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Application of Business Intelligence instrumental tools for visualization of key performance indicators of an enterprise in telecommunications

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Abstract

The article represents the experience of practical application of visual analytics tools that allow to make deliberated and reasonable managerial decisions based on the visualization of large volume of information using Business Intelligence tools. The key feature of the proposed approach is the development of visual models of key performance indicators (KPI) at the strategic level of management of the enterprise. The developed models are considered as a tool for justification of managerial decisions, building business models of high-tech companies, measuring the efficiency of functioning and evaluating the effectiveness of the development of the selected activities. The Business Intelligence tool was used to build a number of visual models for a high-tech enterprise in telecommunications. The novelty of the proposed approach lies in the application of intensively implemented in both Russian and Western companies performance management and management decision making technologies which are aimed at improving competitiveness, import substitution, cost reduction and optimization of business processes. The requirements of a dynamically changing environment, shortening the products' life cycles, global competition with the necessity lead to create specialized visual situational business models built on the basis of powerful automated systems of business planning and graphics, data analysis and processing of information arrays.

Keywords: Key Performance Indicators, Business Analytics, Business Intelligence, Sales Management, Market Analysis, Control Panel, Heat Map, Data Warehouse, Data Mart, Efficiency Assessment, Project management.

Introduction

To improve the competitiveness in the modern world, forecasting and modeling of company activity results in Business Intelligence (BI) is used. Managing customer experience and building long-term relationships with clients is an important aspect of the successful functioning of high-tech companies, especially in the field of telecommunication, which is one of the most promising and fast-growing sectors of the economy. It should be noted that the analysis of customer experience should be transformed into convenient information and telecommunication services. This article is discusses the development of business graphics models for analyzing and improving the activity of a cellular communication operator using a system of key performance indicators. Information processing of informational arrays about the client database and the provided services allow to create powerful tools for making weighted and informed managerial decisions to improve services and build a client information storage based on the system of analytical models.

In recent years, performance management technology based on key performance indicators (KPI - Key Performance Indicators) has become increasingly popular in the design and development of organizational business models, as well as at the stage of

making strategic and tactical decisions for the development of selected business areas. This article represents a visual approach to solving decision-making problems by the example of a Russian high-tech company in telecommunications. Attention is paid to the development and application of visual methods based on the use of business intelligence tools. Using a business analytics tool Tableau, a set of interrelated visual models was built. This set is based on key performance indicators and forms a systematic picture of the operation and development of a Russian high-tech telecommunications company.

1. Applied aspects of implementing Business Intelligence systems in a high-tech business environment

Currently, Business Intelligence systems remain one of the most promising solutions in the field of business intelligence, despite the general economic stagnation and the global economic crisis. In 2017, the volume of the global market for business intelligence platforms (Business Intelligence) and analytical applications reached $ 16.9 billion, increasing by 5.2% in comparison to 2016 [16]. According to the forecasts published by a number of analytical agencies, until 2020 the market for BI systems and analytical platforms will remain one of the most fast-growing segments of the global IT market. Figure 1 shows the distribution of the leading BI-systems in 2017 in the whole world. As can be seen from Figure 1, the leader in the number of implementations is the Tableau system, its share reaches 30%. Thus, the software complex of the Tableau Company was chosen in this article as the instrumental tool to form a system of key performance indicators. The Tableau system implements functions for mixing or combining data from different sources, allowing users to simultaneously operate with an array of information in real time. Visual models are implemented in the system based on a word cloud, bubble and tree-visible (hierarchical) diagrams, which allow to acquire a higher level of business analysis context.

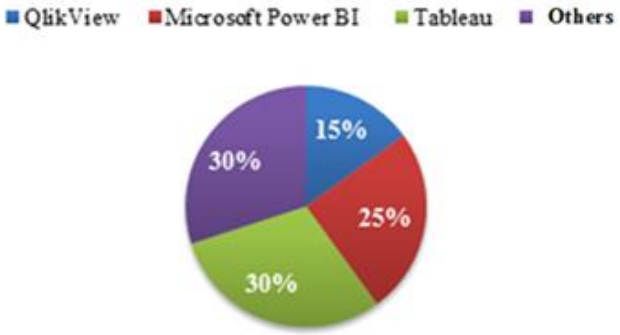

Fig. 1. Distribution of BI-systems by the number of projects-implementations in the telecommunications industry in the world (in 2017).

The analytic hierarchy method (T. Saati) was used to choose the Business Intelligence software product. The main goal is located at the top of the hierarchical tree and it is used to represent the problem. The second layer is occupied by lower criteria, the lowest level – by alternatives. The obtained hierarchical model is shown in Figure 2. Systems were evaluated according to eight criteria, among them are: price policy, implementation period, integration with data storage, availability of support services, mobile platforms support, possibility of quick modifications, integration with Microsoft Office and user-friendly interface.

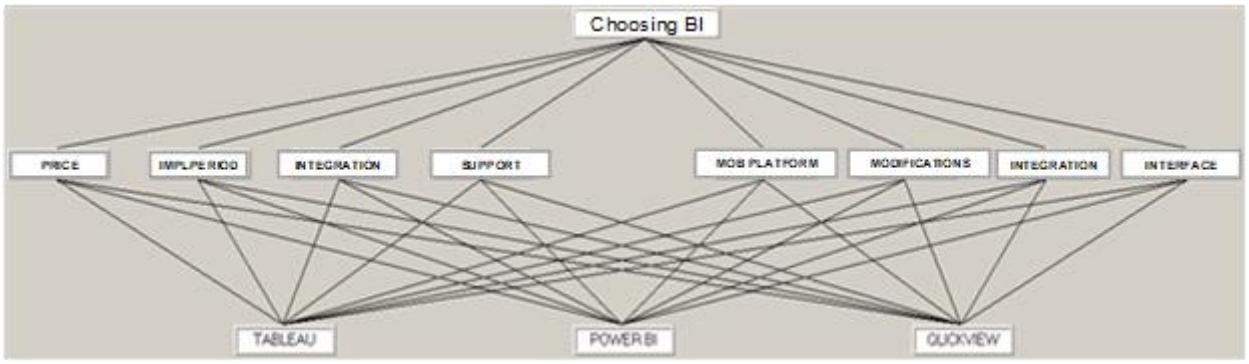

Fig. 2. Visualization of a hierarchical model for choosing the business intelligence system.

It should be noted that the key factors for Business Intelligence systems are the quality and convenience of integration with external data storages. The result of the applying of analytic hierarchy method is represented in Figure 3. MY Priority software was used for the calculations. The sizes of the sectors of the diagram are determined by the priorities of the alternatives, which were calculated using pairwise comparisons of the alternatives.

From the figure 3 it is possible to conclude that the Tableau software product with a priority weight of 0.4302 is the most preferable. The Tableau system is implemented in large telecommunication companies, e.g. Rostelecom PJSC, and taking into consideration industry specificity, it is 1) the most cost-efficient solution, 2) implements a fairly simple possibility of integration with the storage systems, as well as with Microsoft Office packages, 3) has a multi-level Russified support and reduced implementation duration.

