Information Systems in University Learning

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The authors of this article are going to bring into light the significance, the place and the role of information systems in the university education process. At the same time they define the objectives and the target group of the subject named Economic Information Systems and state the competence gained by students by studying this subject. Special attention is given to the curriculum to be taught to students and to a suggestive enumeration of a series of economic applications that can be themes for laboratory practice and for students' dissertation (graduation thesis).

Keywords: *Information System, Academic Partnership, Curriculum, General Competence, Specific Competence, Open Systems*

1 Information System, Instrument of Modern Management

For economic and social organizations to be more and more efficient they must be managed in a scientific way based on: a thorough knowledge of the laws of economy, an exact operative knowledge of the law of supply and demand on the domestic and foreign market, a good knowledge of goods price mechanisms, technological characteristics and of the way in which the available resources can be used. To achieve this efficiency it is required to use some modern methods, techniques and means of acquiring information analysis and decisions.

Among these modern means and techniques an important place is held by the mathematical methods of increasing economic efficiency, of making prognoses and by the information systems.

It is of utmost importance to improve the management systems alongside with improving the information system by applying the modern principles and methods of management and computer science, cybernetics, operational research and econometrics on the one hand, and by informatics and its most efficient methods of data collecting, data verifying, data transmitting, storing and processing on the other hand. Given the fact that mathematical models constitute the scientific component of an information system and bearing in mind that the facilities offered by the use of the computer (as also being a component of the information system) are an efficient instrument in the scientific management of economic activities there are at least some theoretical and practical motives in favor of this idea [3], [7], [11], [12].

a) Information systems offer the possibility to easily simulate economic processes and phenomena at micro and macroeconomic level.
b) They ensure a well-thought correlation between objectives and resources. For example by implementing an information system for programming, launching and operative control of production (based on some mathematical models of harmonizing necessities with resources), it is possible to detail the activity up to the level of a week or even of a day, in terms of increased economic efficiency. Traditionally, the activity of operative control of production was achieved empirically, not for a longer period than that of a term and was not supported scientifically.
c) The use of mathematical models within information systems offers the possibility to choose the best option for various

domains of activity.

For example, in the domain of foreign trade, the best choice is one of the main constrains when contracting. This can be achieved by applying some multi-criteria decision models alongside with ensuring the data about price dynamics, technical documentation, machines and equipments performance.

Generally, the comparative study of price quotations is done empirically and it encounters great difficulties.

d) The information system avoids the anachronism in the organizations' activity manifested by the fact that a great amount of time is used for routine activities, data processing and reporting with too little time left for the activity of gathering technical specialty information, for consulting some related materials, for analyzing and forecasting the economic phenomena and processes.

e) By implementing mathematical models for optimum tailoring of surfaces, information systems offer the possibility to reduce the raw materials per unit of product. For example, in industries such as clothing and knitwear, furniture, car manufacturing and shipbuilding, tailoring the surfaces with the help of computer can increase the use of raw materials by 90%

f) Information systems give greater potential, both quantitative and qualitative to the information offered to decision makers. This regards the information exactness, reality, as well as speed of answer to users' requirements, the information presentation, completeness and costs. Thus, it is necessary to design and implement information systems that use refined techniques of organizing data and include mathematical models. These all will be in the end capable to increase the performance of the information systems and of the basic activities they manage.

Designing information systems used at micro and macroeconomic level, that use the databases' technique and include a series of mathematical models supporting informing and reporting features that have the role to preventively bring into attention the deviations from the normal state, constitutes a superior form of data organizing and processing [2].

This concept meant a major change of the role of the information system transforming it from a passive instrument signaling and analyzing completed economic processes and phenomena, into an active instrument of forecasting, control and command.

The database can be considered as a central point to which comes the information regarding all the processes and activities leaving then towards decision makers and returning from them back to the database. This way the information circuit changes its aspect from a complicated and redundant one into a simple form of rays coming from and to the database as a unique source.

2 Academic Partnership, a Means of Improving the Quality of the Course of Information Systems

Romanian integration in the European Union means the integration of University education into the European University Education in compliance with the new system of education provided by the Agreement of Bologna.

