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Oleksandr Solomentsev¹ , Maksym Zaliskyi¹  , Oleksii Holubnychyi¹ ,
Ivan Ostroumov¹ , Olha Sushchenko¹ , Yurii Bezkorovainyi¹ ,
Yuliya Averyanova¹ , Viktoriia Ivannikova² , Borys Kuznetsov³ ,
Ihor Bovdui³ , Tatyana Nikitina⁴ , Roman Voliansky⁵ ,
Kostiantyn Cherednichenko¹ , and Olena Sokolova¹ 

¹ National Aviation University, Liubomyra Huzara Avenue, 1, Kyiv 03058, Ukraine
mzaliskyi@nau.edu.ua

² Dublin City University, Collins Avenue Ext, Dublin, Ireland

³ Anatolii Pidhornyi Institute of Mechanical Engineering Problems of the National Academy of Sciences of Ukraine, Pozhars'koho Street, 2/10, Kharkiv 61046, Ukraine

⁴ Educational Scientific Professional Pedagogical Institute Ukrainian Engineering Pedagogical Academy, University Street 16, Kharkiv 61003, Ukraine

⁵ National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Beresteyskyi Avenue, 37, Kyiv 03056, Ukraine

Abstract. One of the key tasks of ensuring the level of flight safety is providing a high reliability of radio electronic equipment. This equipment is designed to detect aircraft, determine their coordinates, and provide radio communication between the aircraft and the air traffic controller. The reliability of aviation radio equipment is determined at the stages of design and operation. At the same time, the main procedures include the following measures: the use of a highly reliable element base, the use of various types of redundancy of the structural components of the equipment, ensuring the efficiency of the main operational processes, and others. The processes that have a direct impact on the reliability of aviation radio equipment are monitoring and control of the technical condition, repair, making decisions on corrective and preventive actions based on collected statistical data, and others. This paper considers the problem of the repair procedures efficiency analysis, which includes the diagnostics and detection of failed structural units of equipment, restoration of serviceability, and measurement of diagnostic variables. Efficiency is considered from the point of view of minimizing the duration of repair procedures, their cost and labor intensity. In general, the method of calculating numerical values of efficiency indicators and their statistical characteristics is presented in the form of step-by-step instructions.

Keywords: Operation · Repair · Data Processing · Aviation Radio Equipment · Reliability · Efficiency

1 Introduction

1.1 Introduction to the Problem

One of the key tasks of ensuring the level of flight safety is providing a high level of reliability of the functioning of radio electronic equipment [1, 2]. This equipment is designed to detect aircraft, determine their coordinates, and provide radio communication between the aircraft and the air traffic controller [3].

There are three stages of aviation radio equipment lifecycle: design, production and operation [4]. During the design and operation, the issues of increasing the reliability of equipment are usually solved. The main ways to increase the reliability are:

- the use of a highly reliable element base;
- the use of various types of redundancy of the structural components of the equipment;
- optimization of storage and logistics of spare parts and equipment blocks;
- ensuring the efficiency of the main operational processes;
- monitoring the technical condition of the equipment by measuring the determining parameters and reliability indicators;
- use of intelligent statistical data processing algorithms and decision-making based data processing results;
- prediction of failures and faults, implementation of optimal preventive actions, and others [5, 6].

These tasks are solved in project organizations and equipment operation systems [7]. The operation system (OS) is a complex structural unit containing equipment, means of operation, operating enterprises, technological processes, resource support, managerial influences in the form of control actions and regulatory documentation, personnel, and others [8, 9].

Information signals flow between the structural elements of the OS, which are mostly stochastic in nature [10, 11]. This reason is explained by the influence of many factors, including the environment, the possibility of random failures and faults, and the human factor in the decision-making process. The specified circumstances are a prerequisite for collecting statistical data, storing them in special warehouses and using them in the decision-making process.

1.2 Motivation

Information about quantitative indicators of the quality of operational processes performance is important from the point of view of analyzing their influence on the reliability of equipment functioning. In particular, the determination of the statistical characteristics of the duration of the current repair process gives the possibility for a timely assessment of the equipment steady-state availability and, in case of unsatisfactory numerical estimates, to perform certain preventive actions.

