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ANALYSIS OF THE EXTERNAL ENVIRONMENT OF THE
REGIONAL SOCIO-ECONOMIC SYSTEM

Elena Averchenkova (a)*, Andrey Averchenkov (b)

*Corresponding author

(a) Bryansk State Technical University, Bryansk, Russia, lena_ki@inbox.ru

(b) Bryansk State Technical University, Bryansk, Russia, mahar@mail.ru

Abstract

The article describes a model for monitoring multidirectional data of the external environment of the RSES that makes analyzing data from the open data Portal of the Russian Federation possible. The monitoring functionality consists of aggregate and analytical actions for the formation of a database for DSS (decision-making support system) "DATA" providing collection and processing of up-to-date regional socio-economic information. An algorithm for multidirectional data of RSES external environment monitoring is proposed. The software design package "DATE" is presented containing a set of modules for intermediate calculations and user interfaces, either of which is represented by separate software. This allows either unambiguous differentiating of functions or providing flexibility to expand the system's functionality besides ensuring data access security. The main task of each module aimed at collecting statistics from open sources is a request to the containing data site via the Internet, then load, decollation, parsing the data and memorization on a database. The data validation and aggregate module makes data reduction from various sources possible and for this purpose various indicator names are compared, outlined, converted into unified measurement units alongside with de-duplication and erroneous data verification and cleansing. The module works in semi-automatic mode, most of the actions are invoked by the module on itself.

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1. Introduction

Political, economic, and environmental transformations around the world have convinced us to pay even more attention to the external environment as the source of their appearance (Vikhansky & Mirakyan, 2018). Regions, being a socio-economic system, stand upon an external world as far as supply of resources, energy, personnel, and consumers are concerned. Regions watch and follow external environment for identifying and making use of its favourable opportunities, while avoiding threats and obstacles at the same time (Kuznetsova, 2016a; Leksin & Porfiryev, 2016a). This is possible due to the study of the nature and dynamics of changes happening in the external environment (Leksin & Porfiryev, 2016b; Naumov & Petrovskaya, 2010a; Naumov & Petrovskaya, 2010b) together with drawing up a list of opportunities and threats that in future will open the way to both: using of favourable opportunities and finding effective responses to the challenges of the environment (Ivanter et al., 2018; Novikov & Belov, 2019a; Novikov, 2019b). This process is called monitoring of multidirectional data of the external environment of the regional socio-economic system (hereinafter RSES), which implementation becomes possible through decision-making support system tool kit “DATA” (hereinafter DSS “DATE”).

2. Materials and methods

Monitoring of multidirectional data of RSES external environment analyzes the flow of information coming from this outside environment (Averchenkova et al., 2017). The main function of monitoring is regularly repeated aggregate and analytical actions for the formation of a database for the DSS “DATE” and thereafter providing the collection and processing of up-to-date regional socio-economic information. Figure 1 shows a model for monitoring multidirectional data from RSES external environment.