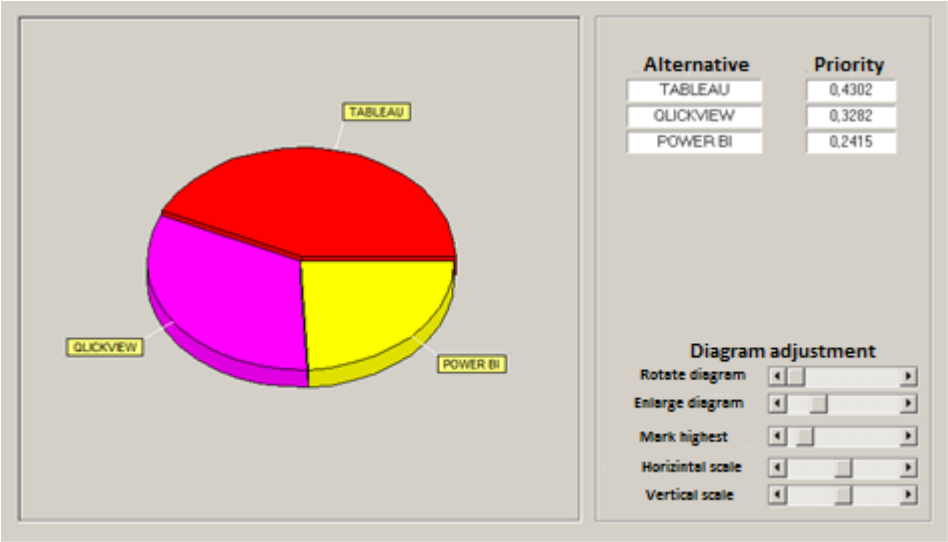

Fig.3. Results of the quantitative comparison of alternatives according to the selected criteria based on the analytic hierarchy method.

The architecture of the proposed BI solution is presented in Figure 4 and displays sources, table storages and showcases which containe data about the calls, money transactions, telecommunication equipment, points of sales and client tariffs. The structure of the proposed BI solution requires the involvement of IT specialists from the big data analysis divisions in order to customize and integrate the information platform with the software systems used in the enterprise.

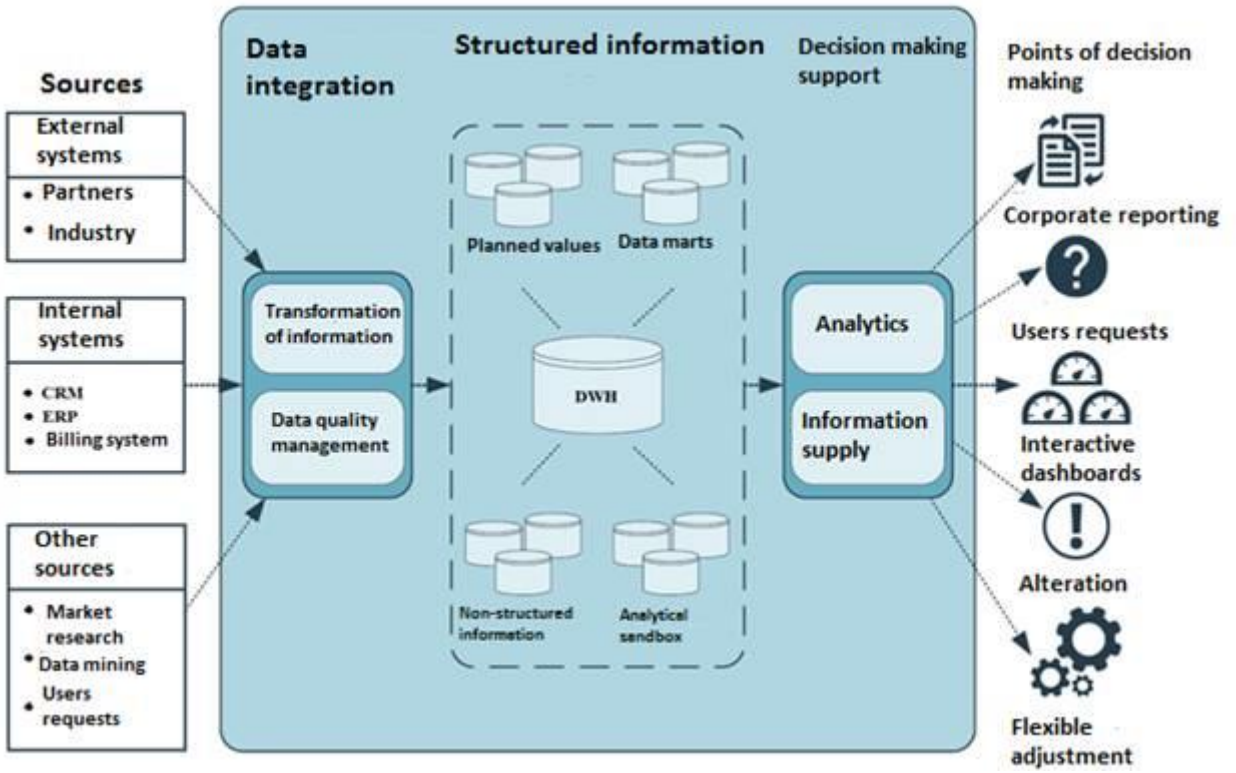

Fig.4. Visual structural model of the BI-system architecture.

The process of data marts adjustment and adapting the application to the necessities of the enterprise is presented in Figure 5. A number of IT specialists, including system analysts and data management engineers (BI specialists), is involved into the process of implementation of a Business Intelligence information system. The process includes the development of data marts and reports (Dash Boards) and their integration into the corporate enterprise information storage (DWH - Data Warehouse), taking into consideration business process reengineering. The process also includes setting up corporate data marts, reports, drawing up a calculation methodology and visualizing a system of indicators, checking data quality, and launching the calculation of key performance indicators. On average, the implementation process takes about eight months, taking into account the involvement of a team of experienced developers: a BI specialist, system analysts responsible for collecting business user requirements for graphical visualization, developing a system of strategic performance indicators, setting up reports in accordance with the business performance indicators model.

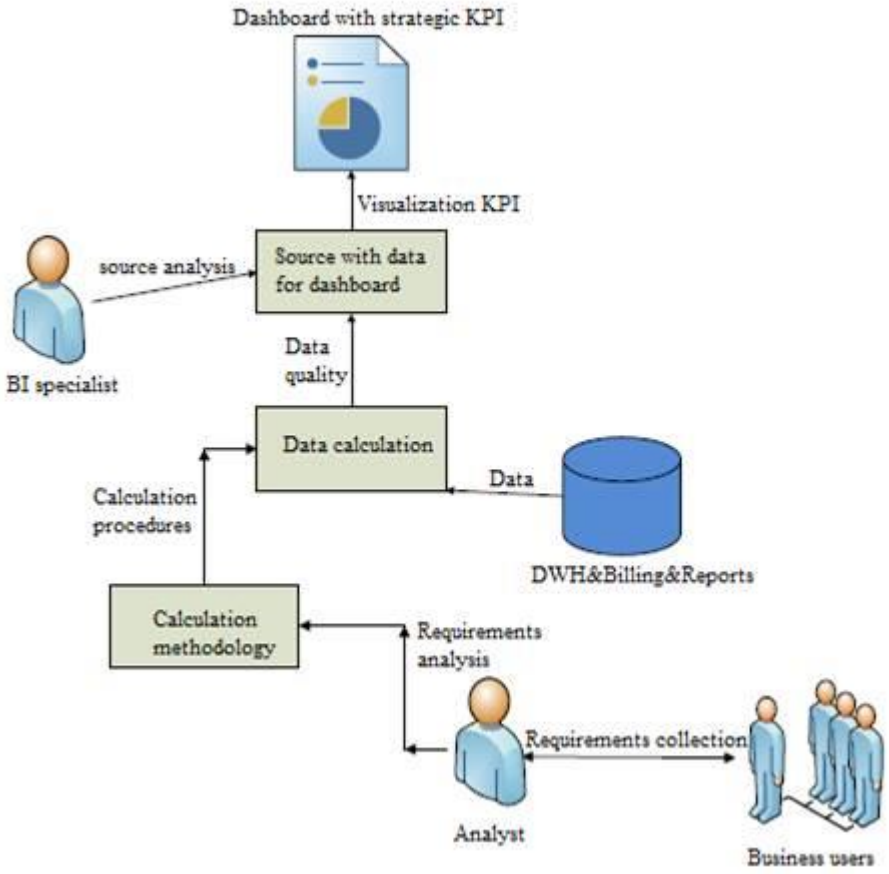

Fig.5. Process of business intelligence application adjustment.

