Higher education decision making and decision support systems

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Abstract: - The authors illustrate several issues in decision support and decision support systems (DSS), state of the art research in these fields, and also their own studies in designing a higher education DSS. The final section contains our contribution in outlining the modules of the DSS, involving the present systems and databases of FSEGA and UBB, results and activities belonging to FSEGA students, teaching and research staff, to assist decisions for all the actors implicated in the processes, in various specific situations.

Key-Words: - decision support, decision support systems (DSS), higher education institutions, Information and Communication Technologies (ICT).

1 Introduction

The mission of a higher education institution is to prepare personnel to the highest level of knowledge at that time in history [23]. Universities should not be just a neutral setting, but the place in which to create and share knowledge, an innovative and prolific actor in interaction with the economic, administrative, and cultural environment. 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 [8].

The decision-making process in an organization or business should be planned and resolved in a comprehensive, reliable, and transparent manner [32]. Managers prepared with information about their relevant organizational cultures, interrelated with the knowledge transfer, can amend their knowledge management strategies to make their organizations more efficient, and to evaluate and maneuver ICT (Information and Communication Technologies) in effective strategies. Quality and well-timed decision-making is fundamental in the success of any organization. They necessitate successful implementation of decision support tools to adequately inform the decision process, but also other desirable characteristics such as imagination and creativity [6].

A firm's capability to take good decisions is mostly important in the face of growing global competition, and the larger uncertainty from exposure to a further number of competitors. Higher education institutions, like the organizations from economic areas, are confronted lately with increasing pressures to improve the quality of education processes and management, but with a number of features specific to academics. There should be taken into consideration the university autonomy, even in financial issues or other forms according to public and academic responsibilities. Therefore, universities seek to apply more the accumulated data, invest more resources in tools that allow them to collect and manage information directly, and involve teaching staff, students and local community in decision-making processes.

The present paper is an extension of our latest studies and publications [5]. We bring in several issues in the field of decision support and decision support systems (DSS), and state of the art research in these fields. In the last part of the paper we present our contribution in designing a DSS for higher education environments, based on the present situation of The Faculty of Economics and Business Administration (FSEGA) at Babes-Bolyai University of Cluj-Napoca (UBB).

2 Decision support and DSS issues

In the last decades, widespread researchers' efforts have been made on understanding and formalizing the activity of decision making all domains. One of the first classifications of the systems qualified to support the activity was as follows [22]:

- information retrieval systems - are computer-based systems to capture, manipulate, retrieve and

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transmit organized data necessary to solve a professional task according to detailed transactions defined by a user;

- decision support systems (DSS) – are knowledge-based information systems to capture, handle and analyze information which affects or is intended to affect decision making performed by people in the scope of a professional task appointed by a user;
- expert systems - are knowledge-based systems to be used instead of or together with a human operator to make decisions in the framework of a professional task with explanations for users.

Recent analysis on decision support and expert systems has shifted from considering these as solely analytical tools for assessing best decision options to seeing them as a more comprehensive environment for supporting efficient information processing based on a superior understanding of the problem context [17]. DSS embrace various definitions [13], but it is largely considered that they are built to assist decision processes and help to identify and resolve problems [6]. DSS symbolize a specific class of information systems designed to help users which rely on knowledge, in a range of decision-making positions to solve the encountered problems that matter for the organization's prosperity [13]. An important point in most common in all DSS definitions is that decision support systems literally refer to 'applications that are designed to support, not replace, decision making' [4].

Up to date classifications of DSS [27] are based on the leading technology that determines the characteristics of the decision-making:

- communications-driven DSS
- data-driven DSS
- document-driven DSS
- knowledge-driven DSS
- model-driven DSS.

