включая научную, техническую, экономическую, финансовую и коммерческую, а также растущие требования к содержанию информации и многообразие форм ее представления являются доминирующим стимулом для развития информационных систем для обмена электронными данными. Патентная информация, содержащаяся в международных патентных базах данных, позволяет компании создавать новые знания, определять существующий уровень техники и ведущие направления развития инноваций, разрабатывать технологические инновации на основе достигнутого технического уровня и регистрировать исключительные права на новые изобретения и инновации.

Ключевые слова: *информационное общество, сетевая экономика, хозяйствующий субъект, информационныересурсы, информационные технологии, инновационная деятельность, патентная информация, научно-техническая информация, инновационно-активные предприятия*

Рекомендовано до публікації докт. екон. наук О.В. Єрмошкіною. Дата надходження рукопису 15.06.14.

УДК 681.3.06

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DECISION SUPPORT METHODS IN BALANCED SCORECARD

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МЕТОДИ ПРИЙНЯТТЯ РІШЕНЬ У СИСТЕМІ ЗБАЛАНСОВАНИХ ПОКАЗНИКІВ

Purpose. Development of the method of KPI tree transformation into the decision tree to be used in BSC.

Methodology. Creating mathematical model of inverse calculations to achieve the above purpose.

Findings. Mathematical tool of the inverse computation to transform the tree of KPI indicators in the decision tree for application was developed. The Balanced ScoreCard concept appeared 15 years ago. But even now many companies face a great amount of problems during its implementation due to unavailability of clear methods and tools. There is a list of problems that appears during the implementation process: suitable performance indicators definition and calculation methods, connection of indicators in different management levels, decision preparation based on the hierarchy of goals, intuition influence on the decision-making process, decision-making support systems design and so on. To solve this problem an enterprise should develop new formalized methods and tools and find new indicators that can be decomposed easily and utilized in the decision-making process.

Originality. For the first time the method of inverse calculations was adapted for extending functionality of ballanced scorecard.

Practical value. The method shown in this paper can be used independently, without the formation of cards, within the BSC framework. This method allows improving such class of enterprise information systems as Business Performance Management.

Keywords: *inverse calculation, management by objectives, KPI, BSC, Business Performance Management*

Scientific Problem. In spite of the development of information technology as a tool for all procedures of decision-making support and availability of mathematical methods, nowadays corporate management experience problems, which are determined by system character. These problems can be grouped as follows:

- problems of strategic goals and indicators conformity on both tactical and operational levels;

- problems of measurements organizing and computer support.

Problems of the existing identification area, decisions preparation and choosing one of the them for implementation.

Theoretical Background. These problems are interrelated with a tool that is popular today – Balanced ScoreCard.

Balanced ScoreCard was created to link accounting indicators and planning indicators, and also strategic planning with other management levels. The Balance ScoreCard concept is one of the most relevant today. It is the only tool to harmonize and synchronize strategic goals with tactical and operational ones, and also to manage the utilization of consistent indicators.

But this fancy tool that can be embedded in Corporate Information System (CIS) (or available apart) cannot provide formalized decision preparation.

The Balanced ScoreCard (BSC) concept appeared 15 years ago, but as we know, it is very important to distinguish the idea and its implementation. Technologies and applied systems undergone the certain evolution that involved the mutual influence of theirs development theory and practice. The ideas that appeared during the process of implementation formed promising directions of information technology development concepts. Later as it always happens some of the directions initiated creation of software products and even later became independent information technologies. At the same time the understanding of the directions transformed under the influence of practice.

Major consulting companies (Accenture, Emst&Young, Price Waterhause Coopers, KPMG) use both the BSC concept and their own inventions. Software corporations produce software that supports BSC (IntersoftLab, BITAM, Business Objects, Cognos, Cristal Decisions, SAS, Hyperion, Pilot software, PeopleSoft, SAP Strategic Enterprise Management, ARIS BSC, Oracle BSC, etc.).

Initially BSC system was invented as a tool for solving problems of strategic planning and ensuring balance and measurement of management quality and connecting strategic goals with management indicators. But practically it is used to heighten the level of management, to increase the accuracy of business planning and operational budgeting, to unite people with common ideas within the company, to define employees' responsibilities, to bring into accordance personal goals with corporate ones and finally establish monitoring and communication [1]. So the resources of the company are utilized for strategy implementation and the hierarchy of goals is transparent for all employees.

