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ORIGINAL CONTRIBUTION

Organizing Decision-Making Support System Based Multi-Dimensional Analysis of the Educational Process Data

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***Abstract*— It is important to make right and immediate decisions on the management of the education process and introduce quick decision-making support systems, which will increase the demand for academic attendance analysis, which is impossible without regular monitoring of the data. All the above-mentioned requires a comprehensive approach to the process management and appliance of modern instruments and informational technologies. The current work discusses the decision-making support systems' architecture, which includes three main components: data storage server, data collection, analysis instruments, and labour market research methodologies. Based on the analysis of the received data from the monitoring of teaching and study, the data warehouse and Online Analytical Processing (OLAP) technology are used. OLAP cube enables us to visualize, make statistical analysis, and study data. In the decision-making process solution, the problem of achieving the qualitative compliance of the professional potential and vacancies available on the labour market has an important role. The most important approach is organizing a market-oriented, flexible, and re-arranging education system out of suggested solutions. The approach provided in work will support education quality assurance service to identify trends, problems, achievement promptly to organize decision-making to improve the education process. The analysis based on the data received from the study and teaching monitoring is presented for which the data storage and OLAP (Online Analytical Processing) technology are applied. OLAP cube enables to visualize data, make statistical analysis and study data. The paper presents the problems related to the correspondence of professional potential and the vacancies available on the labour market during the decision-making process and solution ways. The most important thing is to organize a market-oriented, flexible, easy re-constructible education system .**

***Index Terms*— Decision-Making Support System, Data Analysis, Multi-Dimensional Analysis, OLAP Cube**

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I. INTRODUCTION

Modern educational institutions operate in the technological and informational revolution age characterized by the targeted and large-scale changes in the competitive environment, by economic dependence dynamics. One of the effective instruments of the management problem exploration and management system establishment is the appliance of modern instrumental means of analysis. Reflection of the ongoing processes by means of the mentioned instruments can be the ground for the development of a Decision-Making Support System (DMSS) serving to improve management efficiency.

DMSS is a knowledge-based informational system. They analyze and control information which will influence the implementation of a given task by the consumer. DMSS includes large-scale explanations, but mainly it is considered that its goal is to simplify the decision-making process, as well as identification and solution of the problem. Currently, DMSS is a quite organized instrument for working in any environment, when it is necessary to make a reasonable decision. It is important to take a decision in the educational institution when it is necessary to make a choice between the alternative options of the actions. The concept of the decision-making process is crucial for every manager of higher education, as the educational sector is the decision-making structure and the process of decision-making is continuous [1, 2, 3].

During the increasing competition, the universities try to develop a strategy and use new instruments in order to support ensuring the quality of learning, teaching, or research activities. In the educational sphere, the decision-making process faces strict requirements, which include quick processing of the great volume of information and data. The universities already have financial and administrative data retrospective analysis, though modern higher education institutions need to take the right decisions on the educational process in order to support the decision-making process at all levels of management.

Nowadays, there is no well-elaborated, efficiently functioning DMSS system in the higher educational system, as DMSS depends on the specifics of the problem for the solution of which it is elaborated, accessibility of the data, informational technologies and informational systems,

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information, knowledge, and system users. It is necessary to improve the management system at the educational institution, requiring a comprehensive approach to the management and appliance of contemporary instruments and informational technologies [4, 5, 6].

Adoption of the DMSS by the higher education sector will increase demand for the analysis of the academic performance that will need to monitor the collection of the data without loss. An effective management information system will be able to implement

- supervision of ongoing activities (Educational activities, study processes, administration service resources, students, syllabuses, curricula, etc.);
- data collection on teaching and research processes;
- Creation the common environment (evaluation of the monitoring goal achievement);
- Non-stop linkage for constant development;
- As a result of the data analysis presentation of the important information in order to evaluate and implement alternative ways.

High-quality evaluation, diagnostics, research evaluation, study process planning, and decision-making shall be made. [7, 8, 9]. The importance of the researches is based on defining key directions from the methodological point of view and selection of an effective DMSS formation methodology by the educational institution, considering peculiarities of management-specific objects. There is a discrepancy between the higher education sphere priority role and the lack of modern management technologies. The issue of adapting to modern approached educational institution management in accordance with the requirements of the leading countries. Accordingly, the topic of the research is very important during the reforms of the higher education field.

