8 thousand in rural areas.

The share of births of one child was 97.8%, two children - 2.1%, three or more children - 0.1%.

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38.9% of women under the age of 25 were in labor, 60.1% were 25-39 years old, and 1% were 40 years old and older [2].

Fathers under the age of 25 were 10.7%, 25-39 years - 83.4%, 40 years and older - 5.9%. From the above statistics, it can be analyzed that the number of employed people consists of Figure 1.

Occupational health and safety management systems at the level of an enterprise, association, and industry allow increasing the effectiveness of combating occupational injuries, general and occupational diseases will ensure the achievement of the most favorable working conditions [3].

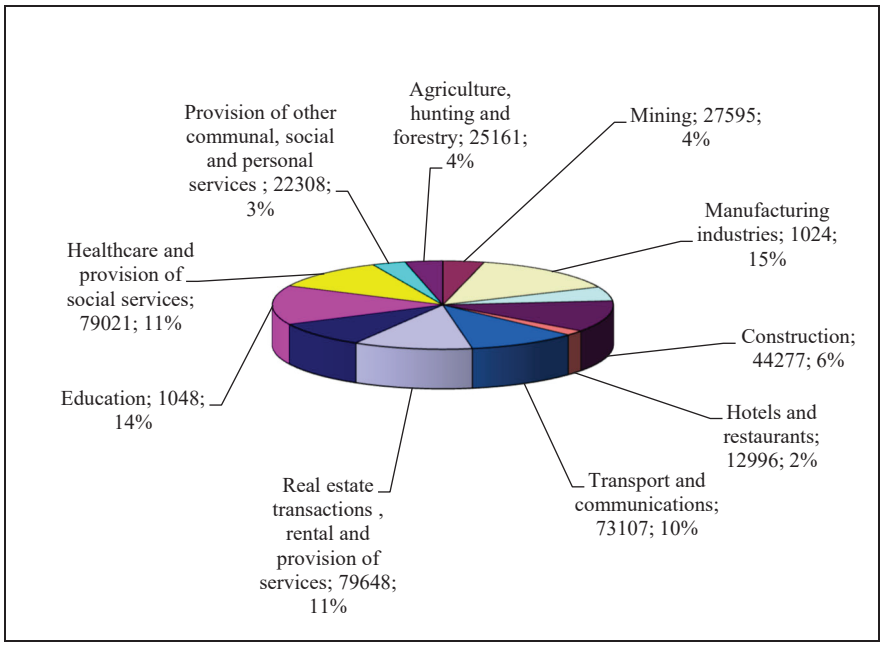

Fig. 1. Structure of the employed population.

In general, the management system consists of a management object, a management body, information processing tools and means of implementing management decisions [4].

The purpose of the operation of the control system is to change the output parameters of the object in accordance with the specified criteria or control program. At the same time, input and output parameters are recorded, which are used to identify the object, that is, to build a sufficiently adequate mathematical model that allows predicting the values of output variables and developing the necessary control actions [5].

The control object is considered as a converter of the vector of input random functions of time x (t) vector of output random functions y (t):

$$y(t) = A_t x(t), \quad (1)$$

where A_t is the object description operator [6].

Each output variable y(t) (i=1, m) is defined by a set of input variables x1 (t), xn(t), however, their full accounting is practically impossible. Therefore, we have to limit ourselves to a part of the defining variables, and attribute the rest to uncontrolled noise[7].

We will define some elements of the management system of occupational safety measures aimed at reducing morbidity.

The object of management in this system is the state of health of the studied contingent of workers.

This contingent is characterized by a certain length of service, age sex and professional structure, and is united according to the principle of qualitative homogeneity of the factors of working conditions affecting it [8].

3 Results and discussion

The purpose of the system is to achieve harmless and safe working conditions that allow for these climatic and socio–economic conditions, taking into account the characteristics of the contingent of workers, to ensure the lowest possible levels of morbidity [10].

