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ALGORITHM FOR ASSESSING THE MODEL OF THE LABOR SAFETY MANAGEMENT IN CIVIL AVIATION OF THE REPUBLIC OF KAZAKHSTAN

Purpose. Development of an algorithm for assessing the occupational safety management model in civil aviation of the Republic of Kazakhstan using the stakeholder approach, the application of which in the context of social justice, will ensure the flexibility of the model, attract investment in improving working conditions and obtain the expected effect of tripartism.

Methodology. This study was conducted using trends and multivariate analyses. The methods of content and correlation-regression analysis were used to construct a mathematical model of the closeness of the relationship between the injury rate and material costs of industry enterprises for the payment of compensation and provision of guarantees to civil aviation personnel for work in harmful and hazardous working conditions. The adequacy of the model was confirmed by using the determination coefficient. The results were validated using Fisher's statistical tests. The methods of situational forecasting and modeling were used to determine possible scenarios for the development of the studied system of factors and the performance indicator with a forecast horizon for 2030. Decoupling analysis was used to assess the balance of interests of priority stakeholder groups and to construct an algorithm for assessing the labor safety management model in civil aviation.

Findings. The mechanisms of providing guarantees, insurance, and special social payments to aviation personnel engaged in work under harmful and hazardous working conditions are considered. It has been proven that the national and industry models of labor safety management are not sufficiently effective. The need to revise the approach to the formation of the labor safety management model in civil aviation in the context of active development of social partnership is substantiated.

Originality. For the first time, a substantiated approach to assessing the effectiveness of the management of the labor safety system in civil aviation in Kazakhstan has been proposed, taking into account modern guarantees for employees of the relevant enterprises.

Practical value. The practical application of the proposed algorithm for assessing the occupational safety management model in civil aviation in Kazakhstan will provide an opportunity to determine the effect of tripartism and, accordingly, make the right decisions on occupational safety management.

Keywords: *harmful working conditions, occupational safety, labor protection, injuries, occupational diseases*

Introduction. Over the past decade, Kazakhstan has done a lot of work to transition to a market model of occupational safety management and has introduced a risk–oriented approach to the practice of enterprises. International standards on labor safety were ratified, labor and social legislation were amended, control was tightened, and so on. However, it was not possible to achieve the desired result in terms of significant improvements in the working conditions. The primary reasons were scanty statistics on labor safety indicators for certain types of economic activity; uninformative monitoring of harmful working conditions, which does not ensure the accumulation of the necessary information for analysis and establishment of cause and effect relationships of injuries and occupational diseases; and lack of a clear algorithm for assessing the labor safety management model, both in the context of certain types of economic activity and in the country as a whole [1]. To find ways out of the current situation, studies were conducted on the state of labor safety of employees of the Republic of Kazakhstan, as well as civil aviation personnel, as one of the most actively developing industries in Kazakhstan.

The object of the study was the model of labor safety management in civil aviation in the Republic of Kazakhstan, which is explained by the persistence of harmful working conditions in the industry and the rapid growth in demand for international cargo and passenger air transportation.

According to the Committee of Civil Aviation of the RK in 2023 domestic airlines carried 13.3 million passengers, which is 21 % more than the previous year. The volume of passengers served at Kazakhstan's airports increased by 24 %, i.e. rose to 26.1 million, and especially at Almaty and Astana airports, which registered record service of 9.6 million (+31 %) and 7.5 million passengers (+27 %), respectively, in 2022. The volume of cargo handled at airports also increased by 15 % in 2022, thereby reaching the level of 145 thousand tons [2].

The airplane fleet has also grown. In 2023, Kazakhstan's airlines purchased 11 aircraft. As a result, the capacity of the fleet increased by 28 %, i.e. up to 15.4 thousand seats [1]. The number of personnel has increased accordingly. As of 01.01.2023, the number of employees of civil aviation amounted to more than 8.5 thousand people. Only during 2022, more than 800 additional workplaces were created in the civil aviation of Kazakhstan. But, unfortunately, with the growth of the number of aviation personnel, the quantity of workers employed in harmful and hazardous working conditions has also increased. However, this situation is observed not only in civil aviation of Kazakhstan, but also in aviation of many countries of the world. According to International Airport review, a survey of aviation workers conducted by experts of the International Civil Aviation Organization (ICAO) in 2022, covering 120 countries of the world, showed that working conditions have deteriorated for more than 1/3 of aviation employees in recent years. Three-quarters of respondents to the survey, organized by the International Transport Workers' Federation (ITF), also reported that the safety of working conditions in aviation is on a negative trend as cargo and passenger traffic grows.

Considering the complexity of the situation and the urgent need to take action to improve the working conditions of aviation workers, the ITF formally submitted a plan to the ICAO Assembly for a "New Direction for Aviation" [3], endorsed by over 250 union organizations representing over one million civil aviation workers

Stiven Cotton, the General Secretary of the ITF, in presenting the plan for a "New Direction for Aviation" [3], highlighted the need for aviation to have a new agreement that would emphasize workplace safety in the industry, otherwise the current crises of tension and unhealthy working conditions would simply become the norm [4].

However, the adoption of a new agreement is not an easy task and it is possible to solve it only by having a clear understanding of the portfolio of the sectoral model of occupational safety management and its assessment in terms of balancing the interests of stakeholder groups interested in minimizing harmful and hazardous working conditions in civil aviation. However, unfortunately, there is still no clear algorithm for its implementation, which significantly complicates decision-making and measures to improve the level of labor safety. Researchers' proposals regarding its construction are predominantly of a fragmentary nature, which indicates the need for further investigations on this topic.

Literature review. The results of the examination of literature sources give grounds to assert that in recent years one of the most urgent problems in civil aviation is the creation of safe and healthy working conditions, as it is not only a moral and legal obligation of the Government and employers, but also one of the ways to achieve the Sustainable Development Goals. In particular, Manahilova Dorina [5] emphasizes that the monitoring and control of working conditions of civil aviation personnel should be mandatory and systematic, because only in this way it is possible to create a full-fledged information support necessary to evaluate the model of occupational safety management and make justified decisions [5].