The first step in adjustment and adapting of a software product is to collect functional and business requirements for the designed system. It is performed by an analyst and business users of the application. The analyst develops the methodology for creating a system of visual models of enterprise performance indicators according to established calculation methods. Corporate data which contains the planned and actual values of performance indicators is used to create visual models. Information from external systems, i.e. ERP, CRM and MES [17] is also incorporated. A Business Intelligence system, therefore, builds and streamlines the corporate data warehouse structure, providing access for external business users to the system of visual models of company's performance indicators. Thus, the company, according to the developed business process, gets an effective tool for creating corporate reporting system, which will contain all the strategic KPIs, their dynamics in various details. The result is a complex system, by analyzing which you can construct an enterprise development strategy based on the created model of key performance indicators, by creating a visual library of indicators for making weighted and approved strategic decisions.

The process of implementation of Business Intelligence information systems depends substantially on the size of the corporate data warehouse, the experience of the project team, including developers and analysts. The economic effect of this class of systems implementation for the medium-sized businesses is reasonably assessed on the basis of integral financial indicators (NPV - Net Present Value, IRR - Internal Rate of Return, DPB - Discounted Payback Period) used in the practice of evaluating efficiency project and investment activities analysis. Figure 6 shows a visual model of a project schedule for implementation of the Tableau information system (describing the application installation and development process), prepared using the Project Expert analytical system. A set of activities displays the stages of formation of the enterprise business model.

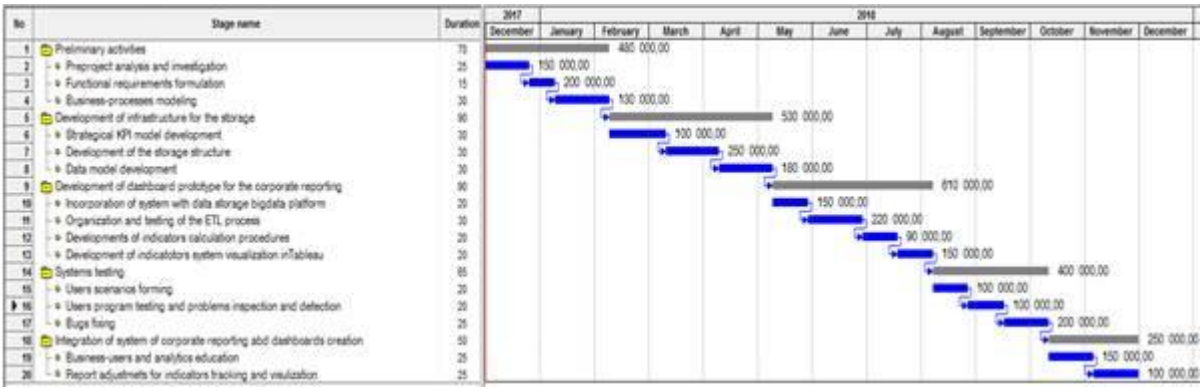

Fig. 6. Project schedule in the form of a Gantt line chart [2,3] of the project for the implementation of the Business Intelligence information system.

Figure 7 shows the payback period for the implementation project of a Business Intelligence information system.

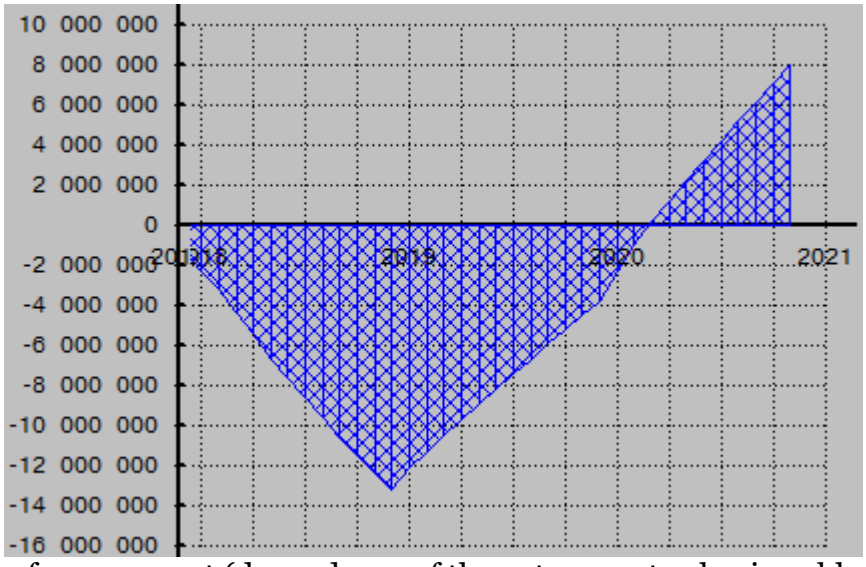

Fig. 7. Schedule of recoupment (dependence of the net present value in rubles during the implementation time) of the project.

The financial model of the implementation project assumes a return on investment over a period of approximately two years at a set discount rate of 15% per annum and an average inflation rate of 7% per annum. By the end of the three-year project implementation period, the value of the net present value (NPV) reaches 8 million rubles. According with implementation of information systems, a deferred effect is usually associated with the necessity of users training, the generation of operational documentation, and the commissioning of the system. At the same time, additional costs at the stage of implementation of software product are related to the necessity of attraction of qualified IT specialists in the field of data mining. The positive effect from implementation of Business Intelligence technology based on key performance indicators is associated with increase in sales, quality of the provided services and management.

2. The visual model of the system of key performance indicators of an organization

In up-to-date conditions of high-tech business, creating a successful business-model of enterprise management gives a competitive advantage on the market, which is especially important in developing companies. According to Russian and Western analytical agencies [10,12,15], the technology of key performance indicators for performance evaluation [11] is the most developed and adopted for the conditions of a changing and growing business. In figure 8 presented a visual model of the influence of the system of key performance indicators (KPI) characteristics on creation of a business model of a successful company [13, 14].

