

Integrated Information Systems in Higher Education

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Abstract: - The paper shortly presents the situation of the Romanian universities regarding information systems implementation and deployment. The information presented is the result of a study regarding the current state of the Romanian universities in the process of data and information system integration, performed at the end of 2007 in 35 accredited universities. This study was used as a base for identifying and analyzing the main factors of influence for developing an integrated university environment and for identifying concrete action directions for accomplishing that integration.

Key-Words: Romanian universities, Management information systems, Enterprise Resource Planning systems, Integrated information solutions

1 Introduction

The implementation of an information system dedicated to the university management is nowadays a fundamental option for the greatest majority of the universities that understood the new trends at international level.

Every university needs an integrated information system that supports all its business functions and offer accurate, clean and stable data, available in real time to users accross multiple departments and business functions. Such a system would allow to operate efficiently, to make informed decisions and to offer the best educational experience possible to the university students.

Adapting the Romanian learning system to the European standards brought into discussion issues regarding the management of the learning process. A higher-education information system can be used as a vehicle for professionalizing and transforming the traditional universities and for developing an integrated and standardized Romanian higher education environment, in the european context.

The present paper will present the results of a first phase of a national research project, "Integrated Information Solutions for Competitive Management in Romanian Universities". The objective of this first phase was to perform a study of Romanian universities in order to obtain a complete view over the present situation. The following phases will analyse the solutions that foreign universities apply, and finally make a pilot implementation in the Academy of Economic Studies.

2 Problem Formulation

At this moment, the Romanian universities are using a pretty high number of various information systems. Almost every faculty or department has its own software applications, developed in-house, applications that use various operation systems, tools, databases and protocols. Those applications are managed by that specific faculty/department and it doesn't offer an integrated view over the activities developed in the university.

The drop in satisfaction levels offered by the existing information systems, the use of unfriendly user interfaces and inflexible reporting mechanisms, but also the wish of modernizing the business processes using technologies that facilitate the electronic data transfer between universities are important aspects that will put pressure on universities to migrate toward ERP systems.

ERPs are client-server applications developed for transaction processing and for enhancing process integration, starting from process planning phase, to the relationships with suppliers, customer or other partners.

Universities are a specific market targeted by ERP vendors. ERP systems provide many benefits for universities such as:

- ERP systems possess superior data retrieval capabilities partly because are integrated and also they are based on a common relational data model. They provide more flexibility to users, offer strong query and reporting

- abilities, also an easier, quicker access to data for reporting and decision-making;
- ERP systems are based on the client/server architecture. Today all universities have a network infrastructure ;
 - The adoption of ERP systems within an university will provide an opportunity to introduce new procedures that will eliminate existing inefficiencies. Implementing the ERP systems includes business process reengineering ;
 - Universities are seeking opportunities to enable students to perform query and update functions via Internet (ex. changing and confirming enrolment in courses). Also ERP systems provide a more flexible form of service to students.

Most ERP solutions are modular and open, including modules for all the functional areas of a company: financial management, order management, resource management, supply-chain systems, marketing automation and so on.

Most of the big ERP providers provide solutions for higher education, including SAP AG, Oracle, JD Edwards, Peoplesoft. For these higher education solutions, most vendors have taken and refashioned corporate solution to respond to the specific needs of academic sector.

Usually, ERP systems for higher education include specific modules to support admissions, financial aid and student accounts activities, campus management, grants management, distance learning and so on.

Our team has achieved a study about the current state of the Romanian universities in the process of data and information system integration.

This study is going to be used as a base for identifying and analyzing the main factors of influence for developing an integrated university environment and for establishing concrete action directions for accomplishing that integration.

We used as a starting point the list of all Romanian universities, offered by the Ministry of Education [5], which consisted of 56 accredited state universities, 32 accredited private universities and 24 temporary accredited private universities.

