

Qualimetric Model for Comprehensive Evaluation of E-business Efficiency

Starkov Alexander Nikolaevich

Power Engineering and Automated Systems Institute
NMSTU
Magnitogorsk, Russia
alstarkov@yandex.ru

Galliamova Maria Sergeevna

History, Philology and Foreign Languages
Institute NMSTU
Magnitogorsk, Russia
maria_gallyamova@mail.ru

Povituhin Sergey Alexeyevich

Power Engineering and Automated Systems Institute
NMSTU
Magnitogorsk, Russia
serge2410@yandex.ru

Ganeeva Lily Fanisovna

Power Engineering and Automated Systems Institute
NMSTU
Magnitogorsk, Russia
lilit1708_@mail.ru

Staschuk Petr Vladimirovich

Power Engineering and Automated Systems Institute
NMSTU
Magnitogorsk, Russia
s_ptr@rambler.ru

Storozheva Elena Vladimirovna

Power Engineering and Automated Systems Institute
NMSTU
Magnitogorsk, Russia
elena777_62@mail.ru

Romanova Marina Victorovna

Power Engineering and Automated Systems Institute
NMSTU
Magnitogorsk, Russia
romanova.mv@mail.ru

Abstract. The article discusses the basics of the methodology for integrated evaluation of the effectiveness of e-businesses on the basis of qualimetry. Using of this methodology will identify the problems and prospects of e-business's evolution, develop evidence-based programs to improve its performance. It discusses the development of the range of evaluation indicators, which includes indicators that characterize financial conditions, customer relations, organization, core business processes, growth and labour e-businesses. The described technique of a complex estimation of e-business efficiency, including the following: identifying purposes of evaluation; identification of evaluation indicators and indicators' characteristics (status and weight); determination of values of effectiveness indicators; effectiveness evaluation; effectiveness indicators convolution estimates into a single comprehensive evaluation.

Keywords: e-business; evaluation of the effectiveness; evaluation indicators; qualimetry; comprehensive evaluation.

I. INTRODUCTION

Nowadays the problem of efficiency improvement has become one of main tasks in our country and abroad. The importance of this question will increase in the nearest future.

However, to increase the efficiency, it is necessary to be able to define it quantitatively as

application of numerical methods – one of the most important prerequisites of correctness of the adopted control solutions.

The evaluation of the effectiveness is the first and main stage of the quality management system. To address issues of organization and implementation of the quality management system, including planning, forecasting, optimization, and others, it is necessary to develop objective methods of evaluating the effectiveness. And first of all – methods of integrated assessment.

The e-business is a decentralized business structure, where interrelations with suppliers and customers and all internal processes are implemented in the electronic form on the basis of modern network infrastructure and Internet technologies, allowing the organization with maximum efficiency to respond to changing market conditions.

The main goal of creation and functioning of any enterprise, including e-business, is to get the greatest possible profit due to the realization of production to consumers (the performed works, the rendered services) on the basis of which social and economic inquiries of the staff and owners of production are satisfied.

Trends in the development of e-commerce in the international economic system give the chance to

conclude that the task of evaluating the e-business effectiveness and also definition of optimum model of e-commerce is important and actual nowadays.

In our opinion, despite quite serious development in the field of evaluation of the effectiveness, business continuity management, the existing methods of efficiency evaluation are not often fully utilized due to the limitation in the formation of indicators and their application, the complexity of such systems according to their contents and use, and also due to the fact that they do not take into account the specific features of evaluating of e-business effectiveness [1, 2].

In addition, the evaluation of e-business effectiveness is often conducted by the expert method that reflects the subjectivity of the data. The effectiveness of e-business is often evaluated on disjointed data in separate directions. The urgency of the problem and topics of research in these conditions are connected with objective necessity of transition to the system of evaluating the effectiveness of e-business, focused on comprehensive, integrated assessment which aims to determine the compliance level of effectiveness of e-business specific requirements, identifying the "problem" of business processes that can help company management in the preparation of the plan for ensuring business continuity.

In modern conditions we need reliable methods of evaluating the performance of e-businesses.

In our opinion, the evaluation of performance of electronic enterprise must use the tools of qualimetry – the system of practices on measuring and quantifying the quality of various items and processes (objects of the real world, both material and intangible).

II. QUALIMETRY AS A TOOL TO ASSESS THE EFFECTIVENESS OF E-BUSINESS

Qualimetry is a scientific discipline that studies the methodology and problems of complex quantitative estimation of quality of any object: animate or inanimate; objects or processes; products of labour or products of nature; having material or spiritual character; having artificial or natural origin, etc [3, 4, 5].

Advantages of qualimetry are the ability to integrate diverse evaluations of objects (tangible and intangible), any intangible object to quantify, the transparency of the mathematical apparatus and experience for the evaluation of objects.

