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METHOD OF OPTIMIZATION OF DECISION-MAKING DURING MANAGEMENT OF SAFETY OF FLIGHTS IN THE ACTIVITIES OF OPERATORS OF AERODROMES

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In modern conditions of limited budget for enterprises of aerodrome operators, the task of optimizing decision making in flight safety management is becoming extremely urgent. Management decisions, which are a safety management tool, must be not only effective in terms of expected improvements in safety, but also cost-effective and appropriate for the enterprise. Optimization in this article should be understood in terms of the mentioned criteria. The article presents a method for supporting management decision-making as part of a safety management strategy for the activities of aerodrome operators. In the presented methodology, an important place is given to indicators of the level of safety of flights and their use in making managerial decisions. Along with the safety indicator, an indicator of financial damage from recorded events is used, which is calculated in value terms taking into account direct and indirect damage to the aerodrome operator. Regression modeling is used in conjunction with the decision-making technique of "human-machine procedures". Regression analysis is performed using STATISTICA software, and allows you to identify the dependence of indicators on the degree of influence of hazard factors. The resulting model, based on data from last year, makes it possible to forecast the values of indicators for the next. Using the decision-making methodology of "human-machine procedures", an assessment is made of the priority of implementing managerial decisions based on an integrated criterion. The methodology ensures compliance with the requirements of Russian and international air legislation for operators of certified aerodromes. The scope of its application can be expanded to SMS of all aviation service providers, taking into account the relevant specifics of the services provided and the existing hazard factors.

Key words: safety risk, indicator, aerodrome operator, optimization, regression analysis, forecast, management decisions.

INTRODUCTION

In 2020 the civil aviation encountered serious challenges concerning its regular activity. According to the Russian Federation Government Regulation № 434[1] the air transportation and airport activity suffered significant impact from the COVID 19 pandemic. It is of utmost importance to consider the balance performing the flight safety management tasks[2] in such conditions, and when the situation becomes stabilized as well.

Aerodrome operators in crisis face the acute budget deficit as a consequence to the decreased passenger flow[3]. The term "airport operator" implies "a person owing an airfield or a helipad under the right of ownership, by lease or any other legal ground and using this airfield or helipad to provide aircraft take off, landing, taxiing and parking"[4]. Nevertheless, flight safety level should be constantly improved or, at least, maintained, as the present situation in the world should not affect it. Flight safety should not be compromised due to budget issues. Figure 1 (borrowed from SMM ICAO Doc 9859) shows the abstract line of the boundaries of the safety space. The safety space decreases with the insufficient funding, which results in the flight safety deterioration.

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[1] Regulation No. 434 of the Government of the Russian Federation On Adopting the List of Industries in the Russian Economy Most Severely Affected by Deteriorating Conditions Resulting from Proliferation of the New Coronavirus Infection. (2020). 5 p.
[2] *Safety Management Manual* (SMM) ICAO Doc 9859, 4th Edition. (2018). 218 p.
[3] *According to international airport association data.* MMA. Available at: http://interairports.ru/ (accessed 19.07.2020). (in Russian)
[4] Federal Law № 60 -FZ 19 March 1997 "The Air Code of the Russian Federation" (1997). 60 p.

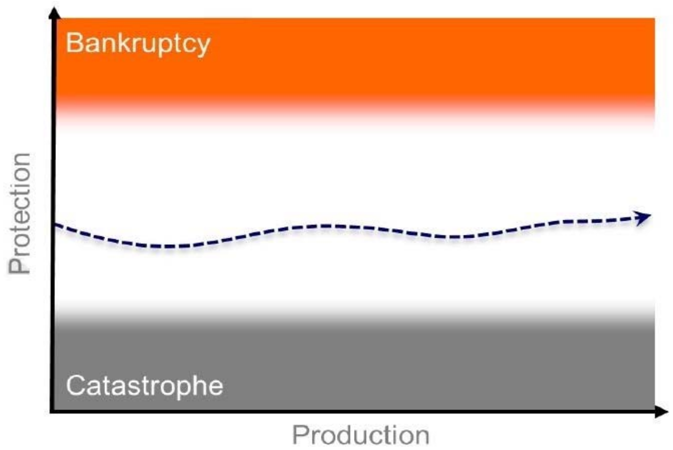

Fig. 1. ICAO Safety Flight Management Balance
(borrowed from the ICAO SMM. Doc.9859, 4th ed. 2018.)