3 Application integration levels

When trying to connect to a certain application, its architecture must be considered. Most applications have a three layer structured architecture [4]:

- *Presentation level* – is the level that displays the information for the final user and allows him to input data;
- *Business logic level* – contains the business functions that action on business data;
- *Data level* – accomplishes the persistent data storing in data stores. This level is also called resource level.

Similarly, there are three connection ways between applications and integration level [4]:

- *Presentation level integration* – the integration level can extract information from the user presentation level using a technique called “screen scraping”;
- *Function level integration* – the interaction between the integration level and the business logic level is accomplished by application or service interfaces;
- *Data level integration* – the integration level can move data to and from data level.

Application integration can be implemented in various ways, using one of the following:

- *Web services* represent application components that describe other services and applications by using standard Web protocol services. They offer a way of describing in detail the interface, allowing the development of interactive client applications. Service description is made in a XML document, using Web Services Description Language (WSDL).
- *Extract, transform and load data* is an integration technology that allows the consolidation of critical information from various organization sources. Data sets are extracted from multiple databases and transformed in order to fit the existing data warehouse model.
- *Message communication protocols*, like TCP/IP, HTTP or FTP, define a specialized transportation method for message exchanges between applications. They can use the protocols directly or can create customized integration methods related to the protocol.
- *Screen scraping* can be implemented by a software emulation terminal that intercepts images from the screen after they have been formatted or intercepts data before they have been formatted for the terminal data flow.
- *Program calls* that access internal application resources.
- *Direct data access* means access to the organization primary data or writing data directly into the file system of the intended

application. Direct updating may generate vulnerability related to data corruption and referential integrity violations, so many applications do not support direct data access.

- *File transfer* involves multiple platforms integration by batch file transfer. This is a secure and cost effective method that allows programming, automatic restart, guaranteed delivery, encryption/ decryption and compression/ decompression.
- *Human resources involvement* in data and processes integration.

Of course, the first one is the most complex and efficient, and the last one is the oldest, the simplest and less efficient method. But, beside performances, there are always complementary factors, as costs or the necessary technology that have a big influence in making the best decision from both technical and economic point of view.

4 Software solutions for Higher Education Management on Romanian market

The performed research revealed that the number of players on the market is reduced, the following four being the most representative at this moment.

SICOB (Information System for Public Organization Management) was a result of a project financed in 2001 by the Ministry of Education in a first attempt of covering the gaps the Romanian universities presented in the field of applications for institution management. It was developed by a Romanian software company and proposed three modules: Financial, Research and Payments. This solution was implemented in about 40 public universities and some of them are still using it.

University Management System (UMS) is an integrated information system dedicated o higher education institutions (public or private). It was proposed for the national IT&C Romanian prize, "The best software product" in 2007. Developed and provided by a Romanian company, Redpoint SA since 2004, UMS ensures the management of academic processes, students, academic staff, tuition fees, admission process, graduation process, scholarships, lodging and accommodation, diplomas, etc.

The main features of University Management System are:

- The system is organized in modules and sub modules which can be easily added or

detached without affecting the functionality of the other modules;

- The usage of high performance technologies and of UMS server monitoring, make possible some very powerful and unique security mechanisms;
- The need of change and the continuous evolution of the academic environment determined the design of a very flexible system, not only from academic point of view, but also from administrative and organizational point of view;
- All the concepts and all the flows managed by UMS follow a natural evolution, very similar to those met in a real university;
- Using client-server architecture, the system allows the interconnection of computers situated in different locations.

Naum Consult system was developed by the company having the same name, Naum Consult SRL and provided since 2003. It uses Visual Fox 9.00 as software platform.

Naum Consult has the following modules:

- ECO2 – Information system for accounting;
- EMA2 - Information system for provision management;
- ESA4 - Information system for personnel management and payroll calculation according to specific regulations;
- EMI - Information system for asset management;
- ALOP – Information system Employment, Dismissal, Resignation and Payments related to academy staff;
- System for student management and for tracking activities specific to the academic management.

