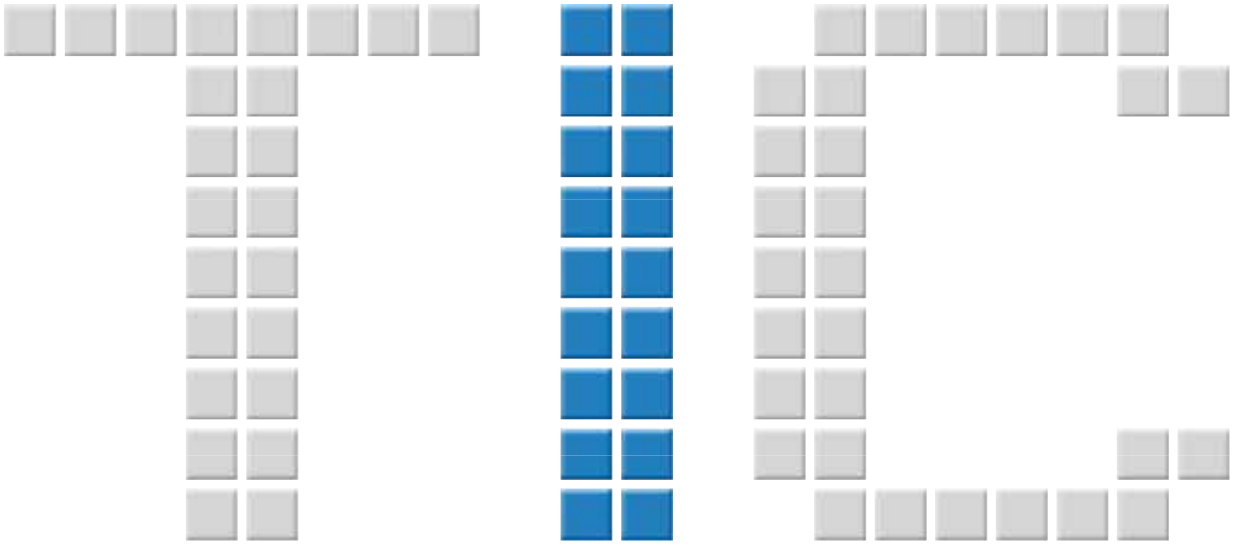
Towards the University of the Future



White Paper on Information and Communication Technologies in the Andalusian University System

JUNTA DE ANDALUCIA
CONSEJERÍA DE ECONOMÍA, INNOVACIÓN Y CIENCIA

Towards the University of the Future

White Paper on Information and Communication Technologies in the Andalusian University System

