

METHOD FOR ASSESSING THE RELEVANCE OF AN INFORMATION RESOURCE OF AN AUTOMATED SYSTEM

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The relevance of an information resource in an automated system for information support for scientific research is defined as a key quality characteristic. A quantitative measure of information resource relevance – the probability of timely publication of scientific information materials – is proposed, and an algorithm for calculating its assessment is presented. The obtained results support decision-making in developing strategies and tactics for rational management of an information resource, taking into account the dynamics of the flow of its constituent materials.

Keywords: information resource; information support for scientific research; information resource quality; information resource relevance; timeliness of publication; information resource management.

Introduction

The high-tech nature of modern scientific and technical activity places high demands on its information support [1, 2]. The fundamental law of information and orderliness emphasizes that information is a vital resource for any organization, the basis for decision-making, management, and effective functioning, without which the organization cannot exist and develop [3, 4]. Indeed, an organization can only survive if it is provided with complete, reliable, and up-to-date information.

Currently, information support tasks are accomplished through specialized automated information support systems. Moreover, the quality of information support directly depends on the operational efficiency of such systems [5, 6]. Given the intended purpose and implementation specifics of technological cycles, the performance of automated information support systems is determined by two aspects:

- the quality of available (internal) information resources;
- the efficiency of searching for and providing requested information.

Given the high level of technical implementation of modern information retrieval mechanisms, the operational efficiency of automated information support systems should be considered as a function of the quality of the available information resources.

Thus, a new paradigm has emerged in which technology has become a means and high-quality content a goal. However, the quality management tasks of modern information resources remain poorly defined and, at the initial stages, require the development of specific algorithms that provide comprehensive assessments of the quality of information resources.

1. Statement of the Research Problem

The high intensity of modern scientific and technical activity determines the dynamism of information resources. New scientific and information materials are continually added to information resources, while those that have lost their pragmatic (scientific and applied) value are removed. Given the exponential growth of scientific and technical products, most experts emphasize the importance of ensuring the relevance of information resources [1, 4].

The relevance of an information resource is understood as its compliance with the current information needs of automated system users, as well as its ability to be quickly updated and accurately reflect the subject area.

The lack of relevance of information resources not only directly impacts the demand for a particular automated information support system but can also lead to its demise. For example, due in part to the slow receipt of new specialized materials, one of the industry subsystems of the state scientific and technical information system, which had existed for more than 20 years, ceased to exist in 2012 [7].

In a general sense, filling an information resource refers to the process of loading any information into the system's machine information base [8]. In the case of an automated information support system, the process of filling an information resource is significantly complicated by the specific requirements users place on information quality [9, 10]. As a rule, filling an information resource is a complex process that includes the stages of loading, checking, and directly publishing scientific information materials in the system [11].

It should be noted that in an automated information support system, various levels of automation of these stages are possible, which determines the stochastic nature of the processes of filling the information resources of automated information support systems as a whole. Given the above, it is advisable to describe the relevance of an information resource using a probabilistic indicator – the probability of timely publication of scientific information materials [9].

2. Algorithm for Calculating the Relevance of the Generated Information Resource

Studying the process of posting materials to an information resource requires constructing appropriate mathematical models that allow for the derivation of specific functional relationships for the characteristics under study.

Given the stochastic nature of the content creation process, it is advisable to base the developed algorithm on appropriate simulation models within the framework of queuing theory and the theory of random processes. We will specify the necessary concepts in the application of the processes under consideration.

A request is defined as scientific information material received by an automated information support system and requiring appropriate processing (checking compliance with the requirements of the off-machine information support system, the machine information base, and for originality) – service.

The software and hardware complex of the automated information support system that performs the prescribed processing of materials will be referred to as the service device. The time elapsed from the moment a material is received by the automated system

until its publication corresponds to the service duration. Finally, the collection of scientific information materials entering the automated information support system will be interpreted as a request flow. In the following, to simplify the developed algorithm, we will use the assumption of an infinite buffer size in the automated information support system. This implies that each uploaded material will be processed.

The central point of the developed algorithm is the selection of theoretical dependencies describing the observed processes, which requires a mathematical description of the request processing time. It should be noted that the actually observed parameters, in terms of distribution characteristics, accumulate their main properties at initial moments [12].