Qi Wang, Chong Wu, and Yang Sun also focus their attention on the significance of creating a full-fledged information support system [6]. The authors note that due to limited sources, information on harmful and hazardous working conditions in aviation is generally inaccurate, subjective or even contradictory, and the evaluation system of the safety management model is a classic gray system, which can only be overcome by applying the analysis of gray relations capable of handling both incomplete and inaccurate information, especially in situations where the sampling distribution model is unknown [6].

Muhafiza Musa, Ahmad Shahrul Nizam Isha [7] emphasize that with the widespread implementation of innovations in airports and increasing traffic volumes, the complexity of air transport ground handling is increasing significantly. Consequently, it is difficult to maintain and improve the safety of ground operations in this dynamic environment, and tracking this activity requires careful consideration of the results of monitoring and evaluating the model of workplace safety management for aviation personnel. Using a case study of airports in Malaysia, the researchers demonstrated the overall assessment of the indicators of safety culture in the field of ground handling and their impact on the effectiveness of the model of workplace safety management in civil aviation. To accomplish the stated objective, the researchers utilized the approach of mixed methods in order to determine the elements of safety culture dimension based on the constructs and empirical results obtained in the research process [7].

Sarah Gharib, Bernard Martin, Richard L. Neitzel [8] take a broader approach to building an algorithm for evaluating a model of workplace safety management, proposing to determine its effectiveness not only by culture, but also by workplace safety climate, using mixed methods of mathematical analysis. The authors conducted a pilot investigation on the example of one of the international airlines in the Middle East to assess the workplace safety of the aircraft ground handling personnel [8].

There is no doubt that each of the researchers' proposals has a rational basis; however, as Stevenson I. and Marintseva K. note, [9], a common problem for all airlines and airports is still the lack of a clear algorithm for evaluating the model of occupational safety management and corporate social responsibility (CSR). In management theory, most attention has been paid to the system of indicators, evaluation criteria and ways of collecting data from enterprises [9]. But, building an estimation algorithm, as researchers and experts recognize, is only in the early stages of development (Giannarakis, 2016 [10], Koep, 2017 [11], Güreş, et al., 2017 [12], Bhinekawati, 2017 [13]) and requires further more in-depth research.

Purpose of the article. The aim of the study is to develop a stakeholder-approach of the algorithm for assessing the model of labor safety management in civil aviation of the Republic of Kazakhstan, the application of which in the conditions of social justice will ensure the flexibility of the model, attract investment in improving working conditions and obtain the expected effect of tripartism.

The following tasks were formulated to achieve this goal:

- to study the national labor safety management model in the Republic of Kazakhstan;
- to study the industry model of labor safety management, in particular, the civil aviation of the Republic of Kazakhstan, as one of the most actively developing industries;
- to developed an algorithm to assess the effectiveness of an occupational safety management model in civil aviation using the stakeholder approach.

Materials and methods. The materials for conducting this investigation were: data of the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan; regulatory and legal documents of international (in particular, regulations of ICAO, ITF, etc.) and national level (in particular, legislative and regulatory and legal acts of the Republic of Kazakhstan in the field of civil aviation).

This work provides a retrospective analysis of the working conditions of civil aviation personnel in Kazakhstan. The research was carried out using trend and multivariate analysis. In particular, the methods of content and correlation-regression analysis were used in the construction of a mathematical model of the closeness of the connection between the level of injury rate and material costs of the enterprises of the industry on payment of compensations and provision of guarantees to the personnel working in harmful and hazardous work environment. The adequacy of the developed model was confirmed by the coefficient of determination. Validation of the results was carried out using Fisher's statistical tests. By methods of situational forecasting "What-If Analysis" and target modeling "What Is Needed For", possible scenarios of development of the studied system of factors and performance indicator with a forecasting horizon for 2030 were determined. Decupling analysis and coding method are used to assess the balance of interests of priority groups of stakeholders, and applied in the construction of an algorithm for evaluating the model of occupational safety management in civil aviation.

Results. The development of an algorithm for assessing the model of labor safety management in the civil aviation of the Republic of Kazakhstan provides for the implementation of successive stages. Thus, the first stage is a retrospective analysis of the labor safety management model in the Republic of Kazakhstan.

The Republic of Kazakhstan, as a state with sustainable economic activity, protects the legitimate interests and rights of every worker to decent work and protects and provides social guarantees. This is confirmed by the adoption of a number of strategic documents within the framework of the Economic Course "Fair Development of Kazakhstan", as well as the Concept of Safe Labor in the Republic of Kazakhstan for 2024–2030 [14].

The Government of Kazakhstan is concerned about the situation that has developed in recent years in the field of labor protection (Table 1); therefore, in the concept [14], safe labor is proclaimed as a priority vector of the Fair Development of the country.

In 2023, almost every second worker (46.8 %) worked in conditions of increased noise and vibration levels, every third worker (33.2 %) worked in conditions of increased dust and gas pollution in the work area exceeding the MAC and every sixth worker (16.7 %) worked in unfavorable temperature conditions [16]. At the same time, the number of people injured in industrial accidents related to work activities in the reporting year increased by 15 % compared with the previous year, amounting to 2,098 people [17].

The main causes of accidents and occupational diseases related to work in recent years have consistently remained: poor organization of work, violation of safety and labor protection rules, gross negligence of the victim, etc. The number of victims of gross negligence was almost 1/3 of the total number of accidents. This indicator tends to decrease over the period under study, but the fact that, in most cases, the worker is the culprit of the injury indicates an insufficient level of training of workers in the field of labor protection, a low level of industrial relations culture, and the inability to make the best decision in conditions of time shortage and psychophysiological overload.

