
Evaluating the Effectiveness of Management Information Systems for Small and Medium-sized Enterprises: a User Satisfaction Approach

G.N. Khubaev¹, I.Yu. Shpolianskaya², A.I. Dolzhenko³, S.M. Scherbakov⁴,
E.N. Efimov⁵

Abstract:

The article introduces a complex approach for the development and implementation of information systems for small and medium-sized enterprises based on small business specifics and customer requirements evaluation of the system being developed. The proposed approach is based on customer requirements modeling and management in systems development and deployment processes.

We consider information system is an integral part of the technological process of a company's management, a part of business. Information system's effectiveness analysis with regard of their consumers by means of conceptual modeling will allow small and medium-sized enterprises make a grounded decision when choosing a program system before its implementation.

Keywords: *Small and medium-sized enterprises (SMEs), management information system, quality Evaluation methods, User Satisfaction, system-like approach, conceptual modeling.*

JEL Classification Codes: C51, C52, C60, C89, D81

¹*Khubaev Georgy Nikolaevich, Ph.D., Professor, Department of Information Systems and Applied Informatics, Rostov State University of Economics, Rostov-on-Don, Russian Federation*

²*Corresponding author: Shpolianskaya Irina Iurievna, Ph.D., Associate Professor, Department of Information Systems and Applied Informatics, Rostov State University of Economics, Rostov-on-Don, Russian Federation, +7863-234-0271, irinaspol@yandex.ru*

³*Doljenko Aleksej Ivanovich, Ph.D., Associate Professor, Department of Information Systems and Applied Informatics, Rostov State University of Economics, Rostov-on-Don, Russian Federation*

⁴*Scherbakov Sergej Mihajlovich, Ph.D., Associate Professor, Department of Information Systems and Applied Informatics, Rostov State University of Economics, Rostov-on-Don, Russian Federation*

⁵*Efimov Evgenij Nikolaevich, Ph.D., Professor, Department of Information Technologies and Information Protection, Rostov State University of Economics, Rostov-on-Don, Russian Federation*

1. Introduction

Despite the fact that a number of information systems and services are available for small and medium-sized enterprises at the software market, many implementation projects fail because they ignore small business specifics, their expectations and the needs of the management. The automated business processes effectiveness analysis, information and technological infrastructure are not paid necessary attention while designing and introducing systems. It results in lack of real data integration; insufficient functionality of the information system; in increasing number of insignificant business operations; growing complexity in information system implementation projects. Small and medium-sized enterprises' managers face a difficult task of choice, on the one hand, inexpensive information system with simple and flexible architecture, good price, feasible system administration tools; and on the other, effective enough to do automated business with all its specific features.

The main quality indicator for information system is its functionality – ability to satisfy the customers' information needs, while taking effective management decisions. Besides functionality and flexibility as the ability of quickly adapting to the constant growth of the company, the important quality features of an information system are: degree of Internet technologies usage, data security, system performance (easy administration, usability, speed and accuracy in information processing, the suitability and adaptability to changes, reliability, fault tolerance, ease of installation, and maintainability, etc.). Eventually, the system is to provide balance among simplicity of use, functionality and adaptability to changes (ISO/IEC 25000:2014).

2. Theoretical, Informational and Empirical, and Methodological Grounds of the Research

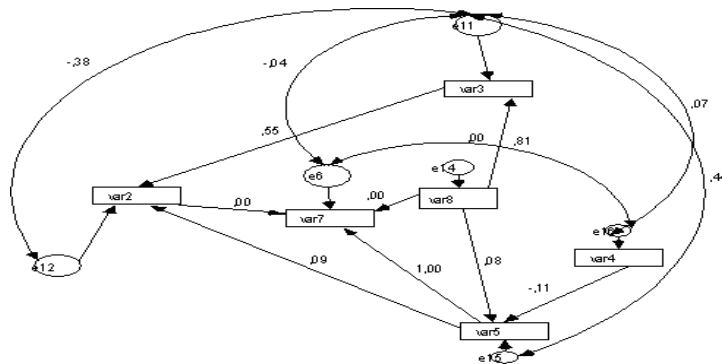
In our research we use the systems approach to define quality criteria of information systems for small and medium-sized enterprises in terms of their end-users. The system of interconnected models and algorithms, which allows the user to make a right choice of the information system among many alternatives, is based on these criteria. The functional structure and main features of information systems for small and medium-sized enterprises available at the Russian market were analyzed to make this research. Such experts as company's representatives as well as specialists in information systems development were surveyed. Statistical analysis was conducted according to the results of simulation modeling of the small enterprise which produces plastic packaging.