Generally, we try to answer these four questions in BSC:
1.What relationship do we have with our shareholders?
2.What relationship do we have with our customers?
3.In what direction should the company develop?
4. How can the company implement innovations and add value?

So in terms of BSC we talk about four perspectives:
- finance;
- customers;
- business processes;
- training and development.

The standardized technology of this concept implementation includes the following steps:

- decomposition of directions from the mission as a starting point to the hierarchy of goals (based on indicators). Though cutting the hierarchy of goals at any level of decomposition gives us an opportunity to consider the dangling vertex of goals' graph as an event, the descent through the hierarchy of goals to concrete events allows us to evaluate available resources more precisely;
- assigning responsible persons for achieving goals at all levels of decomposition;
- identifying strategic goals among "perspectives";
- definition of cause-and-effect relations;
- definition of indicators for different levels of organizational chart;
- the weights assigned by decision-maker. It gives an opportunity to identify more and less perspective directions in manager's opinion;
- aggregation: connecting strategy with processes.

Let's note some of the questions that appear while working with the BSC concept:

1. How can we define appropriate measurements of employee performance and enterprise management performance?

2. Why do we use just 4 directions? May be we should include for example: external stakeholders (apart from customers), partners, government, investors, parent companies, suppliers, intermediaries, clients and so on.

3. The hierarchy of goals can be created based not only on BSC, but also based on organizational chart, management functions, upper level processes. Will these hierarchies be invariant from the view of terminal events? Will the events be invariant with different schemes of complex indicators decomposition (as long as they are available at a terminal vertex)?

4. Can we get the decision tree from the hierarchy of goals? And do we have certain formalisms for this purpose?

5. In fact, in what aspects is the system balanced? Theoretically it is mentioned in some works that balance is provided by coefficients of relative significance definition (or coefficients of goals priority, contribution significance and key indicators). And it is fully logical. But in the majority of works that describe both the methodology of indicators system design and BSC implementation there is no any whatsoever balance available.

Isolation of total unsolved part of the overall issue. The limits of this article do not allow us to find answers to all stated questions and to discuss all identified problems. So let's discuss only a part of them.

The problem of conducting calculations lies in the dimension of harmonization of indicators and, in fact, conducting calculations. Generally trajectory goals that are set by the manager to his/her subordinates are economic indicators only. Management staff of the company should create their own indicators and if they suppose qualitative assessment, it is necessary to set up correspondence with quantitative characteristics. To do so we should work out appropriate scales. The important question is the evalua-

tion of performance of indicators and also ensuring their consistency if in decomposition the low level indicator is linked to more than single higher level indicator. Moreover, the multiplicity of complex indicators decomposition methods can result synonymy and ambiguity.

Indicators that are used for measurement which help to solve practical management problems should support strategy implementation.

At the same time different indicators of departments should be in concordance with each other and organizational chart should provide coordination of its indicators and goals of processes. It removes contradiction between functional and operational management. According to the Key Performance Indicators (KPI) concept [2] all indicators can be grouped the following way:

- branch-wise;
- corporate;
- departmental.

Such indicators of system can have the problem of duality. Contradictions initiate movement, and their resolution lies in "dynamic balance" between system stability and its constant improvement, in other words – searching for new management decisions, because old stereotypes cannot be used under conditions of permanently changing environment. One of the fundamental contradictions marked by G. Simon and typical for companies is the connection duality of individual employee and the company in general. On one hand a company should give him/her as much freedom as possible to utilize his/her creative potential, but on the other hand the degree of organizational influence should be strong enough so that the activities of the individual remain in the field of organizational directions and do not contradict them.

Decision support methods. Measuring the performance of a manager demands new type of indicators for development and these indicators must fit stated goal adequately and measure exactly what we need to measure and analyze, and nothing else. Also, when we make decisions based on the indicator, it is supposed not to influence negatively on other indicators. We can find the origins of idea of performance indicators system of objects and processes creation in works on quality control [3].

However, the question systems had system connection of indicators neither vertically nor horizontally (i.e. the indicators on the same level). There are two opposite views on the indicators complexity in scientific literature that is severely poor with indicator ideology [4]. The first is pragmatic. It states that to measure processes and objects we can use as much indicators as necessary that due to theirs diversity will give complete view for analyses. The second one is the theoretical view. It is based on the idea of the complex creation of indicators that can be decomposed different ways. It is a kind of the integrated indicator that completely measures the main parameters of the process (like aircraft instrument "autohorizon"). A single indicator is the extreme case here [5]. The majority of complex indicators utilized in economics conform to the idea of U. Ashby told about the necessity of bringing into concordance the mechanism of system management and multiplicity of a system.