The increase in the number of workers injured as a result of injuries or occupational diseases is certainly accompanied by material consequences for both the state and employers, since according to the Labor Code of the Republic of Kazakhstan (LC RK) and the Social Code of the Republic of Kazakhstan (SC RK) [18], the state provides social assistance to persons injured [19–22] and compensation for damage to the health of the worker. As a result, the material consequences of accidents and occupational diseases in 2023 amounted to 3,406.8 million tenge, which is almost three times higher than the figure for 2008 [15]. The fundamental basis for such a stable increase in material consequences should be recognized as the existence of a national model of labor safety management in the Republic of Kazakhstan for many years, built on a compensatory approach.

Of course, this approach has a rational kernel from the point of view of social protection of citizens of Kazakhstan, but it does not stimulate employers to invest capital in improving working conditions, i.e. the "cart of harmful working conditions" remains practically in the same place as several years ago, which gives grounds to recognize the model of labor safety management in the Republic of Kazakhstan as ineffective, and the measures taken are not accompanied by the expected effect of tripartism (from Latin Tripartitus) – a triune effect for all parties to social partnership, in particular for: employees – improving working conditions and preserving health; employers – economic interest in creating safe workplaces, increasing labor productivity and reducing economic costs; the state – creating safe labor worthy of the citizens of Kazakhstan [14].

The second stage is the diagnosis of the occupational safety management model in the civil aviation of the Republic of Kazakhstan. According to experts, civil aviation of the Republic of Kazakhstan is one of the most stable and rapidly growing industries in terms of the number of employees in the region (Table 2), which is precisely what makes it attractive for conducting studies of labor safety management models.

Based on the data in Table 2, the number of civil aviation personnel in the Republic of Kazakhstan in 2023 has almost doubled compared to 2008, while the number of workers exposed to increased levels of noise and vibration has increased almost threefold, which, first of all, should be considered as a result of the growth in the volume of passenger and cargo transportation (Table 3).

Consequently, while in 2008 the number of employees who were entitled to at least one type of compensation hardly exceeded two thousand people, in 2023 their number increased by 1.5 times and amounted to 3,487 people. The number of personnel who were granted additional leave for work in harmful conditions changed with similar progress. However, the number of personnel who received additional payments for work in hazardous working conditions during 2008–2023 changed with the opposite trend, namely decreased by almost 50 % (which is difficult to explain due to the lack of full-fledged information support on labor protection management in civil aviation). But even under such conditions, the expenses on payment of additional payments for work in harmful working conditions during the analyzed period have significantly increased, as evidenced by the data.

The increase in additional payments for work in hazardous working conditions resulted from the growth of the subsistence minimum. As is known, according to the Labor Code of the RK and the Social Code of the KR, professional payment at the expense of the employer is made in the amount of 1 minimum subsistence level. And since the amount of the subsistence minimum was repeatedly revised during 2008–2023 the sum of payments per employee working in harmful labor conditions increased accordingly. The hours of work in hazardous working conditions and the level of remuneration have also

Table 1

The number of RK employees engaged in harmful and hazardous working conditions during 2018–2023, persons [15]

Indicators	2018	2019	2020	2021	2022	2023
Number of employees, total	1,671,572	1,683,146	1,645,247	1,641,593	1,671,149	1,668,937
including those employed in conditions that do not meet sanitary and hygienic requirements, of which:	373,142	370,277	366,898	374,987	386,349	389,546
working under the influence of increased noise and vibration levels	169,332	170,034	169,802	169,438	180,975	18,1213
increased dust and gas content in the working area exceeding the maximum permissible concentration limit	128,311	120,825	119,666	120,556	128,135	129,342
unfavorable temperature conditions	65,871	62,799	62,202	61,660	64,571	65,117
those engaged in heavy physical labor	85,274	93,972	94,319	93,647	102,668	10,564
working on equipment that does not meet safety requirements	2,855	3,561	3,556	4,168	2,121	2,098
Number of victims of accidents related to work activities, total, persons	2,160	2,111	2,033	2,133	2,449	2,673
including fatalities	215	190	203	176	205	116
Number of victims of occupational diseases, total	254	251	237	351	657	671
Material consequences of accidents per victim, million tenge	709.6	819.6	969.9	1,236.2	1,676.9	3,046.8

Table 2

Number of air transport employees engaged in harmful and hazardous working conditions during 2008–2023, persons [15, 24–26]

Years	Average number of employees							Number of employees who are entitled to at least one type of compensation				Material consequences per victim million tenge
	Total	Including those employed in harmful and hazardous labor conditions						Total	of them			
		including workers	of which those employed on night shift	Those employed in conditions that do not meet sanitary and hygienic requirements (norms)	Among them working under the impact of				additional holidays	milk and equivalent food products	additional payments for harmful and other unfavorable working conditions	
					increased noise and vibration levels	increased dustiness and gas contamination of the air in the working area	unfavorable temperature conditions					
2008	4,939	1,041	–	2,115	665	175	245	2,111	1,934	234	423	470.6
2009	4,912	890	–	1,795	333	124	157	1,767	1,597	209	309	412.6
2010	5,116	999	–	1,614	772	156	115	751	544	286	371	413.7
2011	5,701	2,575	–	2,052	1,899	98	188	2,289	1,838	477	323	449.0
2012	5,796	3,198	98	1,809	1,744	106	36	2,233	2,077	393	219	522.4
2013	6,203	3,479	1,492	710	681	8	10	2,596	2,454	396	224	579.4
2014	6,733	3,570	1,633	590	673	8	4	2,633	2,444	397	276	718.9
2015	6,756	3,399	2,052	712	723	31	74	2,756	2,593	139	270	592.7
2016	7,054	3,011	3,043	1,355	871	38	–	2,965	2,741	–	–	587.6
2017	7,138	3,393	3,745	1,476	989	47	95	3,148	2,975	–	–	735.2
2018	7,385	3,081	3,373	2,451	1,379	59	–	3,040	3,040	–	–	709.6
2019	8,011	3,657	3,945	3,835	2,871	51	70	3,791	3,596	110	496	819.6
2020	7,480	2,909	4,646	2,144	2,080	31	98	3,461	3,256	93	425	969.9
2021	7,748	2,634	4,285	2,169	2,136	34	98	3,207	3,008	84	288	1,236.2
2022	8,557	3,371	4,723	3,454	1,978	33	93	3,589	3,402	87	231	1,676.9
2023	9,231	3,459	4,811	3,567	2,012	34	97	3,487	3,445	89	256	3,046.8