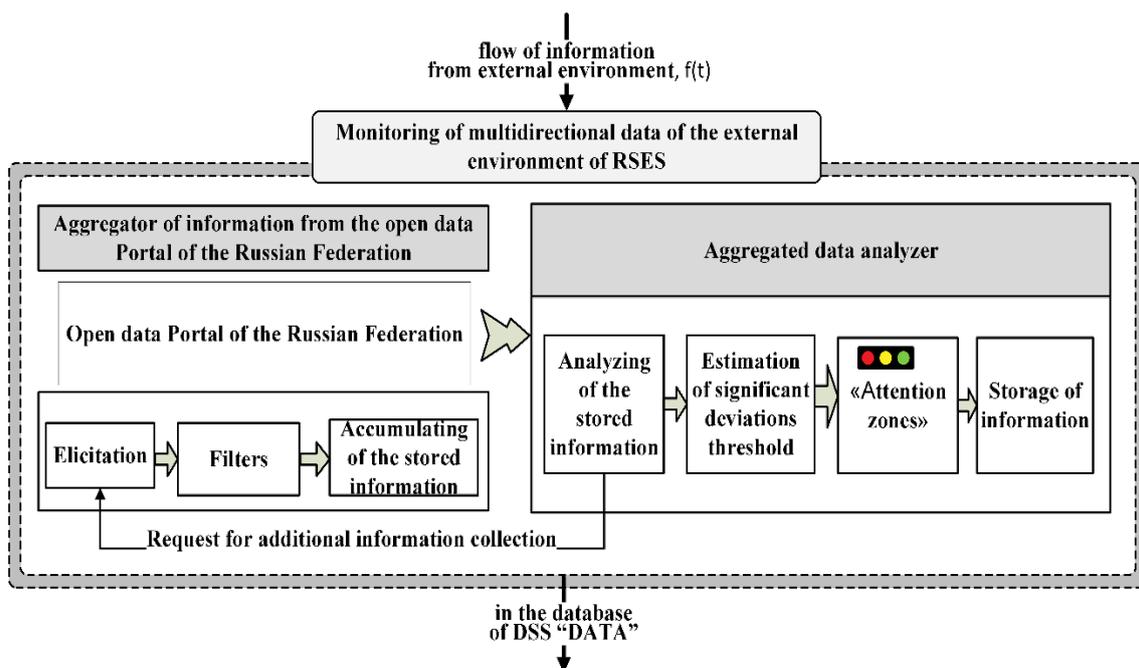


Figure 1. Monitoring model of multidirectional data of the external environment of RSES

The main content of monitoring of multidirectional data of the external environment of RSES is represented by periodically conducted analytical and diagnostic actions to form the information base of DSS "DATE" (Averchenkova et al., 2016)

We shall define the main principles for monitoring multidirectional data of RSES external environment:

- purposefulness;
- consistency, i.e. considering a region be an integral part of the economic, legal and social space of the country;
- comprehensiveness of all indicators used in monitoring;
- unambiguity of conclusions based on the use of quantitative monitoring indicators;
- steadiness in monitoring the region;
- frequency of taking information about ongoing regional changes;
- comparability of monitoring indicators in dynamics.

Monitoring of multidirectional data of the external environment of RSES provides RSES condition control that takes into account a number of targets for making subsequent effective managerial solutions (Averchenkova et al., 2016). In other words, the proposed monitoring model is an information and analytical system for keeping track of a regional situation.

The main nuts and bolts of the model for monitoring multidirectional data of RSES external environment are the aggregator of information from the open data Portal of the Russian Federation and the aggregated data analyzer. The aggregator is a "DATE" module of the DSS (software aggregator), which combines data concerning RSES with the development of common user access (CUA).

The elicitation function is implemented in the aggregator using filters that provide means of selecting a content having specified characteristics. The main function of the aggregator, i.e. information acquisition for its subsequent processing is carried out by the analyzer. The aggregator storage function allows accumulating of the stored information for further systematization and analysis in the dynamic pattern now in the DSS "DATE".

The source of the database content is the open data Portal of the Russian Federation (<https://data.gov.ru/>), which is one of the key tools for implementing national policy in the field of open data. It should be noted that today immediacy of the problem of wider audience access to open data of Public Sector Information is recognized nationwide while the state policy in the field of open state data promulgating is also under way. In addition, fundamental laws and regulations have been adopted obliging public authorities to disclose information of unrestricted distribution in the open data framework and the state information and technology infrastructure of open data are being developed including gradual formation of the open data culture and ecosystem.

The information aggregator of the open data Portal of the Russian Federation processes up-to-date information regarding open data of Federal and regional authorities. In addition, when accessing the Portal resources, the aggregator performs the information filtering function, i.e. if requested it affords an opportunity to find out more about passports and contents of open data sets (DS) without preloading, and also converts an opportunity for implementing the requests to the API of data sources (search, DS upload to the specified selection criteria, SPARQL queries).

