Use of the logical-statistical model as a procedure for assessing occupational risks in the OSH management

T. Kaverzneva, N. Rumyantseva, A. Uljanov, N. Belina
Peter the Great St. Petersburg Polytechnic University, St. Petersburg, 195251, Russia
E-mail: kaverztt@mail.ru, rumyantseva_nina@mail.ru, uljanovalexee@gmail.com, tdf3@mail.ru

Abstract. There is suggested an analytical approach to occupational safety management based on the use of a logico-statistical model for assessing occupational risks, which allows processing large sets of data for instrumental measurements of labor conditions. The results of processing information on the assessment of working conditions using a logico-statistical model allow us to predict the levels of occupational risks at various workplaces, which makes it possible to develop optimal management decisions for preserving the life and health of workers in enterprises. The prospect of using data mining methods in the tasks of OSH management at the enterprise opens up the possibility of creating decision-making mechanisms that take into consideration the dynamism of the working environment and make it possible to increase the validity of the choice of the priority of labor protection measures.

Keywords: Occupational risk, the labor protection effectiveness, effectiveness of the management system of labor safety.

Introduction

Ensuring safe working conditions creates a basis for increasing labor productivity, preventing occupational accidents and occupational diseases, reducing the production-related morbidity, and, consequently, reducing the economic and financial losses associated with them (Mjasnikov, et al. 2014, Idrisova, et al. 2018). That is why the heads of organizations are faced with the task of effectively managing occupational safety, creating safe working conditions in each workplace (Hopkins, 1995). The procedure for management of occupational risks is an important element of the OSH management system. It is proposed to use the logical-statistical model (Rumyantseva, 2012) for the management of professional risks, based on the method of questionnaires and the risk matrix (Li, et al. 2018, Yazdi, 2018). This model is a tool for the formation of an optimal plan of corrective measures in the OSH management system.

Methodology

Adaptation of the logical-statistical model for the procedure for assessing occupational risks consists of three stages.

Stage 1 "identification of hazards", which lies in in determining the number of hazards (inconsistencies) at the estimated workplaces.

Identification of hazards occurs through a questionnaire survey of workers on the following groups of factors: mechanical hazards; electric hazards; thermal, hazards associated with exposure to a chemical
factor; The risks associated with the impact of gravity and the intensity of the work process; the dangers associated with exposure to vibration; The hazards associated with exposure to the light environment; The hazards associated with exposure to the light environment; The risks associated with organizational deficiencies; fire hazards; the danger of transport; hazards associated with the use of personal protective equipment. In the described model, the factors are divided into the following groups: physical (Ph), chemical (C), labor intensity (L), drudgery of work (D), injuriousness (I), non-use of personal protective equipment (PPE).

The questionnaire is a list of issues related to the impact of the following factors on the employee: Ph, C, L, D, I, PPE, which under certain conditions can lead to occupational diseases and occupational injuries, and graphs of the presence of factors in the workplace (Rumyantseva, 2012).

The differential estimation of the measured indicators is carried out according to the binomial scale (Fasola, et al. 2018, Tulyakov, et al. 2018) (the danger is: "yes" or no danger: "no"), taking into account the frequency of factors exposure during the shift and the possible severity of consequences in the case of realization of danger, expressed through the number of "lost days" (Pykhtin, et al. 2017, Sharmanov, et al. 2017, Itsykson, et al. 2017). The use of these tools allows to respond in a timely manner to changes in the source data - the hazards / dangers may be different for each enterprise (depending on the specificity of the work and the targets for assessment). The tasks of the 1st stage of the risk assessment procedure include: identification of the impact of certain hazardous / harmful production factors; determination of the presence and level of safety or the nature and degree of danger / hazard of the types of production equipment and processes being evaluated; comparison of safety indicators (hazard and harmfulness) of similar types of production equipment and processes at the selected workplace (Novokshenov, et al. 2018, Nemov, et al. 2017). Stage 2 is the processing of the obtained results of the control sheets and calculation of the complex risk indicator. For the general characteristic of the assessed object, both an evaluation of all the single indicators taken into account, as well as various methods for their comparison in complex indicators, are necessary (Skripal, et al. 2017). With this approach, it becomes possible to formulate individual particular security tasks, and the general characteristic of the evaluated object. The basis of the work is the set of data obtained from the processing of questionnaires for each selected factor (F = \{F_1, F_2, ..., F_k\}, X = \{X_1, X_2, ..., X_m\}, and similarly for factors L, D, PPE) at each workplace (Rumyantseva, 2012). The systematization, processing and study of a large number of data is carried out by statistical methods. To the bank of the obtained data, we applied the stratification method (Kumazaki, et al. 2017, Damon, et al. 2016), according to which the data are grouped according to a certain qualitative attribute of the impact on the employee of each of the selected factors, i.e. the grouping of data is carried out according to the following statistical sets: Ph, C, L, D, I, PPE. Consider an example of processing a statistical aggregate of the factor F = \{F_1, F_2, ..., F_k\} on N-jobs (Table 1), where F = \{0; 1\}.