However the main problem here is coupling indicators of different management levels. Especially it concerns the top-management level where the strategy is generally defined verbally or probabilistic way and sometimes even the way of uncertainty. The second problem lies in the full connections of lower level indicators and strategy opacity for personnel. An average employee of inferior level has a vague idea of how he/she influences on overall mission implementation process.

What characteristics the indicator of BSC should possess? Drawing analogy with the term "algorithm" the indicator should possess the characteristics of mass and unambiguity, i.e. measurements must be repeatable and unbiassed. Developed indicators must have single understanding (no homonyms and synonyms). However in economics we always face not only determinate measurements but also probabilistic assessments, and also ambiguity, therefore during the indicators development one should assess the availability of data necessary to calculate them and also costs of calculations.

Each indicator in the indicator system must have description that in our opinion is supposed to include the following components:

- type of an indicator (structured, semistructured, unstructured);
- algorithm of its preparation;
- data source and update frequency;
- reporting forms and ways of theirs representation;
- the list of responsible for data collection (calculation) and utilization;
- circulation technology;
- periodicity of generation;
- connection with other indicators;
- planned (max, min), also perspective (max, min) and operational (physical) indicator values;
- indicator significance.

The last attribute of BSC is particularly important, because when we define the indicators significance, we ensure their balance. The value of a single indicator is not indicated among many others. It means that a manager does not have preferences during the process of decision making and all ways of decomposition are equally significant to him, although it is not really true. On the one hand decision-maker can always motivate his/her choice (that is always available) utilizing deliberate knowledge. On the other hand, creating conceptual and theoretical basis for decision support systems one should take into consideration well-known cognitologists research results, stating that apart of mental processes, realized by individual, there are many processes of unconscious thinking in his/her brains. An individual makes 40 per cent of decisions at unconscious, intuitive level. The outstanding mathematician G. Adamer writes: "I insist that there are completely no words in my mind when I am really thinking". And Spinoza considered intuition to be the major tool for perception. It is evident that intuition significance, its role in the processes of thinking in general and in processes of decision making in particular must be taken into consideration when we develop the decision-making systems and its derivatives: assump-

tions, hypotheses, experience, etc. Intuition is especially important for mathematicians: hundreds of years many scientific schools were based on intuitive understanding of series of axioms. It is impossible to examine unconscious thought processes directly. However we can use two methods of not direct research: genetic and axiomatic. The genetic method makes intuition model by means of another theory, the axiomatic method is based on set of axioms that can include the intuitive ones.

During the decision-making process it is natural that a problem of experience, intuition and other semistructured knowledge reflection appears. Decision-maker should indicate in the system the main ways of decision search, that are preferred. Precise methods (optimization, simulation, etc.) can be helpful only when the main strategy for decision search is identified. Moreover all quantitative methods can not characterize qualitative sides of the problem and therefore can be used in the next steps of decision preparation. Completely formalized methods of decision preparation based on well-known optimization methods are not much popular today but they contributed much to the development of this scientific field [6].

Management practice showed us that in the majority of cases the achieved results with methods of this kind hardly reflect the realities of manufacturing practice, because they cannot take into account the abilities of an individual.

However the analyses of development in the field of decision-making support show us extremely poor set of means and methods used to solve such kind of problems. Especially it concerns advising systems that are able to answer a question "What should I do to...?" The problem of inconsistency between theoretical basis of decision-making support systems and changing requirements of the enterprise management quality is more and more important today. Theoretical methods of known decision-making support systems today do not allow us to design tools that can support all steps of decision-making process and synthesize formal methods of decision preparation with knowledge and experience of a manager.

And finally let's talk about main problem. How can we get the hierarchy of decisions from the hierarchy of goals, taking into consideration knowledge of a manager and using formalized tools, i.e. providing direct transformation of a stated goal to a tool for its achievement? First of all we select goal – the starting point the decision-making process. We get it after applying a set of procedures – situation analysis and verification.

The second set of procedures that help us to transform stated goal to a tool for its achievement includes application of inverse calculations and knowledge of resources and reserves that are available for the decision-maker.

