BUILDING A BALANCED SCORECARD FOR THE ESTIMATION OF MANAGEMENT SYSTEM EFFICIENCY: INFORMATION ASPECT

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ABSTRACT

The constant increase in potentiality of information systems force to implement centralized management solutions to guarantee, through immediate actions, high levels of performance and service.

The enterprise strategy and vision have to be as same as information division or it cannot be executed and implemented efficiently. This paper attempts to define the main principles of Balanced Scorecard indicators building and investigate Balanced Scorecard of the information resources management system efficiency.

Key Words: Balanced Scorecard, Management, Information Resources, Estimation, Efficiency

1. Management Strategies

Kaplan and Norton BSC methodology is a management system that enables organizations to clarify their vision and strategy and translate them into action. It provides feedback around both the internal business processes and external outcomes in order to continuously improve strategic performance and results. Founded on BSC methodology Strategic Enterprise Management (SEM) unites:

1. Business Planning and Simulation (BPS).
2. Business Consolidation (BC).
3. Corporate Performance Monitor (CPM) on BSC basis, Economic Value Added (EVA), Value Drive Trees.
4. Business Information Collection (BIC).
5. Stakeholder Relationship Management (SRM), information transfer to investors with a help of Push-service, Pull-service on base of Data Warehouse (DW).

The stuff and the structure of BSC indicators are focused to the utmost on the object and the management system specificity, take into account the stage of a business life cycle (growth, a steady condition, gathering of a "crop"), financial strategies, resource maintenance, external economic environment influence and many other factors. BSC building is a long and labour-intensive process sometimes based on Datamining technologies as well as analytical toolkit use. BSC building is not to be mechanically carried to the other strategic management system.

2. BCS Indicators Classification

BSC information aspect assumes formalization of the structure building and classification of indicators by the most significant attributes. Let us consider the bases of classification of BSC indicators.

1. The BSC is a conceptual framework for translating an organization's vision into a set of performance indicators distributed among four perspectives:

- **The financial perspective**. Timely and accurate financial data (growth of profitability of production, profitability of own capital, net monetary flow, net profit, indicators of a financial status, etc) will always be a priority. But the point is that the current emphasis (акцент) on financials leads to the "unbalanced" situation with regard to other perspectives.
- **The customer perspective** captures the ability of the organization to provide quality goods and services, effective delivery, and overall customer satisfaction. These are leading indicators: if customers are not satisfied, they will eventually find other suppliers that will meet their needs.
- **The internal business process perspective** provides data regarding the internal business results against measures that lead to financial success and satisfied customers. To meet the organizational objectives and customers expectations, organizations must identify the key business processes at which they must excel. Key processes are monitored to ensure that outcomes are satisfactory. Internal business processes are the mechanisms through which performance expectations are achieved.
- **The learning and growth perspective** captures the ability of employees, information systems, and organizational alignment to manage the business and adapt to change. Processes will only succeed if adequately skilled and motivated employees, supplied with accurate and timely information, are driving them.

2. The value of each BSC indicator corresponds with a certain business-unit (Unit of Business – UOB) of the organization. Structural decomposition of the organization into

levels of management and structural units is certainly taken into account while building of the BSC.

3. BSC indicators are adhered to a cycle of management – the Forecast, the Plan, the Expenditure Account, the Analysis, the Regulation. The registration, scheduled, forecasting and analytical BSC indicators have the certain methodology of building.
4. The important classification characteristic of BSC indicators is the category of time; indicators represent values for the fixed date, for an interval of dates, for the calendar period – year, quarter, month, week.
5. Among BSC indicators "productive" and "factor" indicators are distinguished. Productive indicators determine strategy of business performance by the most adequate and full manner; they are connected by cause and effect relations to factor indicators as well as to each other.

Productive indicators determination is carried out by two ways: on the basis of the expert (top-manager) conclusions or as a result of the statistical analysis of connections of observed indicators values (the regression and the correlation analysis). All the parameters can be included in orgraph where parameters correspond to the tops, arches – to connections between them. The orgraph topology and parameters can be used for the analysis of BSC indicators.

3. BCS Structural Units

The semantic contents of the strategy can be represented with a help of Structural Units. Minimal structural unit – an element, a field, an attribute – does not possess definite semantic contents, BSC is built on the basis of data aggregates.

