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# Contents

# Chapter 69
# Information–Analytical Technologies of Decision Support in Management of Power Systems

**Shavkat Ayupov and Abdulla Arifjanov**

**Abstract** In market conditions the effective control of the operation of power systems is directly dependent on the implementation of management decisions. Management decisions in turn depend on whether, what information (volume and quality) comes, how it is processed and used. In the coming decades the relevance of this problem will grow since information becomes the main strategic resource in the competitive struggle. In this regard it becomes topical the problems associated with the unification of territorially distributed facilities power systems into a single information space, which provides: integrated view of the complex control object as a whole; a comprehensive analysis of the collected information about him; the extraction from the huge volume of detailed data some useful information-knowledge about the regularities of its development. Solving these problems is possible by introduction in the practice of modern information and intelligent decision making support technology. In the basis of these technologies are the automated information–analytical systems (IAS) for the collection, storage systematization, processing, analysis and presentation of information. This report is dedicated of the new information–analytical technologies, allowing automating the management of energy efficiency in enterprises. For disclosure essence of information–analytical system of support for management decision-making is considered a formal model of control process. Considered issues of the designing of structure and semantics of the data to form a data warehouse of the information–analytical system for decisions support in Management with the use of a balanced scorecard.

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**Keywords** Effective control of the operation of power systems · Management decisions · Modern information and intelligent decision making support technology · Information–analytical technologies · Formal model of control process · Balanced scorecard

## 69.1 Introduction

Political, social and economic transformations that have occurred in recent years in the world require a change in approach to the management of the country, the economic sector, the industrial enterprise, the socio-economic sphere, etc. Over the past 10 years, the volume, content and quality of business information has changed more than for the preceding 70 years. In market terms effective management is directly dependent what information (by volume and quality) is supplied, how it is processed and used. In the coming decades the urgency of this problem will grow because the information is becoming a major strategic resource in the competitive struggle. The primary role in solving indicated problems is given an information technology (IT), which ensures support of the management activities [9].

Despite of the active development of the IT and ubiquitously their introduction in the management, majority of the enterprises, seeking one way or another to automate the management, get ended up aggregate of disparate and sufficiently of powerful automated information systems (AIS). The reality is that, the process of "a scrappy" of automation in large companies has led to the fact that in a multitude of divisions are applied does not fit with one another program-application. As a result, the movement of information flows in companies is hampered, and this, in turn, makes difficult of realization not only of the monitoring of action of divisions, but also reduces the effectiveness of their activities [1].

With the growth of enterprises and the development of the network of branches always a problem of analysis of activity of the various divisions, as well as the control and planning of activity of the company as a whole. But all the information necessary for the analysis and management decision-making exists, but, unfortunately, it is scattered by various local systems, are collected in the interest of the separate structures and for complex analysis in the interest of the enterprise as a whole are not available.

The absence of a unified technical policy in the deployment of departmental systems has led to the fact that the information in them is not coordinated and does not accumulate, although analysis of its dynamics is extremely important for decision-making on the management of objects. In this regard it becomes topical the problems associated with the unification of territorially distributed facilities power systems into a single information space, which provides:

- integrated view of the complex control object as a whole;
- a comprehensive analysis of the collected information about him;
- the extraction from the huge volume of detailed data some useful information—knowledge about the regularities of its development.

Solving these problems is possible by introduction in the practice of modern information and intelligent decision making support technology [2, 3].

## 69.2 Substantiation of Necessity the Application of Information–Analytical Technologies in Management

Increase of the tempos and the scale of production, improving of the quality of products is now insufficient to achieve a competitive advantage in the market, so many businesses are switching to the new progressive methods of corporate management allowing to timely respond to changing market conditions. For effective management by systemic-complex object, which is of the modern enterprise, is required, above all, the creation of schemes of work with the information as the structure of the interaction of control system with the object. This structure should allow the accumulation and use of meta-information to make controlling decisions [3].

Traditional approaches to data collection and analysis in power systems are scant basis for deep analysis, as to find answers to the questions "how" or "why", as well as to determine the most effective actions for their wider implementation [5]. Existing methods of data analysis and processing of information is absolutely not enough to a detailed analysis of impact specific actions for to improve energy efficiency and better energy management. Even if it is possible to organize a total collection of data about energy consumption—this will not be enough. The obtained measurements require deep analytical processing and analysis. First of all, for the development of administrative decisions, necessary to identify the causes of ("Why is this happening?"), which led to those data, obtained of the accounting systems energy consumption. At that, the sought the reasons can be outside control of energy metering systems [8]:

- in the characteristics and modes of use of technological and auxiliary equipment;
- in the environment parameters;
- in the qualification of management and production personnel;
- in implementing improvements and reconstructions;
- in many other areas, where with energy metering devices are not measured or cannot be measured in principle.