At the same time, Figure 1 shows that flight safety overfunding may seriously affect the production profitability thus resulting in the enterprise bankruptcy. It is obvious, that the flight safety funding should be balanced (the management dilemma), ICAO SMM does not state the methods for balancing the funding.

Managerial decisions have always been the main tool for flight safety management. Such solutions made by the airdrome authorities are the grounds for the measures aimed at diminishing the danger factors in the aerodrome activity.

The mathematical methods for the managerial decisions effectiveness assessment are shown in [1]. However, the solution to our problem is not possible if only one criterion, the effectiveness, is taken into consideration. The managerial decision priority ranking and feasibility have to be evaluated economically. According to the decision theory [2, 3], this is a two-criteria task.

TERMS OF REFERENCE

At present there are different methods for two-criteria task optimum solutions, shown, for example in [3, 4, 5]. The most frequent way is to limit the number of criteria to one. The result is achieved applying the convolution method, global criterion method, threshold criterion method, distance method. As it was fairly stated in [6], the mentioned methods are not strictly justified, thus the application of them is determined by the conditions of the problem and the preferences of the decision maker.

Alongside with the abovementioned methods, Edgeworth-Pareto principle, Nash principle and man-machine decision making tools are being applied. The latter three are of most interest, as they do not imply a predetermined optimal decision scheme, and allow to keep all the obtained data [6].

The first criterion. In order to determine the decision-making effectiveness, it is appropriate to apply the flight safety record based on the previous events. Any record, typically evaluated by the enterprises can serve as an example for that, for instance the ones described in papers [7–12], or others. The present paper will be using the criterion conditionally called F_{spi} (flight safety performance indicator). As it has been established within the industry, this indicator actually shows the hazard level during the flight, so the task for the first criterion is to minimize the first indicator.

The second criterion. The method implies the financial indicator as the second criterion. It shows the numeric value of the cost equivalent in provisional monetary units (used to eliminate any national currency as a reference) required to implement the managerial decision. The paper suggests calling the criterion “the financial loss indicator” (F_{li}). Likewise, the second criterion must also be minimized.

In order to evaluate the factors for both criteria separately, it is appropriate to use statistical analyses and modelling. The model allows to forecast the criteria values in case the featuring operational conditions change.

REGRESSION MODEL FORMATION

Regression modelling is one of the statistical analyses and forecast methods. The variety of its application is presented in the summarizing paper [13].

The main idea of the regression analyses is in composing the regression equation. Such an equation demonstrates the dependence of one variable (dependent) from several other dependent variables.

Let us take F_{spi} and F_{li} as the feedback (dependent variable) (further -Indicators). Every indicator would require its own regression equation. It is also necessary to determine independent variables. In practice, there can be numerous factors influencing the indicators, and it is impossible to take all of them into consideration. For the sake of simplicity, it is suggested using Generalized Hazard Rate or Generalized Hazard. Hazard assumes "the result of the action or absence of action, circumstance, condition or their combinations, which affect civil aircraft flight safety" as it was defined in the Order No. 1215 of the Government of the Russian Federation[5].

Generalized Hazard degree of impact onto the previous events may be evaluated in conditional units(points).

The regression equation general arrangement:

$$\Pi = \beta_0 + \beta_1 \Phi_1 + \ldots + \beta_i \Phi_i + \ldots + \beta_n \Phi_n \qquad (1)$$

where: Π – indicator, dependent variable of the regression model;

Φi – Generalized Hazard (GH), independent variables;

βi – regression coefficients.

There are six GH areas suggested, the GH areas are structured depending on the activity types. The activity types were determined during the ISAGO[6,7] Ground Operation Safety Audit and by aerodrome activity types listed in GOST (National Standard of the Russian Federation)[8].