Modeling information systems functional structure: The main quality criterion of the information system in terms of a company manager is its ability to increase company's commercial effectiveness. It is possible to ensure if the management system involves only those functions which help to meet company's main objective – growth of profits. Consequently functional structure of the designed information

system must include the most significant business processes which define the key factors of a business (Liapis *et al.*, 2013; Keisidou *et al.*, 2013; Havlicek *et al.*, 2014; Bondarenko *et al.*, 2017; Nikolova *et al.*, 2017; Kosinova *et al.*, 2016; Helisek, 2016).

In the proposed approach (Shpolianskaya) the information system functional model is based on target business model, when each goal is reached by means of a corresponding function. The target model is a complex hierarchical structure of interaction of control indicators, where each indicator influences the indicator on the higher level. The quantitative estimates of a model determine the influence degree of each control indicator that is a result of corresponding function on a main objective of a business. This objective is also the information system effectiveness indicator. Ranging of the obtained estimates allow to single out the group of the most significant management functions. The model of interaction of the control indicators is based on statistical data on company’s activity or its simulation model. The data are analyzed with structural equation modeling techniques (SEM), including factor analysis, causal modeling on the basis of latent variables, analysis of variance and multiple linear regression analysis. Figure 1 presents the model to verify the hypothesis on impact of certain control factors on dependent variables (such as “Profits”) as well as on their interaction.

Figure 1. Model of assessment of control factors interaction



Using the model results, we obtain the standardized coefficients of the regression parameters (table 1) that assess the significance of each control parameter, consequently, information functions according to their impact on output indicator – “Profits”.

Table 1. Standardized regression coefficients estimation model

Dependent variables			Independent variables and factors		Regression estimation
Sales volume	Var5	<---	Selling price	Var4	-,109
Sales volume	Var5	<---	Reserve stock	Var8	,084

Size of Purchases	Var3	<---	Reserve stock	Var8	-,001
Capital	Var2	<---	Sales volume	Var5	,094
Capital	Var2	<---	Size of Purchases	Var3	,552
Profits	Var7	<---	Capital	Var2	,004
Profits	Var7	<---	Sales volume	Var5	1,002
Profits	Var7	<---	Reserve stock	Var8	-,001

Hierarchical model successively implements a set of company’s target strategies in a form of balanced system of control indicators and is a basis for the design of functional structure of the information system (Shpolianskaya).

Methods and models of quality assessment of information system for small and medium-sized enterprises: The main criteria used while choosing information system for small and medium-sized enterprises and those to be taken into account in designing are the following: functionality, minimizing of time and resources consumption while working with the system, usability, minimization of system total cost of ownership (Devos *et al.*, 2013).

The comparative analysis of the information systems according to functional completeness criterion: The number of functions available in many information systems for small and medium-sized enterprises totals to hundreds. A number of one destination information system modifications are growing. Consequently there is a problem of the selection of the best available system according to functional completeness criterion. The research looks into (Khubaev, 2016) the methodology of comparative analysis of the functional structure of information systems. This methodology involves the assessment of the functional structure of information systems in relation to “reference” system, which describes user’s requirements, as well as the degree of their similarity and interconnection.

Let us single out systems IS_i and IS_k and introduce the following notations:

$$IS_i = \{x_{ij}\}, \text{ where } x_{ij} = \begin{cases} 1, & \text{if system } i \text{ includes function } j \\ 0, & \text{else} \end{cases}$$

Let us introduce indicators: $P_{ik}^{11} = |IS_i \cap IS_k|$ – cardinality of intersection of sets (systems) in respect of automated functions; $P_{ik}^{01} = |IS_k \setminus IS_i|$, $P_{ki}^{10} = |IS_i \setminus IS_k|$ – cardinality of set difference between the respective systems.

Let s_{ik} be a measure of mismatch between systems IS_i and IS_k : $s_{ik} = P_{ik}^{01} / (P_{ik}^{11} + P_{ik}^{10})$;
 let h_{ik} be a measure of set inclusion for systems IS_k , IS_i : $h_{ik} = P_{ik}^{11} / (P_{ik}^{11} + P_{ik}^{10})$;
 let g_{ik} be a measure of similarity between systems IS_i и IS_k (Jaccard Similarity Coefficient) : $g_{ik} = P_{ik}^{11} / (P_{ik}^{11} + P_{ik}^{10} + P_{ik}^{01})$.

