

THE METHOD OF ASSESSING THE VALUE OF INFORMATION

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ABSTRACT

Context. The task of assessing the value of the institution's information as one of the objects of protection of the information security model is considered.

Objective. The goal of the work is the creation of a method of assessing the value of information, which takes into account the time of the final aging of information.

Method. The results of the analysis of methods for evaluating the value of information showed that modern approaches are conventionally divided into two directions. In the first direction, the value of information is calculated as the amount of information in bytes. In the second direction, the value of information is calculated in monetary terms. It is shown that modern approaches do not take into account the influence of time on the value of information. A method of assessing the value of information is proposed, which takes into account such characteristics as the term of final aging of information, the level of its access restriction, importance, and form of ownership. The value of information is presented as a quantitative measure that determines the degree of its usefulness for the owner. It is proposed to calculate the value of the initial value of information during its creation or acquisition by calculating the normalized weight of the coefficients according to the formula of the arithmetic mean. It was shown that the current value of information has a functional dependence on the time of existence of information and the time of its final aging.

Results. The results of the experiment confirm that the value of information has a nonlinear functional dependence on the time of final aging of information.

Conclusions. The conducted experiments confirmed the efficiency of the proposed method of evaluating the value of information and allow recommending it for use in practice to protect the institution's information. Prospects for further research may include the creation of a methodology for assessing the value of an institution's information, taking into account the aging of information and subsequent adjustment of measures to protect it.

KEYWORDS: aging of information, the importance of information, restriction of access to information, value of information.

ABBREVIATIONS

ISO is an International Organization for Standardization;

TMIP is a technical means of information processing;

VOI is a value of information.

NOMENCLATURE

n is the number of information characteristics that affect the value of information;

k_i is a coefficient that characterizes the quantitative measure of the impact of the characteristics of information on its value;

k_1 is a coefficient that characterizes the influence of the level of restriction of access to information on the value of information;

k_2 is a coefficient that characterizes the influence of the time of final aging of information on the value of information;

k_3 is a coefficient that characterizes the influence of the importance of information on the value of information;

k_4 is a coefficient that characterizes the influence of the form of ownership of information on the value of information;

k_5 is a coefficient that characterizes the influence of the method of storing information on the value of information;

L is the number of levels of restriction of access to information in the institution;

l_i is a quantitative assessment of the level of restriction of access to information in the institution;

I the number of levels of importance of the institution's information

i_j is a quantitative assessment of the appropriate level of importance of information of the institution;

F the number of forms of ownership of information in the institution;

f_j is a quantitative assessment of the appropriate form of ownership of information of the institution;

S the number of methods of storing information used in the institution;

s_j quantitative assessment of the method of information storage;

VOI_0 the initial value of the information of the institution (at the time of its occurrence or receipt);

t is a time from the moment of information occurrence to the moment of determining its value;

t_1 is a time from the moment of information occurrence to the moment of its final aging.

INTRODUCTION

In modern society, the role of information and information resources has significantly increased in all spheres of human life. The transformation of information into a product that has a certain value and corresponding value has led to the emergence of a new object of security – information and information resources. Previously, information security consisted of protecting information and information resources from unauthorized actions. At present, there is a need to protect people, society, or the state from threats that may pose information and information resources. Thus, today the threats that information and information resources can carry affect such aspects of human life as economic, financial, military, technical, and political. The emergence of such threats leads to the improvement of the conceptual model of information security.

The conceptual model of information security conditionally consists of security objects, a model of threats, a model of violators, and an information security system [1–2]. Recently, institutions have increased the cost of developing their information security model. However, not all institutions separately assess the value of information of the institution as one of the objects of security. It also does not take into account the fact that over time, the information loses its value and its further protection becomes impractical.

The object of study is the process of assessing the value of information.

The subject of study is the method of assessing the value of information.

Known methods [8–10] do not take into account the aging time of information, which has a direct impact on the value of information.

The purpose of the work is to develop a method for assessing the value of information, which takes into account the time of final aging of information.

1 PROBLEM STATEMENT

Suppose a set of coefficients $\langle k_i \rangle$ is specified, which characterize the quantitative measure of the influence of information characteristics on its value and take values from the interval $[0 \dots 1]$, $i = 1, 2, \dots, N$.

For a given set of coefficients $\langle k_i \rangle$, the problem of evaluating the value of information can be represented as the problem of calculating the normalized weight of the coefficients according to the formula of the arithmetic mean.

2 REVIEW OF THE LITERATURE

The authors in the scientific works [3–7] reflected on the results of the analysis of the implementation of information security in institutions and proposed to use the international standard of information security ISO/IEC 27001 to manage information-related risks.