Table 1. Distribution of risk at workplaces by physical factor (f)

| Type of risk | Number of identified hazards / hazards due to selected factors in the workplace | Total |
|-------------|--------------------------------------------------------------------------------|-------|
| **Physical factors (Ph)** |                                                                                       |       |
| F_{11}      | F_{12} | F_{13} | F_{14} | F_{15} | ... | F_{IN} | \sum F_{i1} |
| F_{21}      | F_{22} | F_{23} | F_{24} | F_{25} | ... | F_{2N} | \sum F_{i2} |
| F_{31}      | F_{32} | F_{33} | F_{34} | F_{35} | ... | F_{3N} | \sum F_{i3} |
| F_{41}      | F_{42} | F_{43} | F_{44} | F_{45} | ... | F_{4N} | \sum F_{i4} |
| F_{51}      | F_{52} | F_{53} | F_{54} | F_{55} | ... | F_{5N} | \sum F_{i5} |
| ...         | ...   | ...   | ...   | ...   | ... | ...   | \sum F_{ik} |
| F_{K1}      | F_{K2} | F_{K3} | F_{K4} | F_{K5} | ... | F_{KN} | \sum F_{iK} |
| **Total factors** | \sum F_{1} | \sum F_{2} | \sum F_{3} | \sum F_{4} | \sum F_{5} | ... | \sum F_{N} | \sum |
The values of low, medium and high risk of accidents are set by the matrix (Leppälä, et al. 2012, Efremov, et al. 2014) (Table 2), taking into account the frequency of the factor's impact on the employee during the shift and the possible consequences of the implementation.

**Table 2.** Matrix of estimation of probability of hazardous / harmful production factors

| Probability of negative event | Effects |
|------------------------------|---------|
|                              | Microtrauma | First Aid Cases | Light (1-3 weeks) | Moderate injury (> 3 weeks) | Very heavy (disability, year. result) |
| Very often (1t/day)          | AR       | HR             | HR                | HR                        | HR                          |
| High frequency (1 t. week.)  | LR       | AR             | HR                | HR                        | HR                          |
| Average Frequency (1t. month) | LR       | LR             | AR                | HR                        | HR                          |
| Low frequency (1t/ year)     | LR       | LR             | LR                | AR                        | HR                          |
| Rarely (1 time in 5 years)   | LR       | LR             | LR                | LR                        | AR                          |

Symbols: LR – low risk; AR – average risk; HR – high risk.

For a sample from the collection $F$ of terms $F_{ij}$, the following conditions are defined:

$$
F' = \begin{cases} 
1 & \text{if } P_{ij} \geq P^*; \\
0 & \text{if } P_{ij} < P^* 
\end{cases}
$$

(1)

where $P_{ij}$ – the risk of accidents caused by the $i$-th factor $F$ on the $j$-th workplace, $P^*$ – the average risk of the relevant event; $F'$ – the corrected factor $F$ taking into account a matrix of risk.

Thus, the number of hazards ($H$) is sampled, due to the presence of a certain factor (in this case, $HF$) in total and for each workplace:

$$
H_F = \sum_{j=1}^{N} \sum_{i=1}^{K} F'_{ij}
$$

(2)

Similarly, the relevant hazards $H_C$, $H_L$, $H_D$, $H_I$, $H_{RPE}$ are determined. Accordingly, the outcome of stage 2 is to determine whether there is a risk of a hazardous event at the workplace.

Step 3 is to determine the quantitative value of occupational risk.

With the help of the group method, the available statistical data on the estimated workplace are grouped according to the following: the causes (factors) that led to fatal accidents.

At this stage, the following information is very important: microtraumas (Kaverzneva, et al. 2010), statistics on the number and frequency of accidents (by industry), the results of investigations and the causes of accidents, traumatic factors, accounting for tool wear (Kaverzneva, et al. 2013), etc., which can be used to calculate correction factors. If the company records cases of microtraumas and incidents, they can be used as the initial information, or the main sources of statistical information can be used - the annual reports on casualties of accidents (and the causes of their occurrence), presented by official sources, which indicate the main factors of injuries to employees and the main causes of accidents.