Some DSS are hybrid systems driven by more than one major component. Kacprzyk & Zadrozny (2007) mention also the Group DSS and Web based and Interorganizational DSS. They can be briefly described in the next table [20]:

DATA DRIVEN DSS	*emphasize access to and manipulation of internal company data and sometimes external data, and may be based – from the low to high level – first on simple file systems with query and retrieval tools, then data warehouses, and finally with On-line Analytical Processing (OLAP) or data mining tools.*
COMMUNICATIONS DRIVEN DSS	*use network and communications technologies to facilitate collaboration and communication.*
GROUP GDSS	*are interactive, computer-based systems that facilitate solution of unstructured problems by a set of decision-makers working together as a group.*
DOCUMENT DRIVEN DSS	*integrate a variety of storage and processing technologies for a complete document retrieval and analysis; documents may contain numbers, text, and multimedia.*
MODEL DRIVEN DSS	*emphasize access to and manipulation of a model, e.g., statistical, financial, optimization, and/or simulation; use data and parameters, but are not usually data intensive.*
KNOWLEDGE DRIVEN DSS	*are interactive systems with specialized problem- solving expertise consisting of knowledge about a particular domain, understanding of problems within that domain, and "skill" at solving some of these problems.*
WEB-BASED DSS	*are computerized system that deliver decision support related information and/or tools to a manager/analyst using a "thin-client" Web browser (Explorer); TCP/IP protocol, etc.*

Table 1. DSS classification, based on [20]

A decision problem is present when the discrepancy between the current situation and the target situation can be reduced and/or overcome through different courses of action [16]. There are a number of very different ways in which the decision maker can determine which course of action should be taken, and how the decision can be approached [16]:

- purely intuitively without little reflection about the problem
- through routine recourse to procedures used in the past
- by adopting unquestioningly the solutions suggested by experts
- by choosing at random

• on the basis of systematic rational thought supported by relevant information.

The basis of DSS is to provide the informational assist required to diminish the effects of limits and restrictions faced by human decision maker throughout his activities. Modern research of the decision-making processes presents some of the factors that can contribute to successful decisions [32]:

a) Responsibility and Transparency – there are laws and penalties to be respected by the individuals or organizations in decision making processes.
b) Expertise – each decision should be rooted in the profound knowledge of an expert.
c) Coordination – the best decision options are not enough if there is no synchronization to transmit the orders that should be complied with and to manage the decision-making process.
d) Economy Factor – a decision can have a negative result or a single battle can be lost, but overall a good sense in decision making can help to make up for the loss of some encounters.
e) Time – an abundance of time acts with a force similar to the economy factor, allowing decision factors to wait for favorable opportunities.
f) Consensus or negotiation – when there is a complex level of a problem, a more extended analysis of the problem and negotiation or consensus among the parties concerned is required.

Another appealing approach to decision-making processes is through complex tools that are utilized to analyze decisions and offer senior management teams a method for assigning roles and involving the relevant people. RAPID decisional model (Fig. 1) formulated by Rogers and Blenko [29] focuses on the following idea: 'The key is to be clear who has input, who gets to decide, and who gets it done'. The five letters in RAPID correspond to the five decisive decision-making roles: recommend, agree, perform, input, and decide. The roles are not carried out lockstep in this order, for the reason that the authors took the liberty for the sake of creating a useful acronym.