Let us construct matrices $P = \{P_{ik}^{(01)}\}$, $S = \{s_{ik}\}$, $G = \{g_{ik}\}$, $H = \{h_{ik}\}$ ($i, k \in \overline{1, n}$)

and then transform them into logic matrices:

$$P_0 = \{p_{ik}^0\}, S_0 = \{s_{ik}^0\}, G_0 = \{g_{ik}^0\}, H_0 = \{h_{ik}^0\} (i, k \in \overline{1, n}),$$

whose elements are determined in the following way:

$$P_{ik}^0 = \begin{cases} 1, & \text{if } P_{ik}^{(01)} \leq \varepsilon_p \text{ and } i \neq k \\ 0, & \text{else} \end{cases}$$

$$s_{ik}^0 = \begin{cases} 1, & \text{if } s_{ik} \leq \varepsilon_s \text{ and } i \neq k \\ 0, & \text{else} \end{cases}$$

$$g_{ik}^0 = \begin{cases} 1, & \text{if } g_{ik} \leq \varepsilon_g \text{ and } i \neq k \\ 0, & \text{else} \end{cases}$$

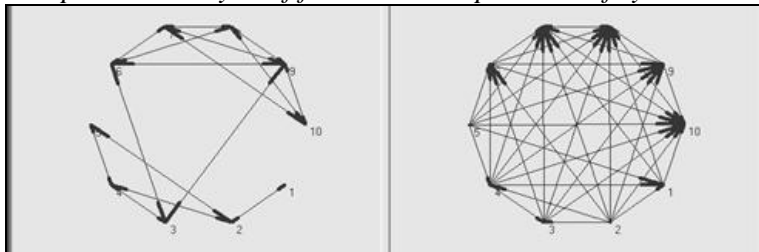
$$h_{ik}^0 = \begin{cases} 1, & \text{if } h_{ik} \leq \varepsilon_h \text{ and } i \neq k \\ 0, & \text{else} \end{cases}$$

where ε - selected limit values.

By means of logic matrices it is possible to assess the degree of similarity between the compared systems IS_i and IS_k : a share of common functions performed simultaneously IS_i and IS_k systems in a total volume of functions IS_i (matrix H); a number of different functions in IS_i and IS_k systems (matrix P_0); number of common functions in the total volume of functions in IS_i and IS_k systems (matrix G).

Systems similarity graph (G0) and inclusion graph (H0) in relation of the available functions result from program's calculation. By setting different thresholds of the degree the systems meet the users' requirements, we obtain different groups of information systems according to functional completeness. Figure 2 shows the results of the comparative analysis of the information system functional completeness for SMEs in relation of the user's requirements (IS_{10}). According to figure 2 the systems IS_7 и IS_8 are preferable, as their set of the automated functions mainly correspond to the user's requirements (system IS_{10}) and comprises the functions of all other systems.

Figure 2. Comparative analysis of functional completeness of systems



Express estimation of the resources spent on the implementation of user-selected information system functions: The proposed methodology involves the following steps:

1. Grouping of the potential users upon the certain feature values (age, sex, physiological traits, etc.). Estimation of the each group share among all client-users;
2. Assessment of time, labor and financial resources spent by each group of users to execute the singled out functions of information system, and organize the interaction with the system;
3. Planning and conducting of an experiment, assessment of actual (obtained in the course of experiment) runtime distribution law to complete the tested function (or a subset of functions) by the users of each classified group, i.e., to estimate the time which the user requires to produce the desired results;
4. Simulation modeling to assess the runtime (for all users' groups) to implement a certain function and/or a singled out subset of functions (according to the share of each group);
5. Analysis of the modeling results, i.e. statistical features (mean, variance, coefficient of variation, asymmetry, kurtosis), histogram and accumulated probability; the user's runtime assessment (with any given probability) to implement a selected subset of the information system functions. The proposed methodology gives more possibilities to select the best information system (according to the criterion of minimum resources spent on exploitation).