The research suggests the following GH areas:

- AS - Aerodrome support
- SET - Special equipment and transport
- ATC - Air traffic control
- OP - Ornithological provision
- BCH - Baggage cargo handling
- SEC -Security

The listed hazard areas are generalized according to the aerodrome operator activity types. Other types of activity are cases, which can this way or another be related to one of the listed above. Firefighting, SAR and emergency services are not listed deliberately, as their activities are intended to diminish the consequences of the hazards.

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[5] About procedure for development and application of safety management systems of flights of air vehicles, and also collection and data analysis about the factors of danger and risk creating safety hazard of flights of civil air vehicles, storages of these data and exchange of them. Order of the Government of Russian Federation November 18, no. 1215. (2014). 3 p.

[6] IATA Safety Audit for Ground Operation (ISAGO). Standards Manual. 7th Edition, Effective February 2018. 350 p.

[7] IATA Safety Audit for Ground Operation (ISAGO) Guidelines on auditing a Safety Management System. Based on GOSM 5th Edition, Effective July 2016. 370 p.

[8] GOST R 57239-2016 (National Standard of the Russian Federation) Aviation Activity Safety Management System. Database. Aviation infrastructural risks caused by aerodrome activity, Moscow, Standartinform. (2016). 43 p.

Consequently, the application of the method is explained using real-world analogous fictional data of one of the Russian airports. The initial data used are the indicators (F_{spi} and F_{li}) for the previous year, and each GH degree of impact onto the events of the month, which took place last year. The degree of GH impact is determined by the experts, conversant with the circumstances the reasons of the events subject to expertise.

Every event, which happened the previous year is to be rated using a 10-point scale (with 1 point which stands for minimum or indirect GH impact on the event and 10 points that stand for the event completely resultant from this very GH). The results are to be grouped by months. The fragment of the possible evaluation is shown in Figure 2.

№	Date	Event circumstances	Previous year indicators		Generated Hazards and their impact expert evaluation					
			F_{spi}	F_{li}	**AS**	**SET**	**ATC**	**OP**	**BCH**	**SEC**
1	11.01	Airport security vehicle is inoperative, substituted by a follow me car		1500	1	3				3
2	17.01	Standardized lighting markers on the TWY partially covered with snow		600	6		1			
3	29.01	Incursion of the active TWY by a luggage trolley (flight delay)		2000			2		8	
January total			**0,754**	**4100**	**7**	**3**	**3**	**0**	**8**	**3**
4	12.02	SAR portable radio stations transmission inoperable		0			1			
5	20.02	Dog on the apron		0	1		1	1		1
6	25.02	A small bird in NLG bay at takeoff		6000			1	6		
February total			**0,515**	**6000**	**1**	**0**	**3**	**7**	**0**	**1**

Fig. 2. A fragment of the source data (example)

Figure 2 also shows the actual values of the indicators, calculated using the methods accepted by the certain aerodrome operator.

Considering the data obtained, the initial data for the regression model are formulated (fig. 3). In order to perform further regression modelling operations STATISTICA 13.5.0.17 (English version) software package is used and instruction cited in [14] are applied.

Data: Month-Fspi-Fli-GHF* (8v by 12c)

Month-Fspi-Fli-GHF	1 Fspi	2 Fli	3 AS	4 SET	5 ATC	6 OP	7 BCH	8 SEC
January	0,754	4100	7	3	3	0	8	3
February	0,515	6000	1	0	3	7	0	1
March	0,368	1200	0	1	4	4	0	0
April	0,294	0	1	0	1	0	2	0
May	0,405	5300	2	1	3	7	2	0
June	0,129	2000	0	1	5	0	0	0
July	0,147	500	0	0	3	0	2	1
August	0,129	800	0	0	4	2	0	0
September	0,423	6110	2	1	9	0	0	0
October	0,257	0	0	0	0	1	0	0
November	0,386	0	0	3	0	0	0	0
December	0,349	5590	1	4	6	0	0	0

Fig. 3. Initial data of regression models in the STATISTICA software package

Two basic linear regression models are constructed based on the data obtained. These regression models illustrate the dependence of every indicator on the GH.

The factor correlation analysis is no sense as the forecast will be based on monthly mean per year, without indicator values for a certain month. Therefore, multicollinear factors may occur in a model (linear dependence between the explanatory variables) [15].

