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FORMATION OF A REPRESENTATIVE SELECTION OF IT-INDICATORS TO ASSESS THE QUALITY INFORMATION SYSTEMS AT ENTERPRISE

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Abstract. For the effective use of the acquired or existing information system (IS) at the enterprise it is necessary to solve the problems related to an assessment of the IS quality. The information system is represented as a set of the functional components therefore it is necessary at first to evaluate quality of each of the components, and then get an integral assessment of the entire system. Quite tricky in the processes of IS quality assessment is the ambiguity of existing methods of formation the set of IT-indicators, most adequately characterizing the current state of functioning of the IS. It is necessary to define quantity and the list of IT-indicators (representative selection) which can be used to evaluate the quality of information systems in the enterprise to ensure the accuracy and veracity of quality assessment of IS. For formation of such selection it is offered to use an expert method. Expert's task is to select the criteria for the assessment quality of IS components, the formation of a representative selection of its indicators that best describe the real state of the information system at the enterprise, establishment of weights for IT-indicators, i.e. the importance of each IT-indicator to assess the quality of entire IS. The implementation of such actions, taking into account the recommendations of existing standards and using the method hierarchies' analysis, are considered.

Key words: information system, quality of the IS, criteria of an assessment of quality, IS status, IT-indicators, selection, representativeness.

INTRODUCTION

There are many methods, criteria and indicators for assessing the economic status of the enterprise [4,9,10,14] and decision-making about the ways of its development in order to achieve a more profitable and sustainable position in the market economy [2,5,11-13, 17]. All are based on the use of a plurality of enterprise information systems, which collect and systematizes a variety of information about its activities. Big enterprises have a large number of information systems for different purposes.

Practice of implementation and maintenance of the modern information systems testifies that the enterprises very often don't receive expected results from their investment in the system of computer data processing and control [20]. This is mainly connected with the increase and complexities of the functions and features of modern information systems, an increase in the volume of processed and stored information, with widespread use of network technologies of distributed information processing, with increasing their vulnerability, with the need to adapt methodologies the exploitation of information systems to rapid progress and perfection in information and communications technologies, etc. On the other hand, the use of information systems is one of the main instruments for the control and management of the business activity of any enterprise this entails the need to address the problems of efficiency and quality of IS. In spite of the fact that information systems provide mass of opportunities for the enterprises, they often are a source of new problems and tasks which require a professional IT-solution. Therefore for effec-

tive use of the acquired or already existing automation systems of information processing it is necessary to solve the problems connected to an assessment of quality of information systems that is inseparably linked with the solution of problems of objectivity and reliability of the received estimates. Suggested methods of selection criteria are justified by quality assessment and the formation of a representative sample of IT-indicators that assess the quality of IS ventures. For the entire set of IT-indicators, which determines state and operation of IS, a quantitative and qualitative assessment measures are offered. They may characterize positive and negative trend changes. Veracity and objectivity of selection process the criteria quality, IT-indicators, as well as the experts, who make decisions about the quality operation of the IS at the enterprise, are confirmed by the use the method of analysis of hierarchies.

MATERIALS AND METHODS

Effective position of the enterprise in the market is determined its ability by adaptation to permanently changing living conditions of economic systems [3]. For steady functioning of the enterprise on each of stages of its life cycle it is necessary to provide execution of a purposeful package of measures and mechanisms of transition to a new level. Rather essential role is played by the automation systems of information processing and control, allowing most quickly take appropriate decisions based on reliable and adequate information. The understanding of dependence of profit and economic productivity of activities of the enterprise from implementation and use of information systems, demands from a management the ability to evaluate benefits which systems of information processing automatization and control can bring, and also to understand how it is possible to check and measure results from investment into the IS. To evaluate benefits means, first of all, the ability to objectively evaluate the quality of information systems. However the analysis of publications on a problem of quality of the IS shows that they belong, generally to the software of information systems. Now there are many different, formal approaches to an assessment and quality control of the IS. However, all of them cover only some specific aspects, such as: determination of financial indicators, formation of quality or heuristic indicators, safety and protection, risk control, probable estimates of quality, control of creation and implementation processes of IS, control of IT expenses, etc.

The analysis of existing methods of IS quality assessment confirmed that the development of an adequate system of evaluation and quality management of IS in the enterprise continue to be actual. Unfortunately, many enterprises are forced to work still at legacy hardware and software based on MS DOS. On the other hand, the most advanced enterprises prefer to conduct preventive measures to avoid problems and accidents in the IT infrastructure, using the recommendations of standards such as ITIL, thus maintaining the required quality of the IS at the enterprise [7].

