

# DESIGNING A DSS FOR HIGHER EDUCATION MANAGEMENT

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**Abstract:** In order to achieve quality in education there is a need to optimally combine a complex of factors for the education system to be developed to highest standards. Competitiveness of higher education institutions is closely related to the development of information technologies, as key factor for future European citizens, to benefit from The European Higher Education Area and the collaboration in education. Data mining thus appears as one of the opportunities that have been less exploited, but whose application increases steadily, to solve various problems by analyzing data already present in the databases of various institutions. One of the viable solutions to support decision makers may possibly be the decisions support systems (DSS) which integrate specific tools to assist decision together with those of general use to form a constituent part of the institutions' information system. In this paper the authors present the design of a DSS which integrates data mining technologies, with the purpose to assist the managers of higher education institutions in quality decision-making processes.

## 1 INTRODUCTION

Seen in the light of rapid changes of our society, the access to information is a requirement of prime importance in any organization that wishes to have a competitive presence in the market field. Managers want accurate and current information provided in real time, in an appropriate format and at low costs.

In recent years, rapid developments in ICT have contributed to a significant increase in the global computer network. The Internet has evolved from a network for researchers and academics, to a platform which gave the opportunity to find new ways to offer products and services.

We are witnessing profound transformations in the manner of transfer and knowledge management. Internet and ICT have had a major effect in the way educational institutions operate - in the sense that they made it possible for many inventive teachers to study new methods for the development of education management and training opportunities.

Due to the increased data volume, and especially because of the complexity of data and relations between them, the possibility for a user to find links between various events encapsulated in the

information systems stored data, is becoming ever smaller. In this context, appeared the need to create automated tools which can transform data contained in various databases by proper processing it into information and knowledge useful especially to decision-making. Here come the solutions like decision support systems and data mining, which find and automatically or semi-automatically verify links between related events. The basis of these systems is to offer the information support needed to mitigate the effects of limits and restrictions faced by human decision maker, with the intention to resolve various decision problems.

In this paper we proposed an instrument to support the managers of higher education institutions in quality decision-making processes, based on data mining technologies integrated in an academic DSS prototype. The main objective was to provide them with ample information and knowledge to prepare new assumptions, in a short period of time, which is presently hard to achieve, and also to suggest viable decisional alternatives.

## 2 DECISIONS AND DECISION SUPPORTING TECHNOLOGIES

The decision is the outcome of a conscious activity to choose a course of action and to engage in it, as a result of processing information and knowledge (Filip, 2005). It belongs to a person or group of persons who have authority and responsibility for the efficient use of resources. The decision is meant to be a fundamental element of managerial activity, as an expression active, dynamic management, through which it fulfils its functions. Decisions taken in the field of education have a much more complex than in other social fields, because the educational activities, scientific research, highlight the individual in training under multiple aspects: professional training but also mental, physical and moral development etc. (Atanasiu, 2001).

The mission of the university is to prepare personnel to the highest level of knowledge at that time in history (Marga, 2007). The functions that comprise its mission are diverse and claim distinct actions, each being met by thematic areas and guidelines. The multicultural profile of Babes-Bolyai University of Cluj-Napoca is accentuated with the development of international dialogues and intercultural approach cultivated by the European Union. Each of the leading persons involved in the decision-making positions have coherent and well set tasks for taking the best decisions, therefore Babes-Bolyai University has increasingly become an innovative and prolific actor in interaction with the economic, administrative, and cultural environment.

### 2.1 Decision Support Systems

Over the years, support for decision making has taken a diversity of forms, and as the forms have evolved, decision making support has become more comprehensive and integrated. Today, there are several system alternatives available, and matching the suitable system to the particular problem or opportunity has created new tasks for management (Forgionne, 2003).

Decision Support Systems (DSS) represent a specific class of information systems designed to help users which rely on knowledge, in various decision-making positions to solve the encountered problems that matter for the organization's prosperity (Filip, 2005). The support received by the decision takers, whether they are top executives, managers placed on different levels (rector, dean

etc.) advisers and other assistants lies primarily in helping them to overcome the limits of knowledge regarding the problem, possible alternatives for action and methods of analysis used in the decision.

Decision support systems are designed to assist and support the decision making processes, and centre on the efficiency of this processes and the precision of the resultant information. The development of this type of system to assist in problems of analysis, solutions building and decision making is presently a major challenge in the academic management. A tendency of the actual decision support systems is to facilitate communication and cooperation between participants in the collective decision or between those who make decisions on the one hand, and those who are meant to provide the necessary information or to execute alternative adopted, on the other hand.