GESCO 2001 is an information system for the management of higher education institutions schooling process. A Romanian company, Genisoft Group SA, developed it.

GESCO takes over all the management activities related to student performances, starting with grades registration, provides rankings for getting special facilities (scholarships, lodging, etc), keeps student information for the entire study period and prints graduation diplomas, lists of grades etc.

It supports budget assessment at cathedra, course or staff member level and allows a correlation with data from accounting module of SICOB. It also offers support for ECT (European Credit Transfer System).

5 Study results analysis

5.1 Implemented solutions analysis

The study was conducted on a number of 35 of the Romanian universities, including small-size universities (under 1.000 students), medium-size universities (1.000 to 10.000 students), or big-size universities (over 10.000 students). This can be considered a representative sample of Romanian universities, encountering a percent of 31.25% of total accredited universities.

Table 5.1. Analyzed accredited universities

	Analyzed	Existent
Public accr. univ.	29	56
Private accr. univ.	6	56
Total univ.	35	112

This study addressed a number of questions such as:

- What kind of information systems were developed within Romanian universities and for what functional areas?
- Do those information systems succeed to fulfill the information requests of Romanian universities?
- Which are the major suppliers of software solutions for Higher Education Management on Romanian market?

Almost all universities have a **financial solution**, and Sicob was the major vendor for the financial module, encountering 36% of total number of implementations, while Naum Consult follows with a percent of 12%.

Anyway, most universities use self-developed solutions for financial and accounting management activities.

Most universities felt the need to implement a Students management module, so that 77% of universities currently use such a module. 41% of those preferred the UMS solution, 11% chose Gesco, 11% chose Naum Consult and there is an important percent of 37% that still use self developed solutions.

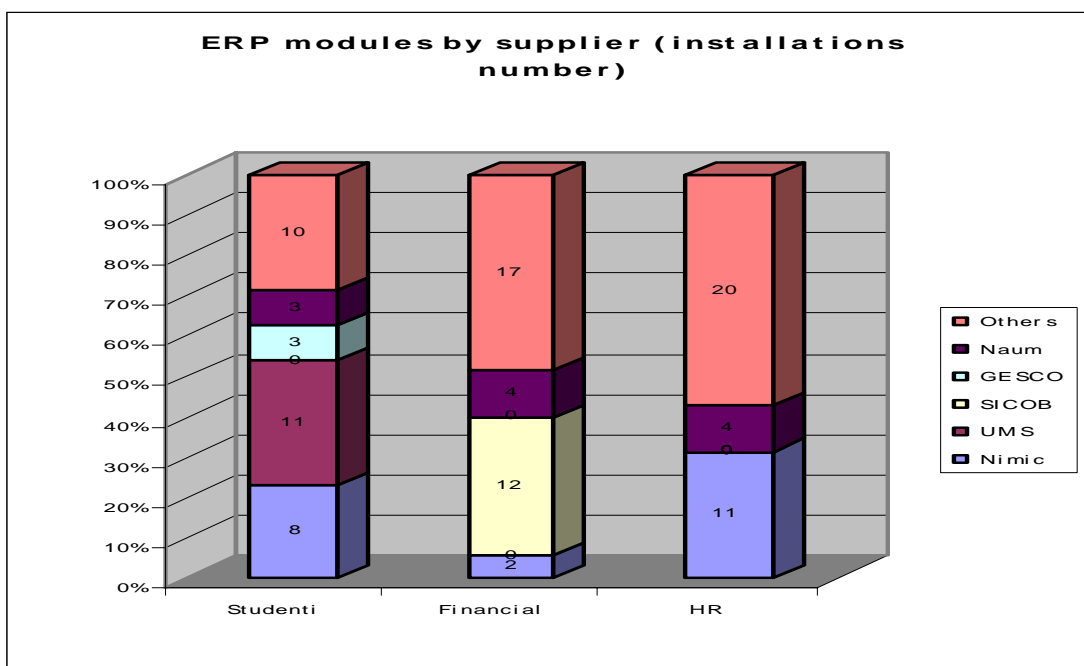
Self-developed solutions are very popular for Financial and HR/Payrolls modules, as they were preferred in order to make cost savings but also to cover the incomplete functionality of the existing software.

