Determination of Deviation Risk of an Event from Mathematical Expectation When Managing Research in Space and Time

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Abstract The paper analyses various time segments of a random process and shows how the covariance of the values of random functions for different times is displayed. It is accepted that any type of management involves the optimal use of factors, avoiding the uncertainties that are inevitable with a statistical approach to the sequencing of scientific research. The model includes the risk minimization of the real process deviation from the anticipated one. The concept of the quasi-ergodic idea of two functions, which characterize this concept with the corresponding form of integrals, is important for a further understanding of the presented theory. Various time segment of a random process are analyzed during the scientific research, and it is shown how the covariance of random functions’ values for times is manifested. The proposed model allows us to expand the boundaries of the automation of the research management process in space and time, taking into account the risk associated with the use of factors of the digital model.

1. Introduction

It was established that it is possible to build the sequence of management strategy of scientific search on the basis of a digital model, which creates the prerequisites for the automation of research activities, a significant increase in the effectiveness of scientific and technological development. A digital model is formed from a combination of statistical information that reflects the retrospective results of the process under analysis, the interdependence of targets and factors.

Visualization of the digital model allows us to illustrate the construction of various variants of management strategy for the solution of the problem and determine the best option which is considered to be as the shortest distance between the isoquants of the surface described by the digital model [1,2,3].

Regardless of the causes of the risk, deviations of the characteristics of research process from the given parameters, each agent seeks to reduce the possible losses associated with the implementation of this risk by making managerial decisions. The risk prediction which is based on its acceptable values for making unambiguous management decisions concerning the process under analysis in space and time is a very urgent task [4-15].
The risk management is not an instantaneous act, but it should be included into the general managerial decision-making process. When setting optimization problems, along with the criteria, the restrictions are expected to be set on the parameters and process variables, i.e. the permissible variations that determine the functioning of the process [16, 17]. The achievement of objectives obtained by means of functions' performance. In the management of research the computing equipment has the tasks of accounting and monitoring the achievement of the given parameters, starting and stopping the solution of the problem, maintaining the given operating mode of the equipment and stabilizing the given parameters. The main difference of the approach under consideration is that the digital model based on the statistical data of the process under analysis is the basis of risk management.

The problem is that the existing management system of the research process does not meet the requirements and accuracy opportunities that allow the process to be carried out automatically. The goal of research is to determine the risk of an event deviating from a mathematical expectation when managing a research process according to a strategy.

Research objectives:
1. To establish a control criterion for an automated scientific search system.
2. To highlight the quasi-ergodicity of the process through the manifestation of the covariance of the values of random functions for different time segments.
3. To determine the calculated values of factor $X_1$ for various points in time, ensuring the security of the research from external risks associated with the influence of other factors.

2. Methods
The largest companies in the world including NASA use the 4-D System. It allows measuring the team capabilities and people behavior that affect team performance and risk management. The 4-D system shows how to improve the performance of business and projects, and it is especially in demand in multi-level large-scale projects and assignments, as well as in complex or critical situations [18]. An automated research management system is a person-machine control system that provides automated collection and processing of information necessary for the optimization of the management of a production facility in accordance with the accepted criterion.

The ratio that characterizes the quality of the managed object as a whole and takes specific numerical values depending on the managerial actions which are used is taken as the control criterion of an automated system of scientific search. It is proposed to conduct the planning on the basis of the theory of random processes, which allows the use of representative statistics that reflect the vast majority of external and internal processes taking into account the object of risk management. The design calculation of reliability is part of the mandatory work ensuring the reliability of any automated system and is based on the requirements of regulatory and technical documentation [19].

The assumption is made that for a given sample size, the risk cannot be less than some $R_0$ (for example, 5%). It is necessary to achieve a narrowing of the control area (relative to the mathematical expectation of a random process) to the interval $[-\delta; \delta]$, which greatly facilitates the management, helps avoiding unforeseen risks. For the control in space and time, time segments and control parameters are indicated, which allows automating significantly the control process.

We introduce the concept of quasi-ergodicity of two functions, which is important for a further understanding of the presented theory, characterizing this concept only by the form of integral

$$\frac{1}{b-a} \int_a^b f(t)dt$$ (Fig. 1).
Figure 1. Quasi-ergodicity of the process, indicating the dependence only on average mean values of the functions \( y = f(t) \) on the interval \([a; b]\), regardless of the shape of the curves.

