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# Technique of Cost Estimation for Information Resources under Protection

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***Abstract*— This article presents results of research on formation of new techniques of cost estimation for the enterprise information resources under protection. Currently there is no universal and objective technique of exact estimation of cost of the protected information resource without the definition for the option of its use in advance. The authors offer to make assessment of parameters of the protected information resource using the available empirical data of estimates of its analogs. The offered technique can be used for assessment not only the cost of information resource, but also other qualitative characteristics. The method makes it possible to identify the closest analogues of the considered information resource by the set of initially selected parameters of its evaluation. The considered not material assets of the company are the protected information resources being a trade secret of the company. Estimation of cost of the protected information resource allows one to carry out more precisely the analysis of information risks and to increase quality of functioning of system of information security in the company. Improvement of system of information security of the company allows one to avoid additional financial expenses when ensuring safety and confidentiality of information. Besides, ensuring confidentiality without excess loading of information systems with means of protection, promotes increase in availability of the protected information resources to legitimate users of information systems of the company.**

***Keywords*— *the protected information resource; trade secret of the company; intellectual property item; estimation of cost of information resources; method of expert evaluations***

## I. INTRODUCTION

Currently in connection with information technology development, means of telecommunications, transition of economy to digital technologies many types of information get huge commercial value, becoming the same assets as fixed assets or commodity stocks.

Increasing number of the enterprises and organizations introduce the regulations of a trade secret for the protected information resources. At the organization of information security in the company a necessary condition is forecasting of possible damage from loss, distortion or disclosure of the protected data. Development of information and telecommunication structure of the company inevitably increases the number of information threats and vulnerabilities of information resources. In these conditions estimation of cost of the protected information resources is necessary for formation of adequate and effective system of information security, economic justification of holding actions for ensuring information security.

Along with increase in level of security of information resources the probability of their destruction, modification, falsification, blocking and other unauthorized actions from violators decreases. Thus, adequate estimation of cost of the protected information resources promotes increase in availability of the protected information resources to legitimate users of information systems of the company.

Assessment of information risks allows one to determine the necessary level of information security and to carry out its support and also to develop the strategy of development for information structure of the company. Besides, estimation of information resources allows analyzing possible options of their most effective use.

Assessment of information risks is a necessary condition during creation of a risk management system and the plan of ensuring continuity and recovery of business. The service secrecy or professional secrecy and also personal data of employees and objects intellectually of property can belong to the protected information resources of the company.

An object of a research are information resources of the company which belong to information of limited access and are subject to protection against disclosure. The purpose of researches is development of a technique of estimation of cost of the protected information resources of the company on the

basis of the existing models of assessment of intangible assets and assessment of intellectual property items. This technique can be applied to risk analysis of information security, allows one to optimize costs of creation of system of information security and also to estimate its profitability.

## II. THEORETICAL FRAMEWORK

Works of the Russian scientists Valdaytsev S.V., Kozyrev A.N., Leontyev B.B., Shipova E.V., Yakubov D.N., Vorontsovsky A.V., Kostrov A.V., Ganicheva A.V. are devoted to a research of problems of assessment of intangible assets, assessment of risks and investments. Besides, it should be noted works Daniel Andriessen, Rene Tissen, Aswath Damodaran, Robert F. Reilly, Robert P. Schweihs and others.

Currently three fundamental approaches are used to estimation of cost of information resources as not material assets: expenditure, income, and comparative approaches. According to [1;2;3;4;5;6;7] the following methods of assessment are generally used:

- a method of the discounted cash flow (DCF);
- method of residual income or distribution of residual income;
- the express – assessment;
- method of direct capitalization (excess of receipts over expenses), which can be taken from an intangible asset and which can arise, in particular, at the expense of an extra charge to the price, reduction of costs or scale effect;
- calculation of cost of a royalty or the rent which the user of an intangible asset would have to pay to the legitimate owner of an intangible asset otherwise;
- method of release from a royalty;
- method of excess profit;
- rule of 25%; - method of real economic effect;
- method of expert assessment.

The following types of intellectual property can be subject to assessment: - licenses; - trademarks; - business reputation; - patents; - brands; - know-how; - copyright and other types.

All applied ways of determination of cost possess the merits and demerits, but there is no universal and not subjective algorithm of rather exact assessment. The task of estimation of cost of the protected information resource without in advance defined option of use is an important and current scientific problem.

During estimation of cost of information resources, let us allocate several types of cost. The book value of information resources is initial cost on accounting, which represents the sum of the actual costs of acquisition or creation and expenses on the current operation.

The investment cost of information resources is cost for the specific investor or group of investors at definite purposes of investment. The consumer value of information resources is the cost which the concrete information resource has for the specific user for satisfaction of his requirements.