The minimal data aggregate (the BSC indicator ***P***) is the normalized structure of the third normal form of relational data model. The parameter unites qualitative or other attribute elements - ***(AE),*** and one base attribute ***(BE)***.

The block diagram of BSC indicator ***P***:

$$P = \{AE_1, AE_2, ..., BE\} \qquad (1)$$

The indicator ***P*** will allow to express uniquely the contents of economic processes, to identify and to measure quantitatively business-processes. BSC indicators form the basis of more complex structural creations (relationals, forms of documents) formed as a result of data aggregate concatenation.

Key rules of the BSC building from the point of information-technological infrastructure of a management system:

- The set of attribute elements must be necessary and sufficient for unique definition of value of the base element;
- Attribute elements provide the semantic contents of indicators;
- The base element can have qualitative or quantitative expression; for a quantitative estimation there is a numerical series and the certain unit of measure, for qualitative estimation it is necessary to assign the metric of the meanings, for example: yes / no; bad / better / well / very well / excellent – the limited set of qualitative characteristics; a scale of points or factors (1-5, 1-10, 1-100, etc.) – the unlimited set of qualitative characteristics, etc.;
- Data structures of indicators are unique, i.e. ***P1*** and ***P2*** are equitype if:

$$P1 = \{AE_1, AE_2, AE_3, BE\}$$
$$P2 = \{AE_2, AE_3, AE_1, BE\} \qquad (2)$$

4. BCS Users

BSC is looking about a "consumer". The consumers are: a decision maker, business unit, Chief Processes Officer – those having the right to make a decision (table 1) in view of the kind of data processing. Each cell on the intersection of columns and rows contains the code of adequacy:

Seek (S) – only reviewing of indicator values;

Control (C) – making a control decision on the indicator value basis;

Modify (M) - modifying of the normative/strategic values taken into account while analyzing the current value of BSC indicator.
The possible combinations of codes are: S; SC; SCM; SM. For example, S means the opportunity to become acquainted with the indicator; SC means an opportunity of new decision development on the basis of the received indicator value; but absence of powers on normative/strategic values modifying that reflect strategy of a management system, etc.

Table 1. The use of BSC indicators

BSC indicators	Management levels / Head of processes (CPO) / Users														
	CPO1			CPO2			CPO3			CPO4			CPOn		
	S	C	M	S	C	M	S	C	M	S	C	M	S	C	M
P1															
P2															
…															
Pk															

The analysis of the table allows to determine the indicators having mass character of application; restrictions of access.

5. BCS Quality

A high quality of BSC information is an obligatory condition of business strategy realization. The basic components making quality of indicators information are reliability and accuracy, urgency and timeliness of a productive indicator values formation, completeness, etc. For the BSC information quality estimation the structure of connections (OR-Graph), as well as algorithms of indicators formation: calculation, supervision, sample, aggregation, etc are taken into account (fig. 1).

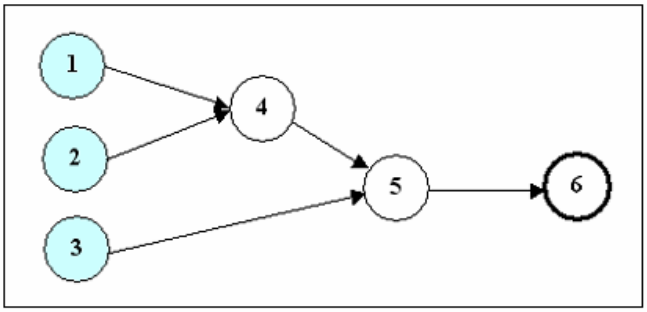

Figure 1. Structure of interrelation of BSC indicators

Thus, BSC indicator 6 is a result of data aggregation of indicator 5. Indicator 5 is a result of joint data processing of indicator 3 and 4, and indicator 4 – a result of joint data processing of

indicators 1 and 2. Indicators 1, 2 and 3 refer to initial[1] indicators as their values are not based on calculations, sample or data aggregation.

On the basis of the graph of indicators interrelation it is possible to receive an estimation of some properties of BCS indicators:

- **The level of information reliability** (probability of a mistake presence) ***d*,** is calculated taking into account a topology of the graph and probabilities of a mistake of data processing.