Such a context makes it imperiously necessary to improve the quality of the educational process, its modernization and that of the knowledge taught, its adaptation to the requirements of the workforce market by harmoniously combining the theoretical and practical aspects deriving from the requirements of our national economy, all these being integrated in the general concept of Durable Development. We consider the establishment of ACADEMIC PARTNERSHIP between universities, research institutes and production units to be one of the means of increasing the quality of Romanian Academic Education and this is in fact the formation of the famous triad EDUCATION-RESEARCH-PRODUCTION

By convening Academic Partnerships with most famous companies in the domain of computer science there may be opened large possibilities of collaboration in the line of research and production with numerous

advantages for all the parties involved, out of which we mention [2], [3]:

- The possibility to attract specialists and professional organizations from specific domains in order to elaborate the new university curricula by taking into consideration the demands of the workforce market and the existing catalogue of professions;
- The possibility of actively and permanently prospecting the Romanian educational market in the field of computer science in order to keep up to date with the requirements and exigencies that emerge in our country and abroad;
- The possibility of reconfiguration of syllabuses by implementing elements of scientific, technical, economic and managerial progress in compliance with the components that are to be taught to students;
- The possibility to establish for each university specialization measures for improvement of the forms and content of the practical activity in production units by attracting companies to employ students for the period of practice and even after graduation;
- The possibility to engage students and teaching staff in solving some problems or achieving activities in commercial enterprises. The theoretical activities and the real problems of commercial enterprises are brought together, doing away with the much talked about gap between theory and practice;
- Establishing partnerships and contacts between universities, corporations (commercial enterprises, administration organizations, organizations in the field of services), research institutes, and units of central and local administration makes the cognitive and technological transfer possible and stimulates social-economic development. It also makes possible for universities to get licenses for software and hardware products, which will develop and improve the technical material basis of the university and implicitly increase the quality of the educational system.
- Furthermore it is possible to improve curricula, syllabuses, teaching methodologies by partnerships with universities from abroad and this will keep up the standards of Romanian university education and will ensure its integration in the European university education in accordance with the agreement of Bologna;
- The possibility of ensuring the feedback from students and employers of specialists trained in our university. It is known that qualifications offered by universities are two-dimensional: the university certifies a certain cognitive domain by certificates and diplomas and there is the professional aspect related to the social division of work. From the perspective of University education the two dimensions are closely related in a professional one, in the sense that the university certification is a professional one. And there are professional associations (the College of Doctors, the Bar of Lawyers, expertise associations) applying specific mechanisms for professional certification and qualification.

So it may happen that a university certification be not professionally valid.

The more numerous the cases of invalidity are, the stronger the probability that the university education has a problem with its social economic relevance. As a result, the corporations may choose to organize their own teaching activities. In this context it can be checked to what extent the graduates of a faculty are employed to work in the field of activity for which they were trained within a year from graduation.

This indicator could influence the financing the faculty or specialization receives from the budget. True to the ideas presented, the authors of this article have established such partnerships with a number of legal entities, work groups and universities from Romania and from abroad among which we mention: Oracle Corporation, SAP, IBM, Microsoft Romania, Crystal System SRL, University of Torino, and University of Bologna.

3 The Place of the Discipline Information Systems in University Learning

In order to establish the place of the subject "Information Systems" in the university learning curriculum and in order to establish how many years of study this discipline should be taught it is necessary to consider some aspects resulting from its specificity and objectives [3], [4].

It is well-known that developing an information system is a long and complex activity involving a large volume of human, material, financial resources and time.

At the same time the discipline "Information Systems" is a discipline of synthesis which implies multiple skills gained by attending other courses such as operating systems, databases, programming languages, operational research, management, the theory of decision, finance, accounting, etc. In such a context and according to the Bologna Agreement regarding Higher Education, the discipline of Information Systems in the Computer Science Faculties requires the structuring of the subject matter of the course into three modules which should form a unitary whole even though each of the modules may be named differently.

Regarding the curriculum it is recommendable to include the first module in the first cycle, in the third year, second semester so that the students get general knowledge regarding information systems and acquire certain methodologies, methods and techniques of developing economic information systems.