Providing a given level of information system usability: Software availability is an important feature of the information system quality. Let us suppose that it is necessary to compare some variants of software interface. Let $A=\{a_i\}$, ($i \in N$) be the compared variants of the user's interface of different information systems; $B=\{b_j\}$, ($j \in M$) be a set of experts. It is necessary to put in order these variants to choose the best variant of user interface. The details of the selection algorithm are as follows:

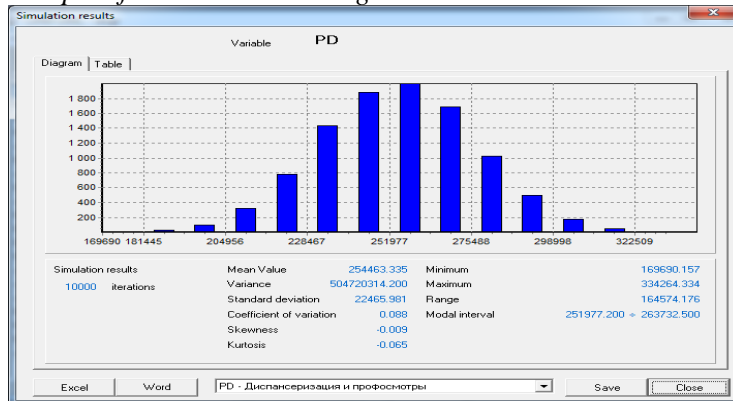
1. Each expert is offered to compare consequently the couples of variants of the design of object M.
2. The matrices, showing the dominating relations between variants of objects' design, are built based on the results of experts' assessment. Matrices' elements are equal either 0 or 1. Element equal to 1 which is in i -line and j -column means that i -variant dominates j -variant. If domination is absent value 0 is put.
3. Matrices of domination $\| E_j \|$ and $\| E_{j+k} \|$ are constructed to range all experts and degree of domination of the design variant given by each expert is being assessed. For the expert E_j : $S_j = \| E_j \| + (\| E_j \|)^2$, and for E_{j+k} : $S_{j+k} = \| E_{j+k} \| + (\| E_{j+k} \|)^2$.
4. Data processing of the obtained results of the expertise is done according to axiomatic approach to ordering by preferences (Kemeny and Snell). Every expert's ranging is presented as ordering matrices in canonical form. These matrix elements are equal: 1, if i is preferred to j ; -1, if j is preferred to i ; 0, if i and j are equal. Kemeny distances $\{d_{ij}\}$ are defined between all rankings. Threshold value of distance d_{thr} is selected according to actual degree of consistency of experts'

responses. Transformation of Kemeni distance values $\{d_{ij}\}$ into relative units $\{d_{ij}^0\}$ is performed in accordance with the selected threshold value d_{thr} . Then threshold value d_{thr}^0 is selected. It is expediently to select values 0.05 or 0.1 as threshold values, i.e. in this case the answers, whose degree of consistency is 90-95%, will be grouped. In the course of such ranking each value d_{ij}^0 matched with d_{thr}^0 and if $0 < d_{ij}^0 \leq d_{thr}^0$, 1 is put, otherwise 0 is put. As a result the interaction matrix among experts' rankings is being formed.

5. Values of Kemeni's median are calculated for the interconnected rankings (for each group). To do this, a ranking search is performed, maximally consistent with the selected group of interrelated responses. The choice of the ranking whose value Σd_{ij}^2 is minimal seems to be justified.

While designing the information system for small and medium-sized enterprises it is necessary to assess the future time the user spends on work in the information system environment while performing this or that function. This criterion is important when the user chooses a certain information system among many others. We have proposed the economic and statistical analysis technique for assessment of the information system capacity to perform a given set of functional operations in various versions of its construction (Khubaev and Scherbakov, 2009). This technique allows assessing labor costs spent on exploitation of the system and comparing the proposed variants of project realization. This approach provides integration of visual and simulation modeling to describe the structure and dynamics of business processes as well as their qualitative parameters, namely cost and time spent on operation performance. The UML diagrams and model's variables allow describing a set of automated functions and the frequency parameters of their execution; to present the structure of each process (sequence of operations, users of the system, alternative and parallel branches of the process). Tools of visual and simulation modeling on the basis of UML language are used to assess aggregated labor costs spent on realization and support of the information system for small and medium-sized enterprises. Figure 3 shows the results of assessment of time features of automated function through simulation.

Figure 3. Example of labor cost modeling results



Assessment of information system functioning effectiveness under uncertainty:

Under lack or incompleteness of information about certain quality indicators while choosing information system for small and medium-sized enterprises it is proposed to use quality scales and preferences among factors in the hierarchy of these factors for integral assessment of its quality. The principles of factors hierarchy formation which define the information system quality and relations of order between them must be determined by business demands (Dolzhenko, 2006).