Let's consider the simplified example of calculation of BSC indicator reliability (fig. 1). If probabilities of a mistake of transformations ***p*** are known, reliability of initial indicators ***d***:

Probability of input mistake while indicator 4 being formed:

$$(1-d)+(1-d)-(1-d)^2=1-d^2 \quad (3)$$

Reliability of indicator 4:

$$1-\left[(1-d^2)+p-(1-d)^2 p\right]=d^2(1-p) \quad (4)$$

Probability of input mistake while indicator being formed:

$$\left[1-d^2(1-p)\right]+(1-d)-(1-d)\left[1-d^2(1-p)\right]=1-d^3(1-p) \quad (5)$$

Reliability of indicator 5:

$$1-\left[(1-d^3(1-p))+p-p(1-d^3(1-p))\right]=d^3(1-p)^2 \quad (6)$$

Probability of input mistake while indicator 6 being formed:

$$\left[1-d^3(1-p)^2\right]+p-p\left[1-d^3(1-p)^2\right]=1-d^3(1-p)^3 \quad (7)$$

Reliability of indicator 6:

$$1-\left[1-d^3(1-p)^3\right]=d^3(1-p)^3 \quad (8)$$

- **The actualization period of BSC indicator** – t_{act} is defined as the minimal value of the actualization period of all the components of the graph;
- Time of BSC indicator obtaining (operationability) – t_r.

Time of data processing for indicator 6 obtaining can be calculated on the basis of a network parameters as a duration of a critical way. The duration of calculations for each indicator depends on the intensity of computing resources usage and on the topology of a network.

BSC indicators are used as indicators of a management efficiency, obtaining of express assessments of strategy realization and operative regulation of the company activity. For the system of management efficiency analysis on the basis of BCS indicators it is necessary:

1. To develop the scripts of variation of *initial* indicators' values used for creation of BSC indicators.
2. To create imitating models of management system efficiency estimation on the basis of BSC indicators.

[1] Some authors agreed with such structurization of BSC indicators interrelations consider initial indicators as drivers of performance – mechanisms or resources of achievement of BSC indicators strategic values.

3. To create optimization models of initial indicators by the certain criterion (BSC indicator).
4. To investigate tolerance range of initial indicators for a given value of BSC indicator.
5. To provide Datawarehouse creation for the statistical analysis and BSC indicators forecasting according to technological architecture of BSC indicators processing system (fig. 2).

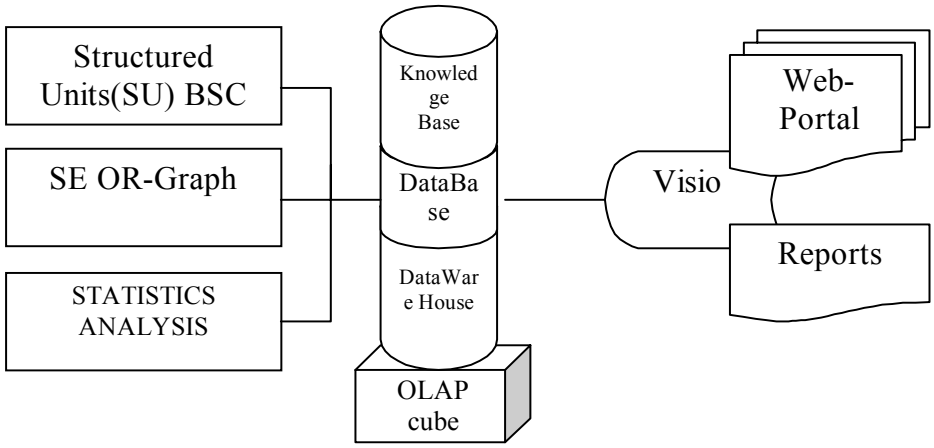

Figure 2. Technological architecture of BSC

6. Information Infrastructure

The information system and information technologies in aggregate form an information infrastructure of management system. The purpose of this system is to create the information resources supporting effective management of business processes. The information resource can be characterized by typical set of indicators that can be considered as independent aspect "Information resources" added to the four perspectives among which a set of BSC performance indicators can be distributed (fig. 3).