Table 3

Dynamics of civil aviation performance indicators in Kazakhstan during 2008–2023 [15, 24–26]

Years	Income, mln. tenge			Passenger transportation, thousand people	Passenger turnover, mln pkm	Transported cargo, baggage, freight and luggage, thousand tons	Cargo turnover, mln tkm
	Total	Including					
		baggage	passengers				
2008	85,219.7	3,611.6	81,608.1	2,838.8	5,549.5	23.7	69.5
2009	85,812.1	3,586.0	82,226.1	2,758.7	5,313.3	21.3	68.0
2010	104,953.3	4,871.3	100,082.0	3,401.18	6,517.2	29.2	94.0
2011	128,803.7	5,228.6	123,575.1	4,111.48	7,859.1	29.4	89.1
2012	136,860.2	3,964.8	132,895.4	4,558.72	8,795.8	19.6	54.9
2013	153,265.8	5,125.2	148,140.6	4,992.97	9,704.6	24.0	63.2
2014	179,372.8	5,008.0	174,364.8	5,447.71	10,588.9	19.6	49.2
2015	179,556.6	4,420.1	175,136.5	5,924.9	11,138.6	17.0	42.44
2016	233,590.9	5,214.9	228,376.0	6,006.12	11,073.0	18.1	42.99
2017	295,584.6	6,294.7	289,289.9	7,352.17	14,384.2	22.4	53.33
2018	343,284.3	7,287.0	335,997.3	7,858.53	16,176.7	29.1	55.67
2019	403,018.2	8,776.2	394,242.0	8,614.79	16,940.3	25.1	54.2
2020	187,696.3	11,623.0	176,073.3	5,489.71	8,335.0	24.2	56.2
2021	366,308.9	17,036.4	349,272.5	9,434.05	14,815.7	34.0	81.68
2022	602,049.6	13,055.7	588,993.9	10,993.6	20,109.3	24.5	54.44
2023	674,316.6	15,107.7	659,208.9	11,478.9	27,112.4	34.9	84.61

changed. And since additional payments for work in hazardous conditions are set as a percentage of basic salary, the number of additional payments has increased accordingly.

Thus, we conclude that there is a certain relationship between the indicators of working conditions and the costs of air enterprises to provide guarantees provided by the Labor Code of the Republic of Kazakhstan [19], the level of closeness of which it is advisable to establish using the main indicators of labor protection, namely, the indicators of occupational diseases and the industrial injuries.

However, we note that occupational diseases develop over many years, and more often decades, and essentially characterize previous working conditions. The level of industrial injuries depends on the current state of working conditions, the organization of the labor process and the specific nature of work (hazardous, heavy, nerve-racking, shift work schedule). It reacts quickly to changes related to the introduction of new safe technologies and equipment, improvement of production culture, etc. In other words, it is a more sensitive indicator of the state of labor conditions and safety.

In view of this, in order to build an economic and mathematical model of the closeness of the relationship between labor protection indicators X_i (factor attributes) (Table 5) with the costs of air enterprises Y on payment of compensations to personnel in connection with work in harmful conditions (resultant attribute), we will form a statistical base for modeling the cause-and-effect relationship between factor X_i, $i = 1, ..., 5$ (injury frequency rate (*TIFR*), fatal injury frequency rate (*FIFR*), injury severity rate (*LTISR*), the number of cases of loss of working time (*LTI*), as well as the number of injuries per worked hour of working time (*LTIFR*) and the resultant attribute Y (Table 5).

Let us calculate and build a mathematical model using methods of correlation and regression analysis with the approach of building a linear regression model with two or more independent factors.

As a result of the calculations, a mathematical model of the closeness of the relationship between the material costs of civil aviation for the payment of compensation to personnel (injured as a result of accidents at work) and the level of working conditions was built

$$MC = 1{,}379.001 + 9.672 \cdot TIFR + 6.403 \cdot FIFR + \\ + 10.014 \cdot LTISR + 0.159 \cdot LTI - 53.472 \cdot LTIFR, \quad (1)$$

where *MC* is material consequences material consequences for the year, thousand tenge; *TIFR* – Total injury frequency rate; *FIFR* – Fatal injury frequency rate; *LTISR* – Lost Time Injury Severity rate; *LTIFR* – Lost time injury frequency rate; *LTI* – the number of victims of industrial accidents, people.

Analysis of the obtained results showed that the square of the calculated correlation coefficient corresponds to $R^2 = 0.941$, which indicates the presence of a reliable correlation relationship.

Guided by the methods of situational forecasting *"What-If Analysis"* and target modeling *"What Is Needed For",* possible scenarios of development of the investigated system of factors and performance indicator with a forecasting horizon for 2030 were determined.

In particular, a schematic representation of the impact of the total injury frequency rate (*TIFR*) and the lost time injury severity rate (*LTISR*) on the material costs of civil aviation to pay compensation and provide guarantees to workers employed in harmful and hazardous working conditions under the "baseline scenario" is shown in Fig. 1.

However, according to Alikhan Smailov, Prime Minister of Kazakhstan, in the near future a number of additional measures will be taken to improve labor conditions by: tightening of control by the state; increasing the responsibility of employers for working conditions; obliging companies with harmful working conditions to annually finance modernization and technical re-equipment at the level of not less than 1 % of total annual income [28].

