Assessment of qualitative indicators in a balanced system of indicators

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Abstract. The purpose of the presented study is a proposal of a methodology of a quantitative assessment of qualitative indicatorrs in a balanced system of network trade companies' strategic indicators. In the presented study a method of eventological scoring for a quantitative assessment of qualitative target indicators is proposed, because a use of expert evaluations, as a rule, is justified on a qualitative level, but does not result in a formation of an integrated quantitative assessment. Final conclusions, obtained as a result of statistical averaging of individual expert evaluations, are unstable. A technology of eventological scoring allows to make managerial decisions in a case of multievent risk and uncertainty of external and internal environment of a company's operations. As a substantive conclusions in the presented study a quantitative assessment of a qualitative target indicator is determined, which allows to interpret not only a current situation, but also to identify main directions of a target indicator increase.

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Introduction

Topicality of the selected research topic is determined by a need to develop a methodology of company's operations target indicators' quantitative assessment.

In economic literature on theory and practice of building BSC (balanced system of indicators) of a company, indicators, characterizing an achievement of strategic goals, are referred to as Key Performance Indicators (KPI) [1,2,3]. Performance indicators in BSC system, first of all, are designed to measure a degree of an implementation of strategic objectives and that's why it is better to use term "key performance indicators", which the authors understand as indicators reflecting a degree of an achievement of strategic goals in BSC system and possessing a quantitative assessment [4]. Key performance indicators, in particular, allow to envision a strategy in a form of specific measurable variables, to formalize procedures of a quantitative planning and control in a strategic management. The first and the most important criterion for a selection of any indicator in BSC, is its ability to measure objectives achievement [5,6,7,8].

Depending on nature of an initial information, which is used to assess a current state and to plan a target value of key performance indicator, indicators can be quantitative, based on a quantitative information (dimensions, data of financial and management reporting), and qualitative, which are based on information that was originally of non-quantitative nature, i.e., subjective evaluation of various phenomena [9]. In a balanced system, indicators are designed to measure a degree of an achievement of strategic objectives of a company and, therefore, they need to be quantitatively evaluated. Use of qualitative indicators in a system of target indicators is, in the most cases, related with an impossibility of an alternative measurement of established strategic objectives' achievement degree. One of obstacles in an implementation of a balanced system of indicators in management is a lack of measurability of qualitative indicators. In a case of an absence of simple and available methodologies for an evaluation of qualitative indicators, it is seems to be appropriate for the authors to offer the procedure, which maximally simplifies a process of data collection for a calculation of key performance indicators values and a determination of their integral value [10].

Main part

Traditionally, an assessment of qualitative indicators is based on heuristic methods, which rely on experience and intuition. The most common are expert evaluations, representing judgments of highly qualified professionals, expressed in a form of a substantive, qualitative or quantitative evaluation of an object, with an intension for an implementation in decision-making.

However, speaking about two possible levels of expert evaluations: qualitative and quantitative, it should be noted that, if an implementation of expert evaluations on a qualitative level, as a rule, is justified, a possibility of an implementation of quantitative evaluations is criticized quite often [11,12]. Expert evaluations are based on vision, intuition, imagination and experience, of those, who form them, and often are expressed not by numerical indicators, but by some kind of verbal images.

One of possible ways to solve a problem of a quantitative evaluation of qualitative indicators may be an implementation of eventological scoring, which technology allows to make managerial decisions in conditions of multievent risk and uncertainty [13]. An implementation of scoring systems began in a field of consumer lending in the United States. Nowadays, a scope of application of scoring is gradually expanding and covering not only banks economy, but also sociology, as well as marketing, and strategic management. Theoretical development of the method is assisted by an emerge of a new school in theory of probability - eventology, which refers to theory of random events, seeking laws of random events sets movement and their interactions [14].

An approbation of eventological scoring methodology is disscussed on an example of one of the key indicators of a performance in a context "suppliers" – "cooperation satisfaction index of goods suppliers" – (I_s) selected by trading network management as an indicator of an achievement of a strategic goal of a cooperation satisfaction of goods suppliers. An interaction with suppliers is a bilateral cooperation; good relationships with suppliers are an essential element in a process of ensuring a continuous availability of a demanded range of goods, which, in turn, will assist in an achievement of established financial goals.

In order to obtain an initial data for I_s indicators and to conduct calculations, closed type questionnaire with binary responses was formed. It should be noted, that the content of questionnaire's questions for calculations was developed basing on the strategic objective that was set in a context of BSC, "improvement of suppliers satisfaction", because of which all main aspects, which have a significant impact on a realization of the goal, were included in questionnaire. Thus, data of the questionnaire is effective only for specific indicators within a framework of strategic perspectives for the studied company. Moreover, eventually, as a company moves towards an established strategic goal, a content of a questionnaire, possibly, also might be changed.