The most effectively resolved issues at the formal level are questions of quality management of a software which are formulated in the DSTU [16] standards. Essential attention is paid to valuation methods and quality control in the determination of complex quality characteristics that reflect some measurable factors and influence the quality of a software system in general. One of the methods of complex evaluation of the quality of the IS is the Cobit standard which is widely spread around the world and is actively promoting by ISACA association [6]. The processes of operation and functioning of the IS according to the Cobit standard operate with IT indicators many of them defines an IS status at the enterprise.

As demonstrated by the analysis of the IT indicators characterizing an IS status, instruments of their measurement, i.e. the procedure for enforcement measures IT assessment indicator to a normalized scale, for example, an interval scale. On such a scale change of an assessment from 0 to 1 means quality improving process, i.e., than the closer the score is to 1 – the subjects "better, above" quality, respectively, the closer the score is to

zero – the subjects "worse, below" quality of an IT indicator.

Such change of a measure represents the positive tendency in a quality assessment. However there is the significant amount of the IT indicators a measure of them has the negative tendency which is characterized by that growth of quality of an IT indicator is defined by the measure which is coming nearer to zero as, for example, an indicator "turnover rate in the IT organizational unit".

For the entire set of the IT indicators defining a status and processes of functioning of the IS, a measure of an assessment can be as the quantitative, and qualitative [16], for example, "What is the percentage of certified IT staff? (2%; 10% or 0,02; 0,1 etc.)", or "What is the level of satisfaction of management and users by experience and skills of IT staff? (satisfactorily – 1, unsatisfactory – 0, the middle level – 0,5, etc.)". The most difficult for formalization are assessment procedures such components of IS as an informational support because of the basic criterion for their evaluation is the training level or professionality of IT staff.

Thus, the measure of an assessment of quality is characterized by the positive (+) or the negative (-) an upward trend of quality and for interval scale from 0 to 1 is defined as:

$$M_{(+)i} = P_i/P_b \,;\; M_{(-)i} = 1 - P_i/P_b \,,$$

where: $M_{(+)i}$ – is the value of a measure of P_i quality score with the positive trend of growth quality, $i=1,\ldots n$, $M_{(-)i}$ – is the value of a measure of P_i quality score with the negative trend of growth quality, $i=1,\ldots n$, P_b – basic value P_i of a quality score.

For example, the measure "Number of employees IT subdivisions, completed advanced training courses, training, training or certification in relation to all employees" is the measure $M_{(+)i}$, for which P_i is equal to "number of the employees who completed increase courses …", P_b is equal to "all employees in IT subdivision". The measure "Churn rate of frames (T) in IT subdivision for the researched period" is a measure $M_{(-)i}$, for which P_i is equal to "number of the dismissed employees for the period …".

The assessment of quality of each IS component is defined as an arithmetic average of measures. Thus P_i and P_b values are defined by experts as a result of interviews with relevant staff of IT departments (selected by a method of the analysis of hierarchies).

Quality of the received information products and services also depends of quality of use and processing of information resources by staff of the enterprise [15]. The quality assessment each component is defined by means of the appropriate indicators and measures.

In general case, the measure of quality assessment of components can be represented as the following model:

$$M_i = \langle p_{ij}, \mu_{p_j}, k_{p_j} \rangle, \quad i=1,\ldots, n,$$

where: M_i – measure of an quality assessment of i component, p_{ij} – indicator (metrics) of quality for IS valuation, $j \in J$, J – set of all quality indicators (metrics), μ_{p_j} – measure of an quality assessment of indicator p_j, k_{p_j} – criterion of an assessment of indicator p_j which is defined on an interval scale from 0 to 1 ([0,1] or [1,0]).

The veracity of this quality assessment is based on a representativeness of selection indicators, which is made from general set of the IT indicators offered in the Cobit 4.1 [18] and ITIL [7] standard. For this purpose is used all set of the IT indicators, offered in [18] (340 indicators for monitoring and management of information systems and technologies).

Let a set J – general set of all IT-indicators that describe the state of information systems and technologies in the enterprise, then subset p_j is a part of objects of general set IT-indicators which correctly reflects general set for enterprise and may be called representational. Research of an assessment of quality of the IS on such selection IT-indicators has probable character and the accuracy of results depends from the size of this selection. Probability with which it is possible to claim that the error of selection of IT-indicators won't exceed some given value, is defined as confidential probability. Assuming that characteristics of

general set IT-indicators can be in selection with probability of 95% it is possible to determine the volume of representative selection [1, 19]:

$$n = \frac{z^2 s^2 N}{\Delta^2 N + z^2 s^2},$$

where: z – trust coefficient (z=1,96 for 95% reliability,

n – selection volume,

s^2 – selective dispersion, $s^2 = pq$,

N – general set volume

p – sign share, q =(1-p)

Δ^2 – the selection error, for example, let will be ≤ 4% or ≤ 0,04.

For a representativeness of selection it is desirable that dispersion was maximum that is reached in case of p = 0,5, selection volume depending on error amount of selection is given in the Table 1.