The market value of information resources – the settlement size equal to a sum of money for which information resource has to pass from hand to hand to date of assessment between the buyer and the seller as a result of the commercial transaction.

## III. THE TECHNIQUE OF ASSESSMENT OF THE PROTECTED INFORMATION RESOURCE OF THE ENTERPRISE WHICH IS THE TRADE SECRET

Let the protected information resource of limited access be characterized by set of parameters (signs). Assessment of the protected information resource can be carried out on the available similar information resources on which estimates already exist [7;8].

Let all available initial information consist of two categories of data. The first category of data of $X$ includes the $x_i$ ($i = 1 \dots I$) parameters, $I$ – total of the parameters known for the estimated information resource and for analogs. The second category $Y$ includes the $y_j$ ($j = 1 \dots J$) parameters, $J$ – total of the parameters known only for analogs, but not known for the estimated information resource. Let full information on m be known to analogs. In this case in the course of data presentation, we receive the table of initial values of basic data consisting of $(I + J)$ of columns and $(m + 1)$ of lines – the estimated resource and $m$ of analogs. An object of assessment is identification of $y_j$ parameters for the estimated information resource.

According to various authors, [9;10;11;12;13] it can act as the $x_i$ parameters:

- reliability of legal protection of an intellectual property item;
- indicator of patent purity (originality) of an object;
- the technical and economic importance of the protected information resource;
- costs of the owner of information resource of his creation (development);
- costs of the owner of information resource of patenting (registration) including, including duties and expenses and also fee to intermediaries;
- costs of the owner of information resource of the organization of his use, including costs of his marketing;
- costs of the owner of information resource of insurance of the risks connected with ensuring its confidentiality;
- period of validity of the security document on the protected information resource (the patent, the certificate) or period of validity of the license contract for an intellectual property item;
- possible costs of the owner of information resource for permission of the legal conflicts connected with ensuring confidentiality of information resource including in a judicial or voluntary order;

- the expected receipts of royalties on the information resource which is an intellectual property item;
- possible receipt of funds in the form of penal payments in cases of the proof of violation of the mode of a trade secret from the third parties or violation of the exclusive rights of the owner of an intellectual property item;
- the period of useful use of the protected information resource;
- life cycle of the protected information resource and the nature of its scientific novelty;
- royalty rates for this type of objects of legal protection;
- production readiness for use of the estimated protected information resource;
- the expenses of the owner of information resource connected with need of payment of taxes and fees;
- the expenses of the owner of information resource connected with introduction and maintenance of the mode of a trade secret at the enterprise.

The $y_j$ parameters don't belong to results of use of the protected information resource and can include the characteristics known at the time of creation of information resource: competitiveness, consumer characteristics of an object, scientific novelty, industrial applicability, field of possible application and others.

The concrete $x_i$ and $y_j$ parameters are chosen for the concrete protected information resources individually, depending on form of ownership of the enterprise, a field of activity, degree of confidentiality and other factors.

It is important to note that parameters of basic data $(x_1, x_2, x_3 \ldots, x_I; y_1, y_2, y_3 \ldots, y_J)$ generally can have the symbolical or verbal description and have to be transformed to numerical values. Parameters of basic data $(x_1, x_2, x_3 \ldots, x_I; y_1, y_2, y_3 \ldots, y_J)$ create $(I + J)$ space of signs (a multidimensional vector). In total according to the initial database it is possible to make $m + 1$ of multidimensional vectors.

For transformation of qualitative, not numerical parameters in numerical it is possible to use methods of expert estimates and in particular a method Delphi [11;12;13].

The Delphi method is different in that it is multi-layered, extramural, and anonymous. This approach allows us to exclude the influence of the authority of the participants of the expert group on the opinion of other participants. The survey can be conducted in absentia, with the assistance of external qualified experts. Multi-level polls ensure objectivity and high reliability of the result. When using the Delphi method, certain conditions must be met:

- questions should be designed so that they are perceived unambiguously;
- experts should be able to record responses in any form;
- participants of the expert group should be provided with all necessary information;
- each answer must be justified by the expert;
- it is necessary to select the optimal number of members of the expert group;
- it is necessary to conduct as many survey stages as is required for each expert to be able to carry out a qualitative assessment;
- it is important to have a clear algorithm for the coordination of expert assessments.

It is necessary to make the discussion more extensive in order to achieve the best result. During the discussion, any criticism is allowed.

These methods are widely known and, it is necessary to use in what the subjectivity of the received estimates is less shown. Let after initial data processing and application of methods of expert estimates all $x_i$ and $y_j$ parameters be transformed to numerical values.