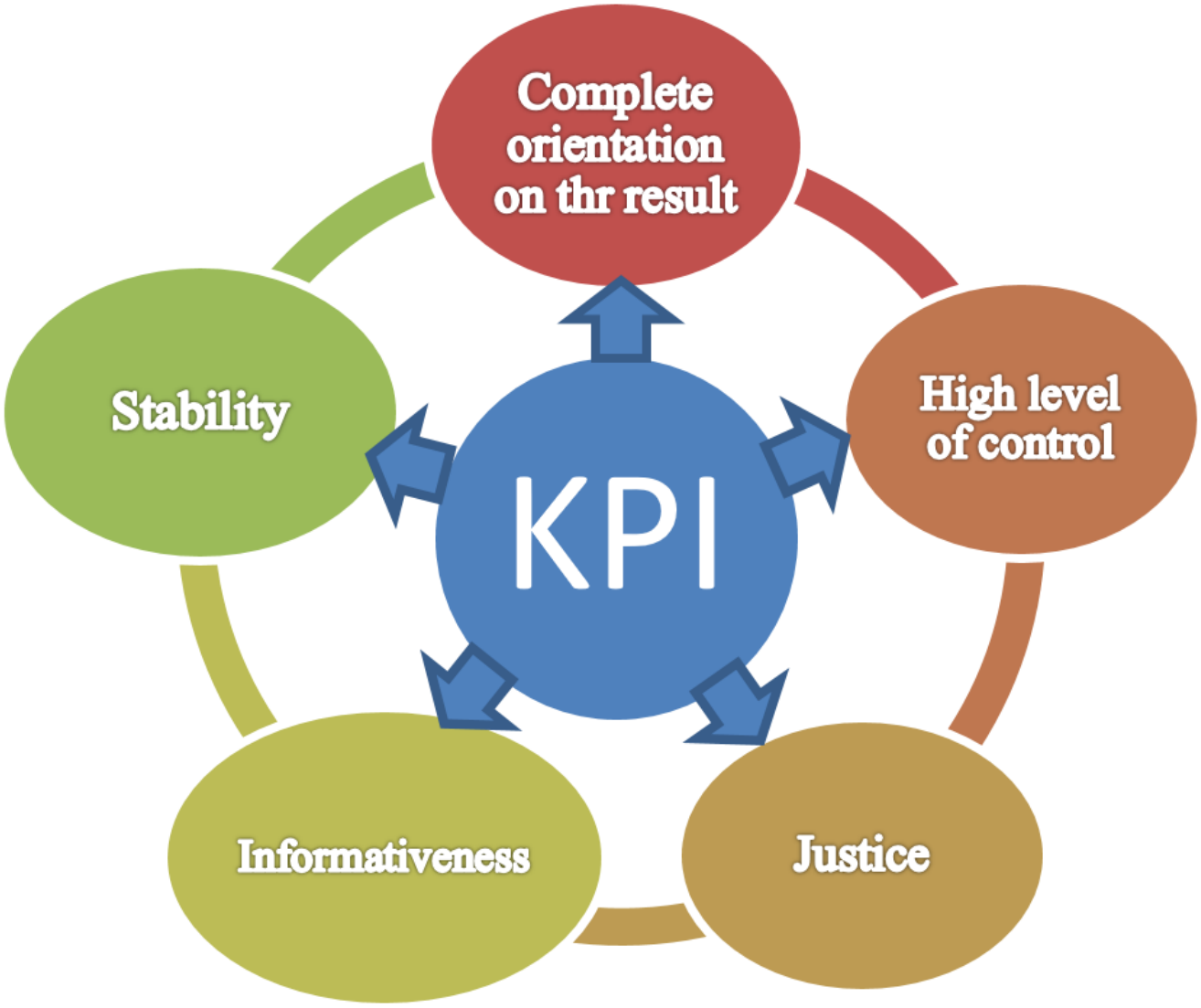

Fig. 8. KPI system and factors for improving business processes in an organization.

In case of a high-tech growing business, application of visual models of key performance indicators using Business Intelligence (BI) tools based on storage, integration, analysis and visual presentation of data [6] is one of the most widely used tools for making managerial decisions [7].

The most frequently used techniques of data visualization in modern BI solutions are information panels [6], in which the analyzed indicators are displayed in the form of scales and scores, which allow to monitor the currently achieved values, compare them with threshold values and, thus, identify potential risks which allows to adjust managerial decisions.

Control panels based on the analysis of key performance indicators [8,9] are designed to compare the current values of the indicators with those established at the preliminary planning stage and display the dynamics of their change over time [1,3].
The visual model [1] of the organization's balanced scorecard indicators system in the telecommunications industry, developed during the implementation of the Business Intelligence Table information system, in case of a mobile operator is presented in Figure 9.

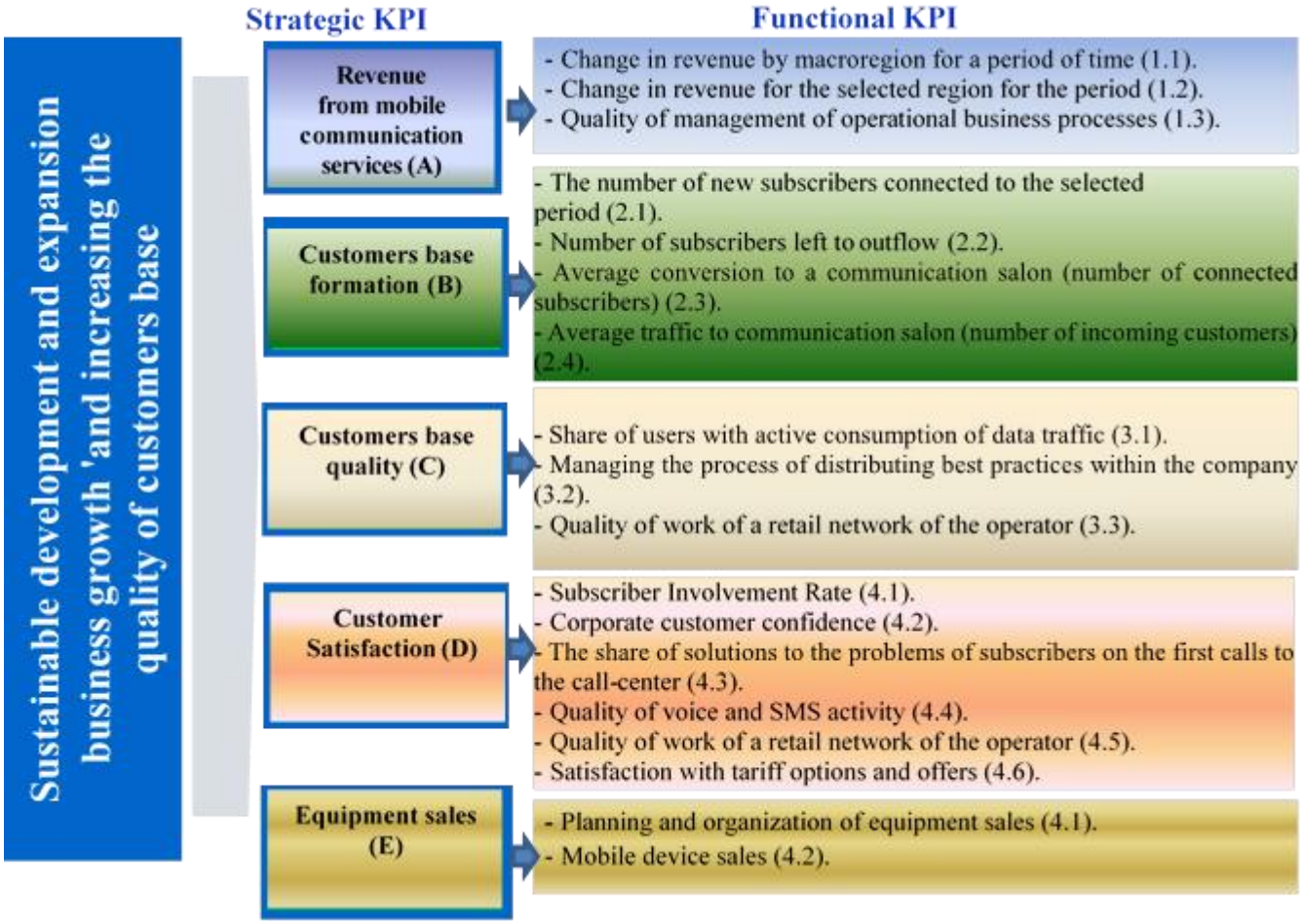

Fig. 9. Visual model of key performance indicators system aimed at creation of company's business model in telecommunication industry.

Using the visual model presented in Figure 9, a control panel is created, and a business model is built, aimed at optimizing the business processes of an enterprise in the high-tech business [14, 15].

3. Technology of key performance indicators visualization based on instrumental methods of Business Intelligence

Data visualization technology enables to use special Data Warehouses, reflecting the current, real and complete information for visual business analysis. Information in the repository, including historical data, is collected from various operational (transactional) systems and is structured in a specific way for more efficient analysis and processing of requests, in the same time to solve narrower, specific tasks, sub-sets of data could be separated from the general repository in the so-called data marts. The scheme of visualization of enterprise efficiency key indicators based on the business intelligence tools, reflecting the processes of adjustment and adapting instrumental software systems, setting up and aggregating data as shown in Figure 10.

The dynamics of changes in the selected performance indicators can be carried out both in retrospect and taking into consideration future forecasted values [3, 14], herewith the step or interval of information displaying may be adjusted by the user.
According to the proposed model and the specificity of high-tech business, in this paper, the dynamics of key performance indicators (KPI) changes [7] taking into consideration an established step (one calendar week) are considered.