In our opinion, the other two modules should be taught in the second cycle of study, in the first year of complementary and specialty master, so that the students may study different technologies of developing Integrated Information systems and experience the work with integrated enterprise systems like:

- SAP NetWeaver including:
  - SAP NetWeaver Developer Studio, which is based on Eclipse and can be extended as a modeling environment through frameworks such as SAP Web Dynpro and development tools such as Java Development Infrastructure and which creates applications that run on SAP Application Server;
  - SAL Composite Application Framework (CPF), a modeling and development environment for creating composite applications;
  - SAP Solution Manager, a SAP's tool for managing the lifecycle of an application and providing a real time connection with SAP support services;
- IBM WebSphere including:
  - IBM WebSphere Process Server;
  - IBM WebSphere Integration Developer,
  - WebSphere Business Modeler,
  - WebSphere Business Monitor;
- Oracle SOA Suite 10g;
- Microsoft Dynamics NAV.

In Integrated Information Systems a special attention is given to Enterprise Resource Planning Systems (ERP) developed within the general context of SOA (Service Oriented Architecture).

It should be remarked that the subject-matter of the course "Information Systems" is taught under various names in almost all the universities of the world which have faculties of economic informatics or of technical profile. The most frequent names for the courses teaching Information Systems are: Information systems, Information systems development, Information systems for management, Integrated Information Systems, etc.

4 Curriculum

The subject-matter of the course "Information systems" is a very complex one and here follows our proposal regarding its structure:

A. Basic Concepts and Aspects regarding Information Systems as Organization Management Instruments should include the following elements:

– Information System as a Management System Component;
– Management Information System Definition and Components
– Management Information System

Objectives;
– Information System Classification;
– Information System Development Stage and Trends;
– Decision Support Systems.

B. Information Systems Development Methodologies and Computer Aided Systems Engineering Tools

This section should present general aspects regarding the methodologies and tools used in developing Information Systems.

Two of the numerous methodologies of developing information systems are presented in detail: Structured Systems Analysis and Design Method (SSADM) from the structural approach methodologies and Rational Unified Process (based on UML) from the object oriented approach methodologies, these two methodologies being the most important.

This section should include the following mandatory elements:

B1. Information Systems Development Methodologies;

B2. Computer Aided Systems Engineering Tools;

B3. Structured Systems Analysis and Design Methodology (SSADM);

B4. Information Systems Object Oriented Analysis and Design.

C. Information Systems Components Design

This section should present aspects which are common to all methodologies regarding a detailed design of some components of Information Systems.

D. Information Systems Implementation

E. Information Systems Maintenance

F. Information Systems Efficiency

G. Integrated Information Systems is an extended section that should talk about the concept of integration, types of integrating information applications, SOA as a new alternative to traditional integration technologies. The service oriented approach as a new paradigm of information system design of the recent years should be presented with aspects related to architecture terms and concepts. The curriculum should include the following:

- Service oriented paradigm – terms and concepts;
- Service Oriented Architecture;
- Enterprise Service Bus;
- WEB Services.

As integrated information systems recently replaced the functional approach of activity model with a business process oriented model, we propose the study of Business Process Management (BPM) and its relationship with SOA. The curriculum should include the following:

- The presentation of BPM;
- BPM terminology;
- BPM and SOA;
- Business Processes Modeling.

An example of methodology is SOAD (Service Oriented Analysis and Design), used for analysis and design of service oriented applications. The curriculum should include the following:

- SOAD elements;
- Service oriented analysis;
- Service modeling;
- Service oriented design.

In order for the student to familiarize themselves with specific application types used in companies, a section of the course will be dedicated to the study of:

- Enterprise Resource planning type applications(SAP, IBM, ORACLE and MICROSOFT Solutions);
- Business Intelligence systems (BI);
- Customer Relationship Management systems (CRM) ;
- Supply Chain Management systems (SCM).

5 The Objectives and Groups of Teaching Information Systems in Universities

The success of an organization is dependent on the ability of the Information Technology Architecture [IT] to meet the ever changing informational requirements of the economic processes.

