Strategy of labour safety management

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Abstract. There is suggested an analytical approach within the preventive measures development for improving labour conditions and safety in a manufacturing enterprise. There is developed a technique of the safe length of service assessment, based on the assessments of professional risk accumulation up to the threshold of acceptable values, which allows forming a management strategy of financing arrangements intended to improve the labour conditions and safety. There is also considered an example of the financing arrangements strategy choice intended to improve labour conditions and safety.

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Introduction

Analysis of labour conditions, presented today in the scientific literature, in particular, in ILO (International Labour Organization) publications [1], shows the need to develop an analytical approach to providing management solutions intended to improve labour conditions and safety.

Known economic approaches to OSH (Occupational Safety and Health) management developed, for example, in the framework of the ILO "Safe Work" [2, 3, 4, 5, 6, 7, 8], do not give a formalized description of the universal mechanisms regulating labour conditions and safety of the production environment. The TYTA model [9], as a tool to assess the cost of labour protection, requires continuous monitoring of expenditure spent on the production environment, as a kind of trial and error system.

The basis of the proposed approach [10] is the introduction of the occupational risk accumulation during the labour activity. The rate of risk accumulation (its annual increment) is a characteristic of labour conditions. Changes performed in labour conditions through targeted investments can be controlled by the generalized parameter (indicator) of risk increment.

Risk of occupational diseases (occupational hazards) determines the probability of health loss by a worker during his or her occupational activity. It depends on the intensity and duration of exposure of harmful and (or) hazardous environment factors, which allows suggesting the accumulation of professional risk during the labour activity.

Let us present the professional risk accumulation R with annual increment dR in a recurrent form:

$$R_i = R_{i-1} + dR_i \qquad \forall\, i \in [1,n] \;, \tag{1}$$

Where (R_{i-1}) is a professional risk of worker's disease occurrence caused by the production environment, for R_i the year i (i-1) of labour activity;

dR_i is an increment (annual increase) of occupational risk characterizing the labour conditions in the year i;

n is the length of service.

Indices of occupational diseases according to the labour condition classes, determined by the statistics of medical observations, can be interpreted, as a valid occupational risks for length of service under existing social values.

Accumulation period of professional risk in a particular production environment, which determines the harmful and hazardous factors impact on a worker, up to the acceptable risk value $R_{доп}$ will be considered by us as a safe length of service N:

$$R_{доп} = R_0 + \sum_{i=1}^{N} dR_i \tag{2}$$

where R_0 is a professional risk value at the initial time;

N is a safe length of service.

For example, under specified labour conditions, when it can be accepted

$$dR = \text{const} \;\; \forall\, i \in [1,n]$$

(production technology remains unchanged, the labour conditions state and the value of the main adverse production factor does not change), a safe length of service equals to:

$$N = N_0 + \frac{R_{доп.}}{dR}, \tag{3}$$

where $N_0 = \frac{R_0}{dR}$ – is a period of initial risk accumulation.

While improving labour conditions and safety, we a priori expect decline in the annual growth of professional risk dR:

$$d\tilde{R} = dR(1-\varepsilon), \qquad (4)$$

where $d\widetilde{R}$ is a value of the annual increment of professional risk since changes in labour conditions (characterizes the new improved and safe labour conditions);

$\varepsilon = 1 - \frac{d\widetilde{R}}{dR}$ is a coefficient characterizing the decrease in the rate of occupational disease accumulation risk due to improved conditions and labour safety.

If the improvement of labour conditions and safety took place at a time N_x, considering the expression (3), we shall obtain:

$$N = N_x + \frac{R_{\partial on.} - R_x}{dR(1-\varepsilon)} \qquad (5)$$

where $N_x = R_x$/dR is the length of service prior to the arrangements of the labour conditions and safety improvement, including the period of the initial risk accumulation;

$R_x = N_x$ dR is the risk accumulated during the length of service prior to the arrangement of labour conditions and safety improvement.

In the general case, when there is j arrangements of changes in labour conditions, a safe length of service N can be determined by the following expression:

$$N = N_x + \sum_j N_j, \qquad (6)$$

where $N_j = {(R_{\partial on.} - R_j)}\big/{dR(1-\varepsilon_j)}$ is the professional activity length of service since the j-th arrangement of the labour conditions and safety improving;

$R_j = R_{j-1} + dR(1-\varepsilon_j)$ is an accumulated risk at the moment of the j-th arrangement of the labour conditions and safety changing;

$\varepsilon_j = 1 - dR_j / dR$ is a relative coefficient characterizing the decline in the annual increment of professional risk in the j-th arrangement of the labour conditions and safety changing.