Although the Student module it wasn't very popular two or three years ago, the universities have caught up and now most of them use a Student solution, even if not a professional one.

Another important remark is that big universities use all the HE ERP modules, commercial or self developed. Small universities, on the other side don't use commercial solutions, because of their cost. Public universities always use Financial and HR/Payrolls modules, regardless of developer, as they have to make mandatory specific reports. A powerful trend is the domination of self developed solutions, mainly because of:

- Budget restrictions;
- Inadequate functionality of the existing commercial solutions, that didn't fit their particular needs;
- Important investments in developing in-house solutions.

Figure 5.1. ERP modules by supplier



A summarized presentation of higher education solutions by suppliers looks like the chart 5.1.

Table 5.2 University application analysis by implemented modules

	Gesco	UM S	Sicob	Naum
Student and faculty	+	+	-	+
Financial	- (integration with SICOB)	-	+	+
HR	-	-	-	+
Learning/ Content management	+	-	-	+

Our study indicates that the number of players on the HE ERPs market is small. Most universities use in-house or low-end solutions. The following charts present a comparison between the main four software solutions used in Romanian universities, on various criteria:

- Available modules;
- Architecture and technology;
- Available features.

Also autonomous software acquisition by departments/faculties within the university, results in shadow systems. Almost every department/faculty had a shadow system to track human resources. This has resulted in inefficiencies such as:

- additional training because of the different interfaces,

Table 5.3 University application analysis by architecture and implementation technologies

	Gesco	UMS	Sicob	Naum
Operation system	Windows 2000 Server	Windows 2003, Unix, Linux	Sun Server	Windows xx, XP, Millenium
Database	SQL Server	Oracle SQL Server MySQL	Progress Workgroup DB	Oracle 10g
Development tools	Microsoft .NET (ASP, Web, XML, C)	Java J2EE, SWING, JSP, Struts, JAAS, RMI-IIOP, Servlet, SRP, EJB	Progress Actuate Developer	Visual FoxPro 9.0
Reporting and analysis	Embedded, based on XML, selftransfer in .pdf or .xls	Embedded, integrated with MS Office	-	Embedded

- inconsistencies in data since each information system has its own database and complex maintenance strategies,
- redundant data,
- problems of data integrity,
- complex tools for data access,
- inconsistent reporting results and wasted time,
- increased information systems investment.

5.2 Integration level

A real process level integration is presented only by University Management System solution. As its developer, the company Redpoint, initiated a collaboration with SAP corporation in order to develop the following modules: financial accounting, management accounting, payroll, virtual library, this solution has a big chance to become a complete and competitive software package for university management.

In Naum Consult we have a partly data level integration by using a common database in several different modules. SICOB, on the other side, is a simple accounting solution, so the integration can be made only external, by another application or support platform. As for the university in-house solutions, there the integration is almost inexistent. The modules doesn't communicate between them, at most they are exported from one module, processes and transformed and then imported into other modules.

So, analyzing the integration method reported to those mention before (in chapter 3), file transfer and human resources involvement are the most frequent ones, but also the most primitive ones.