The results of the correction are compiled to Table 3, where $F = \{0; 1\}$. 

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Table 3. Stratification of risk at workplaces by physical factor (F')

| Physical factors (F) | 1   | 2   | 3   | 4   | 5   | ... | N   |
|----------------------|-----|-----|-----|-----|-----|-----|-----|
| F'_{11} F'_{12} F'_{13} F'_{14} F'_{15} ... | F'_{1N} | ΣF'_{1j} |
| F'_{21} F'_{22} F'_{23} F'_{24} F'_{25} ... | F'_{2N} | ΣF'_{2j} |
| F'_{31} F'_{32} F'_{33} F'_{34} F'_{35} ... | F'_{3N} | ΣF'_{3j} |
| F'_{41} F'_{42} F'_{43} F'_{44} F'_{45} ... | F'_{4N} | ΣF'_{4j} |
| F'_{51} F'_{52} F'_{53} F'_{54} F'_{55} ... | F'_{5N} | ΣF'_{5j} |
| ... | ... | ... | ... | ... | ... | ... | ... |
| F'_{K1} F'_{K2} F'_{K3} F'_{K4} F'_{K5} ... | F'_{KN} | ΣF'_{Kj} |
| Total factors | ΣF'_{11} ΣF'_{12} ΣF'_{13} ΣF'_{14} ΣF'_{15} ... | ΣF'_{1N} | H_F |

The number of accidents resulting in a possible fatal outcome due to various factors is denoted as: AC_{Ph}, AC_{C}, AC_{L}, AC_{D}, AC_{I}, AC_{PPE}, and the corresponding quantitative risk value or risk index that characterizes the relevance of potential hazard to an employee, such as β_{Ph}, β_{C}, β_{L}, β_{D}, β_{I}, β_{PPE}. The significance index is calculated by the formula:

$$
β_{Ph} = \frac{AC_{Ph}}{AC_{Ph} + AC_{C} + AC_{L} + AC_{D} + AC_{I} + AC_{PPE}}
$$

Accordingly, the generalized risk index for the employee will be the product of the indices of detected hazards at his workplace.

$$
β = O_{Ph} \cdot β_{Ph} + O_{C} \cdot β_{C} + O_{L} \cdot β_{L} + O_{D} \cdot β_{D} + O_{I} \cdot β_{I} + O_{PPE} \cdot β_{PPE}
$$

Accounting for weighting factors allows to quantify the previously obtained qualitative data (about the probability of a hazardous event at the workplace). Results

The proposed logico-statistical model of occupational risk assessment is adaptive to changing evaluation criteria in accordance with the organization's policy and the database of the initial data. Logical-statistical model meets the following requirements:

- visibility of the ranking of jobs by the professions and structural units of the enterprise;
- simplicity in assessing the compliance of necessary laboratory measurements with the results of limit values on risk assessment scales;
- the possibility of carrying out inspections of compliance with the requirements of regulatory legal acts in the organization;
- identifying and prioritizing the selection of necessary labor protection measures.

Discussion

Verification: to check the effectiveness of the model, a checklist of questions for identification of risks at the workplace of the installer of metal-plastic windows was made. Verification: to check the effectiveness of the model, a checklist of questions for identification of risks at the workplace of the installer of metal-plastic windows was drawn up. The evaluation of the factors indicated in the questionnaire was carried out directly with the participation of the window installers on the binomial scale after some preliminary explanatory work. The results of the questionnaire after processing are presented in Table 4.
### Table 4.
Matrix of hazardous / harmful production factors in workplaces of the installer of metal-plastic windows

| Number of identified hazards / dangers due to the factor Ph at workplace | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---------------------------------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Answers by factor Ph | 1  | 0  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
| 2  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
| 3  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
| 4  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
| 5  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
| Total | 13 | 13 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |

| Number of identified hazards / dangers due to the factor C at workplace | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|------------------------------------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| C                                                               | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Total                                                             | 2  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |

| Number of identified hazards / dangers due to the factor L at workplace | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|------------------------------------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| L                                                               | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
| Total                                                             | 2  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |

| Number of identified hazards / dangers due to the factor D at workplace | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|------------------------------------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| D                                                               | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
| Total                                                             | 2  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |

| Number of identified hazards / dangers due to the factor I at workplace | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|------------------------------------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| I                                                               | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
| Total                                                             | 2  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |

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Then, using the risk matrix (Table 2), the initial values were adjusted taking into account the frequency and severity of the influence of the selected factors on the working conditions of the metal-plastic window installer (low risk, medium risk or high risk) and the values of single indicators of the type of risk of the estimated workplace were determined. The results of the correction are included in Table 5.