Mathematics is fundamentally abstracted from the specific properties of objects or processes and considers only their ideal mathematical models, and the relationship between these models. Therefore, the mathematical model of quality can be considered as some abstract system of individual properties with different degrees of complexity. This quality model, because of its abstract nature, will be exactly the same for various objects.

At the same time, the substitution in this model values of specific indicators of quality allows you to

move from a general abstract model of quality to a specific model quality of a real-life object [6].

The technique of complex estimation of e-business efficiency on the basis of qualimetry allows to take into account the whole complex of indicators, the diversity of the organization's activities, and hence to assess and compare the enterprise as a whole on many indicators, but not on the disparate criteria, and to get a single comprehensive assessment of efficiency. It will improve the accuracy of estimates, getting rid of one of the main disadvantages of the evaluation expert method subjectivity in making appropriate management decisions.

In qualimetry, regardless of the scope of its application, the process of assessing the efficiency is the following [7]:

- defining the goals of the evaluation object;
- determination of an approach to the evaluation of the effectiveness of the object;
- disclosure of the structure efficiency of the object;
- determination of the range of interrelated performance indicators of the object and the statistical characteristics of the indicators (status and weight);
- determination of values of the object indicators;
- performance of object's evaluation;
- convolution estimates performance indicators into a single comprehensive assessment;
- analysis of the obtained results.

The purpose of the evaluation is to determine the level of e-business effectiveness specific requirements, identifying the "problem" of business processes that can help company management in the preparation plan for business continuity.

III. THE DEVELOPMENT OF THE RANGE OF E-BUSINESS EVALUATION INDICATORS

One of the main stages of efficiency evaluation is to develop a range of evaluation indicators.

In our opinion, the main directions of efficiency evaluation of e-businesses are: economic, organizational, marketing. These trends are reflected in our nomenclature of indicators characterizing the financial condition, customer relations, organization, core business processes, growth and human resources.

The range of evaluation indicators has been developed to solve quantitative evaluation of the effectiveness of e-business. It is a hierarchical structure, where are identified a list of evaluation indicators and a list of specific indicators in each group.

IV. NOMENCLATURE AND STRUCTURE OF E-BUSINESS EVALUATION INDICATORS

1. Financial condition of the company

1.1. Current solvency

1.1.1 Absolute liquidity ratio

- 1.1.2 The current Ratio
- 1.2. Long-term solvency
 - 1.2.1 Ratio of borrowed capital to own
 - 1.2.2 Ratio of interest on loans
- 1.3. Profitability
 - 1.3.1 Profitability of sales
 - 1.3.2 Return on assets
 - 1.3.3 Net profit
 - 1.3.4 Profitability of own capital
 - 1.3.5 Profitability of investments
- 1.4. Financial stability
 - 1.4.1 The coefficient of security with own current assets
 - 1.4.2 The coefficient of maneuver ability of own current assets
- 2. The organization core business processes
 - 2.1. Sales organization
 - 2.1.1 Conversion (the number of orders to the total number of visits)
 - 2.1.2 The percentage of visits to ordering
 - 2.1.3 The average check amount
 - 2.1.4 The average number of items per order
 - 2.1.5 Revenue per employee
 - 2.1.6 Oder processing time
 - 2.2. Organization of marketing campaigns
 - 2.2.1 Cost of the client
 - 2.2.2 Cost of visiting
 - 2.3. Return orders
 - 2.3.1 Percentage of return orders
 - 2.3.2 Proportion of return orders under the claim
 - 2.4. Organization of work with complaints
 - 2.4.1 Share of complaints
 - 2.4.2 Response time to the complaint
 - 2.5. Organization of reception of payments
 - 2.6. Arranging delivery of orders
 - 2.6.1 Provision of different methods of delivery
 - 2.6.2 Percentage of timely deliveries
- 3. Relationships with consumers
 - 3.1. Audience involvement
 - 3.1.1 Share of active visits
 - 3.1.2 Average duration of viewing the website
 - 3.1.3 Proportion of refusals "from the page"
 - 3.1.4 Failure rate "from trash"
 - 3.2. Consumer loyalty
 - 3.2.1 Proportion of repeat visits
 - 3.2.2 Proportion of repeat purchases
 - 3.3. The effectiveness of advertising
 - 3.3.1 CTR (Ratio of the number of users, who clicked on the advertising message, to the total number of users, whom it was shown)
 - 3.3.2 CTB (Ratio of the number of users, who went to the website on the advertisement, made a purchase, the total number of users, who only clicked on an advertising message)
 - 3.3.3 CTI (Ratio of the number of users, who went to the website for advertising, made an active operation, the total number of users, who clicked on an advertising message)

- 3.3.4 CPV ("Unit cost" one visitor to the advertiser)
- 3.3.5 CPA (Cost of any action committed by a user through advertising)
- 3.3.6 CPS (Sale price)

- 4. Security human resources
 - 4.1. The average number of employees
 - 4.2. Turnover of reception staff
 - 4.3. Employee turnover
 - 4.4. Consistency personnel
 - 4.5. The total labour turnover

We proceed from the assumption that all indicators are not equivalent to each other. The indicator of the quality of an object characterized in one of two statuses: dominant or compensated.