For a determination of goods suppliers cooperation satisfaction – I_s in a process of current activities of a network company, 142 suppliers of main groups of provisions and materials for personal production had been interviewed. A calculation of "cooperation satisfaction index of goods suppliers" (I_s) in eventological language described as follows. Presuming, that a work with suppliers occurs within probability space (Ω, *F*, P) with algebra of measurable events *F* and probability *P*. Therefore, all discussed below events will be considered measurable from a point of view of algebra *F*. Specifying $s \subseteq \Omega$ target event "suppliers, generally, are satisfied with terms of a cooperation", and $s^c = \Omega - s$ – "suppliers are not satisfied with terms of a cooperation" (an addition of a target event s). A whole procedure of the survey is designed to assess a likelihood of a target event s using the results the suppliers' survey. A technology of eventological scoring divides all events into two classes: basic - events, referred to in the questionnaire, and questionnaire, which are "created" by suppliers in a process of answering question of the questionnaire [12]. Connecting with every question of the questionnaire basic event $x \subseteq \Omega$ and questionnaire event-response $\hat{x} \subseteq \Omega$. In the discussed case of eventological scoring, it is necessary, basing on the results of the survey, to evaluate a large number of people, which raises a problem of an interpretation of obtained from the survey event-responses as a favorable or an unfavorable in a context of an occurrence of a target event. In fact, as a result of a statistical processing of questionnaires only frequencies p(j,0) and p(j,1) can be obtained, with which suppliers were giving, respectively, negative and positive answers to j-question of the survey (statistical likelihoods of an occurrence of a certain basic events) (table 1).

Table 1. An example of a statistical processing of questionnaires

Questions	Answer "rather agree" (i= 1)	Answer "rather disagree" (i= 0)
1st question	p(1.1)	p(1.0)
2nt question	p(2.1)	p(2.0)
...	...	...
j-question	p(j,1)	p(j,0)
N-question	p(N,1)	p(N,0)

In table 2 obtained during a statistical processing of suppliers' questionnaires study results are presented.

From the authors' point of view, for an interpretation of the survey's event-responses $\hat{x} \in \hat{\chi}$ as a favorable and an unfavorable for an occurrence of a target event, it is rational to implement majority rule. Because a target event in that case is defined as "suppliers, generally, are satisfied with terms of work", it is logical to presume that a satisfaction of the major part of suppliers by one of aspects of work will be favorable for an occurrence of a target event and vice versa. In order to implement majority rule in a model of eventological scoring, entering option $\alpha = 0,5$.

Table 2. The results of a statistical processing of suppliers questionnaires

Questions	Number of a respondent					Number of responses for j-question		Statistical probability	
	1		2		... n =142	Positive +	Negative -	p(j,1)	p(j,0)
	+reply	-reply	+reply	-reply					
x_1	X			X		63	79	0.44	0.56
x_2		X	X			20	122	0.14	0.86
x_3		X	X			94	48	0.66	0.34
x_4	X			X		118	24	0.83	0.17
x_5	X			X		38	104	0.27	0.73
x_6		X	X			94	48	0.66	0.34
x_7	X			X		59	83	0.42	0.58

Thus, if the frequency p(j,1), with which suppliers were positively responding to j-question, resulting from a statistical processing of questionnaires, is greater than or equal to $\alpha = 0,5$, the authors believe, that the response is favorable for a target event: $\hat{x} \cap s$. However, if the frequency p(j,0), with which suppliers were negatively responding to j-question, is greater than or equal to $\alpha = 0,5$, the authors believe, that the response is unfavorable for a target event: $\hat{x} \cap s^c = \hat{x} - \hat{x} \cap s$. An interpretation of the results obtained during the study of the survey's event-responses is presented in table 3.

Table 3. The results of an interpretation of the survey's event-responses

Questions	Answers		Interpretation of survey event – responses as:	
	Rather agree	Rather disagree	favorable	unfavorable
x_1	0.44	0.56>α		×
x_2	0.14	0.86>α		×
x_3	0.66>α	0.34		×
x_4	0.83>α	0.17	×	
x_5	0.27	0.73>α	×	
x_6	0.66>α	0.34	×	
x_7	0.42	0.58>α		×

Further in a procedure of eventological scoring for a favorable and an unfavorable for an event s basic event x, experts attribute positive weight $\omega(s \cap x) \geq 0$ and $\omega(s^c \cap x) \geq 0$, which have a probabilistic interpretation:

$$\omega(s \cap x) \approx P(s \cap x) = P(s \mid x)P(x);$$

$$\omega(s^c \cap x) \approx P(s^c \cap x) = P(s^c \mid x)P(x).$$

In the discussed case of a calculation of a probability of a target event s "suppliers are satisfied, generally, with terms of a cooperation" as an expert weights, in the authors opinion, it is logical to implement frequencies p(j,0) and p(j,1), which were derived from the questionnaire and are reflecting a statistical likelihood of an occurrence of a certain basic event [Satcuk, 2009]. Expert weights $\omega(s \cap x) \geq 0$ and $\omega(s^c \cap x) \geq 0$ obtained during the survey are presented in table 4.