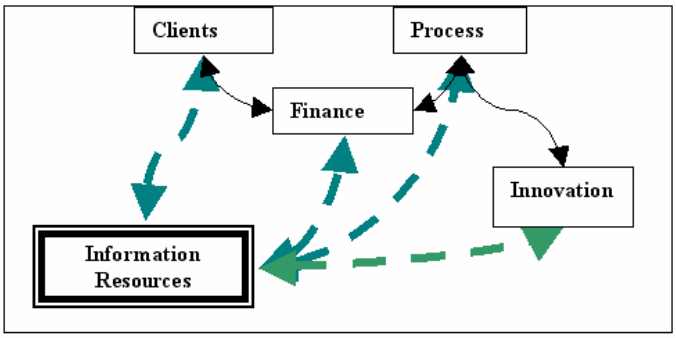

Figure 3. Aspects of BSC indicators' distribution

6.1. BCS Quality

2. Orientation to the all-round support of business processes by the most economic way (process orientation). This strategy is aimed to provide satisfaction of information needs of business processes (especially key processes), ensuring first of all the growth of a management system efficiency. By the other hand it should allow the costs necessary to

succeed in satisfaction the requirements to qualitative and quantitative characteristics of information resources.

Criterion of information resources efficiency can be a maximum of effect (**Effect of Information Technology, EIT**), which is defined as a difference between the total effect of existing business processes (**Effect of Business Process, EBP**) and a total cost of ownership of information resources (**Total Cost of Ownership, TCO**).

This criterion allows completely to take into account requirements to information resources, namely: to the structure, volume, quality of information (reliability, entirety, timeliness, urgency, etc.), to interfaces parameters of the end user and programs from the point of business process. The part of effect of business processes performing due to information resource ***k*** can be defined both statistically (method of a factor analysis) and with a help of expert appraisements.

Model A of efficiency of some information resource:

$$EIT_i = \sum_j EBP_j \cdot k_{ij} - TCO_j \qquad (9)$$

Growth of efficiency of information resource $\boldsymbol{EIT_i}$ can be provided at expense of the correct choice of business processes support sequence in the order of the quantity $\boldsymbol{EBP_j \cdot k_{IJ}}$ decreasing as well as quantity $\boldsymbol{TCO_i}$ reduction..

If business processes implementation causes synergistic effect, the order of implementation of business processes is reflected in the magnitude of ***EBP***. Let us compare two variants of implementation.

1st variant:
The sequence of implementation of business processes is: ***BP1, BP2, BP3***; the synergistic effect of business processes implementation is: {1000, 2000, 1500} pro tanto.

2nd variant
The sequence of implementation of business processes is ***BP2, BP1, BP3***; the synergistic effect of business processes implementation is {2500, 500, 1500} pro tanto.

Let us assume, that needs of business processes in information resource remain constant, and the part of effect from business processes performing achieved through information resource is not changed, too, the gain due to changing of the business processes sequence can be essential. For example, the part of effects of business processes ***BP1, BP2, BP3*** makes {0,03; 0,1; 0,05}.

Then, the total effect from business processes implementation due to information resource will be:

10000,03 + 20000,1 + 15000,05 = 305 (1st variant);

25000,1 + 5000,031500 + 15000,05 = 340 (2nd variant).

Model B of efficiency of a set of information resources:

$$\sum_i EIT_i = \sum_j EBP_j - \sum_j TCO_j \qquad (10)$$

The complete set of information resources adequate in totality to information needs of business processes is considered. Synergistic effect conditioned by the sequence and integrated approach of implementation of business processes increases efficiency of

information resources, but the greater growth of effect is stipulated by the economy of costs on information resources creation and possession.

3. The strategy aimed to creation of uniform information space as a basis of effective management.

In 90th of the 20-th century their appeared a heading - Management by Collaboration (MBC) which was based on the following items:

- Definition of the common goals that should be gained by business partners;
- Organization of dynamical groups of employees for realization of these goals achievement;
- Maintaining the moral of cooperation on a mutually profitable basis (at a level of separate executors, departments and even the companies);
- Creation of motivation and growth of professionalism of employees.