Let the protected information resources during the long period of time belong to the known analogs and information on them in dynamics of their development is a priori known. Each $x_i$ and $y_j$ is known enough $x_i(t_q); y_j(t_q)$ of values at the different moments of their life cycle $t_q$. In statistics it is accepted that in the absence of concrete criteria the solution of problems of linear approximation requires not less than 5-10 values on one coefficient, and for square approximation not less than 15-20 values. We will believe that for assessment of the $x_i(t_q); y_j(t_q)$ parameters is available enough the known data on analogs which allow one to approximate analytical dependences for each $x_i(t_q); y_j(t_q)$.

Thus, we will receive a set of the $f_{im}(x_{im}; t); f_{jm}(y_{jm}; t)$ estimates of the $x_{im}$ and $y_{jm}$ parameters at any moment of their life cycle on each of analogs, and then we form the generalized (average) dependences on all analogs $f_i(x_i; t); f_j(y_j; t)$.

It should be noted that not all $x_i$ and $y_j$ change during life cycle of information resource and for a part them there is no temporary dependence $f_i(x_i; t) = const; f_j(y_j; t) = const$. We will enter designations for the known parameters of the protected resource $P\ (p_1, p_2, \ldots . p_i)$ for not the known parameters of the protected resource $P\ (b_1, b_2, \ldots . b_i)$. For the known parameters of analogs $A_m\ (a_{m1}, a_{m2}, \ldots . a_{mi})$ for not the known parameters of analogs $A_m\ (d_{m1}, d_{m2}, \ldots . d_{mi})$.

As a result we will receive the table of reference values for assessment of the protected information resource (table 1).

TABLE 1 STRUCTURE OF BASIC DATA FOR ASSESSMENT OF THE PROTECTED INFORMATION RESOURCE

| | x1 | x2 | …. | xI | y1 | y2 | …. | yJ | fcos |
|---|---|---|---|---|---|---|---|---|---|
| **P** | p1 | p2 | …. | pI | b1 | b2 | …. | bJ | 1,0 |
| **A1** | a11 | a12 | …. | a1I | d11 | d12 | …. | d1J | $f_{cos\,1}$ |
| **A2** | a21 | a22 | …. | a2I | d21 | d22 | …. | d2J | $f_{cos\,2}$ |
| **….** | …. | …. | …. | …. | …. | …. | …. | …. | …. |
| **Am** | am1 | am2 | …. | amI | dm1 | dm2 | …. | dmJ | $f_{cos\,n}$ |

The values given in table 1 are numerical, but defined at different metrics and scales. Therefore, for the parameters of the original data in table 1, measured in dissimilar physical units, it is necessary to apply the normalization procedure. If we apply Euclidean normalization, then the normalized values of the parameters will be invariant to the units of their measurement.

For analogs the full normalization is possible (elements of all string are used). The full norm is calculated as follows:

$$h_m = \sqrt{\sum_{i=1}^{I} a_{mi}^2 + \sum_{j=1}^{J} d_{mj}^2}\,. \qquad (1)$$

For the estimated protected information resource, it is possible to define only partial norm (only the known elements of all string are used):

$$h_p = \sqrt{\sum_{i=1}^{I} p_i^2}\,. \qquad (2)$$

Then the normalized elements of the source data of table 1 are presented in the following form:

$$\overline{a}_{mi} = \frac{a_{mi}}{h_m};\ \overline{d}_{mi} = \frac{d_{mi}}{h_m};\ \overline{p}_i = \frac{p_i}{h_p}\,. \qquad (3)$$

Let us convert table 1 into a table of normalized values of information data, replacing it with all the parameters of the estimated information resource and analogues of the normalized values $\overline{a}_{mi};\ \overline{d}_{mi};\ \overline{p}_i$.

Measure of proximity of the estimated protected information resource $P$ to analogs of $A_m$_m is possible to interpret as corner size between a multidimensional vector of assessment of the protected resource and the same vectors of analogs [11;14;15]. The Euclidean distance between points of these vectors depends on the scale and units of measure, and the measure of intellectual proximity of two information resources can be considered a cosine of the angle between multidimensional vectors of their parameters. This approach allows formalizing process of identification of uniqueness (feature) of information resources. Assessment objects on one straight line (coincidence of the directions of vectors) can mean intellectual identity or plagiarism. The cosine of the angle between vectors can be determined by the known parameters as follows:

$$(\overline{p}, \overline{a}_m) = \sum_{i=1}^{I} \overline{p}_i\, \overline{a}_{mi}\,;\ (\overline{p}, \overline{p}) = \sum_{i=1}^{I} \overline{p}_i{}^2\,; \quad (4)$$

$$(\overline{a}_m, \overline{a}_m) = \sum_{i=1}^{I} \overline{a}_{mi}{}^2. \qquad (5)$$

Further using formulas (4)-(5), we will determine all values of cosines of corners by the available analogs and we will find among them the maximum value (the closest analog) $\max\{f_{cos\,1}, f_{cos\,2}, \ldots f_{cos\,m}\}$.