Determining the statistical characteristics of the efficiency of the current repair process provides an opportunity for the further implementation of advanced data-driven decision-making approaches in the practice of operation of aviation radio equipment.

1.3 Contribution

This paper contributes to the theory and practice of operation of aviation radio equipment in terms of statistical analysis of the current repair process. The practical significance of this research is associated with building a step-by-step instruction for numerical assessment of the duration, cost and labor intensity of current repair process.

1.4 The Organization of the Paper

The paper contains six sections. The first section describes introduction to the problem, motivation and contribution. The second section concentrates on literature review and problem statement. The third section considers the step-by-step procedure for numerical evaluation of current repair process efficiency. Fourth section presents results and discussions. Fifth and sixth sections are conclusions and future scope.

2 Literature Review and Problem Statement

The OS of aviation radio equipment contains the processes associated with:

- equipment usage for its functional purpose;
- monitoring and control of technical condition;
- maintenance;
- current repair;
- personnel training;
- decision-making on implementation of corrective and preventive actions;
- statistical data processing, and others [12, 13].

The current repair process is implemented after detecting failure or fault of aviation radio equipment [14]. Firstly, current repair process launches the search of failed element, unit or block of equipment based on different diagnostic programs implementation [15, 16]. The next procedure is the recovery of serviceability. This procedure is carried out based on replacement of failed element, performing recovery operations, regulation of various parameters, and others [17]. The last procedure is parameters monitoring that is implemented for decision-making on possibility of further equipment usage and correctness of previous procedures [18].

The scientific results presented in modern literature do not pay enough attention to the problem of efficiency analysis of current repair process. In general case, scientists usually use only expected value of efficiency index [19, 20]. But due to stochastic nature of studied process such consideration does not provide the required information. It is necessary to estimate the probability density function [21]. However, such problem is very sophisticated and, in some cases, requires a big number of experiments. The simpler approach is to make assumption about gaussian nature of studied process and its stationary property. It gives possibility to obtain only estimates of mean and standard deviation that completely describe this distribution [22].

The efficiency indexes of current repair process are:

- the expected value $E(t_r)$ of duration for one repair of equipment;

- the standard deviation $s(t_r)$ of duration for one repair of equipment;
- the threshold value $t_r^{\text{th}}(\theta_t^{(0)})$ of duration for one repair of equipment for significance level $\theta_t^{(0)}$ (significance level is the real probability of repair duration not exceeding the predetermined value);
- the expected value $E(C_r)$ of cost for one repair of equipment;
- the standard deviation $s(C_r)$ of cost for one repair of equipment;
- the threshold value $C_r^{\text{th}}(\theta_c^{(0)})$ of cost for one repair of equipment for significance level $\theta_c^{(0)}$ (the real probability of repair cost not exceeding the predetermined value);
- the expected value $E(L_r)$ of labor intensity for one repair of equipment;
- the standard deviation $s(L_r)$ of labor intensity for one repair of equipment;
- the threshold value $L_r^{\text{th}}(\theta_L^{(0)})$ of labor intensity for one repair of equipment for significance level $\theta_L^{(0)}$ (the real probability of repair labor intensity not exceeding the predetermined value);
- the probability density function of probability of correct diagnostics $f(P_{cd})$ [23].

The initial data for efficiency indexes calculation include the organizational structure of current repair process, operational data of equipment, statistical data on different procedures characteristics [24, 25].

Consider a mathematical formulation of the research problem. In general case, the vector of efficiency indexes $\overrightarrow{Efficiency}$ depends on following parameters:

- reliability properties of aviation radio equipment \overrightarrow{R} ;
- diagnostics method for searching failed element \overrightarrow{DM} ;
- the characteristics of current repair process \overrightarrow{CRP} for one procedure of inspection, control and serviceability recovery from the point of view of duration, cost and labor intensity;
- the veracity of decision-making \overrightarrow{V} in case of possibility of the errors of the first and second kind;
- the parameters that take into account human factor \overrightarrow{HF} ;
- the characteristics of measuring equipment \overrightarrow{ME} .