Enterprise resources and calculations are not difficult apart from the ones that depend on the environment (banking credit interest, custom duty level, national currency inflation, rate of growth, etc.). But even in this situation the ways of receiving of the sufficiently target information can be found.

Key goal can be represented as a hierarchy of goals. Remember, this process is polysemantic. For example, in case you will choose an indicator with divisible model of calculation and there will be several ways to increase the indicator, namely: by increasing the numerator or by decreasing denominator. In case, you divide them the number of ways increases. Moreover in case there are several ways of calculation of the same indicators the process of solution finding becomes more complicated.

Representation of the key goal as the hierarchy of goals is informal, creative process that requires certain knowledge and experience. For the correction of users mistakes the introduction of representation correction of a user coefficient is required. Correction can be provided automatically. These coefficients named goals priority coefficients (GPC), reflected the user's preference of one way of goal (sub goal) achievement to another one. GPC is a tool to manage the process of choosing of the goal achievement direction (sum of the GPC at one hierarchy component relative to the same upper component should be equal to 1). Everyone knows this rule.

Then to provide the indicators real usage in the managing process of the hierarchy of indicators that should be represented as a hierarchy of goals and the hierarchy of goals as a decision hierarchy. In this case we need a method (formal) that takes into consideration not only manager's consciousness of the type "I know what I know", but also the type "I do not know what I know" [7, 8].

Let's study the variant of the dependence exposure inside the compulsory indicator by the example of the indicator Return of Equity (ROE, fig. 1). Return on equity = Net profit (*N*) / own capital (*C*).

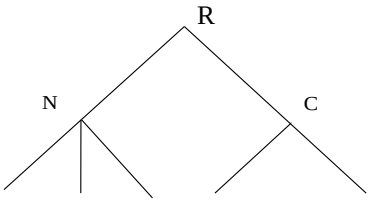

Fig. 1. Fragmentation count of the indicator ROE (R)

A hierarchy of goals tops can be divided in two groups: abstract and terminal. Abstract tops are derived tops (calculated), terminal tops are tops that by implication make the user act as required to reach a goal.

The combined list of the possible situations provided by indicator *R* can be presentedas follows in the table 1.

This table should be corrected by implication by the manager as some situations in the table can be economically unrealized.

Table 1

The combined list of the possible variants provided by indicator *R*

Factor	Changes of the indicator in a situation										
	1	2	3	4	5	6	7	8	9	10	23
R	-	-	+	0	-	-	+	0	-	+	0
N	-	+	+	+	0	-	-	-	-	+	0
C	-	-	-	-	-	+	+	+	+	+	0

In the present example such situations are as follows: 2, 4, 5, 7, 8, 13, 14, 16–18, 20–22. Using the table the manager presents the table of indicators as a hierarchy of goals by filling in the wishful trends of indicator changes. Each component of the hierarchy of goals has a symbol "plus" or "minus" (table 2) that reflects the wishful trend of change.

Table 2

Hierarchy of goals presented as a table with GPC and changers trends indicators indicated

	A	B	C
R	+	α	β
N		+	
C			–

Goal achievement. I.e. indicator's *R* increase in the quantity ΔR should be provided in the volume $\alpha\Delta R$ due to the indicator *N* increase and in the volume $\beta\Delta R$ – due to the decrease of indicator *C*. It's evident that the following conditions should be kept

$$\Delta R\,(N) + \Delta R(C) = \Delta R;$$
$$\Delta R\,(N) = f1\,(\alpha, N);$$
$$\Delta R(C) = f2\,(\beta, C),$$

where ΔR – indicator R increase set (wishful); $\Delta R\,(N)$ – increase provided by the increase of indicator *N*; $\Delta R(C)$ – increase provided by the decrease of indicator *C*; *f1, f2* – inverse functions used for the increase $\Delta R\,(N)$ and $\Delta R(C)$ calculation; A, β – GPS for each of the sub goals (*N* and *C*).

Here the user also defines resources and limits for their usage. Material, financial, working, energetic, informational, time and other enterprise resources, are limited, that is why goal achievement methods should be found by combining of reserves. Stated goal transformation into the tools for its achievement requires the inverse calculations and knowledge of the resources and reserves which the decision maker is provided with.

Transformation of goals into the tools of influence of the real processes allows user to receive answers on the following questions types: what should be done to achieve the goal (to increase the return on equity, to decrease own capital, to increase net profit, etc.)? To provide answers on such questions the system should be able to transform the goal, presented by any measure (for example, by the value of economic indicator) into the tools (other economic indicators) or actions. It can be reached by using inverse calculations [7–10] which are the calculations of the inverse function. Goal is primary, and the tools of its achievement are secondary.