The information system quality (*CQIS* - *Consumer Quality of the Information System*) we will describe by the following fuzzy model $CQIS = \langle G, L, P, A \rangle$, where G – tree graph with vertices F_j ($j = 0, \dots, N_D$), each of which is associated with a set of linguistic values $x_j^i \in L_j$, characterizing the condition of the factor, that determines the specific quality indicator of the information system; $L = \{L_j, (j = 0, \dots, N_D)\}$ – a set of linguistic values (qualitative assessments) of the levels of each factor (vertices of a graph); P – a system of relations of preferences of some factors to the others for one level of hierarchy of factors; A – a set of operators to aggregate information which is defined for not end vertices of a graph and allows to calculate its state on the basis of assessments of subordinate vertices (value of a linguistic variable). While using five-level 01-classifier (pentar scale) for factors a set L_j can consist of the following components:

{Very Low Level (VL), Low level (L), Middle level (M), High level (H), Very High Level (VH)}.

Required: to find the linguistic value of the information system quality on the basis of *CQIS* model and five-level 01-classifier.

Let us present the system of preferences of some factors to the others for the same level of model hierarchy (1) as the following: $P = \{F_i (\varphi) F_j / \varphi \in (\succ, \approx)\}$, where \succ - strict preferences, \approx - indifference. Preferences are introduced in the following way. Let us suggest that on the basis of the information obtained from the experts for factors of one level of the hierarchy F_i and F_j distinct relation of non strict preference R was introduced. This is consistent with the fact that it is possible to formulate one of the following statements: x_i is not worse x_j , i.e. $(x_i, x_j) \in R$; x_j is not worse x_i , i.e. $(x_j, x_i) \in R$; x_i and x_j , cannot be compared with each other, i.e. $(x_i, x_j) \notin R$ and $(x_j, x_i) \notin R$ for any pair of values of linguistic variables (x_i, x_j) .

If the expert has not enough information about the form of preferences, it means there is indifference $R_j (F_i \approx F_j)$ between factors of one level. In this case there is indifference $(x_i, x_j) \in R_j$ between linguistic variables x_i and x_j , only in the case when statements « x_i is not worse x_j » and « x_j is not worse x_i » are performed at the same time, i.e. $(x_i, x_j) \in R$ and $(x_j, x_i) \in R$ or are not performed simultaneously, i.e. $(x_i, x_j) \notin R$ and $(x_j, x_i) \notin R$.

To perform linguistic quality assessment of the information system it is necessary to form an operator to aggregate information for each non end vertices of the graph (Pérez-Fernández *et al.*, 2016), which will allow to calculate its state on the basis of assessments of states of subordinate vertices. The choice of aggregation operator is mostly determined by the properties of the information system domain and is performed on the basis of the information obtained from the experts and analysis of the system functioning (Dolzhenko, 2006).

In Pérez-Fernández *et al.* (2016) OWA-Jager operator and Fishburn coefficients, as the weight coefficients in convolution, are used for aggregation. The Fishburn coefficients

are calculated according to the following formula: $p_i = r_i / \sum_{j=1}^N r_j$, where $i = \overline{1, N}$, N

number of subordinate vertices involved in the information aggregation; r_i is defined on the basis of preferences conditions. If for each indicator ($F_{k,1} \dots F_{k,N}$) on the selected sublevel (k) of graph G model linguistic assessments $L = (L_{k,1} \dots L_{k,N})$ are known and weighting coefficients $p_k = (p_{k,1}, \dots, p_{k,N})$ are determined, then aggregation operator of the sublevel k is a weighted sum and characterized with its linguistic assessments,

determined by the membership function on 01-classifier: $\mu_k(x) = \sum_{i=1}^N \mu_{k,i}(x) p_i$.

Membership function $\mu_k(x)$ is trapezoidal fuzzy number and its calculation can be reduced to operations with vertices of membership functions $\mu_{k,i}(x)$. Membership function $\mu_k(x)$ is to be interpreted to assess linguistic level of the indicator F_k . If five-level fuzzy 01-classifier is used to assess the level of factor F_k , then on the basis of minimum distance ρ_{ki} between a fuzzy set defined by the membership function $\mu_k(x)$, and each of fuzzy sets corresponding to membership functions $\mu_i(x)$ $i = \overline{1,5}$, it is necessary to define minimum distance between $\mu_k(x)$ and $\mu_i(x)$ $i = \overline{1,5}$. To estimate distance between two fuzzy sets A and B absolute or relative Hamming distance as well as Quadratic distance of Euclid can be used. Given the fact that indicator F_k is given by the membership function $\mu_k(x)$ of a trapezoidal type $(a_L^k, a_1^k, a_2^k, a_R^k)$, as well as by membership function five-level fuzzy classifier $\mu_i(x)$ $i = \overline{1,5}$ on 01-carrier also trapezoidal $(b_L^i, b_1^i, b_2^i, b_R^i)$, then the distance between fuzzy sets is $\rho_{ki} = \max\{|a_L^k - b_L^i|, |a_1^k - b_1^i|, |a_2^k - b_2^i|, |a_R^k - b_R^i|\}$.