Then, certain efficiency index is some function φ_i that establishes the correlation.

$$\overrightarrow{Efficiency} = \varphi_i(\overrightarrow{DM}, \overrightarrow{CRP} | \overrightarrow{R}, \overrightarrow{V}, \overrightarrow{HF}, \overrightarrow{ME}).$$

The aim of this paper is to determine this correlation and show the step-by-step procedure for numerical evaluation of current repair process efficiency.

3 Materials and Methods

3.1 General Information

The calculation of the efficiency indicators of the current repair process includes the following stages:

- analysis of aviation radio equipment and determination of the object of current repair;

- analysis of the technological subsystem of the current repair of aviation radio equipment;
- calculation of numerical values of conventional indicators of the efficiency of the current repair of aviation radio equipment;
- calculation of numerical values of efficiency indicators of single current repair of all aviation radio equipment.

3.2 Analysis of Aviation Radio Equipment and Determination of the Object of Current Repair

During the analysis of aviation radio equipment, it is necessary: to describe how and with the help of which measuring means it is possible to determine the serviceability of the equipment; to provide data on equipment configuration and perform an analysis of the schematic and structural features of its construction, on the basis of which to distinguish hierarchical levels (availability of cabinets, racks, blocks, etc.); to provide data on spare parts for certain element of given hierarchical level.

The stage of determining the object of current repair is aimed at obtaining the data on the level of controllability of the specified hierarchical levels of equipment, which will enable the subsequent construction of a diagnostic model.

To systematize the received data, there is a need to use the following system of schematic and structural elements of aviation radio equipment. All structural elements (SE) are divided into six groups:

1. Structural elements at the level of cabinets.
2. Structural elements at the level of racks.
3. Structural elements at the block level.
4. Structural elements at the device level.
5. Structural elements at the electric board level.
6. Structural elements at the level of non-recovery elements (radio component base, mechanical units, etc.).

This paper studies the objects of current repair in the form of SE of the fourth and fifth levels. Elements of these levels can be divided into two sets. The first set has spare parts stored in the OS. In case of equipment failure, the failed SE is replaced with a serviceable one from the number of spare parts. The second set does not have spare parts, so restoration of serviceability is carried out in the repair units of the OS organizational structure.

In addition to the scheme of the hierarchical construction of the equipment, the following data must be collected: information about the defining parameters characterizing the serviceability of each SE, the measurement devices for each parameter, the operational tolerances for each parameter.

3.3 Analysis of the Technological Subsystem of the Current Repair of Aviation Radio Equipment

During the analysis of the technological subsystem of the current repair, it is necessary: to determine the organizational structure of this subsystem, to conduct an analysis of technological equipment, to determine current repair technologies and required personnel.

Elements of organizational structure can be:

- automated workplaces for current repair of equipment and its parts;
- spare parts for a certain hierarchical level of equipment;
- repair and operation workshops of air traffic service enterprises;
- manufacturing enterprises or repair enterprises of aviation radio equipment.

The analysis of the organizational structure ends with the development of a suitable scheme with the definition of the input and output flows of requests for the co-responding element.

An automated workplace should include bench equipment, oscilloscopes, voltmeters, frequency meters, ammeters, power sources, generators of special signals, soldering stations, etc. When choosing these tools, it is advisable to determine their approximate cost and terms of operation.

Repair technology will differ for elements with and without spare parts. For the elements of the first group, a search for the failed element, its replacement and a check of the serviceability of the entire SE will be carried out. For the elements of the second group, repair procedures will be performed, including soldering, adjustment, and regulations of the existing parts of SE. Regardless of the SE group, the first stage of the repair technology is the process of developing the diagnostic model and diagnostic program. During the repair of SE without spare parts, the following procedures are performed: input inspection of the block, node, board in order to confirm the fact of failure, external inspection of the SE to detect the failed element, search for the failed element, restoration of serviceability, output inspection of the serviceability of the block, node, board. Studying the issue of the justification of current repair technologies, it is necessary to build structural diagrams of the interconnection of technological procedures for each automated workplace. The process of localization of the failed element must be carried out in stages, successively moving from a higher hierarchical level to a lower one based on the diagnostic program. From the multi-stage nature of this search, it follows that it is necessary to have several diagnostic programs and use several failure search methods for this.