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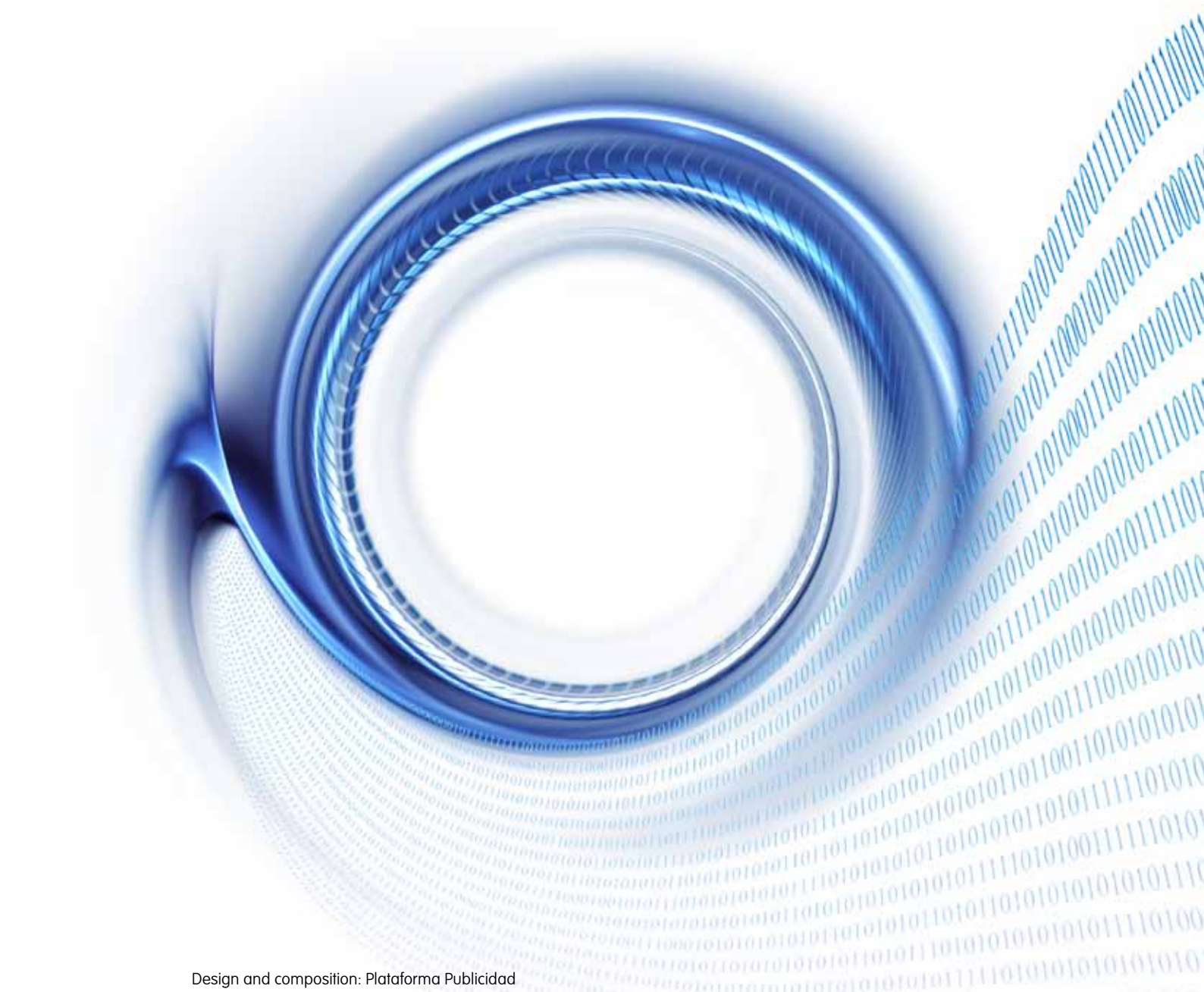

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INTRODUCTION

A New Era in the Digital University

The university is an agent of cultural and social development that is immersed in a process of change which requires it to adapt its IT systems and prepare them for new needs. This change pivots around two axes: the University Strategy of 2015 and the European Higher Education Area (EHEA). The objective of the first of these is to 'guarantee that the Spanish university system as a whole continues on its pathway to excellence and achieves consolidation at an international level, in such a way that by 2015 we can count our universities as being amongst the best in Europe'. The aim of the EHEA is to create an 'open space with no obstacles to the movement of students, academic awards, professors and administrative personnel, and this will be articulated around the recognition of academic awards and other higher educational qualifications, around transparency (a comprehensible and comparable system of awards organised in three levels) and around European cooperation in the guarantee of quality'.

For several years now the CEIC (Ministry for Economy, Innovation and Science), as the body that has promoted and financed Andadlusian universities, has been making an effort to provide the infrastructure and resources that will allow them to work in a sure and certain way towards being in the vanguard of universities that can participate in this change as active agents, working from the front line in an active way to achieve the level of quality and excellence that our society demands. This effort fits into the framework of the strategic project of the 'Digital University' that has financed initiatives in electronic administration since 2005 and allowed the creation of the Virtual Andalusian Campus. It has provided the university campuses with the technology for a wifi network that is accessible to the university community regardless of their whereabouts, improved the electronic services in the libraries, allowed the creation of classrooms with advanced electronic resources and has also allowed the creation and distribution of content, making it accessible from anywhere via the virtual campuses. The white paper that is presented here is yet another initiative, marking the starting point of a new era in the Digital University.

The paper is a summary of more than a years work of reflection and analysis carried out at every level of the universities, centred in the ICT resources and needs of each vice rectory, service, department and user. The study revolves around five axes: (i) ICT Governance, (ii) Teaching and learning, (iii) Research and knowledge transfer, (iv) Management and processes and (v) People, Training and

Culture. All this comes together with a search for alternative solutions in external organisms (such as national and international universities), other solutions for improving communications, the administration of users, the exchange of data between levels and the attention to new needs that the universities will have to attend to in the near future (such as the European supplement to awards, solutions to support mobility of students and researchers and the development of support mechanisms for the exchange of knowledge, to give only a few examples).