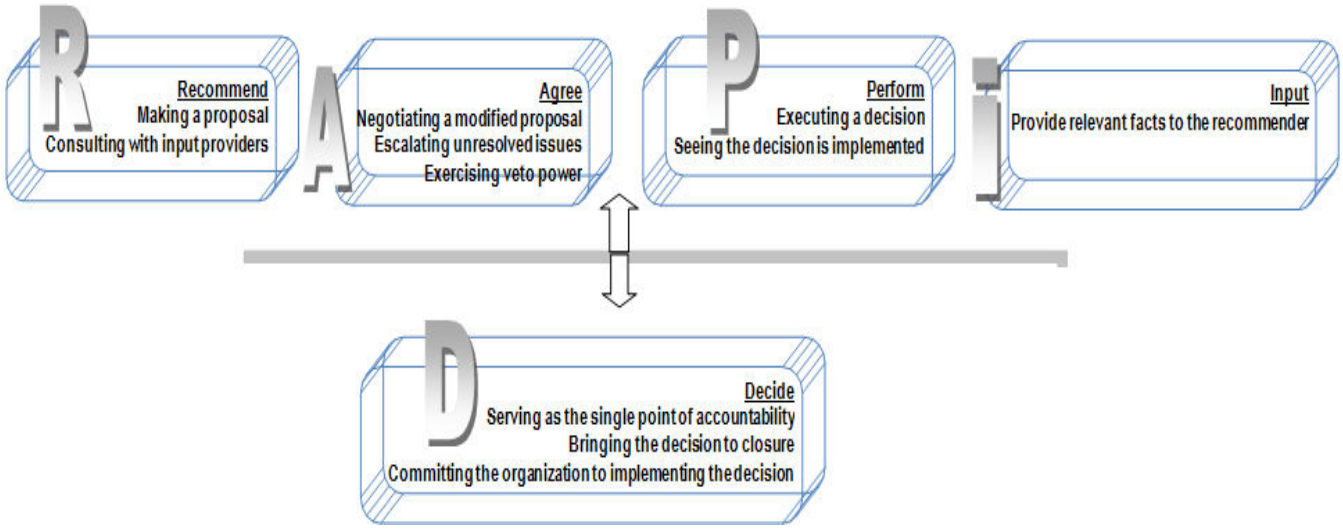

Fig.1 Representation of the RAPID decision model, based on [29]

Some of the attributes and benefits of decision support systems can be described as follows [4]:

Typical Attributes

• Eased Access (to raw distributed data; often updated in near-real time)
• Facilitated Analysis (of data often through use of automated intelligence)
• Rich Communication (of results and new ideas in a meaningful and practical form, often augmented by sophisticated graphical depictions)

Common Targeted Benefits

• Elevated Strategic Advantage
• Reduced Lead-Time to complete work
• Greater Consistency
• Smarter Response (to changes / failures)
• Worker Empowerment
• Reduced Cost.
• Greater Partner Satisfaction (both customers and suppliers)
• Increased Innovation
• Higher Retention

An additional distinction ought to be drawn among stages of maturation of the support technologies for decision making. Some researchers [22] affirmed that any idea concerning the technologies, to be effectively put into service, should have an adequate embodiment

on each of these three levels of problem awareness (Fig 2.):

a) formal specification,
b) design,
c) implementation and maintenance.