Information is a basic resource for an organization, being considered the key to success for an organization, as the person who holds the right information at the right time also holds supremacy in the domain of

reference.
Most often having more information can improve the development of economic processes radically and is the key factor in the decision process. At the same time, information is used to measure and monitor how efficient the economic processes are, to integrate activities in processes, to plan and optimize processes [9].
In the above mentioned context, the objective of the teaching of Information Systems in universities is studying the methodologies, methods and technologies of collecting, verifying, transmitting, storing and automatic processing of data with a view to satisfying managers' informational requirements in their process of substantiation and making of decisions.
Teaching the discipline of Information systems in universities aims at forming and training specialists in analyzing, designing, developing and implementing information systems in economy.
The target group of teaching the discipline of Information systems can be formed of:

- students of the first cycle of specializations like: Economic Informatics, Automatics and Computers, Electronics and Communications;
- second cycle students who attend master courses of applied informatics profile;
- graduates who desire to gain and/or increase their competences to analyze, design/develop and implement information systems;
- new generation of managers, designers, architects, analysts and programmers in order to be ready to implement the new business models of the Digital Economy.

6 General Competences and Specific Competences

By studying the discipline "Information Systems", graduates will get some general and some specific competences. The general competences include [1],[3], [5], [7], [10] and [15]:

- the capacity of investigating the state of a commercial company considered as a system;
- the capacity to evaluate against an adequate formal basis an information system of great dimensions within some regional, national and transnational commercial units with group structure;
- the capacity to evaluate and diagnose the economic social units considered as a system;
- the competence to design information solutions at micro and macroeconomic level;
- the competence to choose and use the most advanced techniques and tools of designing/implementing information solutions for complex problems in the economic and technologic field;
- the competence to develop/improve the functioning of the existing information solution in accordance with the changes that take place within the economic and social units.
- the competence to maintain the information systems;
- the competence to manage and design complex information projects.

Among the specific competences we can enumerate some:

- knowledge of and use of some methodologies, techniques and methods of study, analysis and designing economic information systems;
- the capacity to use ERP components, Navision and Hyperion;
- knowledge of some technologies of developing integrated information systems;
- the capacity to model process oriented business activities;
- developing knowledge and expertise regarding decision processes and decision-support systems;
- gaining knowledge to be used and to operate within databases environments;
- the capacity to design information systems components such as: designing inputs, outputs, designing the databases at logical, virtual and physical level;
- defining local or distributed information systems architectures.

7 Present Day State-of-the-Art and Tendencies in the Developing of Information Systems

The computerization of social, economic activities has met profound changes. Here are some of the changes and tendencies in the developing of information systems [3], [6], [8], [12].

A. There is a clear tendency to share the cost of Information system software

Information systems cost-cutting is due to hardware cost-cutting on one hand and software cost-cutting on the other hand.

As for the software component it is to be noted that years ago there were fewer software products on the market. The usual way of implementing information systems was to program one's own needed software. This way of doing things was very expensive because there was no cost-cutting resulted from using the system on a large scale. The cost of designing, achieving, maintenance and quality assurance for each component should be supported by a single user of the system. Today there is a clear tendency in developing information systems, namely to increasingly base them on high level software.

A software platform corresponds to applications platforms and contains basic software functions and functions that are specific to the company application. The basic functions define and solve the applications common problems and applications specific software defines the supplementary behavioral prospects of the company. Such an approach offers the possibility to generalize and implement the same information systems in several different organizations and has immediate effects of cost-cutting and cost sharing per implementation unit.

The basic idea of a common applications platform is indeed old. Its novelty is that it finally came to be implemented.

B. There is a manifested tendency towards information systems based on computer networks

The increased complexity and diversity of applications as well as the emergence of new software products with an ever better price/performance ratio made it necessary and profitable to connect computers in computer networks which constitute today the most adequate support for telemetry.

A remarkable impact on the development of computer networks was that of the Internet, which offered unlimited access to different types of information as well as communication channels among different people all over the world.

The tendencies in the domain of computer network include different aspects, such as: emergence and development of new protocols and communication environments which allow transportation speed of gigabytes per second; unprecedented development of wireless communications, the development of satellite networks; access from distance for performing E-commerce operations or on-line electronic transactions.

C. In the domain of data organizing there is a tendency towards object-oriented data-bases, multimedia databases and special databases.