In the developed algorithm, the initial data are statistical data on the processing time of scientific information materials in the automated information support system, collected by internal monitoring tools.

To determine the distribution of application processing times based on available statistical data, it is necessary to calculate estimates of the arithmetic mean \bar{b} and variance σ^* of the processing time for scientific information materials prior to publication in the automated information support system. In the absence of sufficient statistical samples, at least at the initial stage of the automated information support system's operation, it is advisable to use the bootstrap Monte Carlo method of multiple sample generation.

Next, the variation coefficient ($\rho = \frac{\sqrt{\sigma^*}}{\bar{b}}$) is calculated, according to which the approximating distribution and the corresponding generating function for service time points are selected [12].

It should be taken into account that the total time scientific information material spends in the software and hardware complex is made up of the waiting time in the queue and the service time. Then, using Takacs's recurrence formula, it is necessary to determine the waiting time points for the material in the software and hardware complex [13]:

$$\bar{\omega}^n = \frac{\lambda}{1 - \rho} \sum_{i=1}^n \binom{n}{i} \frac{\bar{b}^{i+1}}{i+1} \bar{\omega}^{n-i}, \quad n = \overline{1, N},$$

where λ is the intensity of material receipt; ρ is the utilization factor ($\rho \triangleq \lambda \times \bar{b}$); \bar{b}^i is the i -th moment of service time.

Since the service time of a request is independent of its waiting time, the sojourn time of a request in the system is the sum of two independent random variables: the waiting time and the service time. Then, the final sojourn times can be determined by a binomial distribution of the form [13, 14]:

$$\bar{\omega}_{\Sigma}^n = \sum_{i=0}^n \binom{n}{i} \bar{b}^i \bar{\omega}^{n-i}, \quad n = \overline{1, N}.$$

Next, to obtain the final analytical model, an estimate of the variation coefficient is calculated, which is used to select an approximating function for the time materials remain in the software and hardware complex of the automated information management system. The approximation parameters are calculated using known initial conditions.

The resulting model allows us to estimate not only the probability of timely publication of materials but also the probability of exceeding the permissible publication time, which is valuable for the design and qualimetry of information systems.

3. An Example of the Implementation of an Algorithm for Calculating the Relevance of a Generated Information Resource

For simplicity, we assume that the statistical mean and variance of processing (service) time in an automated information support system allowed us to determine a statistical coefficient of variation equal to unity ($\varrho = \frac{\sqrt{\sigma^*}}{\bar{b}} = 1$). Considering that the corresponding coefficient of variation is possible with an exponential distribution of the random variable, the moment generating function will have the following form:

$$\bar{b}^i = \frac{i!}{\lambda^i}, \quad i = \overline{1, N},$$

where i – ordinal number of the moment.

Next, in accordance with the developed algorithm, we calculate estimates of the waiting times \bar{w}^n and the times materials are stored in the automated information support system, respectively, \bar{w}_Σ^n .

The above-determined time points allow us to determine the coefficient of variation of the residence time of scientific information materials in the automated information support system, which takes on values greater than one in this specific example ($\varrho' > 1$). Based on this, a hyperexponential distribution was chosen as the approximating distribution of the material's residence time in the system:

$$w(t) = \alpha\mu_1 e^{-\mu_1 t} + (1 - \alpha)\mu_2 e^{-\mu_2 t}.$$

In this case, the approximation parameters $w(t)$ for known initial moments \bar{w}^n and \bar{w}_Σ^n are calculated using the formulas [12]:

$$\mu_k = \frac{\nu_1\nu_2 - \nu_3 \pm \sqrt{D}}{2(\nu_2^2 - \nu_1\nu_3)}, \quad k = \overline{1, 2};$$

$$\alpha = \frac{\mu_1\mu_2\nu_1 - \mu_1}{\mu_2 - \mu_1},$$

where $D = (\nu_3 - \nu_1\nu_2)^2 - 4(\nu_2^2 - \nu_1\nu_3)(\nu_1^2 - \nu_2)$; $\nu_f = \frac{\bar{w}_\Sigma^n}{n!}$, $f = \overline{1, 3}$.