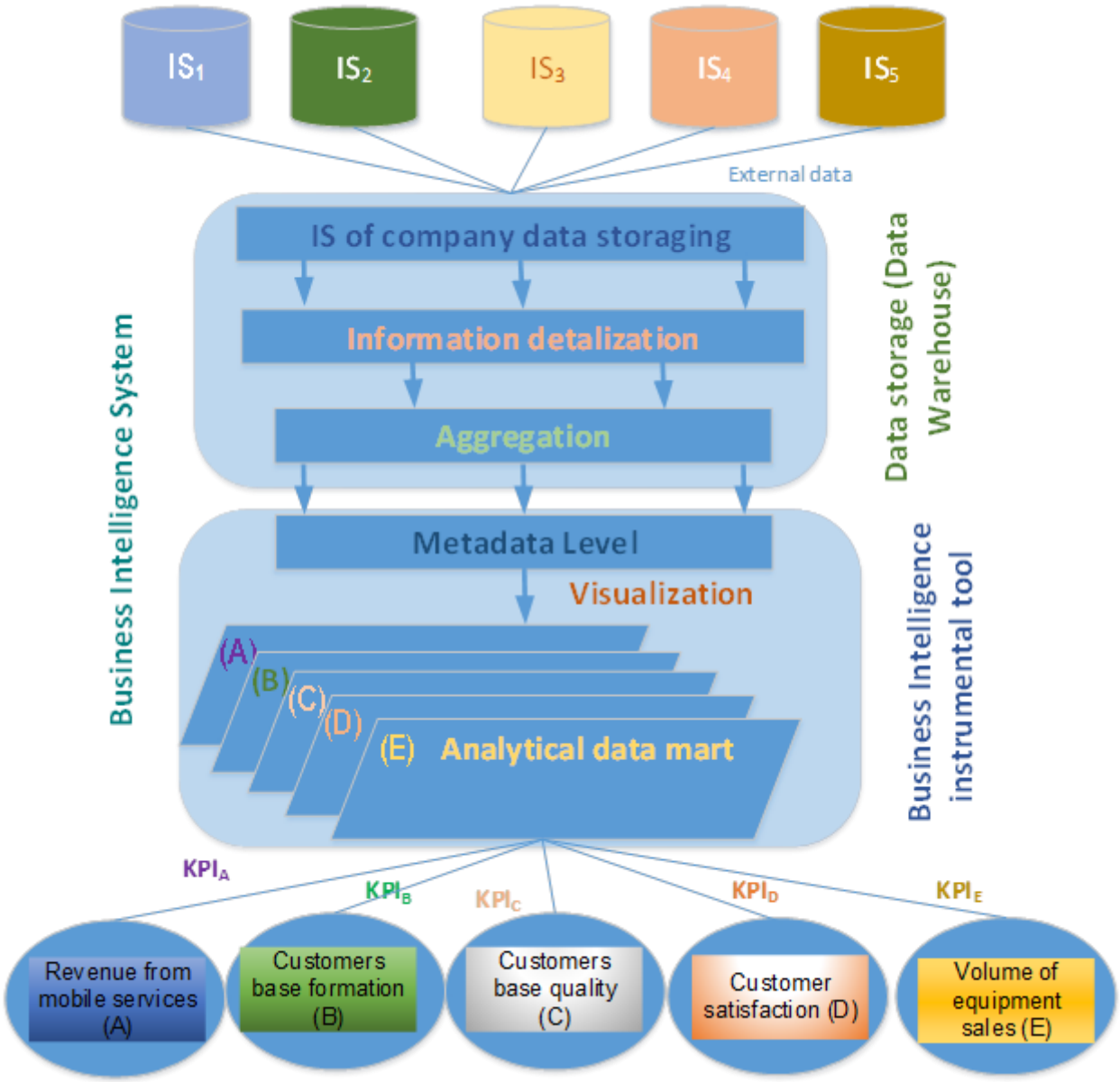

Fig. 10. Visual model of the process of strategic performance efficiency indicators forming [9, 11] based on Business Intelligence tools.

4. Practical application of technology of key performance indicators visualization

Based on the constructed visual model of key performance indicators, let us perform their visualization using Business Intelligence visual analytics tools.
The KPI_A strategic revenue indicator reflects the weekly revenue changes in detail, both for individual macro-regions or regions, and for the whole Russia. Figure 11 presents a visual model reflecting the dynamics of changes in this indicator. The visual model is presented in the format of the heat map diagram of the Russian Federation, which reflects the intensity of

revenue receipt with gradations of color, from yellow, corresponding to a decrease in the amount of funds received from the previous period of time to dark green, which is an indicator of increase in the revenue level. The colors on the heat map reflect changes in performance indicators in comparison with a previous period of time, for example, a week.

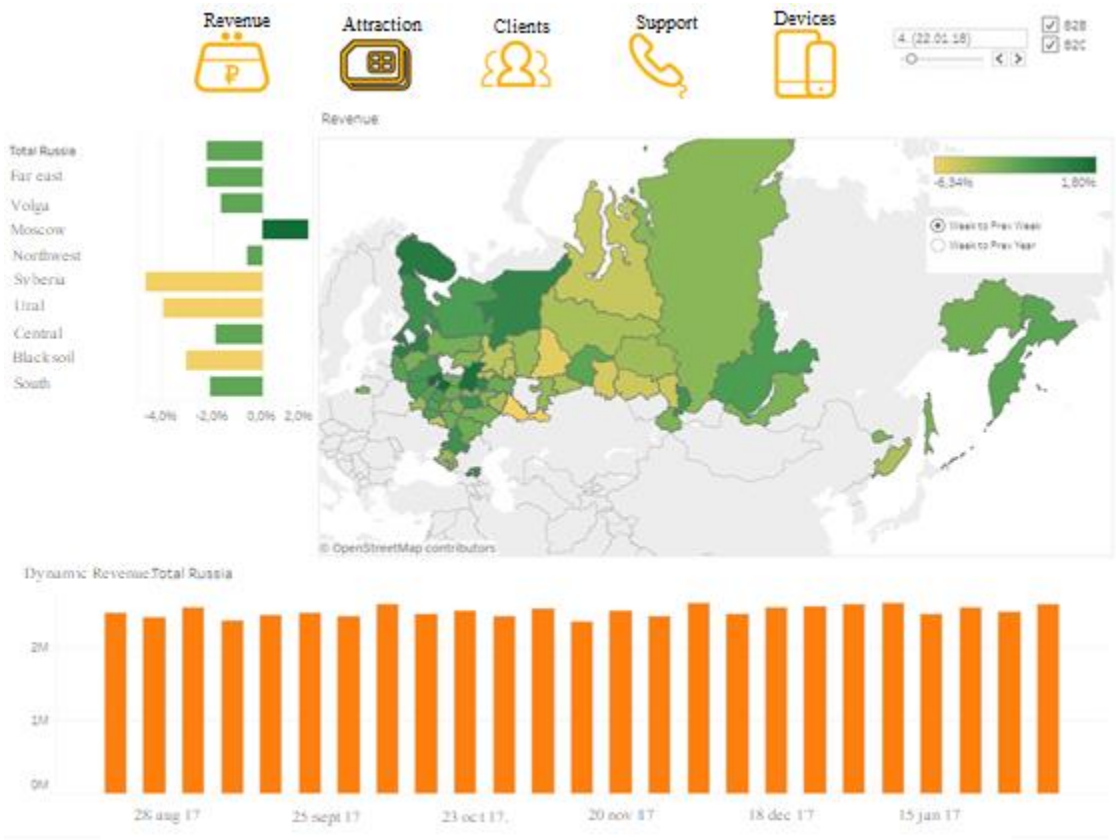

Fig. 11. Visual model of the dynamic changes in the “revenue”
(a combined heat map model and a “bar graph”).