The classical structures of databases based on text and numeric values either prove to be insufficient or data complexity exceeds the storing and processing capacities offered by classic technologies.

The applications associated with technological disciplines such as: computer aided design; geographic information systems and knowledge based systems involve storing great quantities of complex structure information. These applications need support for the types of data which cannot be represented in classical systems.

Some applications require monitoring some drawings consisting of groups of complex elements which have to be combined, separated, superposed and modified in such a way as to allow working out a variant of project.

At the same time, multimedia orientation brings new elements in the world of computer science. Graphs, photographic image, video image, sound, music cannot be treated in the same way as table-structures of names and members are.

While the effort of extending present day technologies in the field of collecting, storing and processing this new type of information as singular elements is most often dealt successfully with, we cannot say the same thing about the proper administration of such data collections.

Traditional databases offer two little theoretical and practical support for unconventional types of data. Object oriented databases allow creating complex objects, each of them having their own attributes and behaviors being able to offer solutions to the problems and applications mentioned above.

D. Increase of Digital Fluency

Nowadays computers and communications not only perform basic tasks such as controlling the engine of our car or connecting our cellular phones, but the boom of the Internet has created a huge collection of digital information that can be transformed into a major competitive advantage by those who are capable of accessing and processing the information in a timely manner. From finding the right map of a geographical area to obtaining quick information about the best offers of raw materials, many users, from all areas of life, are finding the Internet increasingly useful in their social and professional life.

Although the concept of digital fluency is new it can be already found in many of the research related to eLearning and lifelong learning. As a result, during the last years, new software products appeared in the scientific community or even on the market.

Initiatives such as European "Lifelong Learning Program" are currently supporting research in this field and more applications will certainly appear in the future.

These are applications that attempt to direct the creative energy of young students or children from activities such as computer gaming towards studying the principles of computer programming which is an excellent way of inducing digital fluency. The goal of these applications is to offer to teenagers or young students and attractive way of performing basic performing tasks without involving mathematical concepts [13], [14].

E. Adapting the requirements of business process reengineering

Lately, there has been an increase of the interest in the IT field as support for Business Process Reengineering.

The success of modern organizations depends on the ability of IT architecture to meet the constantly changing information requirements of economic processes. IT is more than simple automation; it is a force capable of fundamentally changing the realization manner of business processes. The relationship between IT and business processes is recursive. IT facilities must provide support for business processes and business processes must be formulated in terms of facilities offered by IT.

F. New types of information systems

Relational database systems meet the requirements of the application for which they have been conceived. Data description in the form of tables is well suited for the information manipulated by these applications.

As the computers costs diminished and as their calculation power increased there emerged new applications which manipulate large quantities of data.

Among such applications can be included: the systems for computer assisted design, multimedia systems, and open systems. These applications exist and form a new important market for databases management systems (DBMS).

Most of these applications don't use a DBMS but are built with dedicated systems. This is due to the fact that a traditional, relational database management system (RDBMS) does not offer the required functions.

The new generations of databases will have to take into consideration not only the traditional applications but also the new types of applications. By using a standard DBMS instead of a dedicated DBMS the cost of making these new applications function will be reduced considerably.

It's very likely that other types of applications will emerge. That is why the new generations of DBMS will have to contain the concept of **extension**. That is,

they will have to be able to administer not only the types of applications identified at a certain time, but also to adapt to other types of applications which were not originally meant to be administered.

a) Computer aided design systems

Applications generate series of phases for achieving a product. The data that is to be manipulated is most often very complex, the description of a component being largely dependent upon the other components of the same product. Here an important part of the information of the documentary retrieval can also be found.

The data in the databases represents the real world directly. There is a direct, sometimes explicit connection between the entities generated by applications and the objects in the real world. There will always be a direct connection between the data generated and a real physical system (for example between the data referring to an electronic circuit and the physical circuit).

In traditional applications data, of course, represents objects in the real world, but this is more or less direct. (Example: the data referring to a holiday and the holiday itself).

Data is most often hierarchical. A computer aided design system deals with components which have links to subcomponents, that is, it deals with a hierarchy of components.

The global performance of the system is most often influenced by the way in which hierarchies are manipulated.