Minimal value ρ_{ki} determines whether the indicator F_k belongs to one of the five linguistic levels of the pentar scale on 01-classifier.

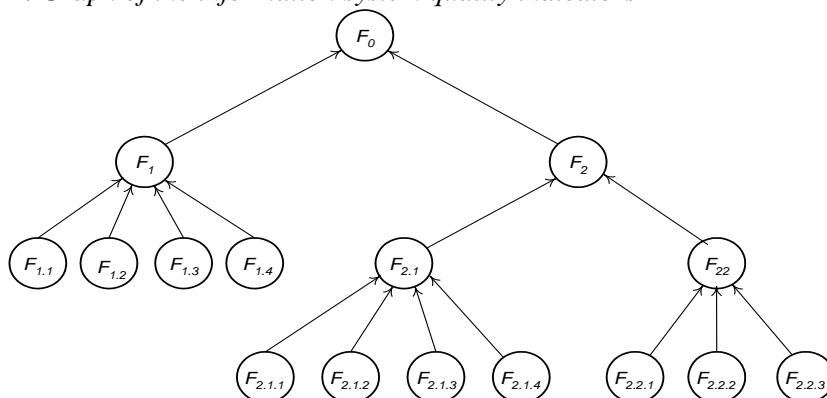
The procedure of factors aggregation for graph G is to be performed for each not end vertices down up to obtain linguistic value of quality of the information system functioning (F0). The algorithm of the integral quality assessment of the information system is the following. 1. Using the domain information we form a hierarchical graph G of information system quality indicators with vertices F_j ($j = 0, \dots, N_D$). 2. The experts

are offered to define preferences $P = \{F_i (\varphi) F_j \mid \varphi \in (\succ, \approx)\}$ between vertices for the given graph. 3. The experts are offered to define a set of linguistic values of factor levels $L = \{L_j, (j = 0, \dots, N_D)\}$ for each end vertices of the graph. 4. To calculate the linguistic values of the not end vertices the aggregation operators are applied.

When this algorithm performed, the linguistic values for the root vertex of the graph which characterize the information system quality in a whole and for the intermediate not end vertices that characterize the system's quality for a certain set of indicators, e.g. the system's functionality, will be obtained.

Let us consider the indicators system of a small business's information system to illustrate the proposed technic for the information system quality assessment. According to the consulting company experts' domain analysis the hierarchy graph scheme that determines interconnection of the information system's quality indicators, is proposed. Figure 4 shows the information system quality indicators graph.

Figure 4. Graph of the information system quality indicators



The following notations are used in Figure 4: F_0 – information system quality integral indicator; F_1 – functional features indicator; $F_{1.1}$ – functional completeness; $F_{1.2}$ – system adaptability to business requirements changes; $F_{1.3}$ – interfaces and integration complexity; $F_{1.4}$ – functional appropriateness; F_2 – nonfunctional features indicator; $F_{2.1}$ – operational characteristics indicator; $F_{2.1.1}$ – system productivity; $F_{2.1.2}$ – system reliability; $F_{2.1.3}$ – system scalability; $F_{2.1.4}$ – information security; $F_{2.2}$ – economic indicator; $F_{2.2.1}$ – aggregate cost ownership; $F_{2.2.2}$ – investments return ratio; $F_{2.2.3}$ – net effect.

The experts set the following fuzzy preferences while researching the information system consumer quality for the given graph: $P = \{ F_1 \succ F_2; F_{1.1} \succ F_{1.2} \approx F_{1.3} \approx F_{1.4}; F_{2.1} \succ F_{2.2}; F_{2.1.1} \approx F_{2.1.2} \approx F_{2.1.4} \succ F_{2.1.3}; F_{2.2.1} \succ F_{2.2.2} \approx F_{2.2.3} \}$.

For each factor the experts have set linguistic levels defining consumer quality (Table 2), and calculation results are given in Table 3. Table 3 shows the analyzed information

system quality is to be highly assessed, while the quality of some non functional indicators got middle assessment. It means that a manager is to pay attention on the quality of system's nonfunctional requirements (system reliability).