Table 5.4 University application analysis by features

	Gesco	UMS	Sicob	Naum
Scope	Curriculas management, schedule, Financial	Learning process management, students, academic staff, tuition fees, admission and graduation exams, scholarships, diplomas, Financial	Financial Research Accounting Payments	Financial Students Human Resources
Modules number	4	12	3	7
Installed base	6 clients	17 clients	35-45 clients	5 clients
Languages	Romanian	Romanian English	Romanian	Romanian
Major Carnegie segments	Big universities	Medium universities (private)	Public universities	Public universities
Compatibility	ECTS	ECTS, European universities	ECTS	-
Analyzed universities that use it	3	11	12	4

5.3. The case of the Academy of Economic Studies from Bucharest

A relevant example is the case of our university. A preliminary analysis of the information system in the Academy of Economic Studies revealed the existence of 7 major information systems, which are independent and communicate with each other only by export-import files or specially developed

transfer programs. Here is a short description of those systems and their relationships with each other.

1. **Student Management Application** is a client-server application that uses a Microsoft SQL Server 2005 database. Its interface was developed in Visual Fox Pro and Visual Basic. It includes three modules:

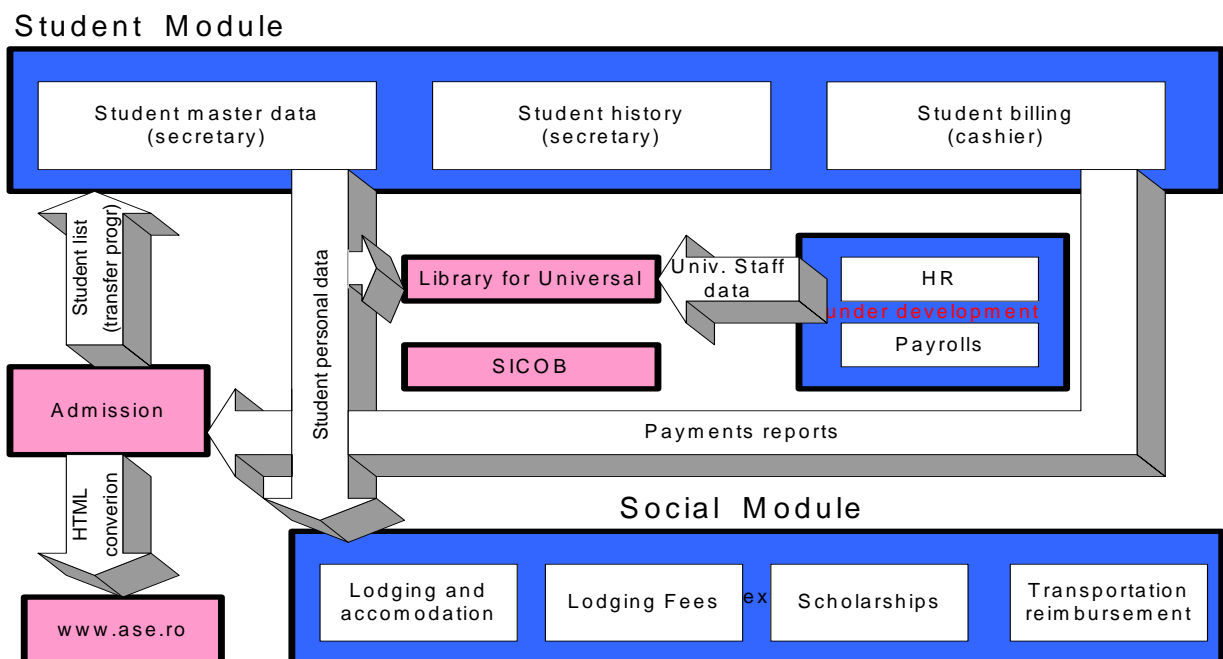


Figure 5.5 Communication flows in the applications of academy of Economic Studies