Undoubtedly, the above measures deserve attention; however, we consider the proposal to annually finance modernization and technical upgrading at the level of at least 1 % of total annual income to be rather controversial. If we talk, in particular, about such airports as Astana, Almaty and Shymkent,

Table 5

Indicators of labor safety of civil aviation personnel of RK during 2008–2023 [15, 24–27]

Years	Number of affected persons		Total Injury Frequency rate (*TIFR*)	Fatal injury frequency rate (*FIFR*)	Loss of working time, days		Severity rate (*LTISR*)	Total injury frequency rate	Lost time injury frequency rate *LTIFR*
	Total (*LTI*)	Including fatal cases			Total	including accidents			
2008	333	13	67.4225	2.632112	5,749	5,749	17.2642	3.9053	38.5403
2009	306	19	62.2964	3.868078	4,142	4,123	13.4738	4.6235	35.6101
2010	266	25	51.9937	4.88663	7,150	7,150	26.8797	1.9343	33.2645
2011	286	25	50.1666	4.385196	6,184	6,184	21.6223	2.3201	28.6764
2012	277	18	47.7915	3.10559	6,683	6,683	24.1263	1.9808	27.3188
2013	275	31	44.3333	4.997582	5,110	5,110	18.5818	2.3858	25.3420
2014	274	12	40.6951	1.782266	5,757	5,757	21.0109	1.9368	23.2623
2015	281	21	41.5927	3.108348	5,164	5,164	18.3772	2.2632	23.7753
2016	287	16	40.6861	2.268217	5,618	5,618	19.5749	2.0784	23.2571
2017	303	20	42.4489	2.801905	5,535	1,479	18.2673	2.3242	24.2648
2018	318	22	43.0603	2.979012	5,948	5,453	17.1478	2.5111	24.614
2019	312	17	38.9465	2.122082	6,788	6,386	20.4679	1.9028	22.2627
2020	455	17	60.8289	2.272727	4,756	4,360	9.58241	6.3479	25.5621
2021	472	17	60.9189	2.194115	5,853	5,731	12.1419	5.0172	18.2635
2022	127	8	14.8417	0.934907	4,933	4,843	38.1338	0.3891	8.48385
2023	141	4	24.6731	1.873468	5,346	5,173	14.5618	2.3515	16.3491

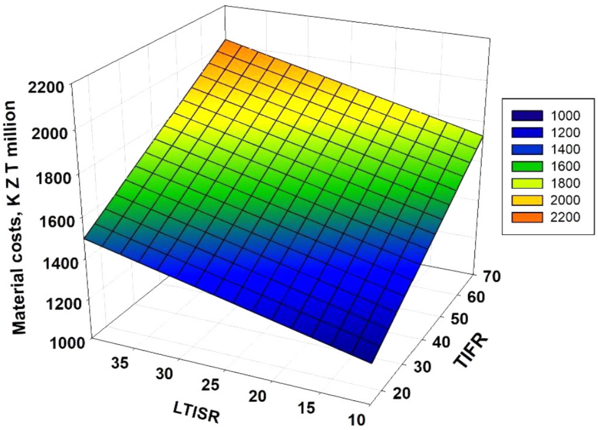


Fig. 1. Effect of total injury frequency rate (TIFR) and lost time injury severity rate (LTISR) on the material costs of civil aviation for payment of compensation and provision of guarantees to workers employed in harmful and hazardous labor conditions under the "baseline" scenario for the period up to 2030

then undoubtedly 1 % of the total annual income is quite a significant amount, but insufficient for the full modernization of working conditions in civil aviation. At the same time, if we talk about other air enterprises of the RK, it should be recalled that most of them are partially subsidized by the state in order to cover the costs of budget flights. Therefore, their investment of capital in improving labor conditions is unlikely. In addition, the material costs of civil aviation to pay compensation and provide guarantees to employees working in harmful and hazardous working conditions are much lower than the need for investments required to improve working conditions, which discourages employers from taking measures to reduce the number of workplaces that have a negative impact on the health of personnel.

Under the current situation, the solution to the issue of improving working conditions in civil aviation of the RK is possible only with the creation of a favorable climate for attracting investments (in particular, ESG-investments), as well as the development of mixed financing. If such a scenario is created, i.e. under the "optimistic" scenario of the development of events, it is envisaged to reduce the total injury frequency rate (*TIFR*) by 50 % in relation to its value in 2022 and the lost time injury severity rate (*LTISR*) will be reduced by 70 %. These changes will lead to a reduction in the material costs of airlines for the payment of compensation and provision of guarantees to employees working in harmful and hazardous working conditions to 1,137.868 million tenges (2030) (Fig. 2, *a*).

Under the "pessimistic" scenario, the total injury frequency rate (*TIFR*) is projected to decrease by 30 % from its value in 2022 and the lost time injury severity rate (*LTISR*) – by 40 %. The specified changes will lead to a reduction in the material costs of airlines for the payment of compensation and the provision of guarantees to employees working in harmful and hazardous working conditions to 1,281.137 million tenges (2030) (Fig. 2, *b*).

For both scenarios, only the values of the two factors were changed: the injury frequency rate (*TIFR*) and injury severity rate (*LTISR*). The remaining factors were fixed at values corresponding to 2023 (Table 5). Thus, the previously obtained polynomial of the mathematical model acquired the following form

$$MC = 951.532 + 9.672 \cdot TIFR + 10.014 \cdot LTISR. \quad (2)$$

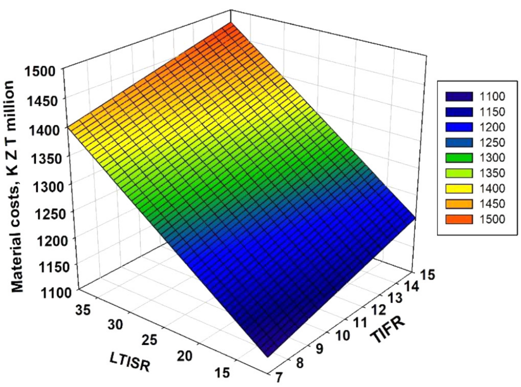
Analyzing Figs. 2, *a* and *b*, we conclude that there is a high level of close correlation between the indicators of the consequences of accidents, as well as material costs of paying the compensation and providing guarantees to employees working in harmful and hazardous working conditions. Therefore, only by investing capital in the creation of a safe working environment and safety culture, it is possible to achieve the result of reducing the number of jobs that have a negative impact on the health of civil aviation personnel in Kazakhstan and, accordingly, reducing the material consequences of accidents and work-related diseases.