The creation of this book and the finishing of the project 'A Study of the Present Situation and the Evolution of Information and Communication Technologies in Andalusian Public Universities' mark the start of a new era in the Digital University in Andalusia. Once the problems of preparation and technological infrastructure have been solved the task that remains to be done is to work towards the construction of a university model whose technological management tends towards open, interoperable and interconnected architectures such as is made manifest throughout this book.

The path that leads to achieving these aims is not easy but it is inspirational. Reaching this objective will give our university system an improvement in its government and management, the services that the university community provide and receive, the generation and dissemination of knowledge and, by extension, the whole of society.

We are working to put Andalusian universities in the forefront of those European universities that are striving towards excellence. This is the motor that moves us, the administration, research workers, teachers and students, because society participates directly in each improvement in the university and in the knowledge that it generates, and this allows us all to advance.

Francisco Andrés Triguero Ruiz,
General Secretary of Universities, Research and Technology
of the Ministry of Economy, Research and Science.

PROLOGUE

Universities find themselves immersed in a process of continual change and adaptation to the new society of information and knowledge. This means that our academic institutions have to almost reinvent themselves as they make the transition from the era of the industrial revolution, based on individual nations, to that of the information revolution, occurring at an international level.

In our particular case we are making the first major step with the implantation of the European Higher Education Area (EHEA). This process implies an important change in our concept of education, moving from one where the focus is on teaching activity to a model that emphasises the student's learning processes. To bring this about we need the development of new forms of communication and collaborative work, innovation in teaching at all levels in all subjects, the inclusion of electronic administration in the daily running of the university and, above all, the application of new IT tools to function in a new world that demands innovative forms of working from our universities: in teaching, in research and in the dissemination of knowledge.

In Andalusian universities, with the collaboration of the Andalusian Regional Government, we are aware of these challenges and that to meet them with a guarantee of success the systematic and progressive use of information and communication technologies (ICT) is fundamental. Backing the use of these technologies is, without doubt, a clear opportunity for improvement.

For this reason the Andalusian University System has put into action a series of initiatives via the 'Digital University' programme with the aim of placing Andalusian universities amongst the most competitive in the area of new technologies. Amongst these initiatives the most outstanding ones are: the implantation of electronic administration, the impulse of the Virtual Andalusian Campus, wifi coverage in all university campuses and the adaptation to the university structures of the EHEA.

The publication of this white paper on ICT in Andalusian universities, analysing the period 2009-2012, is set within this framework. The progress of the work has been coordinated by a directing committee formed by ICT experts from Andalusian universities and a representative of the Ministry for Economy, Innovation and Science, with the collaboration of the Sector ICT of the Public Universities of Andalusia. The elaboration of this work has been carried out by the companies Novasoft and Deloitte.

The white paper starts out from an analysis of the best practices and tendencies at an international level with the objective of establishing, as far as possible, the ICT model of Andalusian universities, and has developed a set of plans of action adequate for achieving this. With this aim in mind the paper has been structured around the five Strategic Axes defined in the initial phases of the project: ICT Governance, Teaching and Learning, Research and Knowledge Transfer, Management and Processes, and, lastly, People, Training and Culture.

The paper has three main sections, each one of which has is self contained and can be read independently of the others. The first deals with the characterization of ICT in the context of the university and, as such, covers an internal analysis of the ten Andalusian universities, whilst also studying the use and evolution of ICT in those higher education institutes that are leaders at an international level.

The second section analyses the model of relations in the university, the key processes and the map of critical activities, with the aim of defining what is the ideal objective model for ICT in an Andalusian university, making special emphasis on the integration and interoperability between IT systems.

Once analysed the present state of ICT in the Andalusian University System and the model we are aiming for, in the third section we describe a detailed plan of action through the inclusion of a series of strategies that materialise in concrete projects.