Combining various types of diagrams, it is possible to perform representative visualization of large information arrays with reference to the selected region, analyzing and monitoring changes in the selected performance indicator. In the lower bar charts of figure 11 dynamics of changes in the whole Russia are shown.

Figure 12 presentes an example of a visual model of the indicator “revenue” in the format of a heat map for a selected region - Yekaterinburg. As it could be inspected from Figure 12, for this geographical region, in the weekly presentation, the revenue indicator fell by 5.9%. Manipulating information using the implemented visual model can be done according with various sectional drawings, combining the search for the necessary information with the process of making managerial decisions.

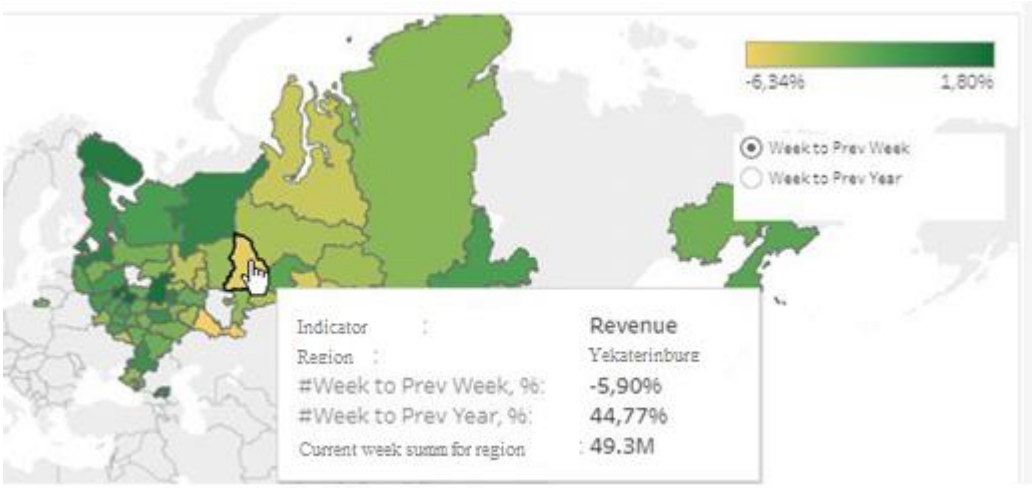

Fig. 12. Visual model of changes in revenue in the selected region of localization in the form of the heat map.

A visual model of the strategic KPI_B performance indicator - the formation of the client base - is presented in Figure 13.

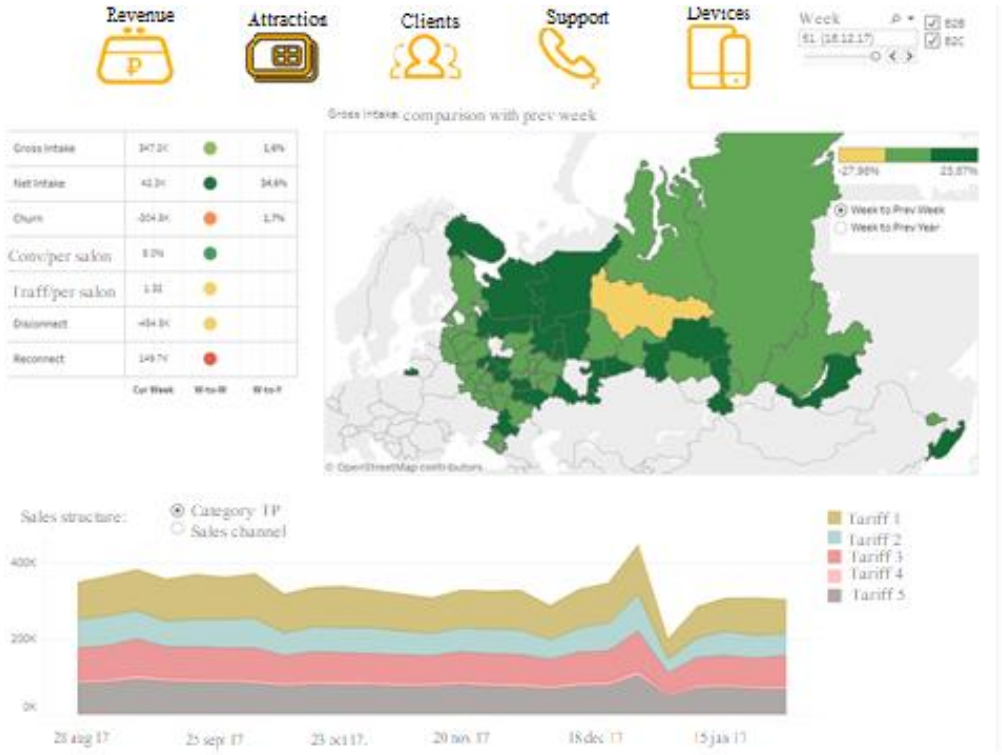

Fig. 13. The visual model of changes in the indicator of the client base formation in the regional representation.

In figure 13 the structure of sales of the main price plans is also shown [13, 14], directly reflecting the structure of the product line. Names of price plans have typical names according with the confidentiality agreement. In figure 13, the following designations were adopted to describe indicators affecting the managerial decision-making process to achieve the required level of a strategic indicator: Gross intake - the number of new subscribers connected over a set period without adjustment to subscribers who refused the service, Net intake - the number of new subscribers connected during the set period, adjusted for subscriber churn, Churn - the number of subscribers who refused the service, Average conversion per salon - the number of customers who connected at the point of sale, Average traffic to the salon - the number

of customers who came into the communication salon, Disconnect - the number of customers disconnected from communication services, or with a blocked account status, Reconnect - the number of customers who renewed use of communication services and a positive balance on the account.
As it is shown in figure 13, directly next to the corresponding numerical value of the indicator, a colored geometric figure, circle, is located, as a result of comparison with the corresponding value, which was obtained in an earlier period of time, the circle is indicated by an appropriate color. The chromaticity gradations are set from dark green, light green, lime green, yellow, light yellow, orange and bright red, indicating, respectively, positive, neutral and negative results of comparison with the previous period of time. At the same time, the more intense the color of the corresponding geometric figure, the more significant will be the managerial decisions that in necessity must be taken based on the results of monitoring this indicator.
Figure 14 represents visual model of the price plans dynamics of sales in absolute terms (by selected categories), reflecting the number of contracts concluded in a selected period of time. The visual model reflects the structure of sales of price plans, which allows to make a conclusion about the seasonality of the indicator, because due to the pricing policy, sales segmentation and customer acquisition, for example in New Year period, for the last week of 2017 the maximum number of contracts was concluded.

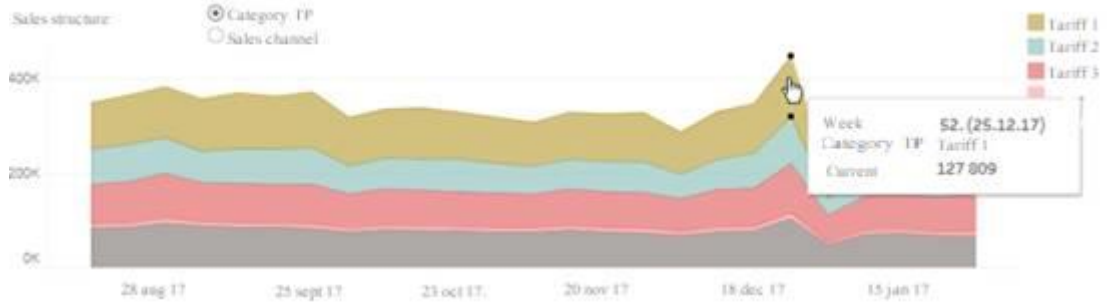

Fig. 14. Visual model of sales dynamics by price plans categories.