The fundamental basis for making decisions on capital investment should certainly be an assessment of the effectiveness of the occupational safety management model, which is the third stage in developing an algorithm for assessing the occupational safety management model in civil aviation in Kazakhstan in the context of developing social partnerships.

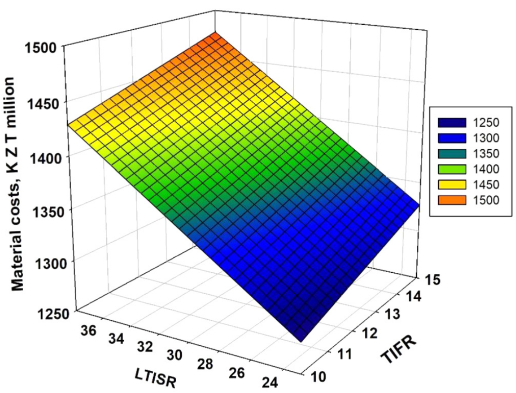
The importance of developing an algorithm for assessing the civil aviation safety management model is determined not only by the lack of a clear stage set for its construction, but also by the intention of the European Commission (DG MOVE) to use the results of the assessment of models for labor safety management in civil aviation of particular countries to assist in the development and implementation of ways to address the "human and social dimension" within the digital unified European sky.

Many researchers, when constructing an algorithm for evaluating the model of labor safety management, give preference to a significant number of stages. However, we are convinced that it is more appropriate to carry it out in three stages:

- identification and normalization of private occupational safety indicators to define social partnership indicators (social



a



b

Fig. 2. Influence of the Total Injury Frequency Rate (TIFR) and the Lost Time Injury Severity Rate (LTISR) on the material costs of civil aviation for payment of compensation and provision of guarantees to workers employed in harmful and hazardous working conditions under "optimistic" and "pessimistic" development scenarios for the period up to 2030:

a – an optimistic scenario; b – a pessimistic scenario policy (I_{SP}), industrial safety climate (I_{SC}) and industrial performance safety culture (I_{PSC})), as well as their mapping to contextual risks affecting work stress and health of aviation personnel;

- conducting case studies depending on the set tasks, building a portfolio of the model of labor safety management and determining its compliance with the interests of priority stakeholder groups by the effect of tripartism;

- developing possible scenarios for occupational safety in civil aviation.

At the same time, the construction of the algorithm is more reasonable according to the stakeholder approach, because in the conditions of social partnership development, the effectiveness of the model of personnel labor safety management should be determined by the level of balance of interests of priority groups of stakeholders interested in changing the current situation with harmful and hazardous working conditions in civil aviation, i. e. by the effect of tripartism (social cooperation of the state, employers and personnel), the achievement of which, as noted in the Concept [16], is one of the most important tasks of the Republic of Kazakhstan, moving towards Equitable Development.

Determining the effect of tripartism can be done through various techniques and approaches proposed by researchers, in particular through: analysis of social agreements, surveys and interviews, analysis of legislation, analysis of cooperation results, etc. Each of these methodologies can be used alone or in combination with other techniques to obtain a more accurate result.

However, according to the results of our research, we prefer to define the effect of tripartism by the triple indicator of balancing the interests of priority stakeholder groups based on the decoupling study, which allows us to determine whether the economic growth of the industry occurs in parallel with the growth of indicators of negative impact on personnel health or whether it is achieved with practically stable or decreasing indicators of accidents, injuries, and occupational diseases.

It should be noted that the founders of decoupling are considered to be P. Tapio (Tapio, 2005), D. Meadows (2008), T. Jackson (2009), M. Fischer-Kowalski (2011), E. U. von Weizsäcker (E. U. von Weizsäcker, J. de Larderel, K. Hargroves, C. Hudson, M. Smith, M. Rodrigues, 2014) and K. I. Zeng and V. M. Wong (Zeng, Wong, 2014). Decoupling has become widespread in various countries of the world, in the program documents of the OECD, UN, UNEP, etc. However, in most cases it has been predominantly seen as a tool for measuring the disconnect between economic growth and ecological pressures on the environment [29]. To calculate it, the most widely used method is the one proposed by the OECD [29] based on the DPSIR model, according to which the *Decoupling Index (DecIndex)* is calculated as follows

$$DecIndex = ER\frac{EP_E}{DF_E}\Big/\frac{EP_B}{DF_B}\Big/\frac{EP_E}{EP_B}\Big/\frac{DF_E}{DF_B} = \frac{I_{EP}}{I_{DF}}, \quad (3)$$

where EP_E and EP_B are indicator values of anthropogenic pressure on the environment (environmental pressure) in E year (E_{nd} – reporting year) and B year (Basic – base year); DF_E and DF_B – indicator of economic growth (driving force) in E year (End – reporting year) and B year (Basic – base year); I_{EP}, I_{DF} – growth index of the relevant indicators in the final period compared to the base period % [29].

But since our research is aimed at developing an algorithm for evaluating the model of workplace safety management, in this situation decoupling should be considered as a tool to measure the gaps between the economic growth of the industry and the growth of labor risks or health burden of the personnel.

Adapting formula (2) to determine the *Decoupling Index* when evaluating the model of labor safety management in civil aviation, we introduce the following notations: I_{lR} – growth rate of the integral indicator of labor risk (or personnel health load) in the final period compared to the base period, %; I_{DF} – growth rate of the integral indicator of economic growth of the industry in the final period compared to the base period, %.

Consequently, the formula for determining the *Decoupling Index* when evaluating the model of labor safety management in civil aviation takes the following form

$$DecouplingIndex = \frac{I_{LR}}{I_{DF}}. \quad (4)$$

To describe the obtained result, it is reasonable to use the classification of decoupling types according to (Tapio, 2005), according to which *coupling*, *decoupling* and *negative decoupling* are distinguished.