We are dealing with a text that supposes a retrospective look at all that has been done in the last few years and that serves as a starting point for the future technology of the Andalusian University System, in a synthesis that combines divulgence with technical aspects and that serves to outline a path to be followed in ICT in Andalusian universities.

Set within the framework of the 'Digital University' project and aware of the fundamental role of ICT in the advancement of modern society, this white paper demonstrates a clear commitment to improving the quality of higher education.

Francisco José Martínez López,
Rector of the University of Huelva
and President of the Sector ICT
of Andalusian Public Universities

ACKNOWLEDGEMENTS

The proposal made to the Sector ICT of Andalusian Public Universities brought with it a professional challenge that could not be refused. The opportunity to work together over the network with colleagues from the ten Andalusian universities and the possibility of imagining a future for ICT in our institutions starting from a blank sheet led me to think of this project as a detoxification cure for fourteen years dedicated to university management.

Before us we have the difficult challenge of analysing, with a critical spirit, the situation of Information and Communication Technologies in our universities and the realisation of concrete proposals that will allow us to successfully face new academic, political and technological scenarios. The impact of the EHEA, the challenge of internationalisation, the full implantation of electronic administration and the interoperability of systems and institutions, to give a few examples, are some of the problems that have been analysed and for which concrete solutions have been proposed. We hope that we have got it right and don't disappoint all those who have put high hopes in this project.

Firstly, I would like to thank the Sector ICT of the Public Association of Andalusian Public Universities for the opportunity they have given me of coordinating this project and its president Francisco José Martínez, Rector of Huelva University, for his support and the facilities he has made available to us. I would like to also extend these thanks to the University of Almeria and its vice-rector of Technology, Manuel Berenguel, who has not only managed everything relating to the project, but has also been involved himself and has encouraged us continually in our work and its completion.

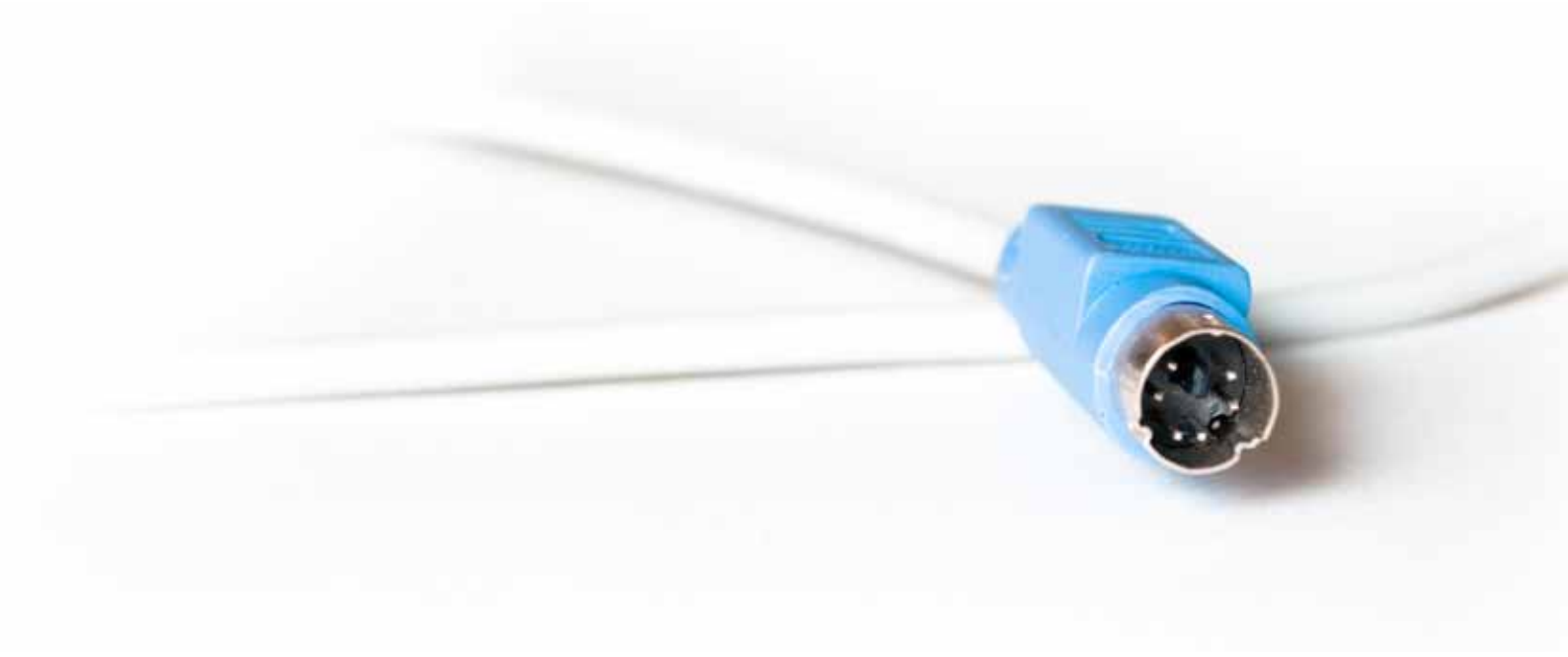
Similarly, I would like to thank the work and dedication of those responsible for ICT services in the ten Andalusian universities, who have opened their doors to us and given us their ideas, points of view, suggestions and corrections, which have been fundamental in our understanding of the current situation in each university and ensure that this white paper is informed by a first hand view of the reality of each institution.