As it is known, the concept of ergodicity is used in the theory of random functions and means that for any two random processes \( y = f_i(t) \) and \( y = f_j(t) \) the condition is fulfilled

\[
\frac{\frac{1}{2t} \int_{-t}^{t} f_i(t) dt}{\frac{1}{2t} \int_{-t}^{t} f_j(t) dt} = 1,
\]

i.e. the ratio of the mathematical expectations of any two random processes on the same interval \([-t, t]\) are equal to one another.

Obviously, the formula (1) is also valid for the interval \([0; t]\), i.e.

\[
\frac{\frac{1}{t} \int_{-t}^{t} f_i(t) dt}{\frac{1}{t} \int_{-t}^{t} f_j(t) dt} = 1,
\]

Since mathematical expectations are equal for an ergodic process at all equal intervals, for example, for functions \( y = -t^2 + \frac{2}{3} \) and \( y = t^2 \), then the ratio of their mathematical expectations is:

\[
\frac{\frac{1}{1} \int_{0}^{1} (-t^2 + \frac{2}{3}) dt}{\frac{1}{1} \int_{0}^{1} t^2 dt} = \left(\frac{\frac{1}{3}}{\frac{3}{3}}\right) = \frac{-\frac{2}{3} + \frac{2}{3}}{\frac{3}{3}} = 1.
\]

For the functions of a random type, the integrals of the mean values of the functions on the same interval are equal, i.e. the mathematical expectations are equal.

It should be noted that all possible implementations of the random process under consideration are described by a function, for example, of type \( y_i = C_i \sqrt{t}, \quad i = 1, n \). We introduce this function into the function (1) on the intervals \([0, t_i]\) and \([0, t_2]\).
\[
\frac{1}{t_2} \int_{t_0}^{t_2} C_i \sqrt{t} dt = \frac{1}{t_2} \int_{t_0}^{t_2} C_{ME} \sqrt{t} dt
\]

where \( C_{ME} \) - management coefficient \( y = C_{ME} \sqrt{t} \), which describes the mathematical expectation of the curve of a random process.

The validity of formula (2) becomes obvious if we reduce the constants \( C_i \) and \( C_{MO} \) and the same multipliers in the left and right sides of formula (2).

By way of analogy with formula (1), we call a random such a process which has quasi-ergodic characteristics (Fig. 2). It should be noted that an additional justification for this term is given by the fact that formula (2) implies formula (1) accurate to a numerical factor.

**Figure 2.** Quasi-ergodicity of the process through the manifestation of covariance of the values of random functions for various time segments.

Let’s take \( y_i = f_i(t) \) and \( y_j = f_j(t) \) as two random processes. Then for any time segments \( t_k \) and \( t_{k+1} \) we have:

\[
\frac{y_j(t_{k+1})}{y_j(t_k)} = \frac{y_i(t_{k+1})}{y_i(t_k)}, \text{ at } i \neq j.
\]

**3. Results**

Since we will analyze various further time segments of a random process, we will show how the covariance of the values of random functions for different times is shown. In the scientific research [7], we obtained a function \( \dot{X}_1(t) = 886.7 \sqrt{t} \), that describes the intensity of factor \( X_1 \) consumption over time.

Let’s find the integral, \( \int_0^6 886.7 \sqrt{t} dt = \frac{2}{3} \frac{2}{3} \frac{6^6}{4} = 886.7 \cdot 6^{2/3} \cdot \frac{2}{3} = 8689, \) and it coincides with the mathematical expectation of a random variable given by the first column of the table given below (segment \( t=6 \)). The time in months is 6 and it is a planned deadline for the work. We similarly define the integral \( \int_0^5 886.7 \sqrt{t} dt = 6608.7; \)
In all calculations, the time associated with $X_i$, is analyzed, i.e. $t_i$.