D.J. Power offered an extended classification of DSS based on the dominant technology that determines the features of the decision-making (Power, 2003): communications-driven DSS, data-driven DSS, document-driven DSS, knowledge-driven DSS, and model-driven DSS. Some decision support systems are hybrid systems driven by more than one major component.

DSS include applications in numerous areas, such as (Kersten et al., 2002): environmental decision making and assessment, water resource management, agriculture, forestry, manufacturing, medicine, business and organizational support, infrastructure etc. Software products like Expert Choice (EC), Exsys, Braincel, Evolver, Excel and other DSS packages, are examples of DSS capabilities and development. Over the years, further categories of systems have been developed to offer decision support, such as group decision support systems, expert systems, executive information systems, knowledge management systems, genetic algorithms, intelligent agents, fuzzy logic etc.

### 2.2 Data Mining and Decision Support

Data mining is the process of extracting implicit and viable information and knowledge which presents interest in processing of large data sets. There are many examples of data mining successful application in different areas: marketing and CRM (Customer relationship management), fraud detection, financial and banking processes, astronomy, genetics, text mining, Web mining etc.

Data mining represents a novel research technology which is being implemented in education

with several promising areas for data mining suggested and partially put into practice in the academic world. Particular attention was given recently to broader implications of data mining technologies in the field of education, and particularly in higher education, applications related to the students' and alumni future career and educational paths, to the students' "baggage of knowledge", predictions of academic failure, school drop-out, as well as those based on data extracted from on-line educational systems (portals, courses, tutorials, on-line examination etc.), and virtual communities (Bresfelean, 2008). The educational data mining was defined as "the process of converting raw data from educational systems to useful information that can be used to inform design decisions and answer research questions" (Heiner et al., 2006)

According to recent trends, the number of students has increased in several faculties and specializations in the higher education institutions; the city of Cluj-Napoca, one of the regions with the fastest economic development, has one of the largest numbers of students in the country. A major concern in the academic institutions is the prediction of students' and graduates' behavior in order to maintain and increase the number of students, to attract them to continue education through master and doctorate studies in the same institution.

Given the large number of faculties of various specializations, each with a variety of departments and fields of postgraduate study, continuing education may become a question mark. This depends on students' personal reasons (family support, current employment, ambitions for the future, etc.), but also on the educational environment in which they operate (technical equipment to faculty, quality of course materials, teaching quality, practical and research activities along with the teachers, relaxed curricula, etc.).

Understanding, prediction and prevention of academic failure are complex and continuing processes, anchored in the past and at present through the information collected on scholastic situations, various surveys and tests applied to students, as well as information resulting from research activities, based on data mining technologies. Constructing a typical profile for students, and also grouping them on the basis of exam failure and continuing education can help both higher education institution and its students. Universities can take such views to meet students' opinions on educational processes, curricula, courses, equipment, specific learning gaps and also

students' requests for further assistance needed for graduation.

Data mining and decision support are two disciplines aimed at solving difficult practical problems, and in many ways they are complementary (Bohanec & Zupan, 2001). To solve a particular problem, decision support tends to rely on knowledge acquired from experts, while data mining attempts to extract it from data. Their combination would result in important benefits in solving real-life decision and data-analysis problems:

- Data mining has the prospective of solving decision support problems, when earlier decision support answers was recorded as analysis data to be used with mining tools.

- Decision support methods typically product a decision model, proving the expert knowledge of decision makers.

### 3 DESIGNING A DSS IN HIGHER EDUCATION MANAGEMENT

Designing ICT based systems for the higher education institutions presents some common aspects with the design of economic systems, but with a series of special features specific to academics. These issues are related to the functioning and organization of educational institutions that have developed in a rapid pace. There should be taken into consideration the university autonomy, even in financial issues or other forms according to public and academic responsibilities. These are some of the main reasons why an in-house developed system can be better suited to the specific needs of a user in an higher education environment. Universities are at the heart of the community and an integrating part of them, having central tasks in education, training, research and other activities, integrated into a whole, called education system.

The higher education's result/product is the knowledge provided under various forms to the society (Popescu, 2008):

- Graduates' competences in specific areas;
- Results of scientific research - broadening the horizon of human knowledge;
- Consultancy, expertise, knowledge transfer to organizations belonging in socio-economic environments, in order to generate novelty and increased their competitiveness.