A visual model of a strategic KPIc - customer baseline quality indicator - is presented in Figure 15. At the same time on this figure 15 presented a heat map by the region and a bar graph for detailed analytics by time periods (weeks) with the indicator as the line which is drawn over for comparison with the previous period (in the year scale) indicator value during the time interval which was the predecessor for chosen one.
The set of quality indicators of the customer base includes:

- Flash Base - current subscriber base,
- 3G / 4G Enabled - the share of devices with support for 3G / 4G standards,
- ADU (Active Data Users) - the proportion of users with active consumption of data traffic,
- 3G / 4G ADU - share of active data traffic users using 3G / 4G standard as a connection source,
- not USIM c 4G - the share of subscribers whose first SIM card is not operator's, but supports standard 4G connections,
- Auto Pay share - the share of users with the service of automatic payment,
- Subs Fee share - the share of users with the promised payment service,
- Talking subs share - the share of "talking" subscribers who make at least one voice call once within 9 days.

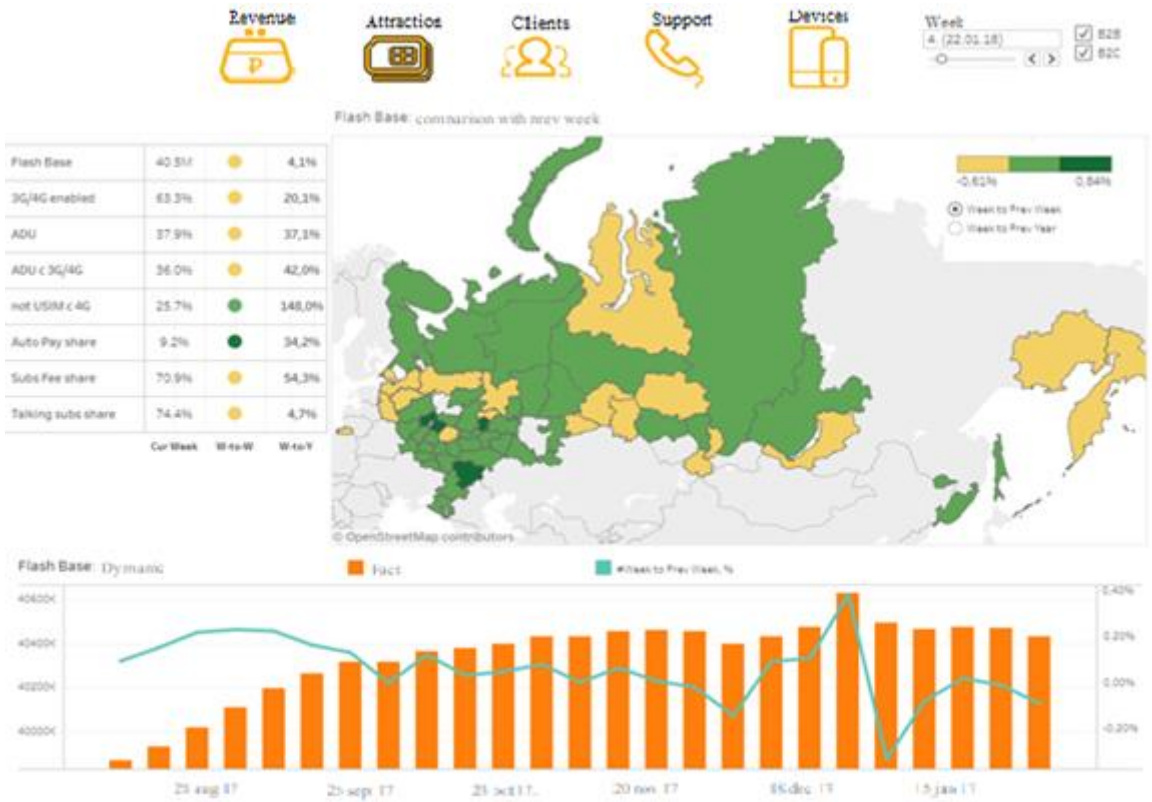

Fig. 15. Visual model of quality indicators of the customer base.

Data presented in Figure 15, as well as the comparison with the previous period - year (indicated as a percentage in the upper left of the chart), shows to business users the general growth trend of the subscriber base and enables to make strategic decisions, implementing a customer segmentation system based on the category of subscribers B2B or B2C.

Visual model of a group of indicators responsible for analyzing devices and the proportion of primary purchased SIM cards by subscribers enables to make decisions about future trends in data traffic usage and sales promotion taking into consideration traffic packets for users of mobile devices with multiple SIM cards. A visual representation of the indicator of “talking” subscribers enables to assess general trends in the consumption of voice traffic and timely identify problems of base stations and coverage areas affecting on the quality of communication.

Visual model of the strategic indicator KPI_D - customer satisfaction with the functioning of mobile operator for the various types of service provision - is presented in Figure 16.

One of the generally accepted indicators of customer satisfaction with the services provided is the NPS (net promoter score) index of consumer loyalty, which enables to determine adherence to a product or company by means of surveys of subscribers. As it could be seen from figure 16, the consumer loyalty index is at a high level, which is marked with a green color indicator in the circle shape.

Data presented in Figure 16 reflects the dynamics of points of contact with service users, which enable to take into consideration the degree of customer satisfaction with selected quality criteria, such as corporate customer confidence, voice and SMS activity analysis, mobile Internet use, call center operation, and the operator’s retail network.

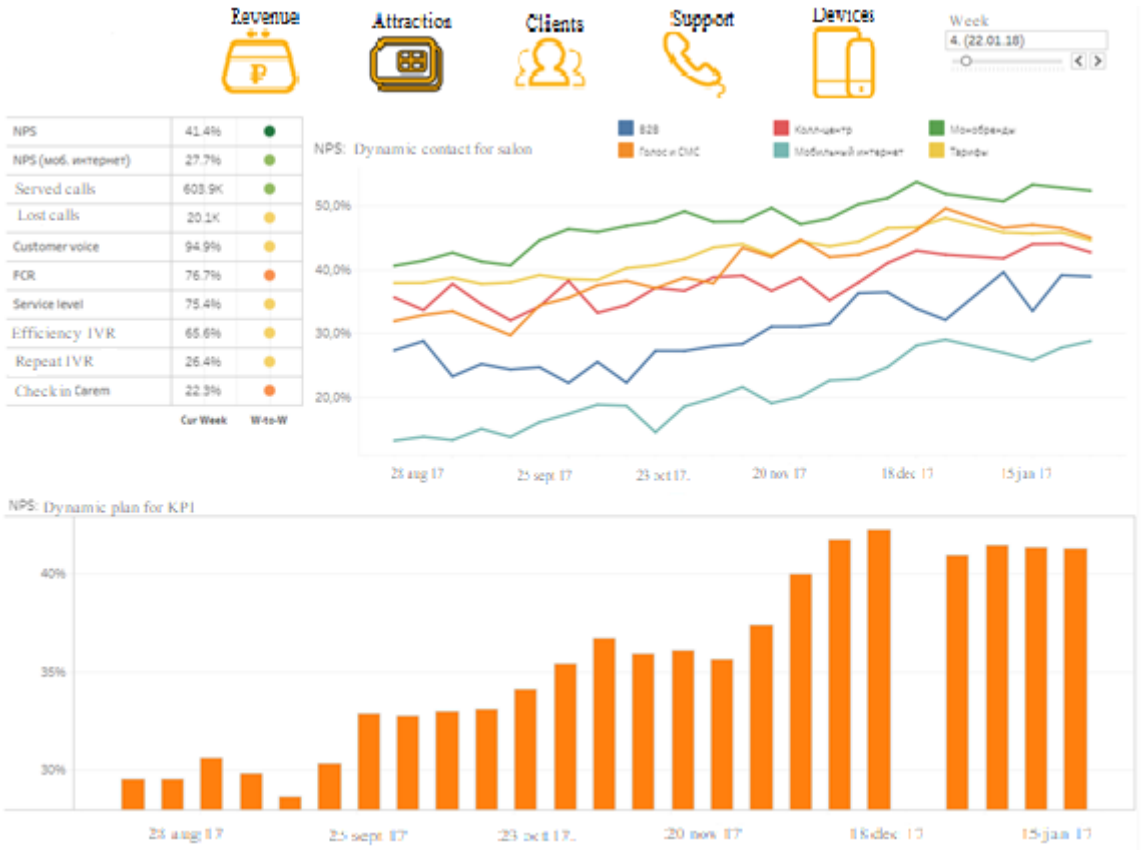

Fig. 16. Visual model of customer satisfaction indicators for a mobile operator.