Coupling is observed when economic growth rates are close to the growth rates of labor risks. It can be: *expansive coupling* – if the rates of economic growth and growth of labor risks tend to increase; recessive coupling – if the rates of economic development and growth of labor risks tend to decrease. But, in both cases, coupling is present only if the *Decoupling Index* stays in the range $0.8 < DecIndex < 1.2$ [29].

As for *Decoupling*, it can be observed when there is a gap between the growth rate of labor risk and the economic productivity growth rate of the industry and can be of three levels: weak decoupling, when the rate of economic growth and the rate of growth of labor risks are simultaneously increasing, but the rate of economic growth exceeds the rate of growth of labor risks (when it is $0 < DecIndex < 0.8$); strong decoupling, when the rate of economic growth increases with a simultaneous decrease in the rate of labor risks ($DecIndex < 0$); recessive decoupling, when there is a simultaneous decrease in the rate of economic growth and increase in labor risk, but the rate of increase in labor risk exceeds the rate of economic growth (i. e. under the condition that $DecIndex > 1.2$).

In case of a negative gap between the rate of labor risk and the rate of economic growth, negative decoupling occurs, which can also be of three levels: expansive-negative decoupling, when the rate of economic growth and growth of labor risk simultaneously increase (in contrast to weak decoupling, only when $DecIndex > 1.2$); strong-negative decoupling, when the rate of economic growth decreases and the rate of labor risk simultaneously increases (under the condition: $DecIndex < 0$); weak-negative decoupling – when economic growth rate and labor risk rate decrease simultaneously (unlike recessive decoupling, only when: $0 < DecIndex < 0.8$) [29].

However, since it is a question of evaluating the model of work safety management of aviation personnel by the tri-partite indicator of the effect of tripartism (the constituent indicators of which are: social policy (I_{SP}), industrial safety climate (I_{SC}) and industrial performance safety culture (I_{PSC}) – (I_{SP}; I_{SC}; I_{PSC}), the *Decoupling Index* should be determined for each of the constituent tri-partite indicators.

In this case, the indicator of the effect of tripartism (T_{SP}) is proposed to be determined by the level of compliance of its components with the boundary value, chosen as 1. That is, if the indicator T_{SP} (1; 1; 1), it should be considered that the level of social partnership of priority stakeholders is rather high, which contributes to their willingness to participate in improving the level of labor safety in civil aviation. In case the indicator T_{SP} (0; 0; 0), it should be taken as almost complete absence between the priority groups of stakeholders or their representatives of social cooperation and their zero willingness and ability to take measures to improve the level of labor safety of personnel [30].

Since there are several variants of situations with deviation of some or other components of the three-component indicator T_{SP}, we consider it reasonable to take its final value according to the majority of values of its components. Thus, if T_{SP} is characterized as (1; 0; 1), then its final value should be taken as 1, and vice versa, if T_{SP} is characterized as (0; 0; 1), then its final value should be taken as 0 [30].

A schematic representation of the algorithm for evaluating the model of labor safety management in civil aviation of Kazakhstan is presented in Fig. 3.

Assessment of the model of labor safety management in civil aviation according to the algorithm based on the stakeholder approach will allow determining not only the degree of criticality of the situation regarding harmful and hazardous working conditions, but also the readiness and ability of each stakeholder to take measures to improve labor safety, which should be taken as a basis for decision-making both at the national, industrial and corporate levels.

Conclusions. The results of the study allow us to state that over the last decade Kazakhstan has done a lot of work on the transition to a market model of labor protection management and introduction of risk-oriented approach in the practice of enterprises. International standards on occupational safety have been ratified, labor and social legislation norms have been changed, control has been tightened, etc. However, it was not possible to achieve the desired result of significant improvement of working conditions. The primary reasons were: scarce statistics of labor safety indicators for individual types of economic activity; low-informative monitoring of harmful working conditions, which does not provide accumulation of necessary information for analysis and establishment of cause-and-effect relationships of injuries and occupational diseases; lack of a clear algorithm for assessing the model of workplace safety management, both in the context of individual types of economic activity and in the country as a whole. In particular, in civil aviation of Kazakhstan the facts of growth of indicators of traumatism and occupational diseases of aviation personnel have been established both with the increase in the number of personnel and with the increase in the volume of passenger and cargo transportation, which led to the growth of material costs of compensation and guarantees (provided by the Labor Code of the Republic of Kazakhstan and the Civil Code of the Republic of Kazakhstan) granted to personnel engaged in work with harmful and hazardous working conditions. Thus, it is proved that the national and sectoral model of labor safety management is not effective enough. The necessity to revise the approach to the formation of the model of labor safety