Lastly my thanks go to all my companions on the directing committee and to all our families for the time that they have dedicated to us.

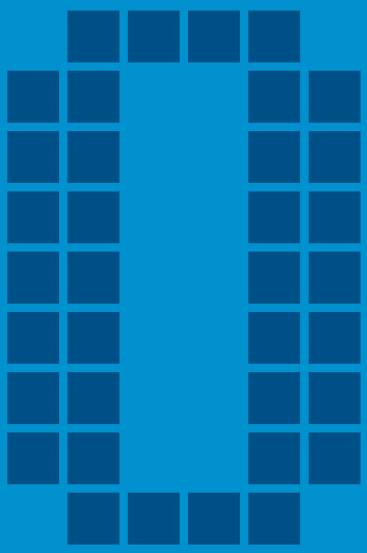
Francisco Pérez García
Coordinator of the White Paper on ICT in Andalusian Universities.

LIST OF CONTENTS

LIST OF FIGURES



LIST OF TABLES



INTRODUCTION

Objectives

Work Plan and Structure

In the long term, higher education and research are two of the most important elements affecting the competitiveness of a country, both in its capacity to attract and generate investment and, of course, in its economic and social development. A university is an institution where the two activities of learning and research should find an ideal space within which to flourish, as also should the exchange, generation and diffusion of knowledge.

Over the last few years the emergence and internationalisation of Information and Communication Technology (ICT) has brought with it new ways to generate, manage and transmit learning and knowledge, along with new forms of resource administration for organisations and their relation with direct users and with society in general.

Aware of this context the Association of Anddalusian Public Universities (AUPA), via the Sectorial Commission for Information and Communication Technologies (AUPA-ICT), has been carrying out intensive work in the field of ICT, pursuing various lines of action in which the cooperation and coordination between universities brings an added value to these initiatives. In fact, many of these initiatives have relied on the support of the Ministry of Economy, Innovation and Research (CEIC) of the Andalusian Regional Government via the Digital University Programme begun in 2005.

This programme contemplates a series of projects that are already underway such as wifi[1] coverage in universities, connection to the EDUROAM space of wireless mobility, the development of the Andalusian Virtual Campus, the setting up of electronic administration with services of support for the digitalization of contents, the creation of digital classrooms with new tools, and the extension of the data warehouse or the Information System for the Direction of universities.

Lastly, the Digital University Programme anticipates the realization of a study on the foreseeable evolution of ICT in Andalusian Public Universities up to 2012, with reference to their incorporation into the government's initiative on the European Higher Education Area (EHEA) and its integration into the world of Information Technology, as is also the case with the European Research Area (ERA).

Taking advantage of this initiative the AUPA-ICT, acknowledging its responsibility towards the university community and Andalusian society in general, decided to make a special effort in reflecting on the present position of the Andalusian Public Universities with respect to the implementation of ICT and the aspired

[1] Owing to its extended use in the field of ICT we have kept the English terminology wherever it seems pertinent.

technological model together with the plan of action needed to achieve these aims.