In the scientific paper [8] the authors defined the multiple criteria value of information and demonstrated the

potential application when conservation issues conflict with monetary issues.

In the scientific work [9] the authors proposed a new approach to assessing the value of information based on the theory of pattern recognition, which expands its scope and can be successfully implemented using declarative programming languages or universal modeling languages.

An approach to calculating the value of information obtained from the example of a fuzzy mathematical model of the queuing system is presented in a scientific paper [10].

In scientific works [8–10] assessment of the value of information is realized using the methods of information theory, where the main property of information is its quantity.

The method of assessing the information potential with the use of coefficient, cost, and effective methods makes it possible to identify reserves of rational information support of enterprises, to determine the cost of information resources and the effectiveness of their use. This technique is proposed in a scientific paper [11] and can be used by the information security service of institutions to determine the cost of information security of the institution.

The authors in the scientific work [12] proposed to use the coefficient of permissible change, which characterizes the losses of the institution that will not lead to its bankruptcy. This ratio is characterized by the ratio of the growth/decline of the capital of the institution to the growth/decline of the amount of damage from the implementation of information threats.

In the results of the research, which reflected in the scientific work [13], the authors proposed a model for assessing the level of protection of information in the social network from external influences on the information social resource. The result is an assessment of the economic feasibility of implementing an appropriate mechanism of technical means of information protection in social networks, depending on the value of information.

Therefore, today there are two known approaches to assessing the value of information: calculating the amount of information in bytes and calculating the value of information in monetary terms. The first approach makes it possible to protect information without taking into account the level of restriction of access, the level of importance, or the form of ownership of information. The second approach implements the protection of individuals, institutions, and the state from damage that may occur in the event of unauthorized actions with information. The second approach also ensures the integrity, confidentiality, and accessibility of information.

The above approaches do not take into account the influence of time on the relevant properties of information. It is a known fact that the time of existence of information affects its value.

3 MATERIALS AND METHODS

The value of information in this study should be understood as a quantitative measure that determines the degree of its usefulness to the owner of the information. The functional dependence of the value of information on its characteristics is reflected in the expression [14–17]:

$$VOI = \frac{\sum_{i=1}^n k_i}{n}. \quad (1)$$

Assessing the value of information based on the methods and techniques of the modern theory of systems analysis provides tools for determining the appropriate coefficients based on the characteristics of information. The coefficients take values from the segment [0 ... 1].

The following characteristics of the information are chosen to assess the value of the institution's information.

1. Level of restriction of access to information.

Restricted information, confidential and/or public information may be processed in the institution. The impact of the level of restriction of access to information on its value is determined by the coefficient k_1 :

$$k_1 = \frac{l_i}{L}, \quad (2)$$

where $i = [1...L]$.

The level of restriction of access to information is determined by documents on the organization of information security.

2. Period of final aging of information.

The time of final aging of information depends on the level of access restriction and cannot be longer than the time during which the level of access restriction exists. The impact of the time of final aging of information on its value is determined by the coefficient k_2 :

$$k_2 = \frac{Ol_i}{OL}, \quad (3)$$

where $i = [1...OL]$.

3. Importance of information.

The importance of information of the institution should be understood as such information, the loss or unauthorized access to which will cause great damage to the institution or completely stop its work [17]. It is advisable to have several levels of importance of information in the institution. In this case, all information in an institution must have its level of importance (rank). A Group of experts determines the level of importance of information.

The impact of the importance of information on its value is determined by the coefficient k_3 :

$$k_3 = \frac{i_j}{I}. \quad (4)$$

where $j = [1...I]$.

4. Form of ownership of information.

The information circulating in the institution may have the following forms of ownership: private, collective, and public. The form of ownership of information must have its level of importance in terms of information security. It is expedient to introduce in the institution an additional division of the collective form of ownership of information into collective information of the institution and collective information of structural units of the institution. The impact of the form of ownership of information on its value is determined by the coefficient k_4 :

$$k_4 = \frac{f_j}{F}, \quad (5)$$

where $j = [1...F]$.

A Group of experts determines the form of ownership of information.

5. Method of storing information.

The method of storing information determines on which media it is stored. Depending on the level of restriction of access to information, its importance is determined by the method of storing information. A Group of experts determines the method of storing information.

The impact of the method of storing information on its value is determined by the coefficient k_5 :

$$k_5 = \frac{s_j}{S}, \quad (6)$$

where $j = [1...S]$.

