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Published in the USA  
European Journal of Technology and Design  
Issued since 2013.  
E-ISSN: 2310-3450  
2024. 12(1): 3-9

DOI: 10.13187/ejtd.2024.1.3  
<https://ejtd.cherkasgu.press>



## Articles

### A Decision Support Information System

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#### Abstract

The article explores a decision support information system. The information system is intended for the management of educational institutions within the Ministry of Education and Science of Russia. The information system is interpreted as a decision support system. The taxonomy of information systems in the field of education is given. The types of management technologies in the field of education are described. The difference between the main goals of commercial and public universities is shown. Management goals set the dynamics of management. A sectoral area has been identified, which is the prerogative of the Ministry of Education. The article describes one of the industry information systems created as part of the assignment of the Ministry of Education. It is designed as a specialized decision support information system with a special interface for ministry employees. The basis for the operation of such a system and its interface is information modeling. The need for additional use of GIS for the operation of such a system is shown. The use of GIS is due to the fact that universities form a geographically distributed system, for the management of which it is necessary to use spatial information. Spatial information is necessary when managing industrial property. The principles of operation of the system are described. The information system diagram is described. The application of information modeling for the operation of the system is shown, using the example of the “property map” geoinformation model. The results of the work are put into practice.

**Keywords:** management, decision support, information systems, information resources, information models, information technologies.

#### 1. Introduction

Information systems perform a variety of functions. Information systems (IS) have a dual application. On the one hand, IS creates information resources for solving applied problems and managing any organization. Such IS are called resource IS. On the other hand, IS is a management tool and a management resource. Such IS are called managed. In modern conditions of big data (Deepa et al., 2022; Lyovin, Tsvetkov, 2017), large volumes of data and the presence of contradictory information in them require compression of information and the formation of not one management decision, but a set of complementary management decisions. ISs that compress information are called selective. ISs that make several control decisions and help select a decision

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based on the situation are called decision support systems (DSS) (Casal-Guisande et al., 2023). Having a big data problem requires the use of DSS.

The sectoral education system is a complex distributed system. The applications of IS in education are varied. In industry education, resource-based IS, managed IS, selective IS and DSS are used. Information systems that combine different information systems are called integrated information systems (IIS). Some IIS (González-Gallego et al., 2015) include DSS. At the industry management level, DSSs are integrated systems.

A distinctive feature of education management is corporate governance (Jiang, Kim, 2020) of universities. Therefore, IS in education is used within the framework of corporate industry management. IIS and DSS are used complementary to the processes of globalization of society and informatization of education (Tsvetkov, 2005a). IS in the field of education is used within the framework of the state strategy for informatization of education. Moreover, this position applies primarily to state universities. Commercial educational institutions have relative freedom to choose a strategy and financial independence. The set of goals they have is the same, but between commercial and public universities there is a difference in the main goals. The main goal of a public university is to provide good training to students. The main goal of a for-profit university is survival. A state university is part of the state unified university system. A commercial university is an autonomous entity in the education market. This difference sets a difference in the purposes of managing educational institutions. This difference determines the difference in the specialization of information systems that are used for management in universities. For public universities there is a special department, which is a sectoral department. Within the framework of sectoral management of higher education, private management policies of individual educational organizations are allowed within certain limits. But the general management for state universities is the management of industry-specific university real estate by the ministry as an independent object of management. Accordingly, specialized IIS and DSS are created for such management. This article is devoted to such information systems.

Specialization of university IP.

Informatization of higher education is part of the informatization of society. It represents a general trend in the development of higher education. Informatization in a broad sense (Tsvetkov, 2005a) is implemented through the use of IS and information technologies. Informatization in the narrow sense is implemented through the creation and use of specialized information systems.

Specialized IS is used by the teacher, by the student, by the Ministry of Science and Education, and by the university. On the part of the teacher, IS is used in teaching, in eliminating the information asymmetry of the student's knowledge, for developing practical skills, and for testing. On the student's part, IS is used for additional preparation, as a reference system, for self-testing, and for information search for educational information resources. On the part of the university administration, specialized IS are used to manage educational processes, to manage personnel, and to manage property within the framework allocated by the Ministry of Education. The university administration has the right to manipulate property within the framework of the standards of the Ministry of Science and Education and the laws of the Russian Federation. On the part of the Ministry of Education, IS is used to analyze educational statistics, for retrospective analysis of the activities of universities, to identify trends in training and for corporate management of industry property, to coordinate the actions of universities and the Ministry for property management. This gives grounds to talk about IS at different levels.