Being a quantitative measure of achievement of goals of economic indicators is calculated by the direct functions. For example, return to equity is calculated on the base of the net profit divided by own capital. Net profit and own capitals are initial numbers. To provide advising of system it is necessary to change places of functions and arguments, this ability is provided by solving of the inverse problem. To answer on the question what should be done to increase the return on investment by ***n*** percent, one should use the return on investment not as a function, but as an argument and net profit and own capital become functions. In case there is a method to calculate the net profit and own capital to provide the increase of the return on the equity by n percents it is the method of the inverse calculations. To provide existence of the inverse function, the direct function should have property of increasing and decreasing and be continued in the range of number axis that makes sense for the present indicator.

Indicators recalculation is held within earlier stated resources or in the situation of the resources changing stated by the user during summary calculation. In case recalculation is provided within stated resources, i.e. there is a limit on increasing of indicators; the limit achievement provides dynamic redistribution of GPC.

Decision making process was examined explicitly, in a half formal way. Explicit method is convenient as the results can be provided relatively independent, half formalized parts of the general process that can be then examined.

Considering a hierarchy of goals and resources of the enterprise to achieve the main known goal one should calculate the increase of the indicators characterizing components of the hierarchy of goals. Calculations are to be provided "from up to down – from left to right". More formal: one should calculate its arguments. Such task is named the plenty variables functions inverse calculations on the function base. Distinctive features are that during the direct calculation one calculates the part of the argument in the general function increase and in the present case one calculates the arguments having the function increase stated and the parts of all the arguments indicated in it. Let's introduce not only relative values of the subgoals, but also relative values that reflect fines for the resource limits taking over. Formally tasks can be presented as follows:

- hierarchy of goals got by the main goal fragmentation;
- actual (initial) value of the indicators that characterize the level of goals of each of the sub goals of the hierarchy of goals achievement;
- wishful indicators increase that reflects the level of the main goal achievement is ± DP10. Depending on the users preferences the increase can be positive or negative (profit increase or cost price decrease, profitability increase or decrease of the reserve stocks, etc.);
- dependence between indicators that quantitatively reflects the main goal and the sub goals.

Resources of the decision maker with statement of the range of their changes required: determine resources enough to achieve the increase of the man goal (equal to $\pm\Delta P_1^0$) with the appropriate calculations. In the result of the sum doing one can get base solution presented as a multitude of values of the hierarchy of goals terminal tops

$$O = (\overline{P}_1, \overline{P}_2, ..., \overline{P}_r).$$

In general case the received result can meet the user's requirements as each of the elements of *O* vector is a guide to action presented in compacto. For example, the content of *O* vector in case of main goal forming as "Increase profitability by 5%" can be presented as follows:

$\overline{P}_1$ – to increase the volume of sales by 1%;

$\overline{P}_2$ – to decrease reserve stocks by 2%;

$\overline{P}_3$ – to decrease cost price by 9%;

$\overline{P}_4$ –t o reduce goods in process by 7%.

Vector *O* content is the base variant of the solution. This method can be used only with ∫ indicators that can be divided in fragments. Indivisible indicators should be analyzed in case of vertical correlation existence. In case of this correlation the usage of the reverse calculations becomes impossible. One can use the fictitious tops that allows user to relate the indivisible into the connected fragments indicators. Here we studied the target setting only under certainty. The topic of reverse calculations for generating decisions not only under certainty but also under uncertainty and also its probability is fully introduced only in one fundamental work of B.E. Odintsov [2] till present moment. Inverse calculation method provides BSC with new features by transforming it from the system of the stated type into the system of decision generating that provides answer for the question "what to do to..?"

Program realization of inverse calculations can be based on any information technologies (sufficient for the given class of goals). However, taking into account that the diagram of BSC solutions, when inverse calculation is applied, turn into the diagram of goals, we can speak about creation (and further usage) of knowledge base, presented in specific form. This means that PROLOGUE-like languages are more sufficient tools for inverse calculations. In other respects, the balanced system of indices conceptually is included in the class of Information Systems named Business Performance Management (BPM). This is a new approach to tools that ensure reasoned strategic decision taking. BPM is not only the innovative management conception, but also one of the most rapidly growing sectors of IT solutions.