Thus, using these tables it is possible to determine the volume of selection of IT indicators in case of the given error of selection provided that the volume of population of indicators is equal 340.

However, the volume of selection is a necessary but not sufficient condition for quality research. For support of accuracy and reliability of results of estimation of quality of the IS it is necessary to define composition and selection structure, i.e. to make a choice of those IT indicators which can be used for an assessment of quality of the IS at the enterprise as the method of formation of selection is more significant characteristic, than selection volume.

As such method of formation of selection the method of expert formation is used. And the task of the expert will consist in:

– choice of criteria of an assessment of quality of component ISs and IS in general,

– selection of IT indicators which the best method describe a real status of functioning of the IS at this enterprise and can be used for an assessment of quality of the IS,

– establishment of scales of W IT-indicators, i.e. importance of an IT-indicator for an assessment of quality of the IS at this enterprise (a simple choice of points on the given scale).

Known methods of determination of criteria [6] are finished taking into account features of systems of information processing automatization and control at the domestic enterprises. The following requirements to a choice of criteria of an assessment of quality of IS component for the domestic enterprises are as a result offered:

objectivity, which means independence from bias and subjective opinions, which may adversely affect the results of professional evaluation of a quality index. The criterion of objectivity completely depends on responsibility of the expert holding a certain position and performing their duties,

measurability which means that the criterion should be able to be measured adequately reality so that the results of measurements of various experts were identical,

clarity, which means that the criteria must be clear and unambiguous and did not differ in the interpretation of the various users and experts,

completeness, which means the criteria should be comprehensive enough to include all the conclusions about the process, which may affect the assessment of the IS quality,

relevance that means compliance to criteria which are related to a subject of estimation and respond the estimation purposes.

For an objective choice of criteria of an assessment of quality of IS component and the IS in general the method of the hierarchies analysis (MAI) is used.

The received results of a choice show that the IT indicators responding to the following criteria most adequately describe a status of quality of functioning of the IS: reliability, practicality, reliability which also can be taken for conditions of a choice of a set of figures of merit of the IS at a stage of formation of representative selection of IT figures of merit.

Using a method of the hierarchies analysis, from the population, offered $P_{i,}$ quality IT-indicators are selected from the Cobit standard [18], by i=1 … n, n – sample volume.

1. Thus the purpose of expert selection of IT indicators is the choice of such IT indicators which the best way to describe a real status of IS functioning at this enterprise and can be used for an assessment of IS quality.

2. As criteria or characteristics of selection are used:

a) possibility of measurement of an IT-indicator,

b) usefulness in achievement of business purposes,

c) importance for an assessment of quality of the IS,

d) reliability (criterion of maintenance),

e) practicality (constructive design criterion of the IS),

f) veracity (information criterion).

The first three characteristics define the general semantic approach of experts in case when specifying data clusters, i.e. groups of nodes of one level subordinated to some node of other level or the dominating node or peak of a cluster.

3. As alternatives IT-indicators of the Cobit 4.1 standard [18] are used.

Formation composition of IT-indicators was carried out taking into account that the total quantity of the selected indicators shall be at least Selection Volume value according to the selection error selected by value (see Table 1).

For each indicator selected by the MAI method its importance (or W weight) in an assessment of quality of functioning of the IS at the researched enterprise (Table 2) is set.

Table 1. Scoping of representative selection in case of the given error

Selection error, Δ2	Trust coefficient, z	Sign share, p	q =(1-p)	General set volume, N	Selection volume, n
0,04	1,96	0,5	0,5	340	217
0,05	1,96	0,5	0,5	340	180
0,06	1,96	0,5	0,5	340	149
0,07	1,96	0,5	0,5	340	124
0,08	1,96	0,5	0,5	340	104
0,09	1,96	0,5	0,5	340	88
0,1	1,96	0,5	0,5	340	75

Table 2. Determination of weight W (importance) of an IT-indicator (fragment)

IT indicator name	Weight W	
	0-10	0-1 (normalized value)
Share of employees of the IT division which were trained or finished the advanced training courses	8	0,8
The current ratio of workers of the IT division employed on the contract and staff of the IT division, in comparison with a plan ratio	4	0,4
Share of the employees of the IT division who underwent testing regarding the tolerance to operation	7	0,7
Share of positions in the IT division, provided with the qualified duty regulations	6	0,6
Share of defects in the acquired IS, found prior to commercial operation	9	0,9
Share of abbreviation of serious operational incidents in a month	9	0,9
Quantity of technological software platforms at the enterprise	8	0,8

It is necessary to mark that objectivity of the received results in the course of formation of representative selection of IT indicators is provided with experts of the IT division of this enterprise who it was made by method of a multicriteria choice with the elementary hierarchy consisting of three levels: purpose, criteria and alternatives.