This decision is not far removed from University Strategy 2015, an initiative coordinated between the Spanish government, the Autonomous Communities and the universities, aimed at modernising Spanish universities through the promotion of excellence in teaching and research, the internationalisation of the university system and its involvement in an economic change based in learning and improvements in innovation.

This ambitious work is documented in a series of technical reports. What follows is a summary of these results in the form of a study of ICT in Andalusian Public Universities, which the CEIC and the AUPA wishes to present to the university community and to Andalusian society in general.

Objectives

The first objective of this study is to ascertain and convince the university community in Andalusia, and all other agents related in one way or another with the universities, of the importance of ICT in all the processes and activities of these institutions.

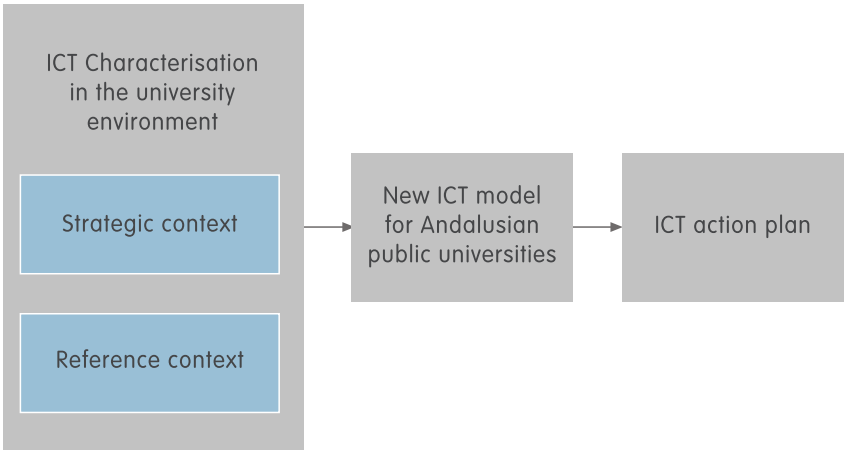
Nevertheless, technology cannot easily fulfil the needs of an entity as complex as a university. There are a multitude of alternatives and possibilities at the moment of incorporating ICT in university processes. This work aims to cast light on the best options with regard to technological architecture that have to form part of the skeleton of university organisation via the formulation of an objective model. This model must, furthermore, give an adequate response to the changing strategic context of the institutions involved (EHEA, ERA, electronic administration, etc.) which, as will be detailed later on, will have an important impact on Andalusian universities.

Lastly, this study constitutes a proposal for a roadmap consisting of a series of objectives, strategies of action and projects that permits the collective of Andalusian Public Universities to reach the proposed technological model and, by doing so, situate itself in the forefront of the most advanced institutions of higher education in the world.

Work Plan and Structure

With the aim of reaching the objectives described above, the white paper has bee divided into sections that correspond to the work plan followed for its elaboration as shown in diagram 0.1.

Diagram 0.1.
White Paper Structure. Source: compiled by author.



With the aim of acquiring the knowledge necessary to project the future technological architecture of Andalusian Public Universities, firstly, an analysis was undertaken of the main elements of the university context that would have to be taken into account for all subsequent work. At this point a study was made of the European strategies relative to the EHEA and the ERA, the initiatives that are being developed at a national level, the regional programme for the Digital University and how these factors influence the area of ICT in the universities.

Secondly, an external analysis was made, consisting of the study of the most important ICT tendencies in the most advanced universities in the world, both at an international level (above all in the United States and Europe) and at a national one, identifying which of these tendencies were best suited to being implemented in Andalusian Public Universities.