The status of indicator in the group – the degree of influence of this property on the overall level of group properties. The dominant indicator shows the property, the main thing that determines a given property group. Reimbursable indicator characterizes the property that in one degree or another increases/decreases the quality of graded group index properties and acts as a supplementary to a dominant. Thus, low quantitative assessment of the dominant indicator cannot overlap high quantitative assessment of these indicators. For example, the dominant figures are "sales" and "marketing campaign" in the metric group "Organization key business processes".

Compensated indicators contribute to the assessment group that for the same level of dominant indicators between electronic companies, in the end, the score will be higher, where the compensable level is higher in this group.

One status indicators within the group differ from each other quantitatively (by weight). When determining the integrated indicator of the effectiveness, each indicator of individual properties will be adjusted by the ratio of its weight (importance). The sum of the numerical values of the coefficients of the weights of all indicators has the same value (in fractions of unity) at all hierarchical levels of evaluation.

The status and validity of the index determine the contribution of properties to the group assessment.

V. THE METHODOLOGY OF INTEGRATED QUANTITATIVE EVALUATION OF THE EFFECTIVENESS OF E-BUSINESS

The methodology of integrated quantitative evaluation of the effectiveness of e-business is based on qualimetry.

It can be summarized the following positions of qualimetry for the evaluation of the effectiveness of e-business:

- efficiency of e-business estimated by comprehensive single numerical indicator;
- comprehensive evaluation is obtained by integration of the unique indicators included in the hierarchical structure of evaluation indicators of e-business;

- by statuses (informative aspect) the indicators are divided into dominant, which cannot be blocked by large value that is less than significant, and offset (less than significant), which should contribute its quantitative contribution to a comprehensive index. The status of indicators is defined using the method of expert survey;
- inside one of the status indicators are different quantitatively – according to the weight coefficient, which is determined based on the method of expert survey;
- the value of each single indicator is estimated in the interval from 0 to 1. The reference base is developed for estimating the index;
- convolution assessments of individual indicators into a comprehensive evaluation is performed on groups of respective levels calculated by special formulas.

We have chosen an expert survey among executives in the areas of e-business, e-commerce economists as methods for determining the status and the weight coefficients of efficiency indicators of e-business. 29 experts took part in the formal survey.

The experts were invited to complete a questionnaire, which is a list of indicators, divided into groups.

The experts were asked to choose in each group of indicators at least one dominant indicator (s) which is the most important in the group, and cannot be quantified, and against it (them) put a letter "D". The experts proceeded from the fact that without the dominant indicator, it is impossible to assess the effectiveness of e-business.

The experts had to rate the significance of the non-dominant indicators on a scale of 0 to 10. To do it, choose from the remaining indicators the most important and rate it 10 points and then select indicators in descending order of importance.

The results of the expert survey have been used to solve several tasks: determining the status of quality indicators in groups; determining weights of the dominant and the compensable rates in groups; the exception of the least significant indicators in groups [8].

On the basis of the developed algorithms it was determined the status of evaluation indicators in the groups and weighting of dominant and compensable rates in the groups.

The organization of collecting information to assess the effectiveness is associated, primarily, with the selection of the data source. For selection and calculation of individual evaluation indicators were used the electronic data of the enterprise.

The development of evaluation indicators was originally carried out in accordance with the official data collected at the factory, including data collected in the automated mode the hardware and software on the email server of the enterprise.

The features and capabilities of collecting information on evaluation indicators have led to the

need of differentiation of indicators by type of data collected in two groups:

- Absolutely measurable indicators (the possibility of obtaining absolute quantitative data). For example, "the average check amount".
- Indicators "set of elements" (the quality of the indicators is expressed by the degree of integration of its components). For example, "the provision of different modes of delivery".

The particular type of data depends on the method of calculating the value of a single indicator. Absolutely measured individual indicators are calculated according to the formulas relative statistical quantities.

Its own set was allocated for each indicator with a data type through a set of items ("the organization of reception of payments" and "the provision of different modes of delivery"). The importance of each element within a set was determined using expert method. The experts were specialists in the field of e-commerce.

As a result, the elements of the indicators were assigned a numerical value (rank) in the range from 0 (lowest importance) to 10 (highest importance).