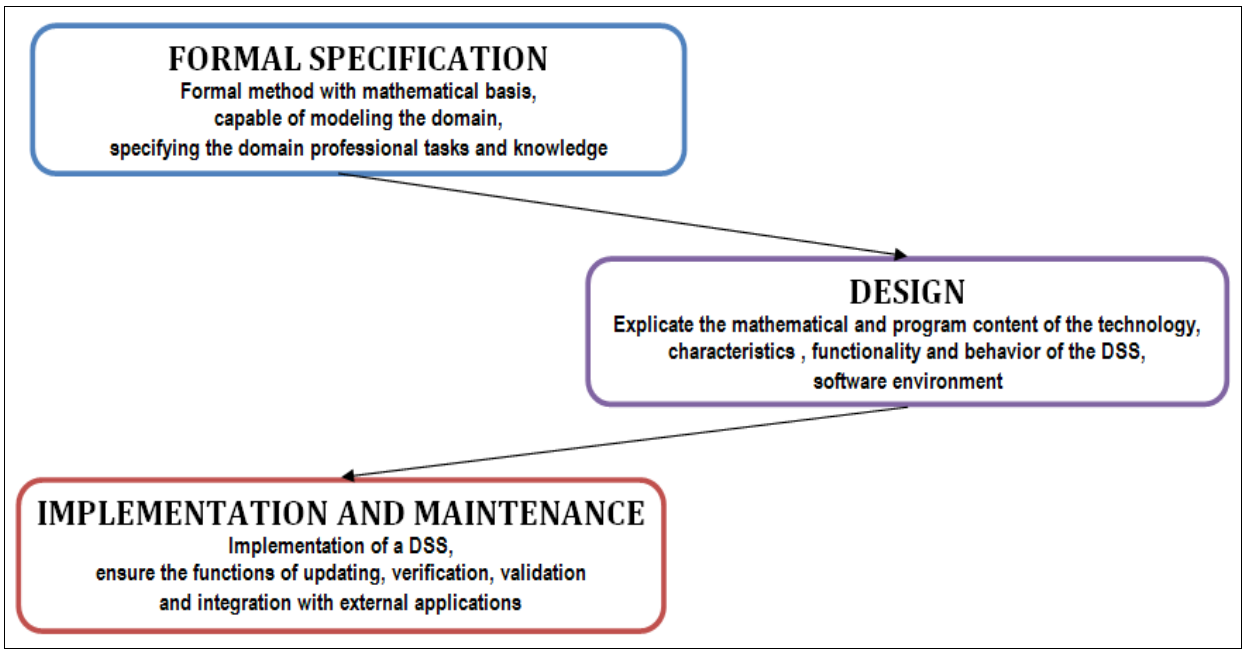

Fig.2 Problem awareness, levels and technologies in DSS creation, based on [22]

DSS can range from a system to answer simple queries that allow a subsequent decision to be made, to a system that provides detailed querying across a spectrum of related datasets, and further to complicated systems which directly 'answer' questions, in particular high-level 'what-if' scenario modeling [28]. The analysis of search and optimization technologies underpins the development of DSS in a multitude of applications across industry, commerce, science and government [10], with a significant level of diversity among optimization and computational search applications. Organizations, such as universities, can frequently deal with the problem of how to make use of a large variety of information resources and how to make this information accessible to the community [35]. Decision support area has received significant attention from the scientific community across many different academic disciplines, including transport scheduling, bioinformatics, personnel roistering, medical decision support and timetabling [10]. State of the art research [35] in decision support and DSS for socio-economic areas, include:

- e-management models that incorporate reliable participatory decision making practices and quality management indicators in academia [19],
- implementation of digital media to allow well-informed collaborative decision making - case studies of community participation in land use planning [25],
- platforms that support integration and interoperability of many data sources concerning social, financial, and physical aspects of the urban environment [3],
- development of on-line planning support systems in the context of public participation [31],
- systems that take advantage of elements of cellular automata and define models for situated cellular agents [2],
- decision support in intensive care medicine [15], [30], etc.

3 DSS for Higher Education

Due to a growing competition in higher education environments, universities try to apply strategies and develop new instruments so to enhance the quality of teaching and research activities and provide the communities with relevant services and knowledge. Decision factors in all fields face increasingly demanding environments, overloaded with information, data distributed throughout the organization, in terms of risk and uncertainty.

Modern higher education institutions experience the need of effective decision support tools to accurately inform them, and assist in all managerial processes. Some educational systems have long had modules for

decision support, but mainly for the retrospective analyses of financial and administrative data. One of the first steps for the creation of a DSS in higher education would be to develop appropriate academic analytic tools to gather, synthesize, and evaluate relevant data and information for effective decision making. Such tools, for example an efficient management information system, would have the role to [6]:

- Supervise existing activities:
  - educational activities,
  - processes,
  - resources which entail students, teaching and auxiliary staff, curricula, syllabi, and all administrative services;
- Collect data on education and research processes;
- Develop a collaborative environment, monitor its activities and measure the accomplishment of its objectives;
- Present important information to assist constant evaluation, and alternatives for performance;
- Offer feedback for constant development.

Universities are at the heart of the community and also an integrating part of them, with key roles in education, training, research and other activities. This is why we consider that a DSS designed for higher education would have to be anchored in on all the existing data of the institution, on the databases of the all its systems (educational, research and grants, financial, accounting, eLearning portal etc.) [7]. As a result, an integration of the newest research results in education managerial issues should be essential, at the same time as taking into account the essential task of a university as a generator of knowledge via teaching and research.

A DSS for higher education should collect information on all academic processes, provide feedback for their improvement, and offer decision-making support with high integration and direct interaction with all the domains of the problem. Higher education managers would have all important data and information at their handle, in a clickable form, for quick analysis and access in certain decisional situation.