1. The purpose is a choice of the expert which can give the most objective estimates of quality of functioning of the IS, owning the general understanding of quality of functioning of the IS and methods of management of quality
2. Criteria: position, length of service, experience in IT
3. Alternatives: all employees of the IT division.

Procedure of rating of alternative versions of decisions on a method of the analysis of hierarchies is the cornerstone of making decision on a choice of the expert. Peak of a cluster is the Expert's Choice node.

For carrying out rating for a cluster "A choice of the expert" the scale of the relative importance of criteria a position, length of service the general, experience in IT (Table 3-5) is used. As a result for criteria "Position", "Standing" and "Experience" procedure of a choice of the expert is rather objective and the transparent.

It is necessary to mark that at the enterprises the chief and basic conductor of systems of automatization information processing are departments of ACS which traditionally exists in an organization structure of enterprise management. Applying the offered cluster "Position", practically the head of department of ACS or the IT manager of the enterprise will be always selected as the expert that doesn't give full objectivity in a quality assessment, in connection with not possible to use other employees of the IT division as experts.

Therefore it is expedient that employees of different levels of control appeared as experts. For this purpose potential experts it is possible to break on 2, 3, 4, etc. groups and from each group select the expert by method of the rating analysis of hierarchies. It is possible to break, for example, on three groups, then a cluster "Position" will consist of three parts: "The top management of the IT division", "Middle administrative staff of the IT division", "Service personnel IT division" (Table 6).

Table 3. Scale of the relative importance of criterion "Position" (According to The National classifier of Ukraine “Classifier of professions-2007”[8])

Relative importance	Position
1	Head of Enterprise Automatic Control Systems Department
2	IT-manager
3	Head of Computer Center (Data-processing center)
4	Head of Information Technologies Department
5	The chief specialist (or the Head) on information security
6	Head of department of ADP equipment
7	Head of department of information
8	Head of testing department
9	Head of department of technological development and implementation of computer center (data-processing center)
10	Head of department of automation and mechanization of productions
11	Database manager
12	Network administrator
13	System administrator
14	Software engineer
15	Specialist of department of the IT service and the material security of control of information technologies
16	Engineer on service of computer systems of technical department
17	Expert of information and technical department

Table 4. Scale of the relative importance of criterion "Length of service (general)"

Relative importance	Length of service
1	1-5
2	6-10
3	11-15
4	16-20
5	21-25
6	26-30
7	31-35
8	36-40
9	41-45

Table 5. Scale of the relative importance of criterion "Experience in IT"

Relative importance	Experience in IT
1	1-5
2	6-10
3	11-15
4	16-20
5	21-25
6	26-30

Table 6. Scale of the relative importance of criterion "Position" on groups of control According to The National classifier of Ukraine “Classifier of professions-2007”[6]).

Relative importance	Group of control	Position
1	The top management of the IT division	Head of Enterprise Automatic Control Systems Department
2		IT-manager
3		Head of Computer Center (Data-processing center)
4		Head of Information Technologies Department
1	Average administrative staff of the IT division	The chief specialist (or the Head) on information security
2		Head of department of ADP equipment
3		Head of department of information
4		Head of testing department
5		Head of department of technological development and implementation of computer center (data-processing center)
6		Head of department of automation and mechanization of productions
1	Service personnel of the IT division	Database manager
2		Network administrator
3		System administrator
4		Software engineer
5		Specialist of department of the IT service and the material security of control of information technologies
6		Engineer on service of computer systems of technical department
7		Expert of information and technical department

Applying a method of the analysis of hierarchies to each group, it is possible to select the appropriate experts for an assessment of quality of the IS.

The experts selected thus can participate in formation of representative selection of IT-indicators of all set of indicators of the IT provided by the Cobit 4.1 standard [18].

Thus, the created set of IT-indicators for use in case of an assessment of quality of component ISs and IS in general, is representative selection and therefore it is possible to speak about veracity of results of an assessment of quality of the IS of the enterprises.

CONCLUSION

1. Procedure of formation of representative selection of IT-indicators from general set by means of which it is possible most veracity and objectively to estimate quality of functioning of the IS at the enterprise is offered.

2. Veracity and objectivity of selection processes of quality criteria, selection IT-indicators and also experts, who make decisions on quality of functioning of the IS at the enterprise, are confirmed by use method analysis of hierarchies.

3. For all set of the indicators defining a status and processes of functioning of the IS are offered the quantitative and qualitative measures of an assessment which are characterized by the positive and negative tendency of change.

4. One of the principal conditions of support of objectivity and reliability of an assessment of quality of functioning of the IS is the correct formation of a set of IT indicators which will describe most adequately an IS status at the enterprise. Such method of formation of representative selection of a set of IT indicators was offered in this paper.

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