Computer aided design is achieved on interactive computers and the user interface has a very important role in such applications. The computer-user interface has become even more powerful and important in applications, as a consequence of using graphic work stations.

Many applications and program products are appreciated depending on the qualities or shortcomings of the dialogue interfaces. The interfaces change the position and tasks of the user considerably, allowing people who are not specialists to use complex applications. Now applications most often contain more than half of the code for making the dialogue with the user.

Relational systems were conceived neither for graphic data nor to support laborious interfaces with the user.

The latest versions of RDBMS have progressed a lost towards supporting this purpose either by specialized components of generating programs (Oracle, Access, Paradox), or by generators together with strong specific language for the user interface.

In order to be able to make a design application, there has to be possible to modify not only the data in the databases but also the methods that is the schema. Such a situation is very different from the previous database generations in which the schema is, if not invariable, at least relatively stable and the schema development is the task of the database administrator (who is an expert).

For designing applications the schema has to be able to evolve very often and to be manipulated without having to resort to a human expert.

b) Multimedia systems

These new types of applications are characterized by the fact that they are administered in a non-traditional way. The best known examples are the applications handling images and sound besides text and graphics. There are already commercial applications that use such data, as are for example the meteorological applications. They are characterized by the large volume of data they deal with. Images are data of a large volume which need efficient storing and processing support.

Optic numeric disks technology is adapted to these applications. A DBMS supporting multimedia applications has to use the traditional treatment of images and administer all knots of connection among them.

For example in a meteorological application, the images that help to detect a cyclone will have to be searched among the images stored.

For such an operation it has to be used the searching technique and classic access to a database, as well as the specific technique of treating images.

The same remarks hold true for the specific technique of treating the sound.
So, for multimedia applications is necessary to integrate the new technology with the traditional one.

c) Open systems and Service Oriented Architecture

The expression "open systems" itself, corresponds to a vague concept. The idea is to bring increasing flexibility to organizations by using applications that were developed free of charge. Flexibility in developing and exploiting the systems belonging to a unit is achieved by:

- the wide range of different types of peripherals and platforms that can be interconnected;
- the easy way of using the instruments of designing open systems;
- the possibility to interconnect applications with other applications developed for different platforms.

With the open systems everything begins with the problem of standards.
Some standards are established by national and international committees, others are imposed by the groups of owners or sellers, others simply exist for certain products which are largely used (example: a C standard version was accepted by an international committee, MOTIF is an interface promoted by a groups of suppliers trying to normalize Unix; Windows is an owner imposed product – Microsoft, etc);
Owners' and producers' standards are better accepted if the product offers interconnection facilities with other standard products (example: the standard retrieval language in the databases – SQL).
In order to evaluate the level of openness of a software product and decide whether it can be considered an instrument for working out applications, the following questions must be answered:

- Is the product written in a standard language or in its own language?
- Does the product use a notation of a standard method or its own notation?
- Is it exploited with a standard interface or not?
- Does it allow connecting with other instruments and standards?
- What is the nature of application for which it can be used?

According to these criteria it will be possible to exploit the ideal instrument in multiple environments and to authorize it by multiple standards.
The only instruments which are really open are the programming languages.
All suppliers sell instruments which facilitate developing applications.
They will introduce non-standard elements. No instrument is totally open unless it produces open applications. The openness norms are relative because they refer to units that evolve, thus openness is a relative notion and different companies tend to improve different types of openness.

d) Systems for the management of electronic activities

Following the extension of the Internet area a special interest is manifested for new applications, among which e-Commerce, e-Banking, e-Government, e-Learning hold an important place.

8 Conclusions

The role that information systems play in the new Digital Economy is a central one. Therefore the study of the "Information systems" discipline in faculties should be treated with maximum attention and the discipline must be studied in conjunction with other economic and technical subjects in the curriculum.The mission of those responsible of the "Information systems" discipline should be that of providing training of specialists with high qualifications in areas and specializations demanded by the labor market by ensuring a high quality education standard both from a scientific and from a methodological point of view.
The most important is to traverse the distance between theory and practice, between academic research and the actual labor market, ensuring the best possible integration of graduates in business organizations.

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