Input variables are environmental and industrial environment parameters and professional and demographic characteristics of employees. Output variables are indicators of morbidity that characterize the health status of workers [8].

The criterion of effectiveness in the system under consideration should be to ensure the background level of morbidity, which is not related to the influence of production, but is determined by climatic, social and other factors uncontrolled in this system [13].

The controlling influences are labor protection measures aimed at achieving the lowest possible levels of morbidity of workers. These measures can improve working conditions, compensate for the damage caused by adverse impacts, contribute to the protection of workers, regulate their work and rest regime [14].

The management bodies in this system are the labor protection (safety and industrial sanitation) services working together with the administration of the enterprise. They analyze the current information about working conditions and the health of workers, consider possible options for management decisions, make action plans and monitor their implementation [12].

Information about the state of the management object contains data on compliance with labor protection rules and regulations, on the implementation of planned measures, current values of factors of working conditions, indicators of the health of workers and economic data.

Information processing tools are organized, technical and software that allows you to generate and accumulate indicators, perform their comprehensive analysis and develop optimal recommendations for management bodies [7].

The means of implementing control actions are research, design and technical solutions, measures of moral and material incentives, means of individual and collective protection, medicines and equipment, etc., necessary for indicators of the health status of workers [4].

To implement the main functions of managing occupational safety measures, an automated data processing system should be created, where the following tasks should be solved:

- registration, control and accumulation of information;
- calculation of statistical indicators and printing of information tables;
- identification of the management object in order to determine the relationship between the parameters of working conditions and morbidity indicators;
- determination of the minimum possible levels of morbidity and their corresponding optimal, but lying within the realistically achievable limits of the values of production factors;
- compilation of various options for preventive actions and selection of the optimal option;
- assessment of predicted morbidity levels;
- determination of the socio-economic effect of the system of optimal planning of preventive measures [5].

With the help of a functional calculation and a scheme, we will consider the sequence of stages of optimizing morbidity. Such optimization involves the use of an automated data processing system [9].

The control object is characterized by input variables-parameters of working conditions, and output variables- indicators of morbidity of workers. This information is accumulated in the corresponding data archives. Such archives are formed and used during the operation of the automated system in the information management mode [12].

In the first case, the archives of data on working conditions and morbidity data are replenished and adjusted with a given frequency. If it is necessary to compile reports or obtain operational summaries for a given sample, the values of production factors are estimated and morbidity rates are calculated. At the same time, it becomes possible not only to promptly obtain the necessary information, but also to compare working conditions and morbidity of individual groups of workers with the help of common signs, identify the most disadvantaged areas of production and thereby facilitate the planning of targeted preventive measures.

When the system is operating in the control mode, it is supplemented with blocks of identification and prediction optimization [9-11]. The parameters of working conditions and morbidity indicators after their statistical processing and grouping, which allows for comparative analysis, serve as the initial basis for the identification model. Here, using the methods of factor and regression analysis, quantitative dependencies are determined [7]:

Where is the intensive indicator of the form of the disease:

- vector of working conditions parameters;
- the number of forms of diseases registered in the studied contingent of workers [15].

Each of the morbidity indicators [5] characterizes the particular properties of the control object, therefore, for a complete description of the object, models should be built according to the indicators.

Morbidity rates [4] were functions of the parameters of working conditions [2] with an appropriate optimum of independent variables, they can take minimal values. These values [6] can be defined as the minimum possible levels of morbidity, provided that at these points they are continuous, differentiable and have global positive minima, and the corresponding optimal values of the arguments [4] are in a realistically achievable area determined by technical and economic constraints [8].

In cases where the minima of the function do not satisfy the specified conditions or the values of the corresponding arguments lie outside the really achievable area, the minimum possible incidence levels are determined by the boundary values of the real area in the direction of the optimum.

Thus, to determine the minimum level of morbidity in the form, it is necessary to solve the following problem [15].