To estimate the cost of resources for current repairs, it is also necessary to determine the quantity and qualifications of the personnel who will work at automated workplaces.

3.4 Calculation of Numerical Values of Conventional Indicators of the Efficiency of the Current Repair of Aviation Radio Equipment

Conditional indicators of the efficiency of the current repair of aviation radio equipment include:

- indicators characterizing the expenditure of resources for the current repair of the j -th basic object, which is part of the K equipment samples, for which there are no spare parts. We assume that there are M samples of aviation radio equipment in total, then $U = M - K$ samples will have spare parts – $\overrightarrow{\text{Efficiency}}(j|K)$;
- indicators characterizing the expenditure of resources for the current repair of the remaining $K - 1$ objects for which there are no spare parts – $\overrightarrow{\text{Efficiency}}(K - 1|K)$;

- indicators characterizing the expenditure of resources for the ongoing repair of U objects for which there are spare parts – $\overrightarrow{Efficiency}(U)$.

While calculating the numerical values of conditional indicators of the efficiency $\overrightarrow{Efficiency}(j|K)$, the following origin data must be obtained:

- diagnostic model of the j -th basic object of equipment;
- a graphic view of the current repair program, which includes diagnostic programs for the j -th object, as well as technological operations of replacing the failed element and output serviceability check after the repair;
- failure probabilities \overrightarrow{q}_n of elements of the object of current repair, where n is the number of elements of the diagnostic model;
- average values of the duration of technological operations of parameter control t_{ci} ($i = 1, n$) at the outputs of elements of the diagnostic model, replacement of failed elements t_{Repi} , and output serviceability check t_{OSC} ;
- average values of the cost of performing technological operations of parameter control C_{ci} at the outputs of diagnostic model elements, replacement of failed elements C_{Repi} , and output serviceability check C_{OSC} ;
- average values of labor intensity of performing technological operations of parameter control L_{ci} at the outputs of elements of the diagnostic model, replacement of failed elements L_{Repi} , and output serviceability check L_{OSC} ;
- probabilities of errors of the first and second kind (α and β), characterizing the uncertainty in decision-making regarding the actual values of the controlled parameters.

The diagnostic model of the equipment as the object of current repair is not necessarily a repetition of its structural or functional scheme. This model must be shown in the form of a graph, during the construction of which a number of assumptions must be used. After making a decision on detection of the failed element, it is necessary to replace it with a serviceable one and check the functionality of the entire SE. If the SE is in serviceable condition, the current repair process ends. Otherwise, the follow-up strategy should be implemented for the cases of the first and second type errors presence.

Let us consider analytical correlations in case of absence of errors of the first and second kind. While calculating the failure probabilities \overrightarrow{q}_n of elements of the j -th object of current repair and probabilities \overrightarrow{Q}_{K-1} for others $K - 1$ objects, we can use the method of approximate reliability assessment. For this case, the failure rate λ_j for the j -th object is determined first. After that, the failure rates of other objects are calculated with the help of correction factors ρ_h . Then

$$\Lambda_h = \rho_h \lambda_j, h = \overline{1, K - 1}. \quad (1)$$

This approach makes it possible to simplify the analysis of the efficiency of the current repair process. The coefficient $\rho_h > 1$ if, based on an expert assessment, it is considered that the h -th object is more complex in terms of schematic design than the basic j -th object. Otherwise $\rho_h < 1$.