Visual analysis of customer service indicators enables to make decisions about operating with contact appeals of subscribers, with indicator of subscriber engagement and with shares of solutions to problems of subscribers for the first calls to the call center.

The bottom graph in figure 16 represents the overall dynamics of the quality assessment of services provided to operators according to weekly data. The decrease in the NPS indicator of the plan fulfillment dynamics is due to the lack of subscriber polling during certain periods of low activity.

Visual model of the strategic indicator KPI_E - an assessment of the sales of branded equipment (mobile phones) of the operator - is presented in Figure 17, data on real model names are replaced by patterns due to the confidentiality agreement.

Visual analysis of equipment sales enables to predict the success factors of a particular equipment model on the market and estimate the share in the overall sales structure, since the most non-functional phone models are used only to activate SIM cards (model 6 in Figure 17) or initialize specialized equipment.

Visual model of indicator make possible to display not only a share in the volume of sales, but also a share in the revenue of a particular phone model.

Visual analysis of sales revenue in Figure 17 allow to make decisions regarding the implementation of a marketing policy aimed at identifying and maintaining a stable level of sales of the most promising mobile phone models. For the market of budget telephones, model 4 is the most promising from the point of sales support view, and for the market of a higher price range, model 2 is the most promising.

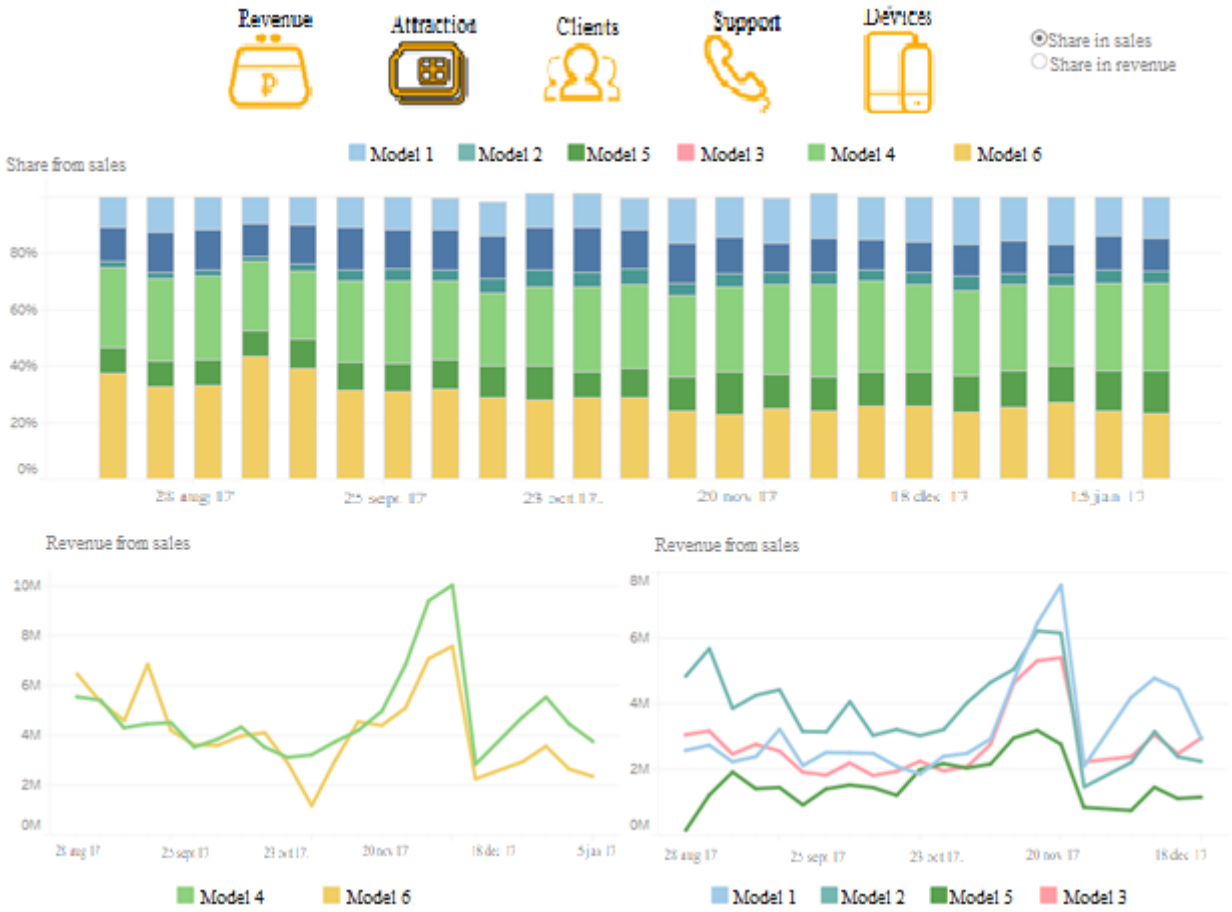

Fig. 17. Visual model of sales rate of mobile operator branded equipment (mobile phones).

Conclusion

Visual models of key performance indicators of a high-tech telecommunication enterprise, presented in the article, make it possible to structure the organization activities, taking into account the factors of increasing competitiveness, operating stability, setting up a business model, optimizing operational and strategic business processes.

Visual models of key performance indicators of a high-tech telecommunication enterprise, presented in the article, make it possible to structure the organization activities taking into consideration the factors of increased competitiveness, operating stability, business model adjustments, optimizing operational and strategic business processes.

A set of visual models developed by the authors make it possible to use visual analytics tools for making managerial decisions in the sphere of strategic and operational planning and also for the management of marketing activities of the company's based on monitoring and display of the dynamics of changes in a selected set of indicators during a specified period of time. The proposed approach to visualization is illustrated by examples from the operation activity of a high-tech mobile operator company in telecommunication industry.

Creation of visual models of key performance indicators of company efficiency assessment is implemented using Business Intelligence tools based on the storages and data marts formation by collecting large information arrays. The formation and implementation of the Business Intelligence system enables to use functional information tools and create powerful techniques for visual analytics of heterogeneous information, taking into consideration performance management technology.

The approach proposed by the authors for the purposes of enterprise business model creation utilizes the methods of visual analytics in order to make approved decisions both at the stage of business planning and

also at the stage of operational planning and management of the organization's activities in the field of high technologies in a competitive environment and integrated business processes.

By implementing BI technology for creation of corporate reporting it is possible to get benefits in the form of a comprehensive solution that will provide access to financial statements for multiple business users. Developed BI system improves the effectiveness of managerial decisions in accordance with the developed key performance indicators strategic model of the organization.

The proposed system of visual models could be adapted to almost any research domain. Portability of the formulated solutions is to make it possible to develop models of key indicators related to the necessity of the enterprise, adjust mechanisms for visualizing performance indicators, data integration in the corporate storage of the organization and flexible application settings, and a comprehensive system of reports formation. By the author's opinion, the main task in the construction of hybrid data visualization systems based on Business Intelligence systems is to develop a detailed and approved methodology for developing a system of performance indicators based on the retrospective of the organization’s functioning, operational and financial experience of the company. The effect associated with implementation of the visual models system is associated with a reduction in decision-making time to promote the company's products or services to the market in modern economy conditions, which is in turn allows the company to increase its competitiveness, by improving product quality and shortening the marketing life cycle of a product.

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