- a. **Student master data:** includes student information, faculties, degrees and programs information, their curricula, courses etc. It uses a specially developed transfer program in order to extract information from Admission Management Application.
 - b. **Student academic history:** includes a list of all grades up to and including
 - c. current term, earned credit points, reprogrammed exams. The secretaries are responsible for updates.
 - d. **Student bills:** includes all kind of student fees, charges, payments. Data are updated by the pay offices (approximately 10 workstations).
2. **Student Admission Management Application** uses as inputs data regarding student personal data, their admission options, faculties and specializations, student photos etc. It provides basic data for the Student Management Application and it uses outputs from Student Bills module, in order to check out tuition fees payment. This application was developed entirely in Visual Fox Pro.
 3. **The Academy Web site:** centralizes all the relevant information for various visitors category, students are not, inside and outside the university. Data are not automatically displayed by interrogating a database, but manually filled in by secretaries and then converted to HTML format. As a result, there is a high incidence of human errors in data and much out of date or incomplete on-line information.
 4. **Social Information System** was developed in Visual Fox Pro and includes four modules:
 - a. Lodging and accommodations: student lodging on university campus
 - b. Lodging Fees
 - c. Scholarships and financial aids
 - d. Transportation reimbursement: public transportation expenses reimbursement
 It imports data from the Student Management Application.
 5. **SICOB** is used for financial and accountability specific operation. It was developed in Progress and uses a Progress Workgroup database.
 6. **Human resources and payrolls** uses a Microsoft SQL Server database and includes 2 specific modules:
 - a. Payrolls: tracks employee benefits, applying payroll deductions, social assurances, social medical assurances, calculates vacation, sick days, and holidays, etc.

- b. Human resources: it is under development.
7. **Library for Universal (L4U):** a classic system for library management that uses data exported from Student Management Application and personnel database, after a previous filtering and transformation by a specially designed program. There is also Web-based Virtual Campus management application for distance learning programs.

Our study revealed that, for the moment, the Romanian market doesn't seem to have raised the interest of the big players of the international Higher Education ERP solutions market. This can be explained by the lack of financial resources that has characterized the Romanian universities until recently.

So, the Romanian market seems to be very immature and far from meeting the international standards. Usually, the software solutions in Romanian universities are based on insufficiently tested technologies, and cover only a part of universities specific demands. They are rather simple, covering only partly the university business flows; the universities continue to be overloaded with red tape.

6 Challenges of organization integration

In order to solve the existing problems, integrate the isolated information systems and add new features, a university can adopt one of the following integration solutions [11]:

- a customized consolidation of existing applications and services, using primarily in-house resources;
- selection, preparation and deployment of an Enterprise Resource Planning system to create a common architecture for financial, human resources and student data management, using in-house and external consultants;
- adoption of a service-oriented architecture (SOA) to provide common reusable middleware for application and services.

Each of these involves specific phases, different levels of complexity and costs. The implementation of an ERP system has higher costs up front, but lower maintenance and adjustment cost post implementation.

Most organizations use as integration strategies one of the following: Enterprise Application Integration, Business-to-Business Integration or Web Integration. An integration methodology of data and application,

if we ignore certain particularities of the involved entities, could be the following [10]:

1. identifying problem domain;
2. identifying data needs;
3. identifying processing needs;
4. identifying application interfaces;
5. identifying application event;
6. identifying data transformation scenarios;
7. identifying the information to be transferred;
8. applying technologies;
9. testing;
10. performance testing;
11. assessing the economic efficiency of the integration solution;
12. developing maintenance procedures.

Previous studies and the experience of other universities revealed that there are two main types of challenges in integrating the information systems in the university.

A. Technical challenges

They appear because organization integration cannot take place instantly, as the existing technologies often very complex and various.

Some examples of technical challenges are presented below:

- specific design of stand-alone applications (initially design for a stand-alone functioning, lack of APIs or external interfaces);
- specific data models (data models that were not initially designed for sharing with other information systems, lack of data access from interfaces);
- heterogeneous technologies (usage of various platforms, applications, programming languages, presence of distributed paradigms: COM, EJB, CORBA);
- legacy systems (old systems, incompatible technologies, lack of documentation for those old systems);
- lack of interfaces (interfaces that were not initially designed, functional constraints or mandatory usage of a specific program);
- semantic discrepancies (in data interpretation, multiple business partners that use their own semantic terms and their own terminology);
- nuclear business processes;
- standards (lack of universal standards, emergence of new interoperability standards, like XML or Web Services);

- security (providing of a consistent security level for all the integrated systems, integration and authorization of policies used in individual systems).