During $\overrightarrow{Efficiency}(j|K)$ estimation, we introduce the set of technological procedures (STP). The STP contain all required operations necessary to recover equipment serviceability. According to probability theory separate STPs make a complete group of

events. The number of STP is equal to the number of elements of the diagnostic model. Each STP is characterized by conditional duration, cost and labor intensity $t(STP_i|j, K)$, $C(STP_i|j, K)$ and $L(STP_i|j, K)$. In this case STP_i denotes the STP for the failure of the i -th SE in the object of current repair.

After averaging for values $t(STP_i|j, K)$, $C(STP_i|j, K)$ and $L(STP_i|j, K)$ and taking into account failure probabilities \vec{q}_n of elements of the object of current repair, we can the equations for $\overrightarrow{Efficiency}(j|K)$ calculation

$$E(t_r|j, K) = \sum_{i=1}^n t(STP_i|j, K)q_i, \tag{2}$$

$$E(C_r|j, K) = \sum_{i=1}^n C(STP_i|j, K)q_i, \tag{3}$$

$$E(L_r|j, K) = \sum_{i=1}^n L(STP_i|j, K)q_i, \tag{4}$$

$$s(t_r|j, K) = \sqrt{\sum_{i=1}^n (t(STP_i|j, K) - E(t_r|j, K))^2 q_i}, \tag{5}$$

$$s(C_r|j, K) = \sqrt{\sum_{i=1}^n (C(STP_i|j, K) - E(C_r|j, K))^2 q_i}, \tag{6}$$

$$s(L_r|j, K) = \sqrt{\sum_{i=1}^n (L(STP_i|j, K) - E(L_r|j, K))^2 q_i}. \tag{7}$$

The probability of correct diagnostics and decision-making on failed element is characterized by probability mass function with following statistical estimates of expected value and standard deviation

$$E(P_{cd}|j, K) = \sum_{i=1}^n D(STP_i|j, K)q_i, \tag{8}$$

$$s(P_{cd}|j, K) = \sqrt{\sum_{i=1}^n (D(STP_i|j, K) - E(P_{cd}|j, K))^2 q_i}, \tag{9}$$

where $D(STP_i|j, K)$ is conditional probability of correct diagnostics in case of the i -th SE failure.

The values of efficiency indicators $\overrightarrow{Efficiency}(j|K)$ are basic values for others $K - 1$ objects. The calculation of efficiency indicators $\overrightarrow{Efficiency}(K - 1|K)$ can be carried out based on following equations

$$E(t_r|h) = E(t_r|j, K)\rho_{h,1}, \tag{10}$$

$$s(t_r|h) = s(t_r|j, K)\rho_{h,1}, \tag{11}$$

$$E(C_r|h) = E(C_r|j, K)\rho_{h,2}, \tag{12}$$

$$s(C_r|h) = s(C_r|j, K)\rho_{h,2}, \tag{13}$$

$$E(L_r|h) = E(L_r|j, K) \rho_{h,3}, \tag{14}$$

$$s(L_r|h) = s(L_r|j, K) \rho_{h,3}, \tag{15}$$

where $\rho_{h,1}$, $\rho_{h,2}$ and $\rho_{h,3}$ are correction coefficients for evaluating the numerical values of the efficiency indicators of the repair of the h -th object from the studied group of equipment in terms of duration, cost, and labor intensity, respectively.

The next step is approximate estimation of efficiency indicators $\overrightarrow{Efficiency}(U)$ for equipment with spare parts. The equations for calculation the efficiency for the ψ -th object are following

$$E(t_r|\psi, U) = A(\psi)[E(t_{Rep}(\psi)) + E(t_{OSC}(\psi))] + (1 - A(\psi))[E(t_{Buy}(\psi)) + E(t_{Del}(\psi)) + E(t_{Rep}(\psi)) + E(t_{OSC}(\psi))], \tag{16}$$

$$s(t_r|\psi, U) = a_t E(t_r|\psi, U), \tag{17}$$

$$E(C_r|\psi, U) = A(\psi)[E(C_{Rep}(\psi)) + E(C_{OSC}(\psi))] + (1 - A(\psi))[E(C_{Buy}(\psi)) + E(C_{Del}(\psi)) + E(C_{Rep}(\psi)) + E(C_{OSC}(\psi))], \tag{18}$$