The tasks of information systems at different levels differ significantly. University information systems are aimed at teaching, managing educational processes as decision-making systems. Information within the university is more structured and formalized. Therefore, it is relatively easier to process. Information that is used comfort in the ministry is significantly larger in volume, more diverse and part of it contains uncertainty. The ministry's information systems are aimed at analytical activities and decision support. Therefore, at the ministry level, a decision support information system (DSS) is used. In practice, the DSS interface operates in two modes: the IS use mode and the manager consulting mode. In the ministry, decisions are made not individually, but collectively. This leads to the need to introduce elements of corporate governance into the DSS.

## 2. Results and discussion

### Features of management of state educational organizations

Management of organizations subordinate to the Ministry of Education of Russia is based on a management complex that uses management theory taking into account the characteristics of state educational organizations and the availability of information educational space (Eliseeva et al., 2016).

Information educational space is a feature of education management. It can be sectoral and within a separate university. The second feature of state educational organizations in Russia and educational organizations in other countries is that they belong to the social sphere. It follows from this that educational organizations (in all countries) are subsidized. Consequently, public educational organizations cannot be compared or equated with commercial, profitable organizations. The social orientation of state educational organizations requires the use of different criteria to assess their effectiveness than for assessing the effectiveness of commercial firms. The first criterion suggests itself – eliminating the shortage of personnel in sectors of the national economy. The second criterion may be the performance of graduates in the form of scientific and technical developments accepted for implementation. But so far such criteria are not applied.

State educational organizations create labor and intellectual resources, without which any state will not be able to develop. Unfortunately, to date, no methods have been created in the field of economic development to assess the effectiveness of educational organizations. Many methods for assessing the effectiveness of educational organizations use a cost approach rather than a resource approach.

In fact, the management of educational organizations is aimed at meeting the information needs of the state to create qualified specialists and the information needs of the population for educational services. The state is both a consumer of the Ministry of Education's products and an organizer of the education system. The key parameters for managing an educational organization and the entire education system are the need for education of the population and the state's needs for human resources.

The interest of the consumer of educational services is aimed at obtaining qualified specialists. Interest on the part of the educational organization is aimed at sustainability, economic survival and enhancing the brand of the educational organization. Currently, consumers of educational services (organizations in sectors of the national economy) cannot directly influence the sustainability and economic survival of educational organizations. Such influence occurs only through the Ministry of Education and Science.

Economic interest on the part of the Ministry of Education and Science is aimed at balancing the costs of education and the production of qualified specialists. Organizational interest on the part of the Ministry of Education is aimed at creating a self-developing education system and self-developing educational institutions. Management of educational organizations is one of the forms of education management.

Modern management of educational organizations relies on information support. Information technologies have changed the management mechanism of educational organizations towards their digitalization. Information support for education management within the Ministry of Education is characterized by an increase in the volume of information, which reflects the problem of big data and the need to take it into account in management. Technologies for managing educational organizations use classical management technologies (Schonwalder et al., 2003) and special educational management technologies (Bhaskar et al., 2020). Educational management uses spatial planning and even geoinformatics methods. The increasing complexity of management within an industry is driving the use of multi-criteria analysis (Dean, 2020) for management. Modern management models include consideration of sustainability criteria. Three factors are considered key indicators of sustainability: environmental, economic and social. A systematic approach to managing the education system leads to the need to use models of complex organizational and technical systems (Zilberova et al., 2020) as a basis for managing universities.