The labour conditions improvement requires investments. Depending on the scope and effectiveness of their use, there can be managed the rate of professional risk accumulation, by reducing the value of the annual increment of professional risk dR_i in accordance with the equation (4).

Let Z_j be the costs at the j-th arrangement of labour conditions and safety improvement;

Z_{max} is the costs on the labour conditions and safety improvement, at which we conditionally believe the increment of professional risk to be equal to zero.

In this case, taking a direct dependence of labour conditions and safety from the costs, we shall obtain:

$$\varepsilon_j = \sum_{m=1}^{M} k_m z_{jm} / z_{\max}, \qquad (7)$$

where m is the serial number of the arrangement on the labour conditions and safety improvement;

Z_{jm} is the costs of the m-th arrangement carrying out during the j-th arrangement on the labour conditions and safety improvement;

k_m is the weighting coefficient, characterizing the efficiency of the m-th arrangement execution on the labour conditions and safety improvement, provided that $\sum_{m=1}^{M} k_m = 1$.

Example of calculation

Labour conditions and safety improvement is realized by the employer in accordance with the proposed list of annual arrangements.

Setting the values of weighting coefficients (determined by expert assessments) and the empirical distribution of funds allocated for each of the planned activities on the example of a conditional enterprise (the class of labour conditions 3.1), we choose two financing strategies: Strategy 1 is the financing activities related to automation and mechanization of workplaces, Strategy 2 is the funding a wide range of planned activities, determined, for example, by a typical list [11].

Table 1. Values of weighting coefficients and distribution of funds allocated for the labour conditions and safety improvement

No.: $\{m\}$	Weighting coefficient k	Weighting coefficient value	Costs for Z arrangement	Allocated funds, (Strategy 1)	Allocated funds, (Strategy 2)
1	k_1	0.045	Z_1	50000	13500
2	k_2	0.045	Z_2	60000	13500
3	k_3	0.057	Z_3	50000	17100
4	k_4	0.032	Z_4	0	9600
5	k_5	0.035	Z_5	30000	10500
6	k_6	0.033	Z_6	30000	9900
7	k_7	0.028	Z_7	0	8400
8	k_8	0.031	Z_8	0	9300
9	k_9	0.033	Z_9	0	9900
10	k_{10}	0.029	Z_{10}	0	8700
11	k_{11}	0.0	Z_{11}	0	0
12	k_{12}	0.027	Z_{12}	40000	8100
13	k_{13}	0.027	Z_{13}	40000	8100
14	k_{14}	0.055	Z_{14}	0	16500
15	k_{15}	0.032	Z_{15}	0	9600
16	k_{16}	0.035	Z_{16}	0	10500
17	k_{17}	0.030	Z_{17}	0	9000
18	k_{18}	0.025	Z_{18}	0	7500
19	k_{19}	0.033	Z_{19}	0	9900
20	k_{20}	0.032	Z_{20}	0	9600
21	k_{21}	0.032	Z_{21}	0	9600
22	k_{22}	0.033	Z_{22}	0	9900
23	k_{23}	0.028	Z_{23}	0	8400
24	k_{24}	0.030	Z_{24}	0	9000
25	k_{25}	0.030	Z_{25}	0	9000
26	k_{26}	0.028	Z_{26}	0	8400
27	k_{27}	0.032	Z_{27}	0	9600
28	k_{28}	0.031	Z_{28}	0	9300
29	k_{29}	0.026	Z_{29}	0	7800
30	k_{30}	0.034	Z_{30}	0	10200
31	k_{31}	0.032	Z_{31}	0	9600

Using the equations (2), (4), and (7) and supposing that dR=0.003, N_0=10, you can build professional risk accumulation curves shown in the Figure 1.

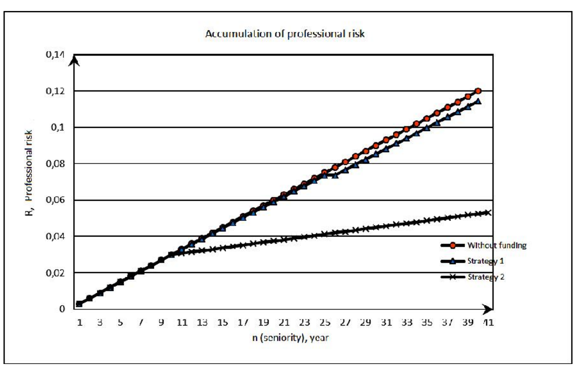

Figure 1. Professional risk accumulation

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