$$s(C_r|\psi, U) = a_C E(C_r|\psi, U), \tag{19}$$

$$E(L_r|\psi, U) = A(\psi)[E(L_{Rep}(\psi)) + E(L_{OSC}(\psi))] + (1 - A(\psi))[E(L_{Buy}(\psi)) + E(L_{Del}(\psi)) + E(L_{Rep}(\psi)) + E(L_{OSC}(\psi))], \tag{20}$$

$$s(L_r|\psi, U) = a_L E(L_r|\psi, U), \tag{21}$$

where $A(\psi)$ is steady-state availability for the system of spare part support for each ψ -th object and considered type of SE; $E(t_{Rep}(\psi))$, $E(C_{Rep}(\psi))$ and $E(L_{Rep}(\psi))$ are expected time, cost and labor intensity for replacement of ψ -th failed object; $E(t_{OSC}(\psi))$, $E(C_{OSC}(\psi))$ and $E(L_{OSC}(\psi))$ are expected time, cost and labor intensity for output serviceability check of ψ -th object; $E(t_{Buy}(\psi))$, $E(C_{Buy}(\psi))$ and $E(L_{Buy}(\psi))$ are expected time, cost and labor intensity for buying ψ -th failed object; $E(t_{Del}(\psi))$, $E(C_{Del}(\psi))$ and $E(L_{Del}(\psi))$ are expected time, cost and labor intensity to deliver ψ -th failed object; a_t , a_C and a_L are coefficient for estimating standard deviation for time, cost and labor intensity of ψ -th failed object.

Analysis showed that the most suitable coefficients are $A(\psi) = 0.95$, $a_t = 0.1$, $a_C = 0.15$ and $a_L = 0.15$.

3.5 Calculation of Numerical Values of Efficiency Indicators of Single Current Repair Procedure

The initial data for calculating numerical values of efficiency indicators of single current repair procedure for all aviation radio equipment contain:

- the probabilities of failure $\overrightarrow{Q_M}$. f all aviation radio equipment;

- numerical values of conditional indicators of the efficiency of the current repair of aviatoradio equipment $\overrightarrow{Efficiency}(j|K)$, $\overrightarrow{Efficiency}(K - 1|K)$ and $\overrightarrow{Efficiency}(U)$;
- expected values and standard deviations for time, cost and labor intensity for searching failed SE in the object of current repair: $E(t_{ro})$, $s(t_{ro})$, $E(C_{ro})$, $s(C_{ro})$, $E(L_{ro})$, and $s(L_{ro})$.

In the general case, during the search for a failed element of a certain type of aviation radio equipment, a priori determined number of diagnostic programs must be implemented. Therefore, without losing generality, we will assume that the elements of all M . objects of current repair are detected as a result of the execution of the same number of diagnostic programs.

The formulas for calculating efficiency in the form of the duration of the current repair process will take the following form:

$$E(t_r) = E(t_{ro}) + E(t_r|\overrightarrow{Q_M}), \tag{22}$$

$$E(t_r|\overrightarrow{Q_M}) = \sum_{\psi=1}^U E(t_r|\psi, U)Q_\psi + \sum_{h=1}^{K-1} E(t_r|h)Q_h + E(t_r|j, K)Q_j, \tag{23}$$

$$s(t_r) = \sqrt{s^2(t_{ro}) + s^2(t_r|\overrightarrow{Q_M})}, \tag{24}$$

$$s^2(t_r|\overrightarrow{Q_M}) = \sum_{\psi=1}^U s^2(t_r|\psi, U)Q_\psi + \sum_{h=1}^{K-1} s^2(t_r|h)Q_h + s^2(t_r|j, K)Q_j. \tag{25}$$