The results of the regression model construction for the indicators F_{spi} and F_{li} are shown in Figure 4.

Итоги регрессионной модели для показателя Пбп:
R= ,95044945 R^2 = 0,90335415
Скорректированный Adjusted R^2 = 0,78737913

N=12	b*	Std.Err. of b*	b	Std.Err. of b	t(5)	p-value
Intercept			0,281991	0,064340	4,38279	0,007136
AS	1,44574	0,461960	0,129607	0,041413	3,12959	0,025970
SET	0,18609	0,174195	0,023684	0,022169	1,06831	0,334220
ATC	-0,30767	0,184020	-0,021643	0,012945	-1,67196	0,155395
OP	0,20519	0,163767	0,013403	0,010697	1,25292	0,265637
BCH	-1,00523	0,492032	-0,077092	0,037734	-2,04302	0,096497
SEC	0,31380	0,293056	0,062253	0,058138	1,07077	0,333214

Итоги регрессионной модели для показателя Пфу:
R= 0,93457158 R^2 = 0,87342403
Скорректированный Adjusted R^2 = 0,72153287

N=12	b*	Std.Err. of b*	b	Std.Err. of b	t(5)	p-value
Intercept			-520,947	1059,050	-0,49190	0,643623
AS	0,908097	0,528675	1170,890	681,668	1,71768	0,146499
SET	0,174757	0,199352	319,888	364,907	0,87663	0,420804
ATC	0,431384	0,210595	436,465	213,075	2,04841	0,095837
OP	0,428934	0,187418	402,978	176,077	2,28865	0,070769
BCH	-0,760775	0,563090	-839,169	621,113	-1,35107	0,234588
SEC	0,166206	0,335378	474,248	956,958	0,49558	0,641202

Fig. 4. The results of the construction of regression models

Here, column "b" shows the regression coefficients, i.e. the constant and the coefficients for every indicator (for every independent variable).

Column "b*" shows the values for standardized coefficient (β).

The GH influence importance values are shown in "p-value" columns.

R^2 – the coefficient of linear determination, which is the regression model adequacy value

Std. Err of b (b*) – the standard mean error of b (b*).

FEASIBILITY ASSESMENT OF THE MODEL

The adequacy and the application spectrum of the model should be evaluated to be able to apply the results obtained.

The determination coefficient for every model is shown in the head of the table (fig. 4) as "R^2".This coefficient may take the values from 0 to 1 and shows the number of factors considered within a model out of those that influence the dependent variable. For this case, the determination coefficients are quite fine (according to [16] if more than 0,8), which proves that the model will be more precise than a simple mean value forecast [17].

Also, STATISTICA software package allows to convey a technical analysis of residual. The theory of regression analyses defines residual as the actual data deviation values from the regression line. Let us analyze the residual for F_{spi} (likewise for F_{li}). Figure 5 shows the frequency histogram of residuals, and Figure 6 shows the probability plots – normal for the residuals.