Then we define the coefficients of quasi-ergodicity, i.e. the ratio of the time segments of the mathematical expectation of the random process of consumption of factor $X_i$ under consideration. The meaning of these coefficients is seen from their definition:

$$K_{m,n} = \frac{\int_0^{t_m} X_1(t) dt}{\int_0^{t_n} X_1(t) dt}.$$

Let us show how this formula is used. We found all the necessary integrals. So:

$$K_{6,5} = \frac{\int_0^{\frac{\dot{X}_1(t) dt}{2}} X_1(t) dt}{\int_0^{\frac{\dot{X}_1(t) dt}{5}} X_1(t) dt} = \frac{66087}{30714} = 1.314; \quad K_{5,4} = \frac{\int_0^{\frac{\dot{X}_1(t) dt}{4}} X_1(t) dt}{\int_0^{\frac{\dot{X}_1(t) dt}{5}} X_1(t) dt} = \frac{16719}{5911} = 2.828.$$

It should be noted that $K_{m,n}$ depends on the distance (time) between the segments $t_m$ and $t_n$, which can be seen from the following diagram (Fig. 3).

![Diagram illustrating the dependence of the quasi-ergodicity coefficient on time.](image)

**Figure 3.** Diagram illustrating the dependence of the quasi-ergodicity coefficient on time.

In accordance with the principle of quasi-ergodicity, the same $K_{m,n}$ are valid for any implementation of the random process under consideration. Let us analyze the principle of constructing the segments of a random process for the following Table 1. The value of the random
variable $X_t$ for the time segment $t = 6$ was taken from the experimental data.

**Table 1** of the sample for the calculation of 95% confidence intervals.

| $t=6$  | $t=5$  | $t=4$  | $t=3$  | $t=2$  | $t=1$  |
|--------|--------|--------|--------|--------|--------|
| 8767   | 6672   | 4776   | 3101,3 | 1682,2 | 597    |
| 8792   | 6691   | 4789,5 | 3110,1 | 1693   | 598,6  |
| 8657   | 6588,3 | 4716   | 3067,3 | 1667   | 589,5  |
| 8798   | 6595,6 | 4721,3 | 3065,7 | 1668,9 | 590,1  |
| 8771   | 6675,0 | 4778   | 3102,6 | 1688,9 | 597,2  |
| 9026   | 6869,0 | 4917,0 | 3192,8 | 1738,0 | 614,6  |
| 9134   | 6951,3 | 4975,9 | 3231,1 | 1758,9 | 622    |
| 8992   | 6843,3 | 4898,6 | 3180,9 | 1731,6 | 612,3  |
| 8974   | 6829,5 | 4888,7 | 3174,5 | 1728   | 611    |
| 8949   | 6810,5 | 4875,1 | 3165,6 | 1723,2 | 609,3  |
| 7537   | 5735,9 | 4105,9 | 2666,2 | 1451,4 | 513,2  |
| 7819   | 5950,5 | 4259,5 | 2765,9 | 1505,7 | 532,4  |
| 9124   | 6943,7 | 4970   | 3227,3 | 1756,8 | 612,2  |
| 8013   | 6098,2 | 4365,2 | 2834,5 | 1543   | 545,6  |
| 7916   | 6024,3 | 4312,3 | 2800,2 | 1524,3 | 539    |
| 8527   | 6489,3 | 4645   | 3016,2 | 1641,9 | 580,6  |
| 8391   | 6385,8 | 4571   | 2968,2 | 1615,8 | 571,3  |
| 9328   | 7098,9 | 5081,5 | 3299,7 | 1796,2 | 635,2  |
| 9105   | 6929,2 | 4960   | 3220,8 | 1753,3 | 620    |
| 8579   | 6528,9 | 4675,5 | 3036   | 1652,7 | 584,4  |
| 7958   | 6056,3 | 4335,2 | 2815,1 | 1532,4 | 541,9  |
| 9213   | 7011,4 | 5018,9 | 3259   | 1774,1 | 627,3  |
| 8979   | 6833,3 | 4991,4 | 3241,2 | 1764,4 | 623,9  |
| 9432   | 7178   | 5138   | 3336,4 | 1816,2 | 642,2  |
| 7923   | 6029,6 | 4316   | 2802,6 | 1525,6 | 539,5  |
| 8122   | 6181   | 4424,5 | 2873   | 1564   | 553    |
| 9247   | 7037,3 | 5037,4 | 3271   | 1780,6 | 629,6  |
| 8255   | 6282,3 | 4497   | 2920,1 | 1589,6 | 562,1  |
| 9008   | 6855,4 | 4907,2 | 3186,5 | 1734,6 | 613,4  |
| 9296   | 7074,6 | 5064,1 | 3288,4 | 1790   | 632,9  |

From the formula for $K_{n,n}$, it follows that in order to find the values of a random variable in the time segment $t=5$, it is necessary to divide the values of the random variable at $t=6$ by $K_{6,5} = 1.314$, for the time segment $t = 5$ we get:
For the time segment \( t = 4 \), we do the same, recalculate the sample for \( t = 5 \) with the quasi-ergodicity coefficient \( K_{5,4} = 1.397 \).

\[
\frac{6672}{1.397} = 4775.95; \quad \frac{6691}{1.397} = 4789.5 \quad \text{and so on.}
\]

The remaining columns of Table 1 are calculated in a similar way.