The formulas for calculating efficiency in the form of the cost of the current repair process will take the following form:

$$E(C_r) = E(C_{ro}) + E(C_r|\overrightarrow{Q_M}), \tag{26}$$

$$E(C_r|\overrightarrow{Q_M}) = \sum_{\psi=1}^U E(C_r|\psi, U)Q_\psi + \sum_{h=1}^{K-1} E(C_r|h)Q_h + E(C_r|j, K)Q_j, \tag{27}$$

$$s(C_r) = \sqrt{s^2(C_{ro}) + s^2(C_r|\overrightarrow{Q_M})}, \tag{28}$$

$$s^2(C_r|\overrightarrow{Q_M}) = \sum_{\psi=1}^U s^2(C_r|\psi, U)Q_\psi + \sum_{h=1}^{K-1} s^2(C_r|h)Q_h + s^2(C_r|j, K)Q_j. \tag{29}$$

The formulas for calculating efficiency in the form of the labor intensity of the current repair process will take the following form:

$$E(L_r) = E(L_{ro}) + E(L_r|\overrightarrow{Q_M}), \tag{30}$$

$$E(L_r|\overrightarrow{Q_M}) = \sum_{\psi=1}^U E(L_r|\psi, U)Q_\psi + \sum_{h=1}^{K-1} E(L_r|h)Q_h + E(L_r|j, K)Q_j, \tag{31}$$

$$s(L_r) = \sqrt{s^2(L_{ro}) + s^2(L_r|\overrightarrow{Q_M})}, \tag{32}$$

$$s^2(L_r|\vec{Q}_M) = \sum_{\psi=1}^U s^2(L_r|\psi, U)Q_\psi + \sum_{h=1}^{K-1} s^2(L_r|h)Q_h + s^2(L_r|j, K)Q_j. \quad (33)$$

Numerical values of parameters according to formulas (25), (29) and (33) are approximate. The numerical values of the parameters $E(t_{ro})$, $E(C_{ro})$, $E(L_{ro})$ are determined on the basis of information on the schematic and structural features of the aviation radio equipment, the number of diagnostic programs, as well as the time, costs, and labor intensity during repair.

Then we define the parameters $s(t_{ro})$, $s(C_{ro})$, $s(L_{ro})$ as follows.

$$s(t_{ro}) = a_t E(t_{ro}), s(C_{ro}) = a_c E(C_{ro}), s(L_{ro}) = a_L E(L_{ro}). \quad (34)$$

Further, we believe that the numerical values of each of the parameters t_r , C_r , L_r are characterized by Gaussian (normal) probability distribution. Taking this into account, threshold values for duration, costs and labor intensity can be determined that correspond to levels of significance $\theta_t^{(0)}$, $\theta_C^{(0)}$ and $\theta_L^{(0)}$. The threshold values are calculated by solving the equations:

$$P(t_r \geq t_r^{\text{th}}(\theta_t^{(0)})|E(t_r), s(t_r)) \leq \theta_t^{(0)}, \quad (35)$$

$$P(C_r \geq C_r^{\text{th}}(\theta_C^{(0)})|E(C_r), s(C_r)) \leq \theta_C^{(0)}, \quad (36)$$

$$P(L_r \geq L_r^{\text{th}}(\theta_L^{(0)})|E(L_r), s(L_r)) \leq \theta_L^{(0)}. \quad (37)$$

Then

$$t_r^{\text{th}}(\theta_t^{(0)}) = \gamma_t s(t_r) + E(t_r), \quad (38)$$

$$C_r^{\text{th}}(\theta_C^{(0)}) = \gamma_C s(C_r) + E(C_r), \quad (39)$$

$$L_r^{\text{th}}(\theta_L^{(0)}) = \gamma_L s(L_r) + E(L_r), \quad (40)$$

where γ_t , γ_C and γ_L are the arguments of the probability integrals in Laplace form, which are respectively equal to $(1 - \theta_t^{(0)})$, $(1 - \theta_C^{(0)})$ and $(1 - \theta_L^{(0)})$.