The value of information changes over time. As a rule, the value of information decreases over time. The dependence of the value of information on time is determined [14–16]:

$$VOI(t) = VOI_0 \cdot 10^{-\frac{t}{t_1}}. \quad (7)$$

4 EXPERIMENTS

An example is considered to verify the method of assessing the value of information of the institution. The institution processes information with the following levels of access: unclassified, confidential, secret, and top secret. According to expression (2), the values of the coefficients are obtained, which are shown in Table 1.

Table 1 – The value of the coefficient k_1

Level of restriction of access to information	Rank	Value
Unclassified	4	0.25
Confidential	3	0.33
Secret	2	0.5
Top secret	1	1

The time of final aging of information according to the appropriate levels of access is set in the institution. According to expression (3), the values of the coefficients are obtained, which are shown in Table 2.

Table 2 – The value of the coefficient k_2

Level of restriction of access to information	Period of final aging	Rank	Value
Unclassified	362	4	0.25
Confidential	1086	3	0.33
Secret	1810	2	0.5
Top secret	3620	1	1

The importance of information in the institution is classified according to the following levels: insignificant, useful, important, and very important [17]. According to expression (4), the values of the coefficients obtained, are shown in Table 3.

Table 3 – The value of the coefficient k_3

Level of restriction of access to information	Period of final aging	Rank	Value
Unclassified	362	4	0.25
Confidential	1086	3	0.33
Secret	1810	2	0.5
Top secret	3620	1	1

The following forms of ownership of information are established in the institution: personal, department of the institution, institution, and state [18]. According to expression (5), the values of the coefficients are obtained, which are shown in Table 4.

Table 4 – The value of the coefficient k_4

Level of restriction of access to information	Rank	Value
Personal	4	0.25
Department of the institution	3	0.33
Institution	2	0.5
State	1	1

The following technical solutions are used to store information in the institution: server, technical means of information processing, and portable storage. According to expression (6), the values of the coefficients are obtained, which are shown in Table 5.

Table 5 – The value of the coefficient k_5

Method of storing information	Rank	Value
Server	3	0.33
Technical means of information processing (TMIP)	2	0.5
Portable storage	1	1

The institution has compiled a list of information in need of protection, which is shown in Table 6.

Substituting the data from tables 1–5 to expression (7) we obtain the initial value of information and the value of information as of 27.01.2022. Calculated values of coefficients that affect the value of information, the initial value of information, and the current value of information are shown in Table 7.

Table 6 – The list information of the institution

Title of the document	Date of create	Period of final aging	Access restriction stamp	Importance	Form of ownership of information	Method of storing information
Activity plan of the department of the institution	05.01.2022	362	Unclassified	Insignificant	Department of the institution	TMIP
A personal plan of the employee of the institution	10.01.2022	362	Unclassified	Insignificant	Personal	TMIP
Enterprise development strategy	05.01.2020	1810	Secret	Important	Institution	Portable storage
Industry development plan	09.01.2021	3620	Top secret	Very important	State	Portable storage
Report on the results of department 1 of the institution for 2021	28.12.2021	1086	Confidential	Useful	Department of the institution	Server
Report on the results of department 2 of the institution for 2021	28.12.2021	3620	Secret	Important	Department of the institution	TMIP
Report on the results of department 1 of the institution for 2020	29.12.2020	1086	Confidential	Useful	Department of the institution	server
Report on the results of department 1 of the institution for 2019	28.12.2019	1086	Confidential	Useful	Department of the institution	Server

Table 7 – Initial and current value of information

Title of the document	k_1	k_2	k_3	k_4	k_5	Initial value	Current value
Activity plan of the department of the institution	0.1	0.25	0.25	0.33	0.5	0.29	0.25
A personal plan of the employee of the institution	0.1	0.25	0.25	0.25	0.5	0.27	0.24
Enterprise development strategy	0.5	0.5	0.5	0.5	1	0.6	0.23
Industry development plan	1	1	1	1	1	1	0.78
Report on the results of department 1 of the institution for 2021	0.33	0.33	0.33	0.33	0.33	0.33	0.31
Report on the results of department 2 of the institution for 2021	1	0.5	0.5	0.5	0.5	0.5	0.56
Report on the results of department 1 of the institution for 2020	0.33	0.33	0.33	0.33	0.33	0.33	0.14
Report on the results of department 1 of the institution for 2019	0.33	0.33	0.33	0.33	0.33	0.33	0.065

5 RESULTS

The study yielded the following results:

1. Assessment of the initial value of information carried out by calculating the average value of the sum of the relevant coefficients. Each of the selected coefficients was calculated using the ranking method. The rank of the relevant information characteristics is determined from the guidance documents on the organization of information security or a specially created group of experts.