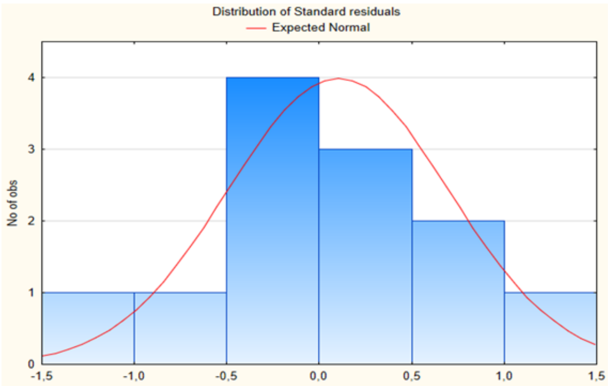

Fig. 5. The frequency histogram of the distribution of residues

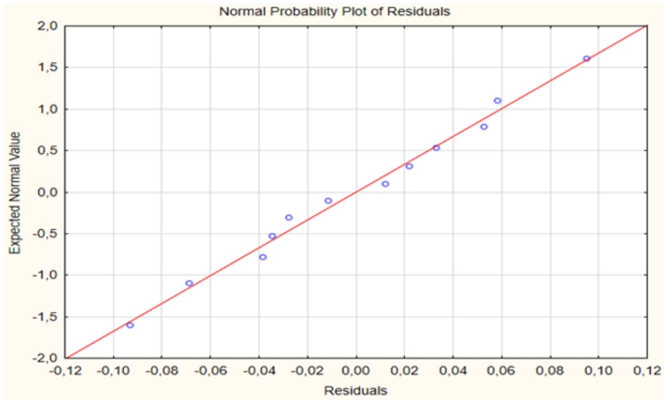

Fig. 6. Normal Probability Plot of Residuals

The given graphs show the normal residual plotting and also the absence of the actual data deviation from the theoretical normal line

Let us enter the monthly mean values of GH for the previous year (M_i mean) from the input data (fig. 3). The model shows the result of the mean indicator values, and the values for their confidence intervals ± 95 % (fig. 7).

Variable	Predicting Values for (Месяц-Пбп-Пфу-ОФО) variable: Пбп b-Weight	Value	b-Weight * Value
AS	0,129607	1,166700	0,151212
SET	0,023684	1,166700	0,027632
ATC	-0,021643	3,416700	-0,073949
OP	0,013403	1,750000	0,023455
BCH	-0,077092	1,166700	-0,089944
SEC	0,062253	0,416700	0,025941
Intercept			0,281991
Predicted			0,346337
-95,0%CL			0,285221
+95,0%CL			0,407454

Variable	Predicting Values for (Месяц-Пбп-Пфу-ОФО) variable: Пфу b-Weight	Value	b-Weight * Value
AS	1170,890	1,166700	1366,078
SET	319,888	1,166700	373,213
ATC	436,465	3,416700	1491,269
OP	402,978	1,750000	705,211
BCH	-839,169	1,166700	-979,058
SEC	474,248	0,416700	197,619
Intercept			-520,947
Predicted			2633,385
-95,0%CL			1627,403
+95,0%CL			3639,368

a b

Fig. 7. Average values and their confidence intervals
a) F_{spi}; b) F_{li}

The analyses of the model shown confirms its applicability within the methods of factor analyses, [18, 19] i.e. the maintenance factors for the aerodrome operators and determining the dependence of the variables. STATISTICA software package allows to construct regressions applicable for the method based on almost any initial data, which exist in practice.

THE APPLICAZTION OF THE MODEL FOR OPTIMIZATION ANY PRIORITY RANKING OF MANAGERIAL DECISIONS

The flight safety management supposes annual planning. The experts are tasked to evaluate the percental decrease in the impact of every GH after the implementation of every managerial decision. The evaluation criteria are shown in Table 1.

Table 1

Criteria for expert evaluation of the impact of managerial decisions on generalized hazards

Percentile impact onto GH	Comment
100 %	Maximum impact onto GH. Eliminates the possibility of GHs after the managerial decision implementation
50 %	After the managerial decision implementation, the possibility of GH is twice as low
5 %	The managerial decision will contribute to the improvement of the only factor out of the total GH
3 %	The managerial decision will moderately contribute to the improvement of the only factor out of the total GH
1 %	The managerial decision will slightly contribute to the improvement of the only factor out of the total GH
0,5 %	The minimum influence onto GH. The managerial decision will slightly contribute to the improvement of the only factor out of the total GH

For example, Table 2 presents the data about the possible managerial decisions showing their implementation costs (in provisional monetary units) and the percentile impact onto the GHs (the managerial decision efficiency coefficients – Kij). These coefficients must be assessed by the experts based on the criteria shown in Table 1.

Table 2

Expert assessments of the impact of management decisions on generalized hazards

The managerial decision	Cost Provisional monetary units	Efficiency coefficients (K_{IJ})					
		AS	SET	ATC	OP	BCH	SEC
1	2	3	4	5	6	7	8
1.To renovate the RWY and TWY ground marking	400	0,015	0,035	0,015	0,01	0,005	0,005
2.To develop a data exchange software package	160	0	0	0,005	0,01	0,005	0
3.To improve the ATC and ornithological service interaction technology	260	0	0	0,02	0,02	0	0
4.To purchase the radio stations	500	0	0,035	0,01	0,005	0,01	0,005