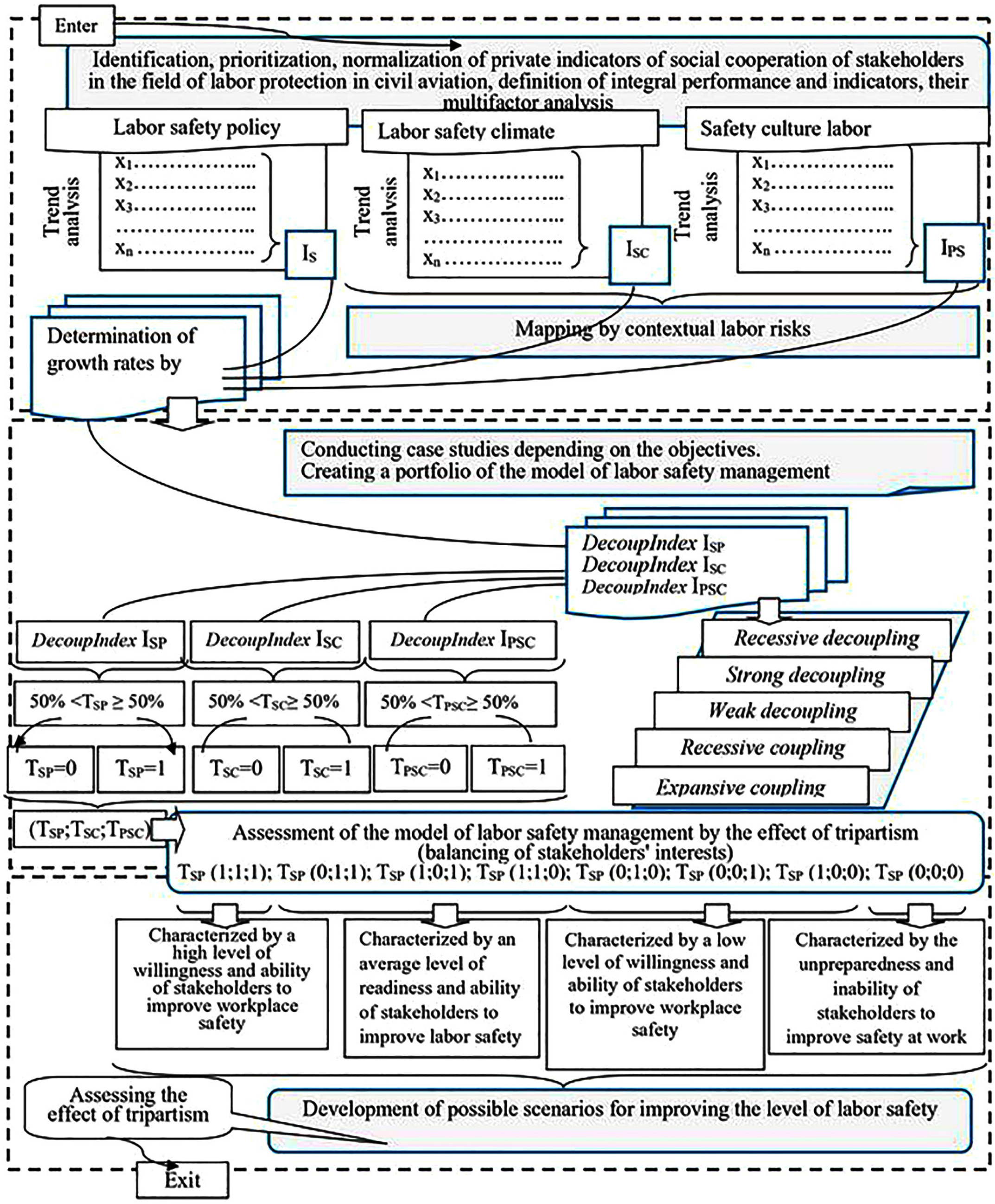


Fig. 3. Algorithm of assessment of the model of labor safety management in civil aviation according to the stakeholder approach

management in civil aviation in the conditions of active development of social partnership is substantiated. An algorithm for evaluating the model of labor safety management in civil aviation of Kazakhstan, the application of which in practice will provide an opportunity to determine the effect of tripartism. For the first time, a substantiated approach to assessing the effectiveness of the management of the labor safety system in civil aviation in Kazakhstan has been proposed, taking into account modern guarantees for employees of the relevant enterprises. It is noted that the tripartism effect was previously determined by researchers using: analysis of social agreements, surveys and interviews, analysis of legislation, analysis of cooperation results, etc. It is emphasized that it is more appropriate to determine the tripartism effect using a decoupling approach, which allows us to establish whether the economic growth of the industry occurs in parallel with the growth of indicators of negative impact on the health of personnel or whether it is achieved with practically stable or decreasing indicators of accidents, injuries and occupational diseases. It is emphasized that the application of the proposed algorithm is expedient under the condition of systematic monitoring and creation of a complete information base on the state of labor safety in civil aviation.

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Алгоритм оцінки моделі управління охороною праці в цивільній авіації Республіки Казахстан

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Мета. Розробка алгоритму оцінки моделі управління охороною праці в цивільній авіації Республіки Казахстан із використанням стейкхолдер-підходу, застосування якого в контексті соціальної справедливості забезпечить гнучкість моделі, залучить інвестиції в поліпшення умов праці та отримання очікуваного ефекту трипартизму.

Методика. Це дослідження виконане з використанням трендового й багатофакторного аналізу. Методи контент- і кореляційно-регресійного аналізу застосовані при побудові математичної моделі щільності зв'язку між рівнем травматизму та матеріальними витратами підприємств галузі на виплату компенсацій і забезпечення гарантій персоналу цивільної авіації за роботу у шкідливих і небезпечних умовах праці. Адекватність моделі підтверджена за допомогою коефіцієнта детермінації. Результати були перевірені за допомогою статистичних тестів Фішера. За допомогою методів ситуаційного прогнозування й моделювання визначені можливі сценарії розвитку досліджуваної системи факторів і результативного показника з горизонтом прогнозування до 2030 р. Декаплінг-аналіз застосовано для оцінки збалансованості інтересів пріоритетних груп стейкхолдерів і побудови алгоритму оцінки моделі управління охороною праці в цивільній авіації.

Результати. Розглянуті механізми надання гарантій, страхування та спеціальних соціальних виплат персоналу, задіяному в авіації та зайнятому на роботах зі шкідливими й небезпечними умовами праці. Доведено, що національна та галузева модель управління охороною праці є недостатньо ефективною. Обґрунтована необхідність перегляду підходу до формування моделі управління охороною праці в цивільній авіації в умовах активного розвитку соціального партнерства.

Наукова новизна. Уперше запропоновано обґрунтований підхід до оцінки ефективності управління системою охорони праці в цивільній авіації Казахстану з урахуванням сучасних гарантій для працівників відповідних підприємств.

Практична значимість. Практичне застосування запропонованого алгоритму оцінки моделі управління охороною праці в цивільній авіації Казахстану забезпечить можливість визначення ефекту трипартизму та, відповідно, прийняття дієвих рішень щодо управління безпекою праці.

Ключові слова: *шкідливі умови праці, безпека праці, охорона праці, травматизм, професійні захворювання*

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