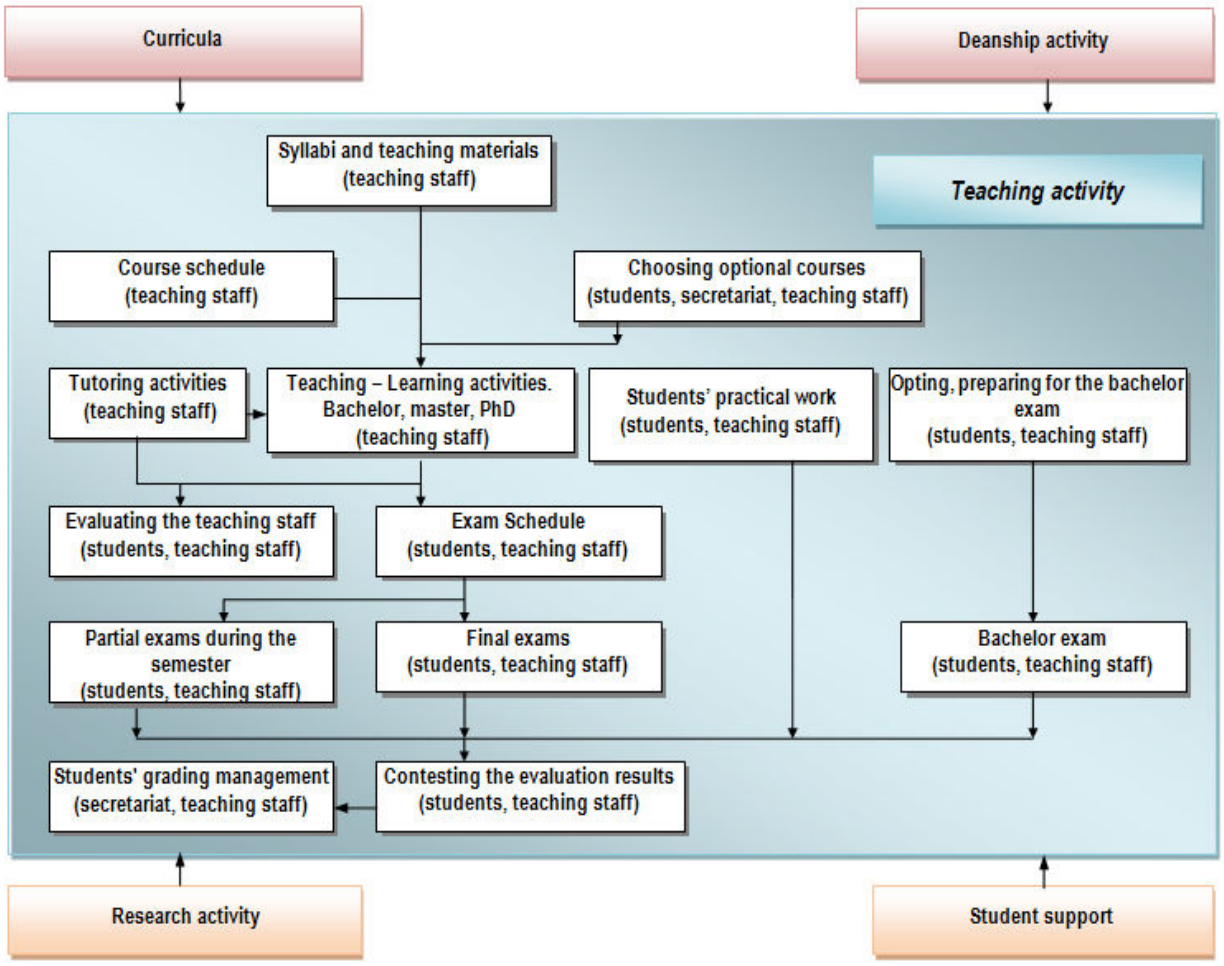

Fig.3 Teaching Activity module – processes' map and "actors", adapted from [36], [9]

The higher education ICT based systems comprise general aspects with the design of economic systems, but also have a number of special features regarding: [8]

- the functioning and organization of educational institutions;
- academic autonomy, even in financial issues or other forms according to public and academic responsibilities;
- universities are entities that generate new knowledge and support the local and global communities;
- universities have central tasks in education, training, research
- international and local specific circumstances etc.