The goal and tasks of management of any enterprise are defined by its strategy, i.e. any control should be aimed at achieving the strategy of the enterprise. Therefore, special attention is given by the strategic management. Research in this area led to the appearance of new paradigms, concepts and tools of management [2, 5].

For solve of problem get away from disparate AIS and transition to a unified platform management of enterprise, must be created information systems of management of the enterprise, which allow to automate the management processes in main areas of activity and levels management of enterprise.

Creating such a structure is connected with the investigation of principally new ways of creation of management systems based on the new information and analytical

technologies that enable optimally to organize activities in the changing market conditions. Use of outdated methods and means hinders the transition of economic management system on the new organizational forms and urgently requires searching of the innovative ways development.

Solution of these problems is seen in the development of comprehensive information management systems that provide a comprehensive analytical processing of the integrated retrospective and operating information for decision making [2, 5]. By such systems are information–analytical decisions support systems (IADSS) in management which are based on the achievements of modern information and communication technologies (Fig. 69.1).

## 69.3 Problems of Creation of Information–Analytical Systems (IAS)

Management objects, for which are realized large-scale projects to create modern IAS, are characterized, as a rule, a number of features, including [2, 5]:

- structural complexity (multi-level hierarchical structure of the organization) and territorial distributivity;
- functional complexity (multi-level hierarchy and a large number of functions performed by the organization);
- information complexity (large number of sources and consumers of information (ministries and agencies, local authorities, partner organizations), a variety of forms and formats for submission of information complex information model of the object—a large number of information entities and complex interactions between them), a complicated technique of passing documents;
- complex dynamic behavior, due to the high variability of the external environment (changes in legislation and regulation, instability of economy and politics) and internal environment (reorganization, turnover).

These features of the objects of the introduction of IAS cause along with an extremely large amount of data in Data Warehouses (DW), and their essential heterogeneity. In such circumstances, ensuring the adequacy and completeness of the information analyzed for decision adequate to the real condition of object of management decisions, is a major problem in the creation of an effective IAS [3, 4]. Because the pile DW IAS information not relating to the subject area and the objectives of strategic management control, dramatically reduces its effectiveness. Therefore the priority for the establishment of IAS is the definition of mandated targets, the composition and structure of the data, allowing to solve these tasks and the development of its information model.

Today, in most cases, the design of the IAS is based on the principle "What you want?" not "What should be?". Since the main on the value of IAS is to support decision making in enterprise management, natural in the analysis of data in