It should be noted that the minimum and maximum elements of time segments are in the same rows of the table. This fact proves the quasi-ergodicity of the random process, as evidenced by the values of the numbers in bold.

Any control involves the optimal use of factors, avoiding the uncertainties that are inevitable when the statistical approach to the planning of scientific research is used [20]. It is necessary to minimize the risk of deviation of the real process from the planned one. Having received the data for the table given above, we can calculate the optimal management. At the same time we assume that:

- In accordance with the Khinchin – Kolmogorov theorem, the spectral power density of a stationary, in the broad sense, random process is the Fourier transform of the corresponding autocorrelation function. Time segments of the random process of the use of factor \( X_i \) are samples from a normally distributed sampled population [21].
- The estimated minimum risk should be taken as \( R = 5\% \), i.e. the probability of the problem’s solution is 95\%, which corresponds to the conditions of the sample size \( n = 30 \).

Let us carry out some preliminary calculations: \( t = \sqrt{n \frac{\delta}{\sigma}} \), where \( n = 30 \) – sample size, \( \delta = 181.74 \) – evaluation precision, \( \sigma = 508.12 \) – mean square deviation, \( t \) - Laplace function argument – \( \Phi(t) \). \( t = \sqrt{30 \frac{181.74}{508.12}} = 1.96 \). Then from the table of values on the basis of the Laplace function is \( \Phi(1.96) = 0.475 \). Calculation reliability: \( P = 2 \cdot 0.475 = 0.95 \), i.e. 95\%.

We give a detailed calculation of the interval \( 2\delta \), in which the values of \( X_1 \) for the time segment \( t_6 \) fall with a risk of 5\%. Since the calculations for the remaining segments \( t = 5, 4, 3, 2, 1 \) are the same, they will be presented more briefly.

1. For the time period \( t = 6 \). Calculation method is \([-\delta, \delta]\).

The values of the random variable \( X_{1,6} \) are shown in the first column of Table 1. The maximum and minimum values of \( X_1 \) are in bold: \( X_{\text{min}} = 7537; \quad X_{\text{max}} = 9432 \). We divide the interval \([7537; 9432]\) into three partial intervals in width \( h = \frac{X_{\text{max}} - X_{\text{min}}}{3} = \frac{9432 - 7537}{3} = 631.7 \).

The number of partial intervals is selected under the condition of obtaining in each interval 8-10 options.

The sample presented in the first column of Table 1 can be described by three intervals of width \( h = 631.7 \). In particular they are \([7537; 8168.7], \quad [8168.7; 8800.4], \quad [8800.4; 9432]\). Then we find the middle of partial intervals:

\[
\text{Frequency } n_i \quad 7537 + 8168.7 \quad 8800.4 + 9432
\]

Let's move on to three equally spaced versions of \( X_i \):

\[
X_i \quad 7852.8 \quad 8484.5 \quad 9116.2
\]

7 + 9 + 14 = 30 – sample size is equal to row number in Table 1 \( n_i \) is determined by the first column of Table 1, indicating the number of options falling into the partial interval with the specified middle.

For further calculations, we need to determine the sample mean and variance, which we will calculate by means of the production method, which is used for the samples with equally spaced
options: $X_m = M^*_h + C$; $D_a = [M^*_2 - (M^*_1)^2]h^2$, where $C$ – false zero (option located in the middle of the sample). We have $C = 8484.5$, $h$ – partial interval width – 631.7. Let us calculate: $u_i = \frac{x_i - C}{h}$.

Conditional option: $M^*_1 = \frac{\sum n_i u_i}{n}$ - conditional option of the first order; $M^*_2 = \frac{\sum (n_i u_i^2)}{n}$ - conditional option of the second order.