### DSS in the field of education.

DSS are systems that combine models of spatial control, situational control, known decision-making methods and decision generation models. Decision generation models include precise mathematical models and reasoning methods based on expert knowledge. IS PPR from the standpoint of system analysis can be determined by the set:

$$DSS = \langle EO, M(EO), F(EO), CC, T, F(DSS) \rangle, (1)$$

In expression (1) DSS is a decision support system;  $EO = \{EO_1, EO_2, \dots, EO_n\}$  – a set of educational institutions in parametric form or a descriptive form of educational institutions;  $M(EO)$  – a generalized model of an educational institution as a connected integral set of parameters used for management;  $F(EO) = \{F(EO_i), \dots, F(EO_n)\}$  – set of functions for managing educational objects; CC – control conditions, T – control tasks;  $F(DSS)$  – DSS system modification function. This component is responsible for the self-development of IS PPR and makes it an adaptive self-improving system

The generation of solutions within a specific EO model is supported by models and inference rules. The transition from one solution to another is motivated by a violation of the control conditions of the SS. The transition is carried out by reacting to the corresponding change in the condition parameter.

The main task of DSS is to help the staff of the Ministry of Education to maintain balance in the education system and support the educational institution to function in a planned (regular) state. The control process has a simple form.

$$(CC \wedge T) \rightarrow DSS \rightarrow R \quad (2)$$

In expression (2) SS control conditions; T – control problems; R – actual control result. The effectiveness of management is assessed based on the actual results.

The DSS framework includes the following components: a corporate governance interface for ministry employees; consulting interface, which includes information and human resources represented by consultants. Decision-making uses Federal databases and Federal information systems, such as the cadastral system or the national property management system, the national fiscal system, all-Russian statistics and others.

Decision-making uses databases of the Ministry of Education, which store educational statistics by year and educational programs. The DSS itself includes a geographic information system as a mandatory component. Educational management is spatial, so the use of GIS and geoinformatics is mandatory. Educational management is spatial, therefore it is necessary to apply methods of spatial economics (Tsvetkov, 2013). Management uses current regulatory documentation at the Federal and industry levels. Control actions change the reporting parameters of an educational institution. As follows from the diagram, the control is multiple. That is, not one object is managed, but many objects of the education system, including educational institutions and auxiliary institutions. Of particular importance is the management of the property complex of the education system.

#### Information modeling in management

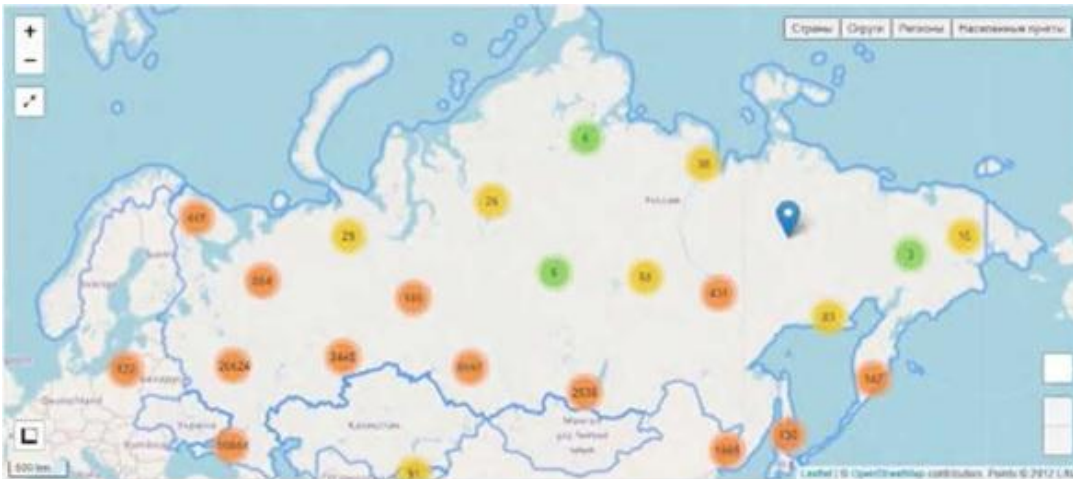
Information modeling (Cheng, 2016) is a fundamental method of cognition and a means of solving many applied problems. Information modeling is the basis for the formation of information resources (Tsvetkov, 2005b) for the tasks of education and management. Information models for management support, which served as the basis for the formation of management modules in IS PPR, are given as follows: information model “property card”; information procedural model “support for coordination of lease and gratuitous use”; information model “accessibility of facilities of organizations subordinate to the Ministry of Education and Science of Russia for people with limited mobility”; information procedural model “use of real estate” information descriptive model “easement”; information procedural model “administration of the receipt of part of the profit into the federal budget after paying taxes and other obligatory payments; information procedural model “state assessment”, information model “inspection reports”; information procedural model “agenda formation”; information procedural model “coordination of write-off of federal property.” During the preparation of reports of more than 1500 pages, many information models were described. Therefore, it is impossible to describe even part of the models within one article.