Table 2. Initial linguistic levels of factors

Indicator designation	$F_{1.1}$	$F_{1.2}$	$F_{1.3}$	$F_{1.4}$	$F_{2.1.1}$	$F_{2.1.2}$	$F_{2.1.3}$	$F_{2.1.4}$	$F_{2.2.1}$	$F_{2.2.2}$	$F_{2.2.2}$
Indicator level	VH	VH	M	M	H	M	L	L	H	L	L

Table 3. Calculation Results

Indicator	Level	Trapezoidal numbers			
F_0	H – high	0,55	0,64	0,75	0,85
F_1	VH – very high	0,65	0,75	0,85	0,95
F_2	M – middle	0,35	0,45	0,55	0,65
$F_{2.1}$	M – middle	0,36	0,45	0,56	0,66
$F_{2.2}$	M – middle	0,35	0,45	0,55	0,65

Information security of the company from the standpoint of its business processes:

Company's business objectives determine its business processes (BP), which in turn are supported by information technologies (IT). The IT presence means the development of the information security system (IS), which protecting nets, services, information resources and actually turns into company's BP security (Efimov and Lapitskaya, 2013). The information security system is to protect information on different stages of its processing, business processes on their main life cycles stages, including IT-infrastructure. Thus, business processes security is crucial in the company's information security system. It is clear from the business processes description which can be represented as a transformation: $P(X, R, F, Z, G) \rightarrow Y$, where P — process, having type of action, $P = \{P_1, P_2, \dots, P_n\}$; $X = \{X_1, X_2, \dots, X_i\}$ – input flows of the business process and their suppliers; $Y = \{Y_1, Y_2, \dots, Y_j\}$ – output flows of the business process and their consumers; $R = \{R_1, R_2, \dots, R_k\}$ – a set of resources used to perform business processes (technical, material, information); $F = \{F_1, F_2, \dots, F_n\}$ – a set of functions performed in the business process; $Z = \{Z_1, Z_2, \dots, Z_m\}$ – a set of participants of business process; $G = \{G_1, G_2, \dots, G_l\}$ – boundaries and interfaces of the process. Actually business process integrates all production process elements, their connections and needed kinds of resources.

Information security system, on the one hand, is to ensure the effective performance of business processes, on the other, IT infrastructure proper functioning. In general, protected objects demand information integrity, accessibility and confidentiality. Possible access points to business processes are interfaces as well as information needed to perform process functions (procedures), interception of information for the business processes when it is received (transmitted) over communication

channels, and because to the theft of media; destruction (change, distortion) of information due to accidental interferences, failures of technical (software) means; unauthorized influence on business process of violators among the number of owners and (or) participants in the process.

To remove operational risks and consequently losses it is proposed to use *Key Performance Indicators* which are business process performance measures (Efimov and Lapitskaya, 2013). There are the following *KPI*: result indicators – number and type of the produced products, including quality assessment; cost indicators – number of spent resources to get result (control over the compliance of costs with norms of consumption, processing time, etc); business process performance indicator (assessment of the conformity of the process to the required algorithm or business rules, the specified technology, etc.); productivity indicator – ratio of result and time spent to get result; effectiveness indicator – ratio of obtained result and resources spent. Control and further analysis of indicators deviations when performing business process is an important part of business process system functioning.

Company's information security process can be automated through *GRC (Governance, Risk management and Compliance)* systems which are considered nowadays one of the efficient ways to manage information technologies and information security. *GRC* is management from three points of view: top management (Governance), Risk management and demands compliance (Compliance).

However it is almost impossible to perform all *GRC* functions in the context of business processes security through one IT solution. The system promoted to solve problems for this concept is to be as complex as *GRC* tasks themselves. It is expedient to use Business Process Management (BPM), Business Performance Management and Business Intelligence intended to automate and manage business process together with *GRC*-system.

It is shown (Efimov and Lapitskaya, 2013) that business processes are primary data sources to organize company information security. Information security system aimed at business processes security apart from traditional ones is to include the following specific function groups: control over result, cost control, process flow control, productivity and business process effectiveness control.

3. Results

Complex research of problems of information system implementation for small and medium-sized enterprises from the users' point of view allowed developing an integrated model of software quality assessment. This model takes into account the information system main quality indicators: system functional structure meets business objectives, functional completeness, total cost of ownership of the software; labor and operational costs; usability indicators; information security indicators.