Some types of decision-making problems in the educational system can be described as follows [6]:

1. Planning decisions for the programs of study and curricula, which lead to the establishment of curricula for long-term education.
2. Tactical decisions:
   a. The curricula and syllabi detailed for each specialization and year of study;
   b. Requirements for the accomplishments of the syllabi: specialized frameworks, necessary investment, software, etc.

It is also important to develop a performance evaluation instrument, with roles in the optimization of higher education institutions' activities, and the implementation of efficient management [7]. As a result, it could allow the allocations from the state budget which cover the basic needs of the universities to be linked to how these needs are actually met both of the state allocated funds and from other revenue [37].

The DSS, on whose design we work, has 3 main modules: Students, Research and Teaching [9]. It is planned to assist in diverse decisional issues of our university, to be applicable for its educational mission, training and academic services offered to the community and society. The Students module (Fig. 3) represents the results and activities of FSEGA students, and serves as the basis for building and providing alternatives in decision-making on students' issues [7]. The Teaching module, which is presented in our latest WSEAS published article [5], comprises the results and activities of FSEGA teaching staff. The last module is based on the Research activities in our faculty and includes the performance achieved in scientific research by the teaching and research staff, departments, PhDs, etc.

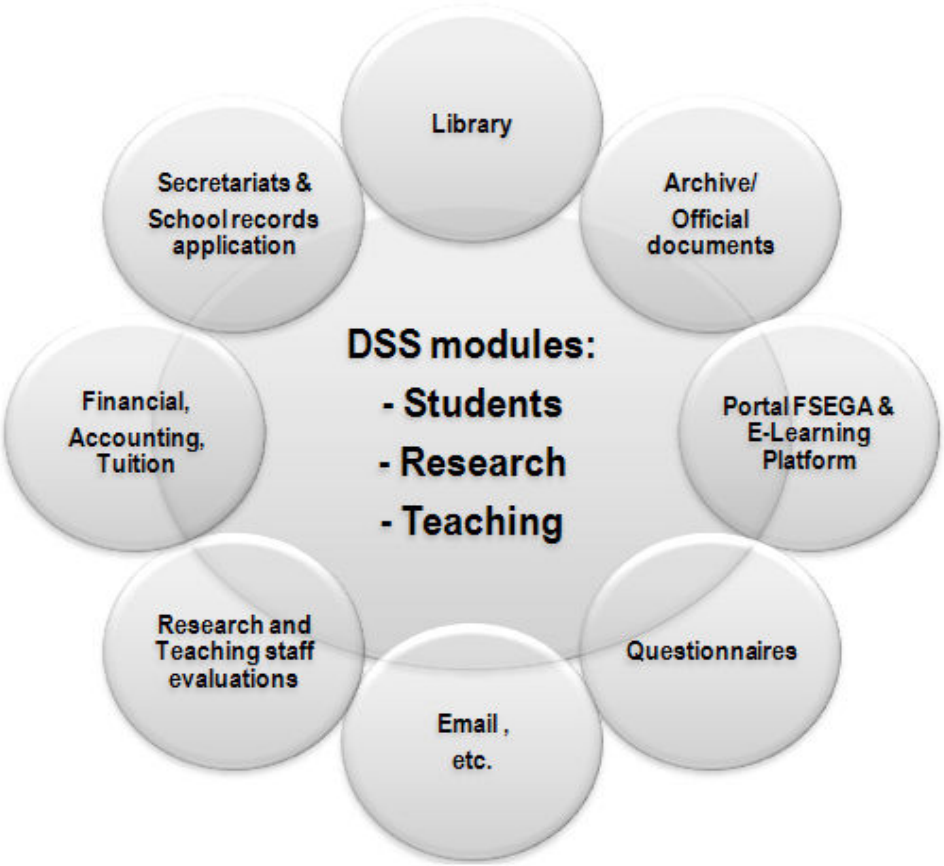

Fig.4 DSS modules and the existing systems, platform and databases, developed from [9]