Where is the lower edge (the exact smallest value) of the morbidity indicator function - the vector of working conditions parameters;

X is the set of really achievable values on which the minimization problem is solved. The vector minimizes the function [9].

Each of the obtained in solving the minimization problem of the partial optimal vectors of the parameters of working conditions minimizes the indicators of the form of the disease [7]. To minimize the total morbidity index equal to the sum of intensive indicators for individual nosological forms, it is necessary to determine the overall optimal vector of parameters of working conditions, all components of which belong to particular vectors [8].

Thus, the general optimal vector of working conditions for the studied contingent of workers can be as a combination of partial optimal vectors minimizing individual forms of diseases [10].

The parameters that make up the overall optimal vector should be used when planning preventive measures. For the automated compilation of individual variants of the plan,

classifiers developed for specific production facilities (workshops, sites, professions, etc.) are indispensable. In these classifiers, not only the harmful factors of working conditions that they counteract, but also the proportion of specific weakening of these factors, as well as the cost of measures, must be matched to each preventive measure [2]. To achieve the calculated optimal values of the parameters of working conditions, with the help of classifiers, variants of prevention plans are compiled, differing in the composition of measures, the total cost and the resulting health effect [3].

In order to determine the most rational variant of the action plan, the optimization problem is solved with a given efficiency criterion, taking into account technical and economic constraints. In the present task, these conditions are the criterion of the minimum possible level of the total morbidity index with limited costs for prevention [12].

Assuming that after carrying out a set of optimal measures, the minimum possible levels of morbidity will be reached after some time, we take this time for the forecasting period [11]. Having estimated by expert means the values that the parameters of working conditions will have over time (without carrying out optimal measures), using the identification model [1] we will determine the real forecast of morbidity indicators [14]:

- the prognostic value of the morbidity index according to the nosological form after the time of non-implementation of measures;
- prognostic values of factors of working conditions through without carrying out activities (Figure 2).

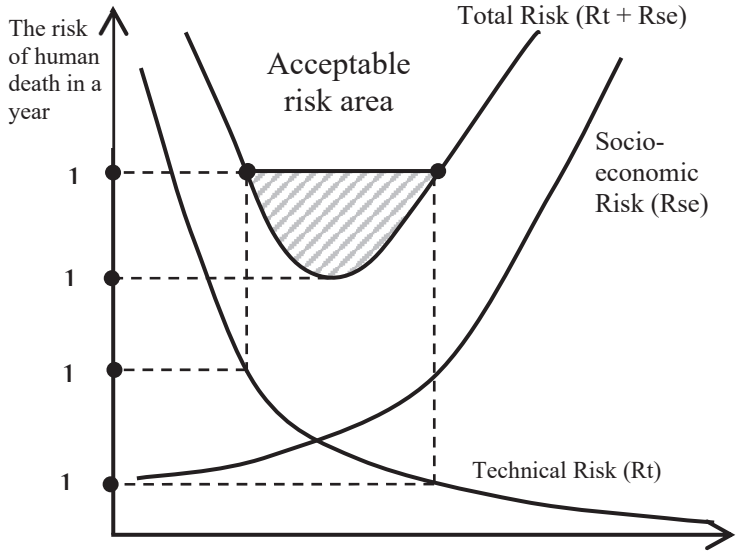

Fig. 2. Acceptable risk.

The calculation of prognostic values of morbidity indicators makes it possible to determine the socio-economic effect that can be achieved as a result of optimizing preventive measures [16]. Assuming that as a result of optimal measures, the incidence rates will decrease to the lowest possible values, we will determine the magnitude of this decrease for individual nosological forms [13].

Summing up this decrease in all the forms of diseases identified for the object under study, we obtain a general decrease in morbidity as a result of optimizing preventive measures.