Its attractiveness urged interest to its implementation by numerous IT-companies in Russia (Intersoft Lab, Lanit and etc.) and abroad (Hyperion, SAP, Oracle, Cognos, SAS and etc.).

The most important management models and BMP subject technologies include the following widespread modem management solutions:

- Key Performance Indicators models (KPI);
- BalansedScoreCard method (BSC);
- budgeting methods;
- corporate motivation models;
- models of monitoring and control of decision performance;
- management accounts methods;
- financial and non financial information consolidation tools.

Conclusion. We may conclude that BPM is the next generation of BI systems, its sequel. BPM includes the group of methodologies and tools that are helpful in planning, sizing and analyzing business and in increasing its performance on the whole enterprise. BPM processes include:

1. Key performance indicators (KPI), record-keeping of results, toolbars and signals, that control production in close connection with operational goals.
2. Scenario analyses "what if".
3. Constant reconsideration and update of performance indicators on real-time basis.
4. Interactive decision taking on all levels of the enterprise, equalizing individual goals to strategic ones.
5. Data research, requests, and analysis, including drill-down.
6. Profitability analysis of a company, business units, products and customers.
7. Integration of numerous ERP, CRM and other systems.

Thus BPM systems close the gap in the functionality DSS and BI providing automation of the planning (strategic and short-term), provides monitoring and control of the key users effectiveness, automate corporate modeling, analysis, maintenance of the management procedures and they are involved in other enterprise business processes. The main management approach used in BPM conception is Balanced ScoreCard that is why its improvement is significant.

References / Список літератури

1. Odintsov, B.Ye. (2004), "Inverse calculations in economic decisions making", *Finance & Statistics*, Moscow, Russia.

Одинцов Б.Е. Обратные вычисления в формировании экономических решений / Одинцов Б.Е. – М.: Финансы и статистика, 2004. – 192 с.

2. Romanov, A.N. and Odintsov, B.Ye. (2000), *Sovetuyushchiye informatsyonnye sistemy v ekonomike* [Advising Information Systems in Economics], UNITY-DANA, Moscow, Russia.

Романов А.Н. Советующие информационные системы в экономике / А.Н. Романов, Б.Е. Одинцов – М.: ЮНИТИ-ДАНА, 2000. – 487 с.

3. Amirov, Yu.D. (1996), *Sovetuyuschiye informatsyonnye sistemy v ekonomike* [Product Quality Control and Certification] Methodical Material, IPKStandarts Publishing house, Moscow, Russia.

Амиров Ю.Д. Квалиметрия и сертификация продукции / Амиров Ю.Д. – М:ИПК Издательство стандартов, 1996. – 104 с.

4. Gershun, A.M. and Nefedieva, Yu.S. (2005), *Razrabotka sistemy sbalansirovannykh pokazateley* [Balanced Scorecard System Development], practical guide with examples, Olimpus-Business CJSC, Moscow, Russia.

Разработка сбалансированной системы показателей. Практическое руководство с примерами: 2-е изд., расшир. / Под ред. А.М. Гершуна, Ю.С. Нефедьевой – М.: ЗАО „Олимп-Бизнес", 2005. – 128 с.

5. Phelps, B. (2004), *Smart Business Metrics: Measure What Really Counts and Manage What Makes the Difference*, translation from English, Balance Business Books, Dnepropetrovsk, Ukraine.

Фелпс Боб Умные бизнес-показатели: система измерений эффективности как важный элемент ме-

неджмента; пер. с англ. / Фелпс Боб – Днепропетровск: Баланс Бизнес Букс, 2004. – 312 с.
6. Zalozhnev, A.Yu., Chistov, D.V. and Shuremov, Ye.L. (2013), "Supply optimization problem for cloud computing services", *Information technology in the financial and economic sphere: the past, present and future. Proceedings of the International Research Conference*, 1C Publishing, Moscow, pp. 112–121.

Заложнев А.Ю. Задача оптимизации предложения облачных вычислительных услуг. Информационные технологии в финансово-экономической сфере: прошлое, настоящее, будущее: материалы международной научной конференции / А.Ю. Заложнев, Д.В. Чистов, Е.Л. Шуремов; под ред. О.В. Голосова, Д.В. Чистова. – М.:1С-Паблишинг, 2013. – С. 112–121.
7. Tolkach, V., Danishevich, S. and Gavrish, M. (2005), Vnedreniye sbalansirovannoy sistemy pokazateley [Introduction of Ballanced Scorecard], Alpine business books, Moscow, Russia.