All modules rely on the internal procedures of FSEGA, with data extracted from FSEGA and UBB systems and databases (Fig. 4): [6],[9]

- UBB and FSEGA systems:
  - the research activity management system;
  - library activity;
  - administrative activities systems (financial, accounting etc.);
  - management of school records application;
  - Web based grade book;
  - fee management application;
  - online and distance education (ODL) portal and E-Learning Platform;
  - email;
  - research management application;
- assessments of academic quality concluded periodically;
- performance versus that of others faculties or across the university;
- learning centers;
- research and teaching staff evaluation;
- research versus teaching performance;
- questionnaires and surveys of graduates, master degree and PhD students, employers, departments;
- different longitudinal studies etc

The resulted data can possibly be used for quality assessment, to complete diagnoses and analyses on the practices of the organization and in management issues. We try to propose a specific design for the DSS so to offer the higher education managers important tools to assist their actions in decision-making activities. These characteristics would be accessible through the user interface, screen formats, menus, graphs, information and knowledge integrated in the DSS. It would prove to be a the starting point for building and providing alternatives and suggestions in decision-making on teaching-learning, research, curricula, syllabi, exam-evaluation issues etc. Consequently, the data, tables, charts, results of data extraction processes could be used to assist decisions for all the "actors" (deanship, teaching and research staff, students, secretariat, etc.) implicated in the processes, in the subsequent circumstances (Table 2).

Each modules is designed to be integrated with the other modules of the higher education DSS, and to act as a whole. The final DSS design model is under further development and improvement, and would be adapted to fit other universities of local and European areas.

DSS MODULE	Students Module	Teaching Module	Research Module
DECISIONAL SITUATIONS	• Students' enrollment • Studies reclassification • Tuition • Choosing a Specialization • Scholarships • Students dorms • Issue Certificates • Web information and announcements • Students' transfer • Expelling students • Interruption of studies • Extension of studies • 2nd or more specializations • Diploma exam in other institutions • Tutorial activities • Career Guidance	• Syllabi and teaching materials • Course schedule • Choosing optional courses • Tutoring activities • Teaching-learning activities • Students' practical work • Preparation for the bachelor exam • Evaluation of the teaching staff • Exam schedule • Partial exams during the semester, and final exams • Students' grading management • Contestation of the evaluation results • Bachelor final exam	• Scientific research evaluation, • performance issues and standards • Salary coefficients • Human resources strategy, • Job opening and interviewing for research positions, • PhDs activity and evaluation • Grants' continuation and management, et cetera.

Table 2. DSS modules and the existing systems, platform and databases, developed from [9]

4 Conclusions

The present work is an integrated part of our latest research [5], in which we begin from the study of local and international of aspects of ICT in education, higher education decisional issues, state of the art decision-making processes and DSS, and continue with our own effort in the design of a decision support system to assist the higher education managers.

In this article, we presented:

- key figures of the DSS definitions and fundamental characterizations of DSS,
- state of the art research in decision support and DSS for socio-economic areas,
- newly formulated decisional model,
- latest DSS classifications from the research literature.

The final section contains our contribution in designing a DSS for higher education environments, based on the present outline of FSEGA and UBB. It involves the results and activities of FSEGA research and teaching staff, using the data extracted from databases in all existing ICT systems and platforms, to assist decisions for all the "actors" (deanship, teaching and research staff, students, secretariat, etc.) implicated in the processes, in various circumstances. We detailed several features of the higher education ICT based systems, particularities and situations of decision-making problems in the academic environments, and features of the DSS modules.

The designed DSS would be suitable for the university's educational mission, innovative research, and latest body of knowledge, academic services offered to society and community, which are an important mission for national and European higher education institution. Its architecture is under further development and improvement and would be extended to other areas of a modern university (financial, public and international relations, administration, new qualifications required by the labor market etc.). The development and integration of a DSS with the university ICT systems may possibly determine a reduced cost and time needed to resolve key issues of drafting and adopting the most appropriate decisions, for the representative complexities of higher educational systems.

Our upcoming research will focus on the direction of detailing and developing the components of the educational DSS, based on databases, data mining and decision support technologies. 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 [34].

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