The defining of the key decisions for the education and research policy is within the competency of the university management model. Defining the typology of such models and analysis of their key characteristics is one of the key elements of the university strategy together with the study of education market behavior. It is necessary for the effective development of management. The components defining the university management structure can be applied: what is the decision-making mechanism and what are the internal and external factors during decision-making? The evolution of the external factors enforces the university to change its goals and strategies accordingly, the university management structure as well.

We can say that the competitive environment of the universities in the market economy requires that higher education institutions improve their management entity what is possible by improvement of the quality of managing decisions. At any level of institution management there is the need for decision-making, to select one out of suggested alternatives and it should serve to its development [10]. The decision-making process includes the following factors, like preparation of the works, a search of the information and processing, problem identification and searching for solution ways, development required documentation, and final fulfillment of the task [7, 11, 12].

DMSS problems are gaining importance from the practical perspective. As a rule, DMSS is an automatized informational system simulating human thinking in the defined field, and its development and appliances require highly qualifies specialists. As for the real systemic appliance of the optimization mathematic methods, due to the specifics of the higher educational institutions, it is impossible or in the best case, it is one-tome and episodic. Therefore, there is a condition when it is impossible to have manual calculations and it is necessary to use modern instruments for data collection and analysis. Based on the collected data it is possible to make a highly qualified evaluation, diagnostics, research assessment, planning of the educational process, and making decisions.

II. METHODOLOGY

The goal of the education process management system at the university is to increase the education quality and development based on the objective results of the regular monitoring of the students' qualitative and quantitative level. Conducting the data analysis is important based on the data received as a result of the monitoring and use of data warehouses and OLAP technologies are recommended.

Fig. 1 presents the scheme for the establishment of the data storage and functioning system composed of three key blocks: data collection, data organizing, and data analysis. The collection and storage of the information, as well as the solution of the informational-search system requirement problem are effectively made by means of the database management system. The information is collected from different transactional databases having different structures and contents in order to make a decision. The key problem here is the inconsistency of the database sources, it means that there is no common logical vision of the corporate data. Accordingly, data storage is applied for realizing storage sub-systems and unifying Online Transactional Processing (OLTP) and DMSS as one system. Final users of the DMSS need metadata describing data structures and visualization instruments. Reduction of expenses on the projection of the data storages and elaboration can be achieved by means of establishment windows, which will include data clustered as a topic. OLAP cube will enable us to visualize data, make statistical analysis, and data research [13].