Let's view how the function of the information aggregator of the open data Portal of the Russian Federation is implemented when monitoring multidirectional data of the external environment of RSES:

1. Periodic (for example, monthly) refresh of the database of the DSS"DATE" by adding new statistical data from the open data Portal of the Russian Federation.
2. New sets of information (reports, analytical notes, etc.) are included in the list based on the screening of information in the open data Portal of the Russian Federation.
3. Invalid and non-updatable sources of information are excluded from the list.

The table shows an example of forming a list of data from the open data Portal of the Russian Federation for aggregation purposes in the monitoring model of multidirectional data of the external environment of the RSES (using the materials of the Bryansk region).

Table 1. Sets of available data for the Bryansk region in the context of the main areas of aggregation in the model for monitoring multidirectional data of the external environment of RSES

Aggregation directions	Sets of available data for the Bryansk region from Portal of the Russian Federation
State	Register of open data of Executive State Government Bodies (ESGB) of the Bryansk region
	Governor of the Bryansk region
	Executive State Government Bodies (ESGB) of the Bryansk region, exercising power in the field of state expertise of project documentation, results of engineering surveys and monitoring of compliance by the local government body (LGB) compliance with the urban development legislation
	ESGB of the Bryansk region, exercising power in the field of promotion of employment of the population including devolved power of social benefits accomplishment for nationals recognized as unemployed in accordance with the established procedure
	ESGB of the Bryansk region exercising devolved power in the field of environmental impact audit
	ESGB of the Bryansk region, exercising power in the field of wildlife conservation and usage
	ESGB of the Bryansk region exercising devolved power of the Russian Federation in the field of civil health protection
	ESGB of the Bryansk region exercising devolved power of the Russian Federation in the field of education
	Institutions subordinate to the Department of physical culture and sports of the Bryansk region
	Multifunctional centers of the Bryansk region
Health	Departments of social protection of the population of cities and districts of the Bryansk region
	Register of socially oriented non-profit organizations of the Bryansk region – recipients of support
	Property of hotels and other places of temporary residence in the Bryansk region
	Judicial districts of magistrates of the Bryansk region
Sports	Medical examination of certain groups of the adult population of the Bryansk region
	Preventive examinations of children in medical organizations of the Bryansk region
Culture	Medical organizations of the Bryansk region
	Information about sports in the Bryansk region
Commerce	Allotments of the Bryansk region
	Register of museums and exhibition halls in the Bryansk region
	Register of food outlets in the Bryansk region

The given example is rather limited (in amount of the number of available data sets): for example, the review of the availability of similar information for the Ulyanovsk region amounted to 357 data sets, and for the Nizhny Novgorod region – 185.

The analyzer makes a reappraisal of significant changes in specific components of RSES based on the concept of materiality of changes occurring – the maximum deviation value, which gives the event being estimated as significant for the subsequent development of a feasible managerial solution (the calculation procedure is discussed in (Averchenkova et al., 2017). In case of significant deviations in the database of the information system three color "attention zones" appear (red, yellow and green) and managerial solutions are subsequently assigned for each one. If necessary, the analyzer makes a request for additional information collection. As a whole the information aggregator of the open data Portal of the Russian Federation and the aggregated data analyzer ensure dynamic collection and processing of regional socio-economic information. It is therefore possible to determine the flow of information from the external environment by processing it through monitoring of multidirectional data of the external environment of RSES and express it in the following form:

$$f_{HY2}(t) = \left\langle e_{\epsilon}^f(t), e_{\eta}^r(t), e_{\tau}^m(t) \right\rangle \quad (1)$$

$$\left\{ \epsilon = 1, 2, K, 8759; \eta = 1, 2, K, 9934; \tau = 1, 2, K, 3503 \right\}$$

where $e_w^f(t)$ – sets of the open data of federal importance; $e_b^r(t)$ – sets of the open data of regional level; $e_p^m(t)$ – sets of the community-based open data. The number of data sets given in the formula (5.6) may change as the latter increases on the website of the open data Portal of the Russian Federation.

Figure 2 shows the algorithm for monitoring multidirectional data of RSES external environment.