4 Results and Discussions

This section presents the numerical example of calculation of efficiency of current repair procedures for the case when object of current repair is receiver of radio communication equipment. This device can be presented in form of diagnostic model that twelve SE. We assume that information about failure probabilities \vec{q}_{12} of elements of the object of current repair is known and the errors of the first and second kind are possible. Let

$$\begin{aligned} q_1 &= 0.023, q_2 = 0.047, q_3 = 0.052, q_4 = 0.059, q_5 = 0.055, \\ q_6 &= 0.058, q_7 = 0.124, q_8 = 0.082, q_9 = 0.231, q_{10} = 0.111, \\ q_{11} &= 0.12, q_{12} = 0.028, \alpha = 0.01, \beta = 0.02 \end{aligned}$$

The search of failed SE was realized using engineering approach. The corresponding diagnostic program is source for obtaining the probability mass function of the probability of correct decision-making. The calculated probability mass function is shown in Fig. 1.

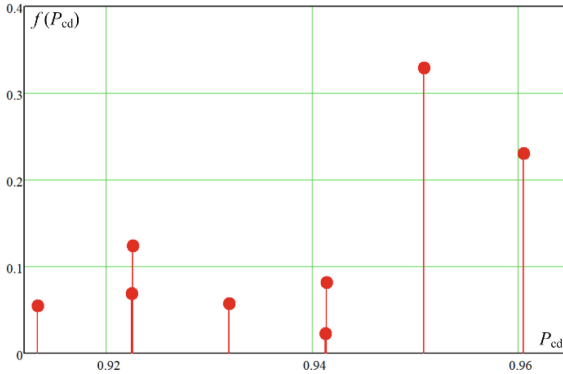


Fig. 1. Visual presentation of probability mass function of the probability of correct decision-making.

The presented probability mass function contains complete information about considered efficiency indicator, including expected value and standard deviation. Figure 2 and Fig. 3 show the dependencies of expected value and standard deviation of the probability of correct decision-making on the probabilities of the errors of the first and second kind. We can see that for $\alpha = \beta = 0$, we get $E(P_{cd}) = 1$ that confirms the correctness of calculation.

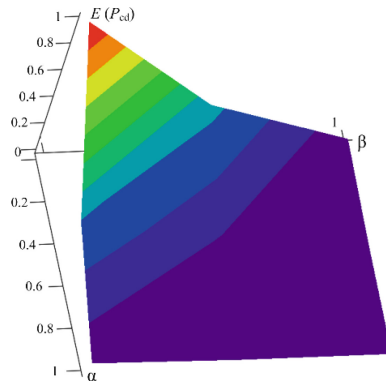


Fig. 2. The dependence of expected value of the probability of correct decision-making on the probabilities of the errors of the first and second kind.

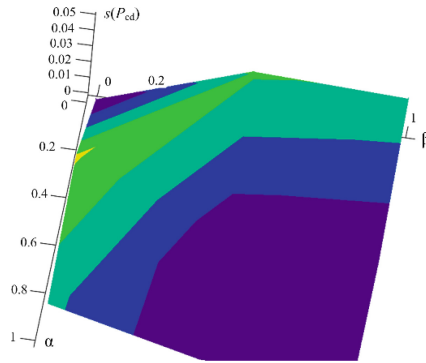


Fig. 3. The dependence of standard deviation of the probability of correct decision-making on the probabilities of the errors of the first and second kind.

5 Conclusions

The paper considers the issue of developing the methodology for calculating the numerical values of the efficiency indicators of the current repair for aviation radio equipment. The analytical ratios are given for the expected values and standard deviations of the duration, costs, and labor intensity of the repair process. The step-by-step instructions for evaluating efficiency are considered. The obtained calculation results confirmed the complex stochastic nature of the evaluated indicators and the necessity of their usage for timely and correct preventive actions.

The presented results can be used while solving the task of creating a subsystem for the current repair of aviation radio equipment that is the part of OS, during the improvement of these subsystems, and during the analysis of certain OS in case of repair procedures implementation.

6 Future Scope

The future research directions will be associated with: the substantiation of statistical characteristics of diagnostics process; the calculation of optimal repair personnel for aviation radio equipment; improvement of operation processes; building the optimal structure of repair enterprises for the level of country.

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