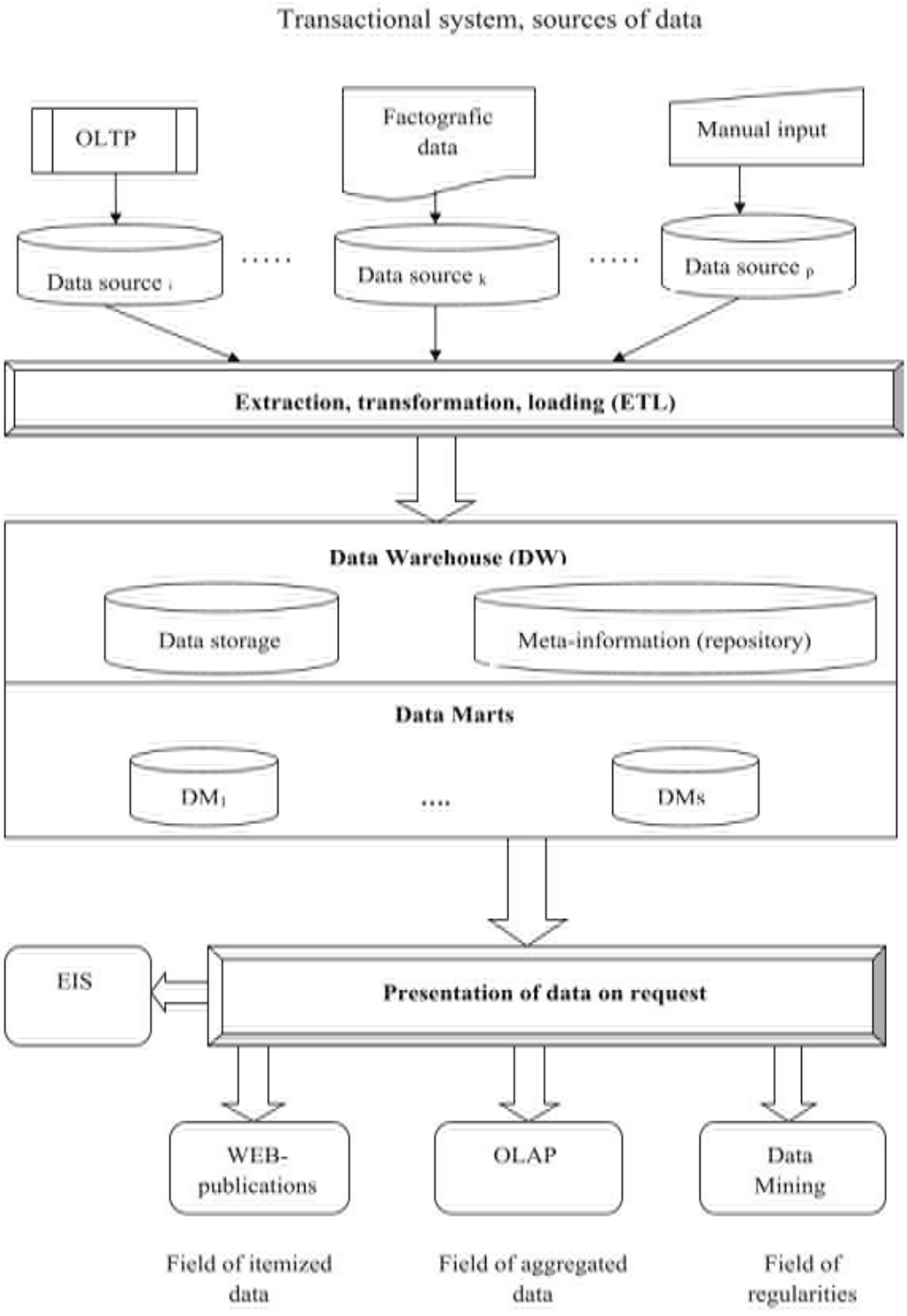


**Fig. 69.1** Structural scheme of information–analytical decisions support systems

the system needs to be performance indicators strategic and tactical plans of the enterprise. But to establish measurable indicators that reflect a causal connection between the operational and strategic goals of the enterprise is not always possible.

## 69.4 The Approach to the Creation of Information–Analytical Systems Using the Balanced Scorecard

Today in the solution of this problem the most promising is proposed by Kaplan and Norton approach based on the balanced scorecard (BSC) [12] that define the structure and semantics of data to form a Data Warehouse and develop Business Intelligence (BI) applications, which in recent years has turned into a full-featured custom applications. Outgrown the bounds of conventional appraisal system, BSC has provided a new approach to the strategic management of companies of any complexity operating in different industries. Kaplan and Norton have proposed a system based on cause-and-effect relationships between strategic objectives that reflect their parameters and factors of achieving planned results. It consists of four components—financial, customer, internal business processes and learning and staff development, goals and objectives which impact financial and non-financial indicators.

Basic adjustment of the concept of balanced scorecard is that traditional financial and economic indicators are insufficient for determining the strategic success of the enterprise and provide feedback. To solve these problems, it is necessary to have a more "balanced" set of indicators of enterprise activity in various planes, allowing the control of the factors influencing these indicators, not just track results. For successful monitoring of progress in achieving strategic goals should not all the attention should be concentrated on the evaluation of past performance. It is necessary to consider the indicators that will affect the company's results in the future [11].

The key idea, proposed by Norton and Kaplan, was to review the activities of the company as a whole from four different points of view–perspectives: financial, customer, internal business processes and learning and development, within which are the goals of the company [12]. The allocation of such perspectives is obvious and understandable internal logic: the better the enterprise is the case with the qualified staff and technologies (developmental perspective), the easier it is to maintain the efficiency of internal business processes of the enterprise. This in turn contributes to an organization of production that meets the interests of suppliers and subcontractors, and also contributes to the production of quality products that meet the requirements of buyers. All this helps to achieve its financial plans, including revenue, profit and cash flow.

Thus, based on the methodology of BSC–formalize strategy of enterprise, in the form of a strategy map, which contains about 20–30 objectives grouped by perspectives. These objectives should clearly state the patterns of development of the enterprise. Between the objectives need to be formalized causal relationships, allowing to

localize the search for possible problems in the implementation of the development as a whole, and gave a vivid dynamic picture of implementation of all measures [12].