**Table 5.**
Matrix of hazardous / harmful manufacture factors in the workplace of the installer of metal-plastic windows by selected factors with the account of the risk matrix

| Number of identified hazards /dangers due to the factor PPE at workplace | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 6 | 7 | 8 | 6 | 7 | 8 | 8 | 6 | 8 | 7 | 8 | 7 | 7 | 8 | 2 | 2 | 1 | 2 |

| The number of identified risks of medium and high risk (by factor Ph) at workplace | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| The number of identified risks of medium and high risk (by factor C) at workplace | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| The number of identified risks of medium and high risk (by factor L) at workplace | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| The number of identified risks of medium and high risk (by factor D) at workplace | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| The number of identified risks of medium and high risk (by factor I) at workplace | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
Accordingly, the generalized risk index is:

\[ \beta = \sum_{i=1}^{K} \beta_i \]

As a result of the calculation, the amount of hazards \( (H) \) due to the presence of a certain factor is expressed as:

\[ H = \sum_{i=1}^{K} P_i = 131 \]

\[ H_c = \sum_{i=1}^{K} C_i = 22 \]

\[ H_p = \sum_{i=1}^{K} P_i' = 10 \]

\[ H_l = \sum_{i=1}^{K} L_i = 16 \]

\[ H_{p+} = \sum_{i=1}^{K} PPE_i = 22 \]

Having statistics of injuries at the enterprise or in the industry, we calculate the indices of significance for the worker (the installer of metal-plastic windows). In this case, they will take the following values:

\[ \beta_{ph} = \frac{AC_{ph}}{AC_{ph} + AC_C + AC_L + AC_D + AC_I + AC_{p+}} = 0.85 \]

\[ \beta_c = \frac{AC_C}{AC_{ph} + AC_C + AC_L + AC_D + AC_I + AC_{p+}} = 0.005 \]

\[ \beta_p = \frac{AC_D}{AC_{ph} + AC_C + AC_L + AC_D + AC_I + AC_{p+}} = 0.003 \]

\[ \beta_L = \frac{AC_L}{AC_{ph} + AC_C + AC_L + AC_D + AC_I + AC_{p+}} = 0 \]

\[ \beta_I = \frac{AC_I}{AC_{ph} + AC_C + AC_L + AC_D + AC_I + AC_{p+}} = 0.7 \]

\[ \beta_{p+} = \frac{AC_{p+}}{AC_{ph} + AC_C + AC_L + AC_D + AC_I + AC_{p+}} = 0.7 \]

Accordingly, the generalized risk index is:

\[ \Sigma \beta = 5.95 + 0.005 + 0.006 + 5.6 + 0.07 = 11.631 \]
Conclusion

The use of the logical-statistical model of professional risk assessment as a risk assessment procedure makes it possible to rank the calculated risks in terms of their importance for further management decisions depending on the level of risks, and to engage people directly involved in the work environment in assessing the occupational risk (through a questionnaire survey) allows you to talk about a sufficiently high verification of the results of the study.

In developing the proposed methodology, a system of indicators used to assess hazards at workplaces was substantiated. In addition, the coefficients for ranking of labor protection measures were obtained.

The proposed approach makes possible to take into account all the factors affecting the safety of workers, and allows integrally assess their impact on the degree of occupational risk, what allows to move to the system management of labor protection. The developed method allows a company to choose alternative strategies for improving working conditions based on the requirements of legislation and the allocated budget for labor protection.

The development of the proposed approach is the design of a software product allowing to accumulate data for the assessment of occupational risks and the decisions taken to reduce them and, on their basis, to make strategic planning in the management of labor protection at the enterprise. Further research is required to clarify the results and expand the possibilities of using the logical-statistical model to assess the risk of occupational diseases.

One of the directions for further research is the use of big data processing methods in the field of labor protection, which will fundamentally change the approaches to labor protection management and increase the level of workers' safety.

Acknowledgements

The research carried out with the financial support of the grant from the Program Competitiveness Enhancement of Peter the Great St. Petersburg Polytechnic University, Project 5-100-2020.

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