The calculation results are shown in Table 2.

|   | 1  | 2  | 3  | 4  | 5  | 6  |
|---|----|----|----|----|----|----|
| $X_m$ | 7852.8 | 7 | -1 | -7 | 7 | 0 |
| $X_m$ | 8484.5 | 9 | 0 | 0 | 0 | 9 |
| $X_m$ | 9116.2 | 14 | 1 | 14 | 14 | 56 |
| $X_m$ | 30 | 0 | 7 | 21 | 65 | 65 |

Let us check the correctness of the calculations.

$$\sum n_i (u_i + 1)^2 = \sum n_i u_i^2 + 2 \sum n_i u_i + n = 65$$

$$\sum n_i u_i^2 + 2 \sum n_i u_i + n = 65.$$  

65 = 65 – so, the calculations are correct.

We calculate the conditional moments of the first and second orders:

$$M^*_1 = \frac{\sum n_i u_i}{n} = \frac{2}{30} = 0.23; \quad M^*_2 = \frac{\sum (n_i u_i^2)}{30} = \frac{21}{30} = 0.7.$$  

The sample mean is:

$$X_m = M^*_h + C = 0.23 \cdot 631.7 + 8484.5 = 8629.79.$$

In Table 1, for the time segment $t = 6$, the average mean value (experimental game) is 8689, which is close to the value $X_m$, what indicates the adequacy of the theory and the experiment.

Let us calculate the dispersion of the time segment $t = 6$.

$$D_a = [M^*_2 - (M^*_1)^2]h^2 = \left[0.7 - (0.23)^2\right] (631.7)^2 = 258182.$$ Hence we get the standard deviation $\sigma_a = \sqrt{D_a} = 508.12$.

The interval estimate for the mathematical expectation of the integral population (provided that the sample is the 1st column) is representative and can be written as:

$$X_m - t\sigma / \sqrt{n} < X < X_m + t\sigma / \sqrt{n},$$

where $n$ – sample size, $n = 30$.

If we indicate the reliability of a random variable falling into a certain interval, so we have $P = 0.95 = \gamma$, and $t$ – Laplas function value $F(t) = \frac{1}{2} \gamma$, is found in the table. We have $F(t) = 0.475$, and consequently $t = 1.96$.

The confidence interval for the mathematical expectation of the population is:

$$8629.79 - 1.96 \cdot 508.12 / \sqrt{30} < X < 8629.79 + 1.96 \cdot 508.12 / \sqrt{30}.$$  

Hence we have $8448.05 < X < 8811.53$, i.e. the most probable values $X_1$ fall into the interval of width $\frac{8811.53 - 8448.05}{2} = 181.74$, what coincides with the value $\delta = \frac{1.96 \cdot 508.12}{\sqrt{30}} = 181.74$.  

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Consequently in segment $t = 6$, the deviation of the values of $X_1$ from 8689 with the probability 0.95 does not exceed 181.74, this determines the control to the moment $t = 6$.

According to the experiment $X_v = 8689$ (Table 1) what makes the middle of the interval $[8448.05; 8811.53]$, which is a confidence interval with 95% reliability. The deviation in the consumption of $X_1$ in time segment $t = 6$ from the expected value with the probability 0.95 does not exceed 181.74, what satisfies fully the practical requirements.

Further calculations for $t = 5, 4, 3, 2, 1$ are made in a similar way.

For reference:

Let us symbolize $\delta_k$ - the value of the deviation of the use of factor $X_1$ from the mathematical expectation with the risk of 5%, we get:

\[ \delta_1 = 12.4; \]
\[ \delta_2 = 35; \]
\[ \delta_3 = 64.23; \]
\[ \delta_4 = 98.97; \]
\[ \delta_5 = 138.3; \]
\[ \delta_6 = 181.74. \]

Let us find the dependence $\delta(t)$ as a function:

\[ \delta = dt^2 + bt + c. \]

\[ \begin{cases}
  a + b + c = 12.4 \\
  a + 4b + c = 98.97 \\
  36a + 6b + c = 181.79.
\end{cases} \]
4. Discussion

According to Cramer’s formulas:

\[
\begin{align*}
    a &= \frac{\Delta_1}{\Delta} = \frac{-75.17}{-30} = 2.5; \\
    b &= \frac{\Delta_2}{\Delta} = \frac{-489.85}{-30} = 16.3; \\
    c &= \frac{\Delta_3}{\Delta} = \frac{193.02}{-30} = -6.4.
\end{align*}
\]

Introducing the data into the formula (3) we get:

\[
\delta = 2.5t^2 + 16.3t - 6.4;
\]

where \( t \) time (months), \( 2 \delta \) - interval width, in which with the probability \( P=0.95 \) the deviations from the average mean \( \overline{X_\delta} \) more than \( \delta \) will not be observed.