Traditional bureaucratic structures for which formalism, centralization and functional specialization are typical, are too sluggish and do not ensure competitiveness of the company. The new type of an organization structure of management – not hierarchical type of network organization with free information interchange and decentralization of discretions for decision makings has been generated. With growth of business scales the geography of interacting partners is being changed creating the necessity of unification and standardization of the forms of submission and content of information. The structure and the volumes of acceptable data (technologies of Data warehouse, mobile access – Intranet/Internet, "transparency" and openness of information about the company, etc.) ensure the extension of business, create image of the "open" partner.

4. Ensuring of reliability and quality of information resources.

Indicators of the quality of information resources are:

- Entirety of the information for decision making.
- Urgency of data contained in information reports.
- Timeliness of information resources necessary for business processes.
- Authenticity of the information.
- Necessary and sufficient level of data representation accuracy.
- Availability for perception of the form and content of information reports.
- The reliability of the information resource as a property of maintaining of the resource qualitative characteristics during the certain period of time.
- Protection of an information resource both from external and internal noise.
- Life cycle of an information resource (duration, phases).

5. Orientation to all-round satisfaction of information resources users.

All users of information resources can be divided to a number of categories:

- Chief of business processes – CPO (Chief Process Officer);
- Manager using information resources during his activity – MBP (Manager of Business Process);
- Partner on business, the supplier, the customer – Partner;
- Chief of information resources – CIO (Chief Information Officer);
- Staff supporting information resources – IT Personal;
- External user.

Each category of users interacts with information resources at a certain level, forming or applying information resources. For users – consumers of information resources (CPO, MBP, Partner, External User) such characteristics as the forms of external representation, operational parameters (time of inquiries' realization, productivity of a management system,

etc.), value of an information resource from point of practical activities are most essential. For CPO the suitability of the information resource to reinvestment in conditions of business processes developing has a great meaning. For users – producers of information resources (CIO, Personal IT) manufacturability of processes of information resources creation and use is the most significant.

6.2. *BCS Information Infrastructure*

1. Class of information systems

There are the following classes of information systems: MRP (Material Requirements Planning); MRP II (Manufacturing Resource Planning); ERP (Enterprise Resource Planning); CRM (Customer Relationship Management); SRM (Supplier Relationship Management); SCM (Supply Chain Management); BPM (Business Process Management); SEM (Strategic Enterprise Management), etc.

Classes of information systems have specific attributes (structure of supported business processes, informational technological architecture, basic information technologies, variety of hardware-software platforms for information system realization). Information systems should meet perspective needs of a management system. As a measure for the given parameter it is possible to offer expert appraisements of two types:

- Class of information system AS IS;
- The required class of an information system TO BE.

The indicator of discrepancy of the information system type:

$$\Delta ab = \sum_i (a_i - b_i)$$

Where a_i is the class of information system ***AS IS***; b_i is the class of information system ***TO BE***, i is an index of the expert.

If magnitude Δab is close to 0, the type of an information system fully corresponds to requirements of a management system (i - number of experts).

2. Level of standardization of information system components

Quality of the information system is largely defined by the use of the standardized elements, including:

- Licensed software;
- Certificated computer complexes, computer networks and office equipment;
- Unification of document systems and document circulation;
- Qualification of all categories of users of information resources;
- Classification and coding schemes of information, etc.

The indicator describing a share of components conforming the requirements of standardization can be applied for this category. The indicator value should approach to 1 (100 %).

3. Informational technological architecture

There are the following kinds of informational technological architecture (ITA) of information resources building:

- Centralized;
- Distributed
- Web-based.

Basic ITA indicators:

- Software (system software – an operating system, utility programs, network software – an operating system, applied software – functional programs);
- Program interfaces structure;
- Complex of hardware (classes and models of computer complexes);
- Amount of levels of the client-server architecture;
- Topology and the size of the network;
- Maximum network traffic;
- Amount of servers and their functionality;
- Database and data warehouse size;
- Level of information resources protection;
- Level of information resources reliability;
- Possible number of users;
- Maximum productivity (the number of transactions per unit of time);
- Cost of information resources service;
- Labor intensity of service of information resources, etc.

4. Operating characteristics of information resources

Among operating characteristics of information resources it is necessary to distinguish those indicators that generally characterize the performance of information resources:

- Amount of simultaneously working users;
- Average time of single transaction;
- Average waiting time of the answer in the interactive mode of inquiry;
- Average cost of organization of the user's working place;
- Average cost of training of the information resources user;
- Percentage of the certificated users.

References

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