The BSC approach from the beginning defines the business aspects of analyzed data that allows you to design analysis information system top-down in parallel with the introduction of the company MBO (Management by objectives–management based on the achievement of the objectives). Instead of exclusively retrospective-governmental financial metrics, in data warehouses, based on the BSC approach, will be considered "leading indicators", al-lowing to predict changes in the business. Such storage will provide analysts with a complete picture of the development of the enterprise, at least in four areas [6, 10, 12]:

- financial direction, considering the efficiency from the point of view of return on investment
- marketing direction, including assessment of usefulness of goods and services from the point of view of the end consumer
- organizational and technological direction, evaluates internal operational efficiency and effectiveness of the organization's business processes
- direction of innovation and learning, revealing the capacity for constant improvement and new ideas.

To reveal the essence of information–analytical systems of support of acceptance of administrative solutions (IAS DS) consider a formal model management process.

The process control as an organization of purposeful influence on the object can be implemented by a two-stage scheme [9]:

$$\mathrm{A} \longrightarrow \mathrm{Z} \longrightarrow \mathrm{U}.$$

At the first stage according to the needs $A$ and the condition of the external environment $X$ is defined the purpose of management $Z$:

$$\mathrm{Z} = \varphi_1(\mathrm{X}, \mathrm{A}),$$

where $\varphi_1$ is a algorithm synthesis of management purpose $Z$. This task is solved on an intuitive level.

At the second stage is determined the control (controlling action) $\mathrm{U_x}$, the implementation of which ensures the achievement of the purpose Z, generated in the first stage, which leads to the satisfaction of the subject. It is at this stage can be used all the power of the formal apparatus, by which on the purpose Z is synthesized control $\mathrm{U_x}$.

$$\mathrm{U}_x = \varphi_2\,(\mathrm{Z}, \mathrm{X})\,,$$

where $\varphi_2$ is the control algorithm. This algorithm is the subject of decision making in management by any object.

Thus, the separation of the management process into two stages reflects known science-informal (intuitive expertise) and formal—algorithmically. If until first is fully owned by the person, the second is the object of the application of formal

approaches. Naturally, these various functions are performed by different structural elements. The first function ($\varphi_1$, executes the subject, and the second ($\varphi_2$ is control device). The control system performs the function of management objectives Z generated by the subject.

The main task in making management decisions is selecting the best alternative providing achieve certain goals, the existing constraints or ranking of many possible alternatives for degree-nor their impact on the achievement of this goal. To solve this main problem, it is first necessary to solve the nontrivial problem of multiple criteria evaluation of alternatives. Selection criteria assessment of achievement of that goal (alternative solutions) is a complex task. To solve this problem can be used, in particular, the approach of decomposition of the main goal to the level of detail when a lower level of a hierarchy of objectives you can formulate criteria that enable to adequately describe the degree of achievement of objectives in the adoption of any alternative, that is, for each level must be defined goals and measuring their performance. First we defined the main strategic goal. Is further decomposed into sub-objectives [1–3, 6].

To ensure the decision-making process for the proposed scheme are adequate and sufficient information necessary for effective instrumentation. These tools are key performance indicators (KPI) and the balanced scorecard, widely spread in management practices in Western companies [6, 7, 12]. KPI is a set of core indicators describing the achievement and the efficiency of the company. Under the KPI system is a system of financial $I_f$ and non-financial $I_{nf}$ indicators influencing the quantitative or qualitative change of results in relation to strategic objectives (or expected results)

$$KPI = \{I_f, I_{nf}\}, \tag{69.1}$$

KPI are quantitative indicators to measure critical success factors, expressed in numerical form. When forming indicators, it is necessary to concentrate on the most essential of them, cutting off all secondary, reducing their number to the so-called "key". The number of KPI should be limited (to insure their implementation and to ensure the required quality of monitoring).

The balanced scorecard includes KPI required for each jth object control (manufacturing or business subdivision), and the methods of their evaluation

$$BSC = \{KPI_{ij}, O_j\}, \quad i = 1, \ldots, N, \quad j = 1, \ldots, M, \tag{69.2}$$

where N is the number of KPI, M—number of control objects.

These systems or techniques make a basis at decision-making, are based on an assessment of efficiency of activity of the enterprise and are directed on achievement of strategic objectives of the organization.