Continuance of Table 2

1	2	3	4	5	6	7	8
5.To carry out refresher training for the interacting departments	300	0	0,035	0,005	0,005	0,005	0,005
6.To repair the RWY and TWY pavement	3000	0,015	0,015	0,005	0,05	0,005	0
7.To set the fence from the water body	250	0	0,005	0,02	0,01	0	0
8.To purchase the equipment (parts etc.)	1500	0	0,01	0,05	0,01	0	0
9.The airdrome trolley repair/renovation	400	0,005	0,005	0	0,01	0	0

Considering the data makes it possible to correct the monthly mean (for the previous year) coefficients for each GH contribution to the indicator after the implementation of each managerial decision, using the Formula 2.

$$M_{ij} = M_{i\,cp.} - M_{i\,cp.} * K_{ij} \qquad (2)$$

Where: Mi cp – the monthly mean GH for the previous year;

Кij – managerial decisions efficiency coefficients.

The new coefficients (M_{ij}) are shown in Table 3.

Table 3

Contribution coefficients of generalized hazard factors considering the predicted effect of the implementation of each managerial decision

MD	Coefficients M_{ij}					
	AS	SET	ATC	OP	BCH	SEC
1	1,1492	1,1258	3,3654	1,7325	1,1608	0,4146
2	1,1667	1,1667	3,3996	1,7325	1,1608	0,4167
3	1,1667	1,1667	3,3483	1,7150	1,1667	0,4167
4	1,1667	1,1258	3,3825	1,7413	1,1550	0,4146
5	1,1667	1,1258	3,3996	1,7413	1,1608	0,4146
6	1,1492	1,1492	3,3996	1,6625	1,1608	0,4167
7	1,1667	1,1608	3,3483	1,7325	1,1667	0,4167
8	1,1667	1,1550	3,2458	1,7325	1,1667	0,4167
9	1,1608	1,1608	3,4167	1,7325	1,1667	0,4167

Using the models (fig. 4) made on the basis of the initial data for the previous year (fig. 3) enables to forecast the indexes for the following year considering each managerial decision implementation. The changes of the indexes ΔF_{spi} and ΔF_{li} may be calculated using the Formula (3):

$$\Delta\Pi_{fsj} = \Pi_{fs0} - \Pi_{fs}; \quad \Delta\Pi_{flj} = \Pi_{flo} - \Pi_{flj}; \qquad (3)$$

where $\Pi_{fs\ 0}$ / $\Pi_{fl\ 0}$ - upper fiducial limit (+95%CL) for the indexes not taking the implementation of managerial decisions into account (see fig. 7);

$\Pi_{fs\ J}$ / $\Pi_{fl\ J}$ - upper fiducial limit (+95%CL) for the indexes considering each managerial decision implementation.

As this is a two-criteria problem, let us introduce two criteria for the managerial decision efficiency:

$$C_1^j = \frac{\Delta \Pi_{fsj}}{Q_j};\ C_2^j = \frac{\Delta flj}{Q_j} \tag{4}$$

where Q_j is the cost of the *j* – number managerial decision.

The values of the efficiency criteria are estimated for every managerial decision.

Further, it is necessary to calculate the specific values, as it is recommended in [3]. For the criterion C_1 the specific value C_1^{j*} is calculated as (5):

$$C_1^{j*} = \frac{C_1^j - \min C_1^j}{\max C_1^j - \min C_1^j} \tag{5}$$

where $\max C_1^j$ are $\min C_1^j$ the maximum and minimal values of the criterion.

The calculations for C_2^{j*} criterion are likewise, as both criteria (indexes) are supposed to be diminished.

As the theory of man-machine procedures cites, the solutions of a multi-criteria problem of the decision-making theory require to determine weighted coefficients of the criteria importance w1 and w2, that should sum to a one. For example, let us suppose that the airdrome operator sets the criteria priority as w1=0,6; w2=0,4. Then we can estimate the complex criteria $\mathbf{C^j}$ for every managerial decision using the formula (6):

$$C^j = C_1^{j*} w_1 + C_2^{j*} w_2 \tag{6}$$

The results obtained from the calculations (formulae 3-6) are the grounds for the complex criteria evaluation. It is reasonable to rank the managerial decisions in descending order (tab. 4).