- The involvement of academic community members in the society - the transfer of knowledge achieved through direct involvement in organizations of the local, regional, national and international community.

Among the activities to be carried out by the designed decision support system, we mention:

- Providing a suitable framework for representing data;

- Modeling and processing data, performing operations on the representations previously established;

- Administrating more complex representations of the data: graphs, tables, images and other synthetic representation of data;

- Providing new means of data processing and making models (extraction and aggregation of certain data, calculate various indicators, graphics, comparisons, trends, etc.).

- Integrating modules to generate knowledge (data mining) and suggesting alternatives in making decisions.

### 3.1 DSS Existing and Newly Generated Data

The in-home DSS for higher education management system was designed to work best with the existing data of the Babes-Bolyai University (UBB) and the Faculty of Economics and Business Administration (FSEGA), using the separated databases of the following systems:

- The research activity management system - for teaching staff and research management of the departments, faculties and administration. Its aim is to highlight the research activity of teachers and synthesize it to different levels.
- ManageAsist system - developed to model administrative activities at UBB and for the integration of administrative facilities.
- The EvidScol system - related to the management of school records (plans for education, faculties, students and their grades),
- The AcademicInfo - centralizes databases of Secretariats providing facilities to access the information registered in the Secretariat, teachers and school management, resulting a Web based gradebook available online for students (access founded on code numbers and passwords).
- The application Taxes for fee management in the FSEGA.
- The web education portal available for online and distance education (ODL).

Data mining extracted data is centered on two main methods: classification learning and data clustering, and with the objective to build a typical profile for students and to predict their options, based on exams failure and continuing education. The higher education institution can learn about the students' content/discontent regarding the educational processes, the curricula, courses, equipment, and can also discover specific learning gaps and students who might require extra attention and training in order to graduate, and also can improve teaching methods and educational management processes.

### 3.2 DSS Architecture

The design process followed a thoughtful analysis and interpretation of the actual systems' models in order to use them later in the decisions, concerning the creation of a resourceful new system (Figure 1). The DSS is designed using a modular structure, in accordance with the basic activities of the higher education institution: teaching activities (Teaching module), scientific research (Research module) and scholastic situation management (Students module). It is developed from the model presented in first author's book (Bresfelean, 2008).

The DSS has 3 main modules (Figure 2): Students, Research and Teaching. The Students module represents the results and activities of FSEGA students, with data extracted from scholastic, fees, databases, questionnaires, and the eLearning platform. It serves as the basis for building and providing alternatives in decision-making on students' issues, based on the internal procedures of FSEGA. In this respect, based on the data, tables, graphs, the results of data mining processes, the system is able to suggest decisional alternatives in the following situations:

- Students' registration
- Students' transfer
- Suspension / extension of studies,
- Other specializations,
- Students' reclassification
- Granting dormitories,
- Granting scholarships,
- Tutors,
- Career Guidance, etc.

The Research module includes the performance achieved in the scientific research by the teaching staff, departments, PhDs, etc. and it is based on the databases extracted from the scientific research management system, the Department reports, questionnaires.