The assessment of the current value of information is carried out by taking into account the time of final aging of information and the date of creation (receipt) of relevant information. The value of the current value of information is calculated as the product of the initial value of information by the power factor, which characterizes the aging process of information.

2. In the method of estimating the value of information, a coefficient is calculated that takes into account the place of storage of relevant information. The need to introduce this factor was to take into account additional organizational measures aimed at restricting access to information. Thus, to obtain information stored on removable media, an attacker must obtain it from the information protection service. This approach introduces additional controls and limits the list of people who can carry out an insider threat.

3. Each institution has a list of information that needs protection. According to the level of restriction of access to information, the time of final aging of information is set, as well as its form of ownership and level of importance for the owner. For information from this list, its initial value is calculated.

4. The results of the experiment showed that for information that has the same values as the initial value, over time, the value of the current value of the information decreases. For the information contained in the documents of the first department of the institution, namely in the activity reports for the year, the initial value of the information is 0.33. A year later, the value of information decreased almost 2.4 times, and after 2 years almost 5 times. The results of the experiment confirm that the value of information has a nonlinear functional dependence on the time of final aging of information.

6 DISCUSSION

The results of data analysis in Table 7 show that the initial values of information value for a typical document of one department of the institution with identical details, except for the date of creation, are the same. Also, the initial value of information has the same values. At the same time, the current value of the value of information decreases as the time of existence of this information increases. This is explained by the fact that when the time of existence of information approaches the time of final aging of information, the importance of this information is lost.

Taking into account the time of final aging of information for different levels of access to information, (Table 3) will make it possible to evaluate the value of in-

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formation and provide information to the head of the institution to make a decision on the feasibility of further expenses for the protection of relevant information.

The method of assessing the value of information consists in finding the initial value of the value of information by calculating the average arithmetic value of the coefficients characterizing the quantitative measure of the influence of the characteristics of the information on its value. When the number of such coefficients increases, the adequacy of the model, which is used to calculate the value of information, will also increase.

CONCLUSIONS

The scientific novelty of obtained results is that the method of assessing the value of information was improved. This method allows obtaining a quantitative value of information, taking into account the level of restriction of access to information, the level of importance of information, period of final aging, method, and place of storage, as well as the form of ownership of information. The proposed method provides an opportunity to automate the process of assessing the value of information on the current date using the mathematical apparatus of the modern theory of systems analysis.

The mathematical model used in the method of assessing the value of information provides an opportunity to investigate the value of information that belongs to the person of the institution and the staff of the institution.

The practical orientation of the study is to use the developed method in the information security service of the institution to assess the value of information of the institution and in deciding on the choice of an adequate method of protection of relevant information.

Prospects for further research are to study the impact of the proposed set of coefficients based on the characteristics of information for a broad class of practical problems in information security.

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МЕТОД ОЦІНЮВАННЯ ЦІННОСТІ ІНФОРМАЦІЇ

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АНОТАЦІЯ

Актуальність. Розглянуто задачу оцінювання цінності інформації установи, як одного з об'єктів захисту моделі інформаційної безпеки.

Мета роботи – створення методу оцінки цінності інформації, що враховує час остаточного старіння інформації.

Метод. Результати аналізу методів оцінювання цінності інформації показали, що сучасні підходи умовно поділяються на два напрямки. У першому напрямку цінність інформації обчислюється як кількість інформації в байтах. У другому напрямку цінність інформації обчислюється в грошовому еквіваленті. Показано, що сучасні підходи не враховують вплив часу на цінність інформації. Запропоновано метод оцінки цінності інформації, який враховує такі характеристики, як термін остаточного старіння інформації, рівень її обмеження доступу, важливість і форма власності. Цінність інформації представлена як кількісна міра, яка визначає ступінь її корисності для власника. Пропонується розраховувати величину початкової вартості інформації під час її створення чи отримання шляхом розрахунку нормованої ваги коефіцієнтів за формулою середнього арифметичного. Показано, що поточна цінність інформації має функціональну залежність від часу існування інформації та часу її остаточного старіння.

Результати. Результати експерименту підтверджують, що цінність інформації має нелінійну функціональну залежність від часу остаточного старіння інформації.

Висновки. Проведені експерименти підтвердили працездатність запропонованого методу оцінювання цінності інформації та дозволяють рекомендувати його для використання на практиці для захисту інформації установи. Перспективи подальших досліджень можуть включати створення методології оцінювання цінності інформації установи з урахуванням часу старіння інформації та подальшим коректуванням заходів із її захисту.

КЛЮЧОВІ СЛОВА: старіння інформації, важливість інформації, обмеження доступу до інформації, цінність інформації.

ЛІТЕРАТУРА

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