Based on the resulting expressions, the probability of timely publication of scientific information materials is estimated, as well as the probability of exceeding the permissible publication time (specified by experts or the resource owner):

$$W(t) = 1 - \alpha\mu_1 e^{-\mu_1 t} - (1 - \alpha)\mu_2 e^{-\mu_2 t}.$$

The probability of exceeding the permissible publication time is:

$$P_d(t_d) = 1 - W(t_d),$$

where t_d is the permissible delay in publishing the information material.

The implementation of the developed algorithm in the context of the example discussed can be represented by the diagram in Figure 1.

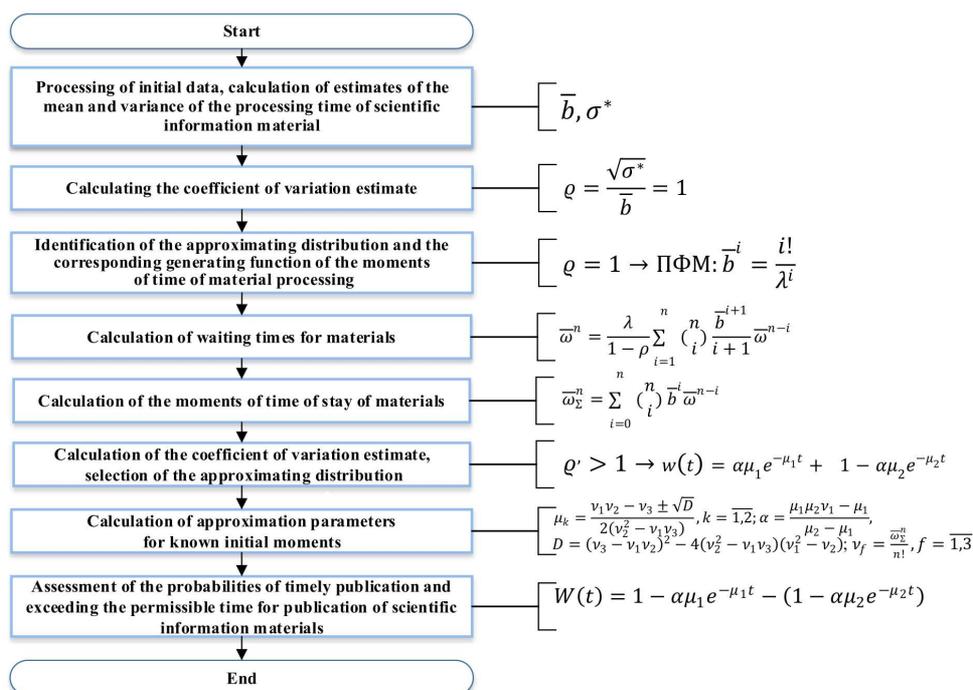


Fig. 1. Algorithm for calculating the timeliness of publication of materials in an information resource

4. Conclusion

Currently, competitive advantage in the scientific and technical fields is largely determined by access to high-quality information resources. It is important to consider that technological processes for processing newly incoming materials, implemented in various automated information support systems, lead to delays in the publication of scientific information materials, which reduces the relevance of information resources. The developed algorithm for assessing the relevance of an information resource provides objective quantitative assessments of relevance for the development and implementation of strategies and tactics for rational information resource management, taking into account the requirements for the probability and time of processing materials in the software and hardware system. Furthermore, the developed algorithm can be used to obtain predictive estimates of the consequences of modernizing technological information processing cycles under conditions of changing flow rates of materials constituting the information resource.

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МЕТОД ОЦЕНИВАНИЯ АКТУАЛЬНОСТИ ИНФОРМАЦИОННОГО РЕСУРСА АВТОМАТИЗИРОВАННОЙ СИСТЕМЫ

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Дано определение актуальности информационного ресурса автоматизированной системы информационного обеспечения научных исследований как ключевой характеристики его качества. Предложена количественная характеристика актуальности информационного ресурса – вероятность своевременности опубликования научно-информационных материалов – и представлен алгоритм расчета ее оценки. Полученные результаты обеспечивают поддержку принятия решений при выработке стратегии и тактики рационального управления информационным ресурсом с учетом динамики интенсивности потока составляющих его материалов.

Ключевые слова: информационный ресурс; информационное обеспечение научных исследований; качество информационного ресурса; актуальность информационного ресурса; своевременность опубликования материалов; управление информационным ресурсом.

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