Easy to use methodology, which allows comparing the assessments of information interface versions based on the experts' agreed opinions, is proposed. The tools, including a set of interconnected software modules, were developed in the basis of the indicator calculation methodology. These tools allow correctly and with minimal labor costs to systemize the data on functional structure of the information system, to make a labor cost assessment to introduce and operate the system in a whole and regarding to a certain function. The tools allow singling out the information system groups with similar functionality to compare their prices, usability, interfaces, security provision and other consumer features.

Thus, the designed software forms quantitative assessment of compliance of the analyzed system with user's requirements both for certain characteristics and for the integral indicator in a whole.

4. Conclusions and recommendations

The developed tools allow the designers to increase the quality of the software due to more accurate accounting of user's requirements on the basis of system quality and quantity modeling. And users themselves are able more reasonably to assess and choose the needed information system.

References

- Bondarenko, G.T., Isaeva, A.E., Orekhov, S.A., Soltakhanov, U.A. 2017. Optimization of the Company Strategic Management System in the Context of Economic Instability. *European Research Studies Journal*, 20(2B), 3-24.
- Devos, J., Van Landeghem, H. and Deschoolmeester, D. 2013. *Information Systems for Small and Medium-sized Enterprises: State of Art of IS Research in SMEs*. Berlin, Heidelberg: Springer.
- Dolzhenko, A.I. 2006. Fuzzy models of analysis consumer's quality of information system. *Vestnik of Rostov State University of Economics*, 2(22), 123 – 131.
- Efimov, E.N., Lapitskaya, G.M. 2013. Information Security and Business Processes. *Izvestiya SFedU. Engineering Sciences. Issue: Information Security*, 12(149), 254-260.
- Havlíček, K., Thalassinos I.E. and Berezkinova, L. 2013. Innovation Management and Controlling in SMEs. *European Research Studies Journal*, 16(4), 57-70, Special Issue on SMEs.
- Helisek, M. 2016. Supporting Small and Medium-sized Enterprises in Preparing for the Euro Adoption in the Czech Republic. *European Research Studies Journal*, 19(4), 27-41.
- ISO/IEC 25000:2014 Systems and software engineering – Systems and software Quality Requirements and Evaluation (SQuaRE) – Guide to SQuaRE. The International Organization for Standardization. URL: <http://www.iso.org>
- Keisidou, E., Sarigiannidis, L., Maditinos, D. and Thalassinos, I.E. 2013. Customer satisfaction, loyalty and financial performance: A holistic approach of the Greek banking sector in *Marketing Intelligence and Planning*, 31(4), 259-288, Emerald Group Publishing Ltd., DOI: 10.1108/IJBM-11-2012-0114.
- Kemeny, J.G., Snell, L.J. 1960. *Mathematical Models in the Social Sciences*. Ginn, Boston
- Khubaev, G.N. 2016. The design of multifunctional products: the composition of operations

and minimization of costs of resources (the case of design software). *European Journal of Economics and Management Sciences*, 4(1), 22-29.

Khubaev, G.N., Scherbakov, M.S. 2009. Construction of Simulation Models in Economics and Control. Rostov on Don: «RINH».

Kosinova, N.N., Tolstel, S.M., Sazonov, P.S. and Vaysbeyn, D.K. 2016. Development of Methodological Approach to Enterprise's Financial Strategy Based on Comprehensive Evaluation of Its Strategic Potential. *European Research Studies Journal*, 19(2), 21 – 33.

Liapis, K., Rovolis, A., Galanos, C. and Thalassinou, I.E. 2013. The Clusters of Economic Similarities between EU Countries: A View Under Recent Financial and Debt Crisis. *European Research Studies Journal*, 16(1), 41-66.

Nikolova, V.L., Rodionov, G.D., Afanasyeva, V.N. 2017. Impact of Globalization on Innovation Project Risks Estimation. *European Research Studies Journal*, 20(2B), 396-410.

Özgün, I. 2016. Adopting Information Systems in a Small Company: A Longitudinal Study. *Journal of Applied Economics and Business Research*, 6(4), 269-283.

Pérez-Fernández, R., Alonso P., Díaz I., Montes S. 2016. Multi-factorial risk assessment: An approach based on fuzzy preference relations. *Fuzzy Set and Systems*, 299, 26 – 40.

Shpolianskaya, I.Yu. 2006. Consumer quality of information systems for small enterprises. *Applied informatics*, 2(2), 58 – 65.