The social effect of health-improving measures should be determined by the number of workers removed from the influence of harmful and harsh working conditions, which directly affects the reduction of morbidity rates [11]. Thus, the calculated decrease in the number of sick people, the number of cases of diseases can be considered the equivalent of one of the types of social effect obtained by optimization [19]. The reduction in the number of working days lost as a result of diseases will be considered an indicator of the socio-economic effect, since, indicating a reduction in the severity of diseases, it means a reduction in the loss of working time, and hence a decrease in under-production. Knowing the cost of one working day, according to this indicator, it is possible to calculate the economic efficiency of optimal planning of measures aimed at reducing the morbidity of workers.

The first stage of the automated system of accounting and analysis of information on working conditions and morbidity of workers has been introduced into industrial operation in the main workshops of the production association. This system implements the following stages of the above-described approach to optimizing labor protection measures: statistical processing of data on working conditions of workers and on morbidity with temporary disability; printing of information tabulograms; modeling of quantitative dependencies between factors of working conditions and morbidity indicators. The approbation of the subsequent stages of the described approach to the optimization of labor protection measures is assumed during the implementation.

4 Conclusion

Optimal planning of preventive measures aimed at reducing the morbidity of workers should be based on the functioning of an automated control system.

The management system of occupational safety measures aimed at reducing morbidity should contain blocks of statistical processing of information, modeling of quantitative levels of morbidity associated with production, classification and optimization of preventive measures.

Optimization of measures aimed at reducing the morbidity of workers should be based on the criteria of maximum health effect and be carried out taking into account technical and economic constraints.

Automated control system, including the stages of statistical processing and modeling.

References

1. Yu.M. Kundiev et al. *Application of the automated information system "Occupational diseases" in order to optimize preventive* (Tashkent, 2001)
2. E.G. Dudnikov et al., *Automated health care system as a subsystem of the automated control system of the industrial complex Instruments and control systems* (Tashkent, 2005)
3. V.V. Bessonov et al., *Some principles and results of the development of a system of automated control of industrial impacts on the environment and man as a subsystem. Metallurgical plant* (Tashkent, 2014)
4. A.A. Bagrov, G.P. Borodin, A.A. Razdorozhny, *Problems of personnel management and social development in a production association, enterprise* (2017)
5. I.A. Dolin, *Safety handbook* (Moscow, Energoizdat, 1982)
6. Units of physical quantities GOST 8417-81 (Moscow, Standards, 1982)
7. AI and its measurement, terms and definitions GOST 15484-81 (Moscow, Standards, 1982)

8. The main issues of reliability and durability of machines Studies Allowance (MADI , 1969)
9. R.I. Aizman, *Fundamentals of life safety textbook* (m: Business Express, 2005)
10. V.N. Burkov, E.V. Graziansky, S.I. Dzyubko, A.V. Shchepkin, *Models and mechanisms of security management* (M., SINTEG, 2001)
11. A. Andreev, A. Doronin, V. Kachenkova, B. Norov, Z. Mirkhasilova, E3S Web of Conferences **365**, 04028 (2023)
12. N. Saidkhujaeva, A. Khojiev, Z. Mirkhasilova, Muxammad-Ali, N. Norkuzieva, An Interactive Method in the Study of the Topic “Research of Fire Extinguishing Equipment” (2022)
13. Kh. Aliakbar, R. Muradov, N. Rajabov, T. Khaydarov, B. Utepov, International Journal of Engineering and Advanced Technology 6907-6911 (2019)
14. A. Khojiyev, M. Avliyakulov, Sh. Khojiyeva, E3S Web of Conferences Conmechydro **26** 04004, 7-13 (2021)
15. A. Khojiyev, R. Muradov, Sh. Khojiyeva, Kh. Yakubova, E3S Web of Conferences Conmechydro **264** 04004, 28-32 (2021)
16. A. Khojiyev, R. Muradov, T. Khaydarov, J. Pulatov, IOP Conf. Series: Materials Science and Engineering Conmechydro **883** (2020)
17. International Standard ISO 45001 Occupational Health and Safety Management Systems – Requirements and application guidelines (2018)