Table 4. Eventological scoring-questionnaire for a conditional probability determination of a target event

Questions	Expert weights	
	answer "rather agree" $\omega(s \cap x)$	answer "rather disagree" $\omega(s^c \cap x)$
x_1	0.44	0.56
x_2	0.14	0.86
x_3	0.66	0.34
x_4	0.83	0.17
x_5	0.27	0.73
x_6	0.66	0.34
x_7	0.42	0.58

Because eventological distribution of basic events in that case is unknown, it would be practical to calculate a conditional probability for three possible types of basic events structures - the least overlapping, s-independent and embedded.

A calculation of a conditional probability of a target event s in a situation of the least overlapping basic events. For a calculation the equation is used, which is previously defined on a basis of linear multifactor regressions method:

$$P\left(s \mid t_s^{\cup}(X)\right) = \frac{\sum_{x \in X} \omega(s \cap x)}{\sum_{x \in X} \omega(s \cap x) + \sum_{x \in X^c} \omega(s^c \cap x)}.$$

Auxiliary calculations are presented in table 5. Calculating a conditional probability of a target event s in a case of the least overlapping basic events:

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$$P\left(s \mid t_s^{\cup}(X)\right) = \frac{\sum_{x \in X} \omega(s \cap x)}{\sum_{x \in X} \omega(s \cap x) + \sum_{x \in X^c} \omega(s^c \cap x)} = \frac{2,15}{2,15 + 2,73} = 0,441.$$

A calculation of a conditional probability of a target event s in a case of the least overlapping basic events.

Table 5. A calculation of a conditional probability of a target event s in a case of the least overlapping basic events

Questions	Results of the survey	
	$\omega(s \cap x)$	$\omega(s^c \cap x)$
x_1		**0.56**
x_2		**0.86**
x_3	**0.66**	
x_4	**0.83**	
x_5		**0.73**
x_6	**0.66**	
x_7		**0.58**
$\sum$	**2.15**	**2.73**

In a case of s-independent basic events, logistic regression method can be applied, which allows to obtain the following equation for a calculation of a conditional probability:

$$P\left(s \mid t_s^{\cap}(X)\right) = \frac{1-\prod\limits_{x \in X}(1-\omega(s \cap x))}{1-\prod\limits_{x \in X}(1-\omega(s \cap x))+1-\prod\limits_{x \in X^c}(1-\omega(s^c \cap x))}.$$

A calculation of a conditional probability a target event s in a case of s-independent basic events. In a case of s-independent basic events logistic regression method can be applied, which allows to obtain the following equation for a calculation of a conditional probability:

$$P\left(s \mid t_s^{\cap}(X)\right) = \frac{1-\prod\limits_{x \in X}(1-\omega(s \cap x))}{1-\prod\limits_{x \in X}(1-\omega(s \cap x))+1-\prod\limits_{x \in X^c}(1-\omega(s^c \cap x))}.$$

Axillary calculations are presented in table 6.

Calculating a conditional probability of a target event for eventological structure of s-independent basic events:

$$P\left(s \mid t_s^{\cap}(X)\right) = \frac{1-\prod\limits_{x \in X}(1-\omega(s \cap x))}{1-\prod\limits_{x \in X}(1-\omega(s \cap x))+1-\prod\limits_{x \in X^c}(1-\omega(s^c \cap x))} =$$

$$= \frac{1-0,00874}{1-0,00874+1-0,01892} = \frac{99126}{1.97234} = 0,503.$$

Table 6. A calculation of a conditional probability of a target event s in a case of s-independent basic events.

Questions	Results of the survey		Calculation	
	$\omega(s \cap x)$	$\omega(s^c \cap x)$	$1-\omega(s \cap x)$	$1-\omega(s^c \cap x)$
x_1		0.56		0.44
x_2		0.86		0.14
x_3	0.66		0.34	
x_4	0.83		0.17	
x_5		0.73		0.27
x_6	0.66		0.34	
x_7		0.58		0.42
$\prod\limits_x$	–	–	0.00854	0.01272

A calculation of a conditional probability of a target event s in a case of embedded basic events. In a case of embedded basic events, a conditional probability of a target event is calculated as follows:

$$P\left(s \mid t_s^{\cap}(X)\right) = \frac{\max\limits_{x \in X}(1-\omega(x \cap s))}{\max\limits_{x \in X}(1-\omega(x \cap s))+\max\limits_{x \in X^c}(1-\omega(x \cap s^c))}.$$

Axillary calculations are presented in table 7.