As an example, consider the “Property Map” information model. This is a visual spatial model that is created using geoinformatics methods. The model is created using GIS tools and is an electronic thematic map generated using a geographic information system and web technologies. Property map is an interactive web map of the complex of organizations subordinate to the Ministry of Education and Science of Russia, which includes all educational organizations. These organizations are presented on the map as real estate objects and land plots owned by subordinate organizations.

The property map information model acts as one of the tools of the functional module “Management of educational objects”, and is also a tool for obtaining information on objects of the

property complex in other functional modules. This model serves as the basis for constructing an algorithm and creating the “Property Management” functional module. The “Property Management” functional module is the main tool for drawing up a map. Data on objects of the property complex are entered into the system by employees of subordinate organizations with the formation of an up-to-date database on the property complex

When you launch the “Property Management” functional module and select the “Map” section, an overview map of Russia is loaded (Figure 1) with icons placed on it that integrate educational objects with digital symbols. The numbers indicate the total number of objects per given unit of area.



**Fig. 1.** Property card

Scaling the map entails scaling the integrating icons by dividing the overall integrating icon into a group of icons, displaying the number of objects corresponding to the icon per given unit of area. In order to increase the clarity and readability of the map, different colors are used to indicate icons displaying a certain number of real estate objects on the map: the red color of the icon means the number of objects per unit area greater than 100, the yellow color of the icon means the number of objects per unit area from 10 to 100 green – the number of objects per unit area up to 10.

With a further increase in scale with the transition to the map scale, at which individual buildings of objects of educational organizations are displayed, the integrating icons with the number of objects are replaced on the map with separate markers - icons indicating individual objects. The electronic map provides general information on objects indicating their number:

1. Cultural heritage sites, land plots;
2. Objects registered with the state cadastral register; objects in respect of which the ownership of the Russian Federation has been registered; Objects registered in the register of the Russian Federation;
3. Organizations with capital construction projects: educational schools, educational institutions of secondary vocational education, preschool educational institutions, educational institutions of additional vocational education, scientific institutions, government institutions, other organizations, higher education, unitary enterprises, cultural institutions

The “Property Map” model within the framework of the “Property Management” functional module is implemented as an independent interactive tool, with the ability to view data on real estate objects and land plots of subordinate organizations with their geographic location. The property map has been successfully integrated into various sections of the IAS “Monitoring” related to objects of the property complex, visualizing their spatial localization and allowing to obtain additional information on objects (rent, free use, assignment and redistribution of property, unfinished construction objects, etc.) with ensuring transition to the object page. The main purpose of the model is visualization of the state and integration of different types of information into a form convenient for decision-making. The model is associated with numerous reference books and makes it possible to obtain extensive reference information.

### 3. Conclusion

The management of educational organizations uses a complex of technologies and systems. Along with the general principles of managing organizations in the field of education, the social component is important. The social component is more important than commercial benefits. Factors of the social component can be taken into account during expert assessment. Therefore, only decision support systems that allow alternative management options are applicable for education. The decision support information system is not rigid and deterministic. It is adaptive and self-developing (Gural, 2014). Such a system is the core of a complex organizational and technical system that has proven itself in managing complex corporations and organizations. The decision support information system is the basis of situational centers. Its main advantage is the combination of human intelligence and experience with computer analysis and processing. This work was carried out within the framework of a state assignment on the completed topic "Methodological and information and consulting support for processes of increasing the management efficiency of organizations subordinate to the Ministry of Education and Science of Russia." The results of this work made it possible to systematize information about educational institutions and build models based on it. The models made it possible to improve the analysis of information, highlighting it at different levels of management. All this together has facilitated the work of the ministry and increased the reliability of decisions made.

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