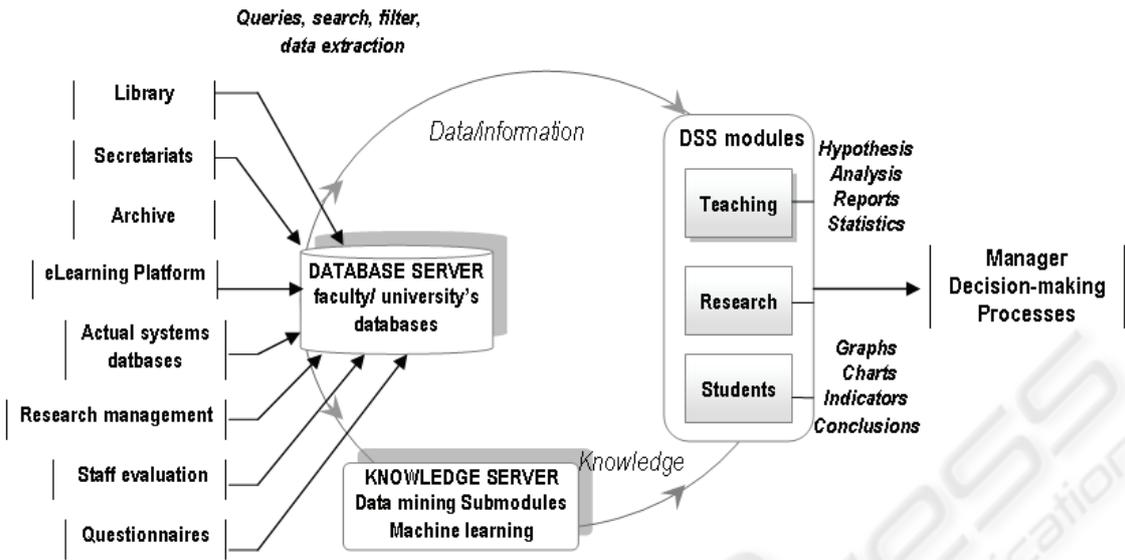


Figure 1: Main architecture of the designed DSS for higher education management.

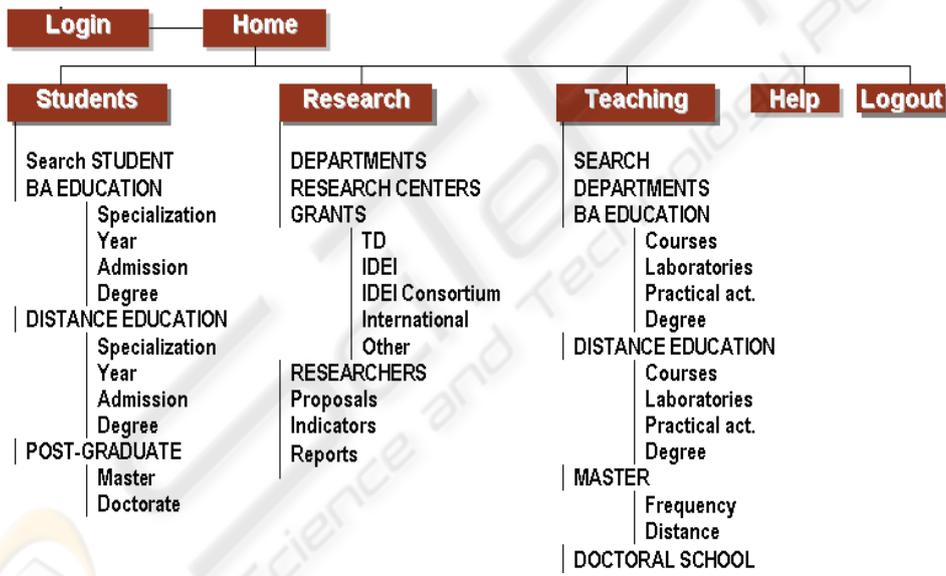


Figure 2: Module map of the designed DSS.

The Teaching module represents the work of the teaching staff of the faculty, through data extracted from staff assessment (by colleagues, students, and managers), databases of the faculty and university. Research and Teaching modules serve as the basis for building and proposing alternatives in decision-making on the staff's management engaged in teaching activities and scientific research, based on the internal procedures of FSEGA, in the following situations:

- Evaluating teaching performance,
- Scientific research evaluation,

- Establishing salary coefficients (depending on performance)
- Establishing human resources strategy,
- Job opening and interviewing for teaching / research positions,
- Insurance jobs associated with teachers and overlapping,
- PhDs activity and evaluation,
- Laying Optional courses packages,
- Drafting of new teaching materials, etc.

The system is designed to provide the higher education managers, in this context, with important

tools to facilitate their actions in decision-making activities. These features are available through the user interface, screen formats, menus, graphs, information and knowledge generated by data mining processes integrated in the DSS.

## 4 CONCLUSIONS

In an attempt to support the managers of academic institutions in decision-making processes, we proposed in this paper the design of a DSS which also incorporates data mining technologies. This study is part of a range of activities that has evolved continuously, from the revision of several aspects of general education in Europe, higher education management, single issues in the implementation of information technology, to the personal achievements to assist the higher education managers in decision-making processes.

Prospects for further research directions rely on the grants of the Business Information Systems department and on the general objectives of the Strategic Program of Babeş-Bolyai University of Cluj-Napoca for 2007-2011. These will include:

- Further research to develop and implement the academic decision support system, and fully integrate other modules;
- The application of other modern technologies, such as data warehouse, to the new system architecture;
- The continued application of data mining technologies on scientific research databases and teaching activities, to disseminate the results of research activities and teaching;
- Comparative analysis on the new direction of higher education and the results obtained in terms of integration into EU structures.

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