The assessment of efficiency is the tool which allows to define as far as management of the organization corresponds to the level of achievement of strategic objectives. This tool facilitates process of adoption of administrative decisions due to providing the person making the decision full information and allows to identify the fact and area of emergence of a problem.

Why it is about the management founded on efficiency? Accumulation of rates and scales of production, improvement of quality of production are already insufficient for achievement of competitive advantage now in the market and therefore many companies pass to new progressive methods of corporate management. These methods allow to react in due time to change of conditions in the market, and foreign firms successfully apply them.

The problem of system of KPI and the balanced indicators consists in transfer of strategy of the company S to the complex set of indicators of its activity {I} determining key parameters of system of measurement $P_m$ and controls $P_c$

$$\text{BSC} : S\{I\} = \{P_m, P_c\}. \tag{69.3}$$

The set of indicators sets a basis for formation of strategy of the enterprise and includes quantitative characteristics for informing employees on major factors of success in the present and the future.

Formulating the expected results, the enterprise sets the purpose and creates conditions for its realization, and the top management directs energy, abilities and knowledge of employees on the solution of problems of a long-term outlook.

Basic installation of the concept of the balanced indicators consists that traditional financial and economic indicators are insufficient for definition of strategic success of the company and providing feedback. For the solution of these tasks it is necessary to have more "balanced" set of indicators of activity of the company in various planes allowing to control the factors influencing these indicators, but it isn't simple to trace results. For successful monitoring of progress in achievement of strategic objectives it isn't necessary to focus all attention on an assessment only of last activity. It is necessary to consider also those indicators which will influence results of the company in the future.

The reference point on the indicators characterizing only one sphere of activity can negatively be reflected in the end result. Therefore the system of the balanced indicators includes four main aspects which are in a complex characterizing any manufacturing enterprise:

- Financial activity—aspect "Finance";
- The relations with the consumer—aspect "Market";
- Internal production activity aspect "Production";
- Training and development—aspect "Shots and an innovation".

The BSC is a set of the interconnected purposes (tasks) and indicators estimating them

$$\text{BSC: PURPOSES (TASKS)} \rightarrow \text{INDICATORS} \rightarrow \text{MEASUREMENTS}. \tag{69.4}$$

Arrangement of target (planned) values of indicators means their subsequent measurement and the accounting of actually reached results. Then can be corrected both target values of indicators (plans), and structure of the purposes and indicators (strategy). Schematically it is shown in Fig. 69.2.

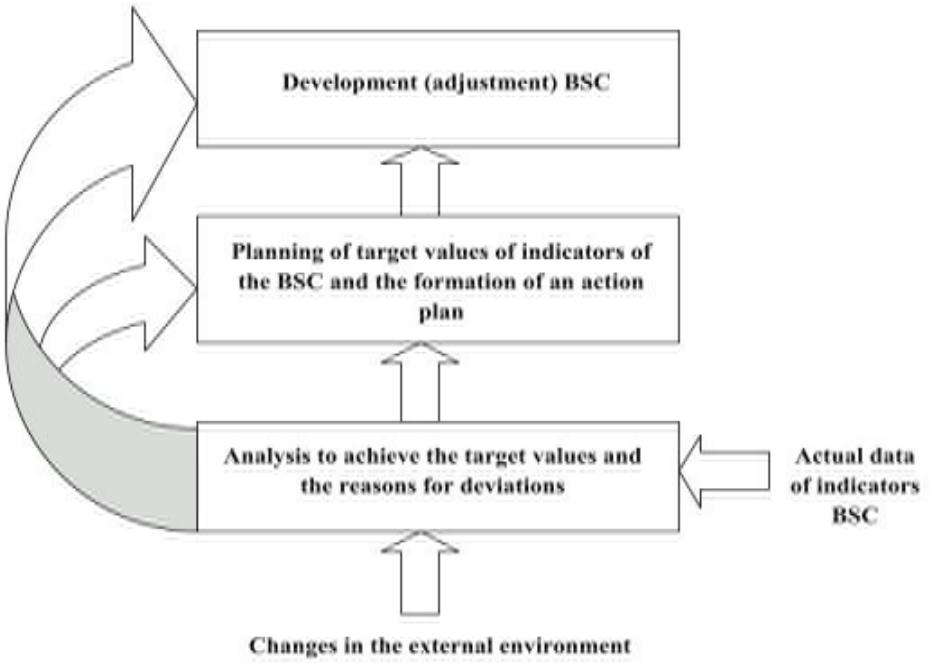


**Fig. 69.2** Basic scheme of the concept of the balanced indicators

If to say that the BSC is strategy formalization, the mechanism described above is that other, as the closed cycle at the strategic level of management. And the set of the used indicators defines system of strategic management accounting. The structure of the balanced scorecard is shown in Fig. 69.3.