Reporting from electronic data of the enterprise we know about the presence of each element from the set.

A numeric value with data type through a set of items is the proportion of the presence of elements of a metric on the e-enterprise, given the fact that the elements are not equivalent. Each element from the set scores the mark in the interval from 0 to 1, depending on the grade of the item.

If this set element is not available at e-enterprise, the assessment of this element takes value 0, otherwise, the assessment of this element takes the maximum value, depending on the grade of the item, i.e. if the element has rank 10, then the estimate will be equal to 1, in grade 9, assessment will take the value of 0.9, etc. The value of a single indicator with a data type of the set elements will be equal to the average of estimates of the elements of this indicator, i.e. when calculating values for a set of items as values to provide estimates of indicators.

For absolutely measurable evaluation indicators are calculated on the basis of the obtained values.

Original brand measured data for single indicators are presented in different measurement systems (people, pieces, hours, roubles, etc.).

Efficiency is measured in a particular measurement system, which includes a base of comparison (reference point), so all single evaluation functionally converts in the interval from 0 to 1. For evaluating brand measured indicators, it was developed the reference base, where all evaluations were divided into two categories: increasing and decreasing.

Evaluation of these categories rise or fall respectively with the growth rate.

Regardless of the category of evaluation, all individual indicators get numerical grades from interval between 0 and 1. For determining specific

values of measured brand evaluations of individual indicators is taken the model dependency of the ratings from metric values (example of increasing values).

Estimation of the minimum (worst) indicator values P_{min} equal to 0. When you change the indicator from P_{min} to a value P_1 , its assessment increases at low speed to 0.2. That is, the change in the interval from P_1 to P_{min} does not give a significant increase in quality.

The change from P_1 to P_2 (P_2 is determined on the same principle as P_1) causes the active growth of quality. The assessment of the indicator varies from 0.2 to 0.8 with a velocity greater than the interval from P_1 to P_{min} . A further increase to the level of P_{max} increases to 1, but at slower rate than in the previous interval.

For decreasing indicators the schedule of changes is built on the same principle as for increasing. Thus, on the basis of the model described above for each indicator should be calculated its reference points (P_{min} , P_1 , P_2 , P_{max}) by the method of standard deviation [9].

The integration of individual indicators into an integrated evaluation is made by the levels of item evaluation indicators of e-business, starting with the lower level where there are single indicators.

The dominant and offset indicators within one group are collapsed in different formulas with weights.

Convolution of dominant indicators is the following [7, 10]:

$$D = \frac{\prod_{i=1}^n d_i \cdot \frac{1}{n} (1 + d_i)^{P_i}}{2}$$

D – the dominant evaluation group indicator,
 d_i – evaluation of a single dominant indicator,
 P_i – the ratio of the weight of a single dominant indicator,
 n – number of single dominant indicators in the group.

Convolution of offset indicators is the following [7, 10]:

$$K = \sum_{i=1}^n v_i \cdot k_i$$

K – the offset evaluation group indicator,
 k_i – evaluation unit offset indicator,
 v_i – the weighting factor unit offset indicator.

Convolution of dominant and offset indicators in complex assessment is performed using arithmetic formulas [7, 10]:

$$O = \frac{\sqrt{D \cdot K} + D}{2}$$

O – comprehensive evaluation,
 D – the dominant evaluation group indicator,
 K – the offset evaluation group indicator.

VI. CONCLUSION

The method of comprehensive evaluation of e-business efficiency allows to measure the activities on a variety of parameters. The quantitative

integrated assessment reflects the diversity of e-businesses. The effectiveness of e-business will be evaluated by single numeric comprehensive measure, which, if necessary, can be deployed according to the levels of the hierarchy for information about specific assessments of group indicators and individual indicators for tracking the contribution of each indicator to the overall evaluation. It gives you the opportunity to obtain a general picture on the effectiveness of individual activities of e-enterprise, organization of key business processes.

It can be used to identify problematic business processes that allow management of e-enterprise, to pay attention to the indicators that received the lowest rating, to analyze the relevant areas of the company, and to develop an action plan for improving the effectiveness of work in these directions [11].

The control of effectiveness should have the character of monitoring. The continuous monitoring is necessary to adapt the goals of the enterprise and ways of their realization.

One of the main advantages of the technique is the possibility to obtain deterministic information, in contrast with the diffuse, which is often used by the experts of the enterprise nowadays.

The evaluation method allows to obtain formal information about the effectiveness of e-business.

The methodology of integrated quantitative assessment of efficiency allows to get rid of the subjectivity of the expert method of evaluation.

It can be concluded that the technique of comprehensive evaluation of e-business efficiency will allow to reveal problems of functioning and prospects of its development, to elaborate a reasonable program of improvement of e-business activity.

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