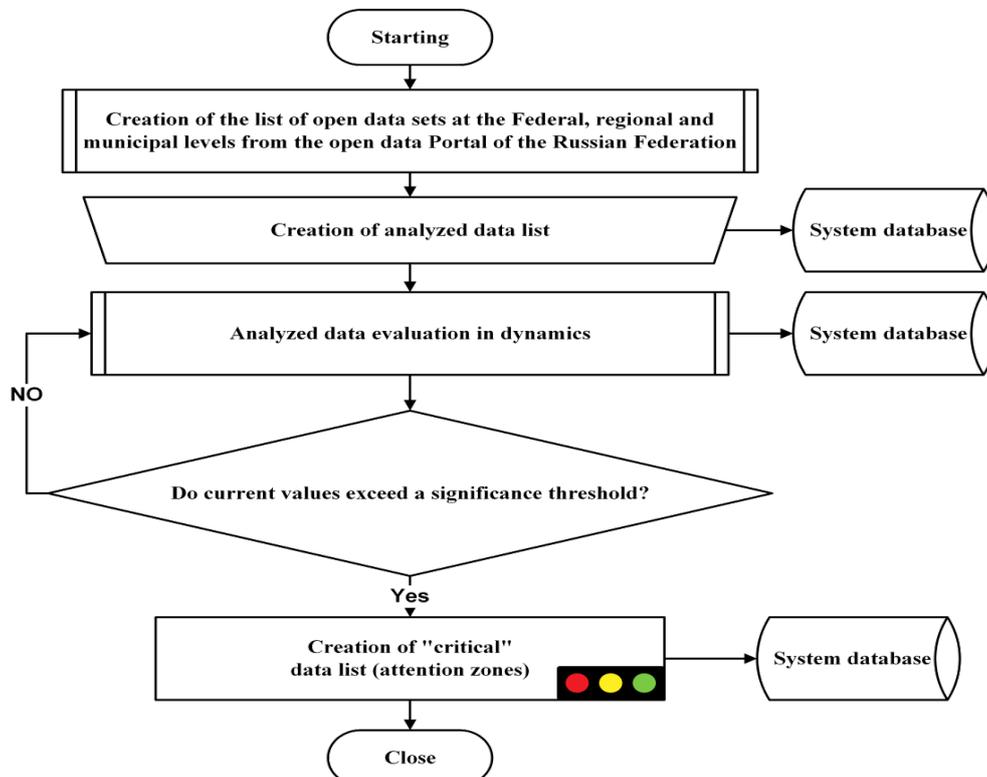


Figure 2. Algorithm for monitoring multidirectional data of RSES external environment

The main nuts and bolts of the algorithm for monitoring multidirectional data of the external environment of RSES take the shape of a list of open data sets at the Federal, regional and municipal levels from the open data Portal of the Russian Federation. Creating a list of analyzed open source data and their "desired" (normative) values allows request for additional information collection. If there are significant deviations, then a list of "critical" open source data is developed in the system database showing "color zones of attention" in the automated system database constituting the basis for managerial solutions, that are subsequently made. Thus, a machine-oriented solution is created, which diagnoses the external environment of the RSES irrespectively and establishes the basis for making managerial solutions.

3. Results

Let's distinguish the design peculiarities of modular architecture of the DSS "DATE" for the purpose of monitoring multidirectional data of the external environment of RSES.

The developed architecture of the information system contains modules for intermediate calculations and user interfaces, either of which is represented by a separate software that provides clear unbundling and flexibility necessary for expansion of functional of the system including the security of access to the data (Figure 3).