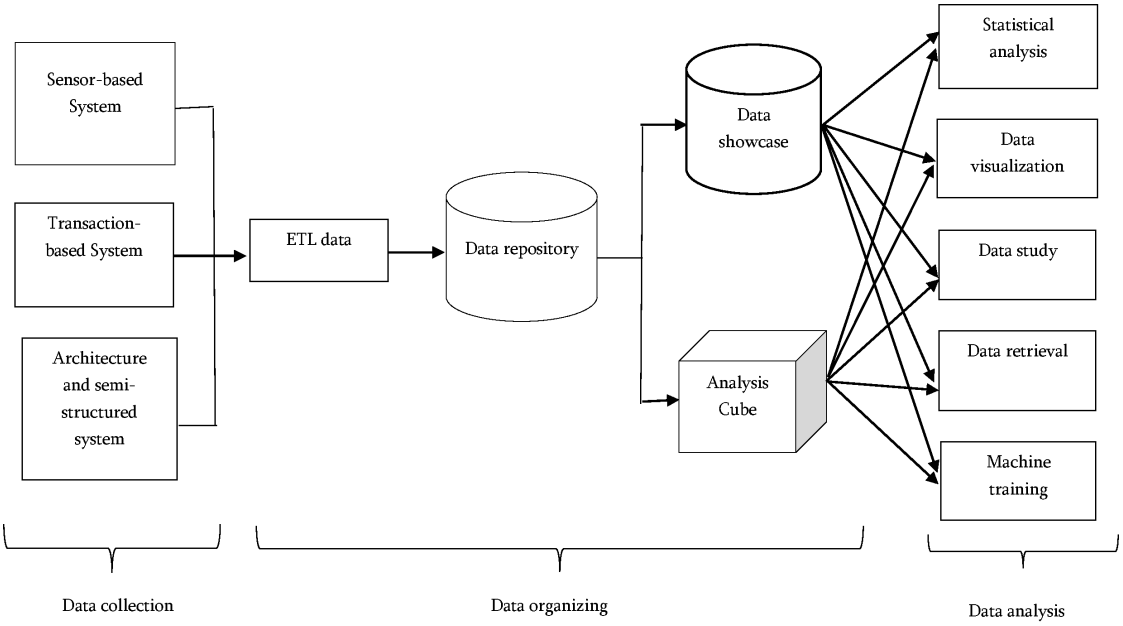

Fig. 1. Establishment and appliance of data storage

III. RESULTS

For the solution of the data analysis problem we have a process database "*University*". We included the data about faculties, departments, lecturers, and students. We have identified data sources that are composed of the database tables and we designed the dimensional tables as a result. The attributes for the individual dimensions were divided as hierarchies. We produced the fact tables and received OLAP cube that was spread on the server.

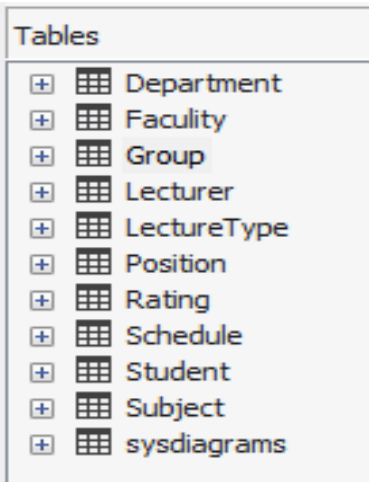

Fig. 2. Establishment and appliance of Data storage

Produced cube enables us to make aggregation and detaining operations according to the hierarchic structures. Accordingly, We can make tables out of the OLAP cube made by us with multi-dimensional data for their analysis. This technology gives the possibility to transfer any data hierarchy at any time. Visualization of the data is possible in the form of graphics, diagrams, and tables.

OLAP technology appliance for operational analytical processing of the multi-dimensional data is recommended during the decision-making process. We have designed DMSS architecture during the educational process based on the data analysis (Fig. 2):

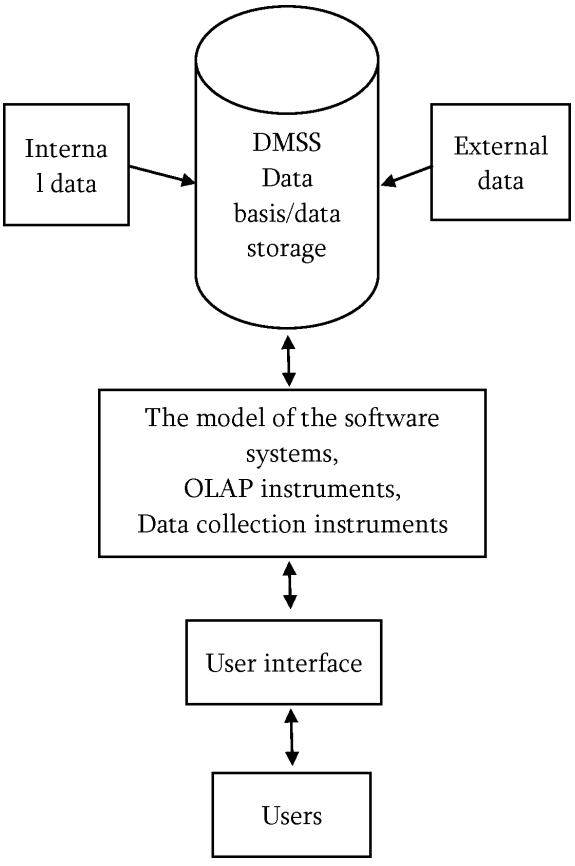

Fig. 3. DMSS architecture

Labor market study is important for the proper organizing of the higher education system. The effective way of problem-solving is data mining. It will provide a higher educational institution with precise information about the subjects and educational programs demanded on the labor market. It can be made by using data from the OLTP and OLAP cubes for the construction of the models of hidden trends and regularities to take further decisions. It is recommended to add the big volume of data about the labor market to the above-mentioned data and modern intellectual analysis methods and server technologies will be used for analytical processing [14].