Толкач В. Внедрение сбалансированной системы показателей: пер. с нем. / Толкач В., Данишевич С., Гавриш М. – М.: Альпина Бизнес Букс, 2005. – 478с.
8. Urintsov, A.I. and Dik, V.V. (2008), *Sistemy formirovaniya i prinyatiya resheniy v usloviyakh informatizatsyi obshchestva* [System Formation and Decision-Making in the Information Society], Eurasian Open Institute, Moscow, Russia.

Уринцов А.И. Системы формирования и принятия решений в условиях информатизации общества: монография / А.И. Уринцов, В.В. Дик – М.: Евразийский открытый институт, 2008. – 224 с.
9. Seletkov, S.N. and Dneprovskaya, N.V. (2011), *Upravleiye informatsyey i znaniyami v kompanii* [Information and Knowledge Management in the Company], Textbook, Infra-M, Moscow, Russia.

Селетков С.Н. Управление информацией и знаниями в компании / С.Н. Селетков, Н.В. Днепровская – М.: Инфра-М, 2011. – 208с.
10. Urintsov, A.I. and Sitnov, A.A. (2013), *Instrumentalnye sredstva upravleniya i adaptatsyi ekonomicheskikh sistem na osnove operatsyonnogo audita* [Management Tools and Adaptation of Economic Systems Based on Operational Audit], Monograph, Eurasian Open Institute, Moscow, Russia.

Уринцов А.И. Инструментальные средства управления и адаптации экономических систем на основе операционного аудита: монография / А.И. Уринцов, А.А. Ситнов – М.: Евразийский открытый институт, 2013. – 512с.

Мета. Розробка методу трансформації дерева ключових показників ефективності (KPI) в дерево рішень для використання в системі збалансованих показників (BSC).

Методика. Використані методи системно-комплексного підходу, методи математичного апарату зворотних обчислень.

Результати. Розроблений математичний інструментарій зворотних обчислень для трансформації дерева показників у дерево рішень для практичного використання. Виявлений перелік проблем, що виникають у процесі реалізації концепції збалансованих показників: відсутність чіткості показників ефективності та методів їх розрахунку, підключення індикаторів на різних рівнях управління, підготовка рішення, що засноване на ієрархії цілей, процес прийняття рішень дизайн-системи підтримки та інше. Рекомендовано для вирішення цих проблем розробити нові формалізовані методи та інструменти, а також застосовувати нові показники.

Наукова новизна. Наукова новизна дослідження полягає в тому, що вперше метод зворотних обчислень адаптований для розширення функціоналу системи збалансованих показників.

Практична значимість. Запропонований у роботі метод може використовуватися як самостійний і незалежний, без формування карт, так і в рамках системи збалансованих показників. Це дає можливість удосконалення такого класу корпоративних інформаційних систем, як система Business Performance Management.

Ключові слова: *зворотні обчислення, управління за цілями, KPI, BSC, Business Performance Management*

Цель. Разработка метода трансформации дерева ключевых показателей эффективности (KPI) в дерево решений для использования в системе сбалансированных показателей (BSC).

Методика. Использованы методы системно-комплексного подхода, методы математического аппарата обратных вычислений.

Результаты. Разработан математический инструментарий обратных вычислений для трансформации дерева показателей в дерево решений для практического использования. Выявлен перечень проблем, возникающих в процессе реализации концепции сбалансированных показателей: отсутствие четкости показателей эффективности и методов их расчета, подключения индикаторов на разных уровнях управления, подготовка решения, основанного на иерархии целей, процесс принятия решений дизайн системы поддержки и др. Рекомендовано для решения этих проблем разрабатывать новые формализованные методы и инструменты, а также применять новые показатели.

Научная новизна. Научная новизна исследования заключается в том, что впервые метод обратных вычислений адаптирован для расширения функционала системы сбалансированных показателей.

Практическая значимость. Предложенный в работе метод может использоваться как самостоятельно и независимо, без формирования карт, так и в рамках системы сбалансированных показателей. Это дает возможность совершенствования такого класса корпоративных информационных систем, как система Business Performance Management.

Ключевые слова: *обратные вычисления, управление по целям, KPI, BSC, Business Performance Management*

Рекомендовано до публікації докт. техн. наук Є.В. Кочурою. Дата надходження рукопису 15.06.14.