Theoretically KPI indicators in the BSC can be detailed until they don't capture all indicators used in traditional management accounting. But in reality of it doesn't occur as specification of KPI is usually limited to the level of departments/processes owing to labor input of its development and the subsequent use. On the other side


$$\text{EMS} := \{\text{STRATEGY} \rightarrow \text{BSC} \rightarrow \text{PURPOSES} \rightarrow \text{INDICATORS} \rightarrow \text{MEASURMENTS} \rightarrow \text{SUBSYSTEMS}\}.$$

**Fig. 69.3** The structure of the balanced scorecard

of a task at management accounting and at the balanced system of indicators are various: the first is necessary for daily monitoring of operational activity, and the second is for periodic control of following to the chosen strategy.

BSC is a link between subsystems of management, a peculiar uniting control. If the task of creation of a enterprise management system is set (EMS), it is necessary to begin with strategy, then BSC, but only after that—other subsystems of management:

$$\begin{aligned}\text{EMS} :\equiv \{&\text{STRATEGY} \rightarrow \text{BSC} \rightarrow \text{PURPOSES} \rightarrow \text{INDICATORS} \\ &\rightarrow \text{MEASURMENTS} \rightarrow \text{SUBSYSTEMS}\}.\end{aligned}$$

Design of information and analytical systems on the basis of the BSC is carried out in two stages [6, 7]:

(1) Design of the card of strategy—its graphic description in the form of a set of relation-ships of cause and effect. For each prospect (finance, marketing, technologies, innovations) strategic objectives have to be defined and the tree of the purposes is constructed.
(2) Definition KPI (Key Performance Indicator), numerical characteristics of the chosen purposes (metrics which need to be collected in storage of data). In fact, these metrics set structure of data in storage.

It is necessary to distinguish KPI of the top and lower level. Has to contain in storage of data both information for strategic management, and detailed data on the basis of which this information was received to provide possibility of transition from strategic objectives to actual data which stand behind these purposes. Such transition (drill-down-descent by data) in information and analytical system is realized by means of the OLAP-tools realizing multidimensional (and at the same time multilevel) data presentation.

Design of multidimensional data presentation begins with formation of the card of measurements. For example, in the analysis of sale of products can be expedient to allocate the separate parts of the market (developing stable, large and small consumers, probability of appearance of new consumers, etc.) and to estimate sales volumes on products, territories, buyers, segments of the market, sales channels and the sizes of orders. These directions form a coordinate grid of multidimensional representation of sale—structure of its measurements.

As the activities of any enterprise takes place in time, the first question that arises when analyzing is the question of the dynamics of development of business. Proper organization of the time axis will allow qualitatively to answer this question. To analyze the effectiveness of the divisions should establish its measurement.

It is important to distinguish values of KPI in the set coordinate grid from actually KPI (for example, the number of transactions is the indicator characterizing operational activity of the enterprise, and the number of transactions in the set region for last month is a value of this KPI).

## 69.5 Conclusion

The problem of creating effective systems for strategic management of major energy companies and enterprises are one of the most pressing at the present time. It is caused that the success of any company or enterprise today is largely determined by the quality of its management system. It should provide the achievement of strategic goals through the solving current problems, provide of managers at all levels timely, complete and accurate information needed to make economically justified managerial decisions.

Solution of this problem is seen in the development of comprehensive information management systems that provide a comprehensive analytical processing of the integrated retrospective and operating information for decision making. By such systems are information–analytical decisions support systems (IADSS) in management which are based on the achievements of modern information and communication technologies.

These features of the objects of the introduction of IAS cause along with an extremely large amount of data in Data Warehouses, and their essential heterogeneity. In such circumstances, ensuring the adequacy and completeness of the information analyzed for decision adequate to the real condition of object of management decisions, is a major problem in the creation of an effective IAS. Because the pile DW IAS information not relating to the subject area and the objectives of strategic management control, dramatically reduces its effectiveness. Therefore the priority for the establishment of IAS is the definition of mandated targets, the composition and structure of the data, allowing to solve these tasks and the development of its information model.

In designing of information–analytical systems today a perspective is a business-oriented approach, based on the BSC (Balanced Scorecard). BSC approach from the outset defines the business aspects of the analyzed data that allows you to design information–analytical system from top to bottom in parallel with the implementation in the company MBO.

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