IV. DISCUSSION

The data storage and OLAP technology-based systems enable us to conduct comparatively full and in-depth analysis of the problem and take more reasoned decision. OLAP technology makes it possible to make real structures and linkage modeling based on the data, which is especially important for analytical systems. The key difference and advantage during data processing compared to other means is that it is applied for the development of multi-dimensional, multi-parameter models for presenting real process more adequately. OLAP technology ensures to observe data immediately according to the selected parameters and makes a decision-maker possible to have full control of the situation.

By means of OLAP technology, it is possible to analyze different situations and forecast accordingly. The key advantages of the system are as follows:

- Correspondence of the initial information and the results of the analysis. It is possible to track information sources regularly and define the logical linkage with the results and initial data. The subjectiveness of the analysis result is minimized.
- Conducting a multi-optional analysis. OLAP technology gives the possibility to have multiple scenarios for developments based on the initial data collection.
- Detailing management. Detailed presentation of the results can be varied according to the consumers' demand. At the same time, it is not necessary to make complicated re-organization. The report includes the information which is required for decision making.
- Exploring hidden linkages. The possibility to explore and defining hidden interaction appears based on multi-dimensional linkages in different processes or situations, which influences the organization activities.
- Development of joint platform. The possibility to develop joint platform for forecasting and analysis all the processes in the organization by means of OLAP system.

So, the systems based on OLAP technologies are the best for the solution of such objectives which require processing big amounts of data in the shortest period. It has to be considered, that the data storages get information from several sources and formats, like text files, excel sheets, multimedia files, etc. Accordingly, these data require cleaning and transformation.

Data warehouses and windows require a frequent update of data, while the volumes of uploaded data often are quite big. For the mentioned processes it is possible to use SQL Server Integration Services (SSIS) which enables us to upload directly mass data from the plain file tables and SQL servers. It is recommended to install the SSIS service package by the possibility of restarting, as a restart of the packet from the initially estimated point, package function or container will take place. Though it should be considered that the possibility of restarting can significantly influence the time, especially, when a big amount of the information is processed from different sources.

Update of the data warehouses and windows in the system can be not a very easy process, as both types of the data warehouses include periodically variable measures which are very hard to be managed.

VI. LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

In the presented system the data are supplied from the structural database, the analysis of the received data takes place by OLAP technology. The volume of the non-structured data and the demand for the processing have been especially increased nowadays. In higher education institutions, it is required to collect and process video, audio, text files that needs to enhance the system presented by us and its development in the given direction.

VII. CONCLUSION AND IMPLICATIONS

The paper presents a decision-making support system and its role in managing decision-making in higher educational institutions. The role and advantages of OLAP technology are analyses for the data analyzing problems. The key difference and advantages during data analytical processing against other instruments are that it is used for the development of multi-dimensional, multi-parameter models for presenting real models much more adequately. The suggestion of OLAP technology is caused by the fact that it ensures immediate observation of the data according to the selected parameters and it will give the possibility of full control of the situation by the decision-maker. Many problems identified during the monitoring and recording of the processes in the higher educational institutions are linked with providing data from different sources. The solution to the problem caused the support of the data warehouse and integrated information system which includes updated and reliable information about educational programs, educational plans, teachers, resources, and students. Data warehouse and data analysis OLAP technologies are characterized by the simplicity and high speed of access to the information. The information stored in the data warehouses meet the defined requirements, like subject orientation, integrity, chronology support, and unchangeability. It has the possibility to provide precise data and information in the shortest period and at minimal cost and due to the mentioned characteristics data warehouse is considered as the best for data analysis.

The approach presented in the paper will enable education quality service to identify trends, problems, achievement timely which will help to the improvement of the educational process-related decision formation.

Declaration of Competing Interest

The authors declare that there is no conflict of interest.

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