Table 7. A calculation of a conditional probability of a target event s in a case of embedded basic events

Questions	Calculation	
	$1-\omega(s \cap x)$	$1-\omega(s^c \cap x)$
x_1		**0.44**
x_2		**0.14**
x_3	**0.34**	
x_4	**0.17**	
x_5	**0.27**	
x_6	**0.34**	
x_7		**0.42**
$\max\limits_x$	**0.34**	**0.44**

Calculating a conditional probability of a target event for eventological structure of embedded basic events:

$$P\left(s \mid t_s^{\cap}(X)\right) = \frac{\max\limits_{x \in X}(1-\omega(x \cap s))}{\max\limits_{x \in X}(1-\omega(x \cap s))+\max\limits_{x \in X^c}(1-\omega(x \cap s^c))} = \frac{0,34}{0,34+0,44} = 0,436.$$

Closing remarks

Aforementioned points allow the authors to form a quantitative assessment of KPI "cooperation satisfaction index of goods suppliers"(I_s), which is equal to 0.441 and is interpreted as a conditional probability of an occurrence of a target event s – "suppliers, generally, satisfied with terms of cooperation", which is based on the results obtained during a survey. In other words, basing on the responses of suppliers received during the survey, concerning various factors of terms formation of the cooperation and the company, it can be stated, that suppliers were generally satisfied with terms and of the network company, with a probability 0.441 [11,12,15,16].

In addition, the proposed methodology of eventological scoring, basing on an analysis of the event-responses, which were interpreted as an unfavorable for an occurrence of a target event s *(x_1 x_2, x_5, x_7)*, allows to determine the main directions of discussed indicator's improvement. For example, corporation management has strategic measures aimed at satisfying suppliers by those aspects of a cooperation, which were referred to in the questionnaires. The duration of the specified strategic measures is 2 years. According to planning estimates, the target value of the discussed KPI "cooperation satisfaction index of goods suppliers"(I_s) is 0.765. The realization of planned strategic measures will allow to increase the current value of the indicator by 0.324 (0.865-0.441).

Table 8. Planned results of the survey and their interpretation in a calculation of "cooperation satisfaction index of goods suppliers"

Questions	Planned results of a survey		Interpretation of survey event – responses as:	
	Rather agree	Rather disagree	favorable	unfavorable
x_1	0.75>α	0.25	×	
x_2	0.35	0.65>α		×
x_3	0.60>α	0.40	×	
x_4	0.74>α	0.26	×	
x_5	0.70>α	0.30	×	
x_6	0.85>α	0.15	×	
x_7	0.60>α	0.40	×	

Table 9. A calculation of a conditional probability of a target event s in a case of the least overlapping basic events "cooperation satisfaction index of goods suppliers"

Questions	Results of the survey	
	$\omega(s \cap x)$	$\omega(s^c \cap x)$
x_1	**0.75**	
x_2		**0.65**
x_3	**0.60**	
x_4	**0.74**	
x_5	**0.70**	
x_6	**0.85**	
x_7	**0.60**	
$\sum$	**4.19**	**0.65**

Calculating a conditional probability of a target event s in a case of the least overlapping basic events.

$$P\left(s \mid t_s^{\cup}(X)\right) = \frac{\sum_{x \in X} \omega(s \cap x)}{\sum_{x \in X} \omega(s \cap x) + \sum_{x \in X^c} \omega(s^c \cap x)} = \frac{4{,}19}{4{,}19 + 0{,}65} = 0{,}865.$$

Thus, a conditional probability of target events for three different eventological structures of basic events was identified, based on the data obtained during the survey of suppliers. In spite of the fact that true eventological distribution of basic events is unknown, in the authors opinion, it seems to be the most logical to assume a presence of a structure of the least overlapping basic events, because the questionnaire reflects multifaceted aspects of conditions of a copertaion with suppliers.

Conclusions

Thus, an implementation of eventological scoring technology allows to avoid quantitative numerical evaluations of experts, which contradict heuristics-based nature of an expert's evaluation, to simplify as much as possible data collection procedure for a calculation of key performance indicators and to determine their integral value. An empirical study allows draw a conclusion about self-sufficiency of the methodology proposed by the authors and a possibility of its application in a practice of retail network companies. It should be noted that, in spite of the apparent complexity of calculations, processing of the surveys data and performing necessary calculations do not require complex procedures and can be easily implemented on the basis of Microsoft Excel or directly into ERP system.

A search for the most suitable methods of a quantitative assessment of qualitative indicators will be continued in future studies.

The proposed methodology in further works can be used to calculate a conditional probability of any target events in a case of a calculation of qualitative indicators in a system of key performance indicators, both for trade network companies and companies of other industries.

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