Table 4

Ranking managerial decisions by degree of optimization

№	Managerial decision	Cost	Complex criterion
1	1. To renovate the RWY and TWY ground marking	400	0,945
2	9. The airdrome trolley repair/renovation	400	0,519
3	5. To carry out refresher training for the interacting departments	300	0,474
4	3. To improve the ATC and ornithological service interaction technology	260	0,432
5	7. To set the fence from the water body	250	0,362
6	6. To repair the RWY and TWY pavement	3000	0,352
7	4. To purchase the radio stations	500	0,282
8	8. To purchase the equipment (parts etc.)	1500	0,236
9	2. To develop a data exchange software package	160	0,158

Managerial decision ranking emphasizes their priority according to the complex criterion chosen. The result obtained may be applied by the person who makes decisions about the feasibility and priority of managerial decisions implementation.

CONCLUSION

The paper suggests the methods for the flight safety management decisions in aerodrome operators' activity. The research introduces the method of the managerial decision efficiency evaluation based on the two-criteria task of "man-machine procedures" using statistical analyses and the method of regression modelling.

The regression analyses allow to forecast the flight safety records based on the previous year data, considering the implementation of the new managerial decisions. The method considers the impact of the managerial decisions onto the flight safety, taking their feasibility into account.

Thus, the suggested method allows to rank the managerial decisions and may be applied as the grounds for the flight safety resources allocation.

STATISTICA software package is suggested as the problem solution tool. The method application does not require mathematical skill as the results may be computed using a personal computer.

The method described may be applied for inspections and flight safety departments of the aerodrome operators. The application area may be extended to Flight Safety Management Systems of all aviation enterprises regarding the services specifics and typical hazards.

The method upgrade to the level of practical application will require further research and trial based on the actual data.

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МЕТОДИКА ОПТИМИЗАЦИИ ПРИНЯТИЯ РЕШЕНИЙ ПРИ УПРАВЛЕНИИ БЕЗОПАСНОСТЬЮ ПОЛЕТОВ В ДЕЯТЕЛЬНОСТИ ОПЕРАТОРОВ АЭРОДРОМОВ

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Работа выполнена при финансовой поддержке РФФИ в рамках научного проекта № 19-38-90215

В современных условиях ограниченности бюджета операторов аэродромов задача оптимизации принятия решений при управления безопасностью полетов становится чрезвычайно актуальной. Управленческие решения, являющиеся инструментом управления безопасностью полетов, должны быть не только эффективны с точки зрения ожидаемых улучшений в безопасности, но и экономически выгодны и целесообразны для данного предприятия. Под оптимизацией в данной статье следует понимать минимизацию по этим критериям. В статье представлен метод поддержки принятия управленческих решений в рамках стратегии управления безопасностью полетов в деятельности операторов аэродромов.

В представленной методике важное место отводится показателям уровня безопасности полетов и их использования при принятии управленческих решений. Наряду с показателем безопасности полетов используется показатель финансового ущерба от зафиксированных событий, который рассчитывается в стоимостном выражении с учетом прямого и косвенного ущерба для оператора аэродрома. Используется регрессионное моделирование совместно с методикой принятия решений «человеко-машинных процедур». Регрессионный анализ выполняется с применением программного обеспечения STATISTICA и позволяет выявить зависимость показателей от степени влияния факторов опасности. Полученная модель на основе данных за прошлый год дает возможность выполнять прогноз значений показателей на следующий. Используя методику принятия решений «человеко-машинных процедур» выполняется оценка приоритетности внедрения управленческих решений на основе комплексного критерия. Методика обеспечивает выполнение требований российского и международного воздушного законодательства для операторов сертифицированных аэродромов. Область ее применения может быть расширена до СУБП всех поставщиков авиационных услуг при учете соответствующей специфики предоставляемых услуг и имеющихся факторов опасности.
Исследование выполнено при финансовой поддержке РФФИ в рамках научного проекта № 19-38-90215.

Ключевые слова: риск безопасности полетов, показатель, оператор аэродрома, оптимизация, регрессионный анализ, прогноз, управленческие решения.

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