B. Management challenges

They appear because every university has particularities that differentiate it from other types of organisations, or even from other universities. Its structure is complex, composed of large number of diverse groups, making communication difficult. Responsibilities are not very clear, but with overlapping or gaps, and the control of university members is made by diverse, often informal systems. Also, the university style is not task oriented, but loosely coupled, so the decision making process is usually slow. Here are several aspects that may impose constraints or cause problems:

- New collaboration (closer relationships with external partners, a new level of organization policies, work practices , cultures, internal policies);
- Project scope definition (a correct estimation of resources for a complex project, assessment of a project realism from the time planning point of view, integration of requirements of various stakeholders);
- Continuous support for stakeholders (many potential stakeholders that need to be informed, involved in decision making and kept satisfied);
- Time constraints (need of rapid solutions delivery of solving requirements with pressing deadlines);
- Cost constraints;
- Migration (guarantee of a correct functioning of the existing software applications during the new technical solution implementation, following of delivery plans in order to reduce time lags);
- Expertise (involvement of internal or external experts).

Beside all that challenges we must take into consideration that systems for universities management have specific particularities and demands, reporting needs in compliance with state requirements. When analyzing the ERPs on the market in order to choose the proper solution, we must keep in mind that all those differentiate them from industry ERP implementations and make them more difficult, especially regarding project management aspects and university specific process modelling aspects.

7 Conclusion

The solution we have chosen, the deployment of an ERP system ensures a much higher integration degree of the functional application modules that are linked by the use of common data and interfaces, or even more, by common processes. In a first phase, the implementation phase, integrating costs related to consultancy or IT are consistently higher, but then, the costs implied for maintenance and further changes or development are much lower. This happens because the business processes modeled in the application are relatively constant, bringing to an increased efficiency.

Implementing an ERP in a university may cost millions of Euros, which represents a substantial financial commitment. ERP adoption requires expenditure on hardware (servers, workstations, network infrastructure, ERP software package, consultants to assist the implementations, cost of training). But there are important benefits including quantifiable factors, such as reduced staffing costs as well as no quantifiable factors, such as better information. There are many risks, but integration of systems and data is confirmed as a powerful motive for ERP investment.

The low budget of the most Romanian universities limit their activities, so they are often forced to use in-house developed information systems or to buy cheap software solutions from small vendors having no experience in the field. The main problems of those information systems are that they have a low integration level, they don't communicate with other applications from other vendors, bringing to:

- excessive paper use;
- lack of real time information;
- need of repeated manually data inputs;
- redundancy in data inputs;
- lack of transparency.

The Romanian learning system was recently integrated, at least at a formal level, in the European learning system, automatically bringing the need of adapting to European practices (e.g. ECTS).

The capacity of Romanian universities information systems to respond to the demands and the challenges of European education system was very modest until now.

Universities should realize that they are not so drastically different and given that, they should collaborate in order to influence vendors to become more sensitive to higher education needs. This way, ERP vendors should provide some best practice models to reduce the costs of ERP implementation. European integration of Romanian higher education system might benefit from the support of European

funds. But, in order to access the European funds, the universities should manifest interest, make congruent efforts and put some pressure on the decision factors, on one side, and, on the other side, the political support is also very important. For the moment none of them seems to be strong enough.

In conclusion, an integrated information system can provide a better access, understanding, management and reporting for the university if the project follows the development phases involved by the integration methodology, it overcomes the challenges and problems during its implementation in the expected timeframe and it turns into account the lessons learned from previous implementations in other foreign universities.

The achieved benefits and efficiency can be increased as more university data can be integrated into common data warehouses and data management systems, ensuring valuable information necessary for decision making.

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