The risk of deviations from \( \overline{X_\delta} \) more than \( |\delta| \) is 5%.

Thus, the obtained formula \( \delta = \delta (t) \) allows controlling the process of parameter conversion with a risk of 5% (with reliability \( P = 0.95 \)).

\[
X_1(t) = \frac{886.7 \sqrt{t}}{\sqrt{t}}; \quad X_1(t) = \int_0^t X_1(t) dt = \int_0^t \frac{886.7 \sqrt{t}}{\sqrt{t}} dt.
\]

For example: \( X_1(t) = \int_0^t 886.7 \sqrt{t} dt = 591.1 \) etc.

Figure 5. The calculated volumes of consumption of factor \( X_i \) for various time periods.

The values of the mathematical expectation in the time segments \( t = 1,2,3,4,5,6 \) are obtained, as shown earlier, using the integral \( \int_0^t 886.7 \sqrt{t} dt \), where we successively take \( t_i = 1,2,3,4,5,6 \).

In order to determine the calculated values of factor \( X_i \) for various time fragments, it is necessary to protect the process from external risks associated with the influence of other factors [27].

Therefore, in order to ensure a reliable operation of the system, it is necessary to have the corresponding value, for example, of the elements \( K \), which is determined for the time segment \( [t_i, t_{i+1}] \) using the formula:
\[
\frac{X(t_{i+1}) - X(t_i)}{Q} = K,
\]

Where \( Q \) – intensity of impact of elements \( K \).

For example, in the time interval \([5; 6]\) the following amount will be needed:

\[
\frac{8689 - 6608.7}{500} = 5\delta \theta.
\]

It can be interesting to compare the result obtained by the calculations by means of Lorentz transformation for \( X_i \). Let us assume that

\[
X'_{i} = \frac{X - mt}{\sqrt{1-u^2/c^2}},
\]

where \( c \) – light speed in the special theory of relativity. Let us take \( c = 1 \), because the speed of light \( c \) in Lorentz transformations is often written equal to unity [28, 7].

In our example, \( c \) makes sense having the maximum performance (or normative one). Then \( q \) is the intensity of additional elements for a particular system in fractions of \( c \).

Let us insert into the formula \( 8689 = \frac{6608.7 - 6q}{\sqrt{1-q^2}} \).

Further \( 75498721(1 - q^2) = (6608.7 - 6q)^2 = 43674915.7 - 79304 + 36q \).

From here it follows that:

\[
q^2 - 0.0005q - 0.42 = 0 \Rightarrow q = 0.0005 + 0.648q = 0.6485 \text{ (out of 1)}.
\]

This means that the intensity calculated in space and time should be 64.85% of the maximum (or normative one). From here it is easy to find the required number of elements.

As studies [29] show, quantum information processing and quantum computing carry a significant reserve of increasing the accuracy of determining the desired parameters.

5. Conclusion

The concept of quasi-ergodicity of two functions is introduced in the article, and these functions are represented by the corresponding forms of integrals. These concepts are important for the further development of the theory of research automation. The paper analyses various time segments of a random process and it is shown how the covariance of the values of random functions for different time periods is manifested. It was established that when planning a process it is extremely important to determine the risk of random situations with unforeseen consequences. The need is shown to have a functional relationship, which would allow calculating the risk of unforeseen consequences, as a random event that develops over time. When using the statistical characteristics, it is advisable to proceed from a 5% error (risk). For individual calculation points, \( t = 1, 2, 3, 4, 5, 6 \), in fact, the width of the \( 2\delta \) interval should be calculated, which includes the influence factor with unforeseen consequences with the probability of 0.95. This allows us to obtain the tabular dependence \( \delta = \delta(t) \), (1), and then move on to its analytical expression.

So that the system could function in a given way at the right time the necessary parameters of the factors are provided in an amount determined by the corresponding time interval. For the calculated parameters of the factors used in different periods of time, the reliability of the research process from the risks of erroneous decisions is ensured. The given model allows us to expand the boundaries of automation of the research management process in space and time, taking into account the risk associated with the use of factors of the digital model.

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