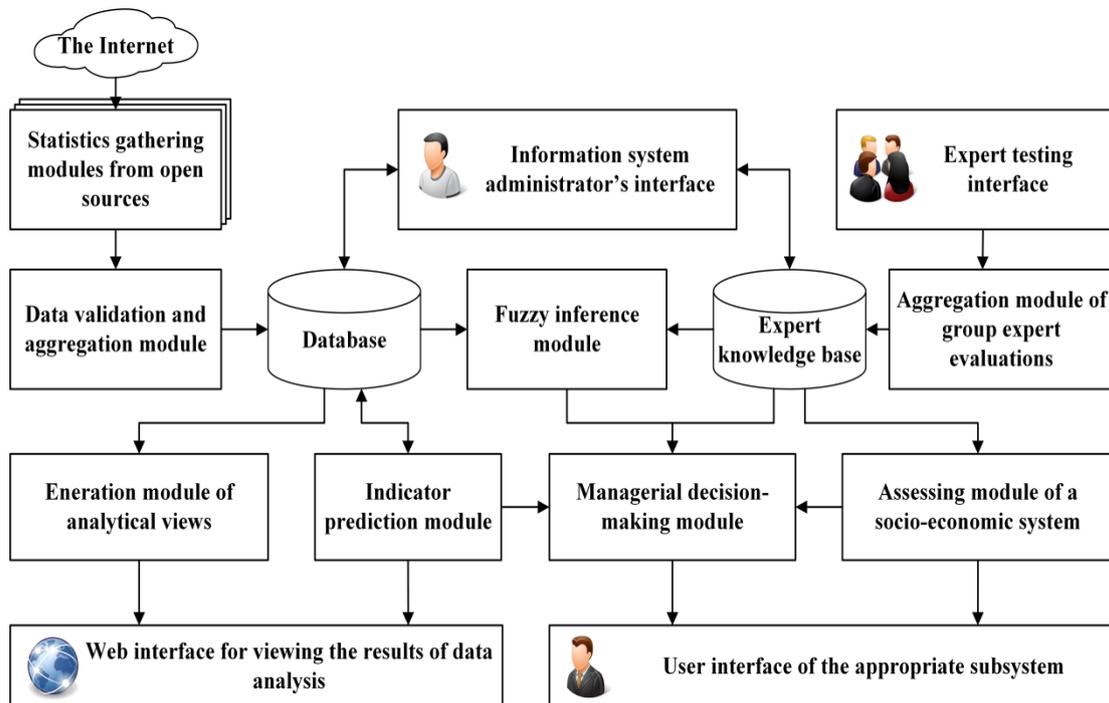


Figure 3. Modular architecture of the DSS "DATE" for the purpose of monitoring multidirectional data of RSES external environment

1. Statistics collection modules from open sources. Each open source has its own data lay-out. As a result, it was necessary to develop separate modules to work with each of them. The main task of each module is accessing the containing data site via the Internet, as well as there is a loading, a necessary decollation, an interpretation, a memorization in the database. Herewith there is a data base maintenance through metainformation in regard to the source, date, and the implemented module.

2. Module for checking and aggregating data. Data provided by different statistical services have different reporting forms, which may vary from year to year. In this regard, the same indicators may have different names (for example, due to changes in the qualification reference lists), units of measurement, and presentation format. The data may also be incomplete or duplicated in different sources, as well as contain errors making its direct utilization or in the applied mathematical methods impossible. The basic needs met by the data validation and aggregation module are: reduction of data got from various sources by means of comparing various indicator names, data outlining into a hierarchical family, translation into single units of measurement and alongside with all these steps duplicates are removed, and erroneous data is verified and cleared. The module works in semi-automatic mode, most of the actions are performed by the module on itself, and if the solution is ambiguous, it is postponed and then it can be offered to the information system administrator.

3. Indicator forecasting module performs a regression analysis of regional indicators values for detecting trends in their development and extrapolation. The information concerning values of indicators assigned to each of the structural divisions serves in the function of master data including volumes of financing. The result is the values of the indicators being timely within the future period of three years, taking into consideration the trend of development, the current values variances comparing to statutory indicators for the federal district, the error of the official forecasts of previous years as against current values and forecast ensured by extrapolation. Forecasting for more than 3 years is not effectual, since it will have low accuracy due to the impact of decisions in regard to changes in the values of indicators, made either at the regional level or on a nationwide scale.