We will assume that between the $b_i$ and $p_j$ parameters there is a stochastic communication of the same sort, as well as between the $a_{mi}$ and $d_{mj}$ parameters. In this case let this measure for the estimated protected resource is defined by coefficient $\alpha_i$, and for analogs in coefficient $\beta_{mi}$:

$$\alpha_i = \frac{b_i}{\sum_{i=1}^{I} p_i}\ ;\ \beta_{mi} = \frac{d_{mi}}{\sum_{i=1}^{I} a_{mi}}\,. \qquad (6)$$

It is necessary to use information on all analogs, taking into account a degree of their similarity with the estimated information resource. In this case, the values of the cosines $f_{cos\,m}$ are used as the values of the weight coefficients, then the averaged value $\beta_{mi}$ will be:

$$\overline{\beta}_i = \frac{\sum_{m=1}^{m} (\beta_{mi} f_{cos\,m})}{m}\ . \qquad (7)$$

If to assume that $\alpha_i \equiv \overline{\beta}_i$, then the required $b_i$ parameters can be estimated as:

$$b_i = \left[\frac{\sum_{m=1}^{m} f_{cos\,m} \left(\frac{d_{mi}}{\sum_{i=1}^{I} a_{mi}}\right)}{m}\right] \sum_{i=1}^{I} p_i\,. \qquad (8)$$

## IV. THE SEQUENCE OF EVALUATION OF THE PROTECTED INFORMATION RESOURCE OF THE ENTERPRISE

Thus, for evaluating the protected confidential resource it is possible it is offered to apply the following algorithm of actions:

1. We define categories of parameters of assessment of the protected information resource, we carry out the description of these parameters and we select analogs for the same parameters.
2. By methods of expert estimates we translate it (is interpreted) qualitative characteristics of the description of parameters of estimates in numerical quantitative characteristics for the protected information resource and its picked-up analogs.

3. We collect information on dynamics of change of indicators of estimates of analogs for the greatest possible period of time (best of all during their life cycle) on each of parameters $x_i$ and $y_j$.

4. We analyze collected data on item3 also we approximate them in analytical dependences of $f_i(x_i; t); f_j(y_j; t)$ on each of analogs, and then we form the generalized (average) dependences on all analogs.

5. We conduct the normalization of the collected data according to the formulas (1) to (3) and generated a table of normalized values of the information data $\overline{a}_{mi}$; $\overline{d}_{mi}$; $\overline{p}_i$.

6. We calculate on formulas (4)-(5) cosines of corners between multidimensional vectors of parameters of the protected information resource and its analogs, we define the closest analog.

7. We carry out assessment of stochastic communication between different types of parameters at analogs taking into account values of cosines of corners as weight coefficients of similarity of analogs to the estimated protected information resource.

8. We calculate required values of unknown parameters of the estimated protected information resource on formulas (6)-(8).

9. Calculate the evaluation values of the parameters $x_i$and $y_j$ at any time of the life cycle of the protected information resource.

For check of an opportunity of use of the offered technique estimation of cost of two intellectual property items (inventions) on which there were non-exclusive license contracts has been carried out. Results of calculations were compared to expert estimates of five independent experts. The difference between expert assessment and calculation has made less than 10% of value of assessment.

## V. CONCLUSIONS

Advantages of the offered method of estimation of cost of the protected information resource consist in the following:

- it is possible to estimate not only the cost of the protected information resource, but also other quality indicators of information resource;
- it is possible to estimate quality indicators at any timepoint of life cycle of the estimated protected information resource;
- it is possible to estimate the protected information resource before creation, knowing future qualitative characteristics;
- it is possible to apply this technique to select the option of practical use of the protected information resource.

To shortcomings of the offered method of estimation of cost of the protected information resource it is possible to carry:

- need of collecting a significant amount of initial information on analogs;
- subjectivity of expert estimates at interpretation of qualitative characteristics of the description of parameters of estimates in numerical quantitative characteristics;
- the offered technique of estimation of cost of the protected information resource doesn't consider the casual nature of change of ways of estimation of the known and unknown parameters of analogs (that can be connected, for example, with change of the legislative base).

Despite the available shortcomings the offered technique has the prospects of further improvement and practical use for estimation of cost of the protected information resource of the enterprise.

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