4. Module for producing analytical representations collects and aggregates gathered statistics together with the results of forecasts in accordance with the specified forms of analytical reports, which can later be presented diagrammatically or tabular. The module generates aggregate data representations in the database, developing data outline supported by OLAP technology providing real-time data science receiving regardless of the volume of cumulative data, since new data supplements the existing data and does not lead to their complete recalculation. The module works off-line in the background, making calculations as new data becomes available.

5. Group estimate reduction module is designed to combine expert's review and to assess the overall impact of environmental factors on RSES in the context of the need of RF National projects implementation. This module is necessary for making a balanced generalized and, as a result, more objective assessment of the degree of factors effect on known issues as well as determining the list of effective measures to minimize negative impact factors. Qualitative integration of expert's review is an important stage in any expert knowledge-based systems, especially in decision-making support systems, since the solutions proposed for implementation hinge on the results of expert testing and the qualitative interpretation of its results.

6. Module of the state value of socio-economic system determines the overall condition of the studied RSES, as well as identifies existing problems in it. Possible problems are identified in the database for each of them, its value is determined based on the available trends of all indicators alongside with dependencies of influence on RSES taking into account strength of the influence of these factors over possible problems. All parameters are available in the database and defined by other modules. In such a

way, the most important current problems in the region are identified and for each of them there are factors having either a strong impact on the problem or significant deviations from positive indicators.

7. Fuzzy inference module is a separate subsystem that is used by other modules for phasing operations, performing logical inference based on a given fuzzy production model and dephasing operations as well. The module is used with different input and output values both at the stage of reducing fuzzy expert estimates, and at the stage of making managerial decisions. In this regard, the implementation of the module is flexible within the framework of the developed system.

8. Module for making managerial solutions is one of the main modules resulting in the system's work for further representation in the user interface of the advising system. Based on the overall condition of the system under study and taking into consideration all the reported issues, this module selects the most effective measures to improve the performance of RSES and to eliminate the problems discovered in it. Herewith the degree of factors impact on each specific problem, the degree of factor's involvement in each of the reported issues, and the effectiveness of the proposed measures are taken into account. Thus, the elaborated decisions are complex and ranked in order of their implementation priority.

9. IS administrator interface is designed for software package operating. In this interface there is an opportunity of all source data editing; there are also configuring and interacting with all modules of the system; viewing of their status; editing of the linguistic support used by the information system; creating new forms of analytic reports that will be collected by the analytic representation module and finally for end users of the system. You can also set separate operation parameters for each module. This interface has an authentication procedure and guarded communication with subsystem cross-points, since system control significantly affects not only the quality of its operation, but also its overall performance.

10. User interface of the advising subsystem is one of the main interfaces of the system. This interface is intended for managerial decision-makers. It makes the view of the results of the analysis of RSES current state using the tools of (control device) CD№1, 2 and 3 available. The main content of the interface is a toolbox of corrective actions for achieving the goals of national projects of the Russian Federation within certain regional projects. For each of the proposed activities, you can view additional background information about the methods of their implementation and impact. The interface contains a color differentiation of the results of the analysis of the external environment of RSES using the tools of CD№1, 2 and 3, which allows evaluating and ranking the identified management problems in order of importance.

11. Web interface for viewing data analysis results is a web application for perusing analytical reports. Reports are presented graphically, diagrammatically and in tabular and become the base of the expert's estimation of the overall condition of the socio-economic system under study. This part can be open and does not require user authentication, so it is placed in a separate program block.

4. Conclusion

DSS "DATE" can be used for accumulation of knowledge and experience of key specialists and successful leaders of public management and transferring it to every manager and public employees to support the decision-making process in the field of analysis of multidirectional data of the external environment of RSES. It is assumed that as part of the automated workplace of a public employee, the

software package will implement the process of supporting regional management decision-making process based on the analysis of multidirectional data from the external environment of RSES. The conceptual content of the developed software package is a diverse analysis of trends of environmental influence upon RSES and subsequent creation of alternative management decisions based on artificial intelligence technologies.

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