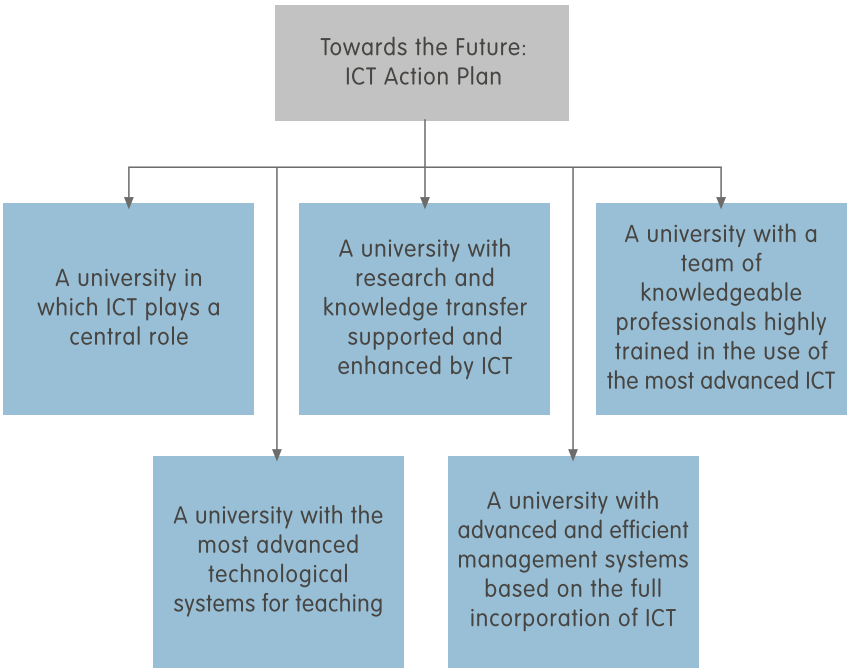
This examination was completed with an observation on the present situation in Andalusian Public Universities in the field of ICT, concluding with a diagnosis that would serve as a starting point for the construction of our model.

Once the analysis was concluded it served as a reference for the systematic design of an Objective ICT Model for universities in the future. The setting out of this model starts from the premise that ICT has to provide a response to the complexity of relations found in the university system (the collective of agents

that are related to or with the institution) on the one hand, and, on the other, the activities that had to be undertaken in teaching and learning material and in direction, support and management.

To facilitate the achievement of this objective, the final stage of the work plan and, consequently, of this report, proposes a series of strategic aims and actions to undertake to attain this model. These are represented graphically in diagram 0.2. below:

Diagram 0.2.
Proposed Strategic Aims. Source: compiled by author.



Lastly, this document contains a list of the main references used in its elaboration, a glossary of terms used and a list of acronyms that helps clarify some of the more technical terms used in the text.

CHARACTERIZATION OF ICT IN THE UNIVERSITY ENVIRONMENT

Frame of Reference and Structure of Analysis of the Present Situation

External Analysis

Internal Analysis

The complete characterization of ICT in the university environment is carried out here in an initial analysis that is indispensable for ensuring that any proposals made later in this area are justifiable. This exercise has been undertaken on three complementary levels.

In first place, it is fundamental to know the strategic context within which universities are situated. At present there are a series of challenges that have an important influence on their strategy and functioning and it is necessary to know, above all, what is the foreseeable impact of this on the use of ICT.

In second place, it is relevant to know the tendencies in ICT design, implementation, management and development that are already occurring in universities, on both an international and a national level. This analysis can provide valuable clues about which aspects are giving the best results in the institutions under investigation.

Finally, this characterization has to be complemented with the concrete case of Andalusian Public Universities, which facilitates the gathering of information about the initial situation in this area, and thus about the path that has to be taken in the area of technological development.

1.1. Frame of Reference and Structure of Analysis of the Present Situation

1.1.1. Strategic Context of Reference

It is difficult, when we are immersed in the present moment, to obtain a historical perspective on the relevance of the social changes that are taking place, each with their different fields (economic, educational, new discoveries, etc.). Nevertheless, and despite the fact that European universities are institutions with lengthy traditions, we may dare to say that they are facing a moment of fundamental change. This is equally true in the field of Information Technology, which evolves now at a vertiginous rate, encroaching on every field of endeavour in both private and professional life.

These changes are in a great part brought about by three fundamental challenges that face Spanish and Andalusian universities, in each of which ICT plays a crucial role.

These challenges are:

- The European Higher Education Area.
- The European Research Area.
- The implantation of electronic administration.

Taking the above into account, in this section we analyse the characteristics and implications of these three strategies in our universities from an eminently technological perspective.

Apart from this there are support instruments that serve as a reference point for universities in this process, their study is also included in the following. These are:

- The University Strategy 2015.
- The Digital University Programme.

European Higher Education Area

The European Higher Education Area constitutes the main point of reference in the European university context. This is an intergovernmental project that began on May 25th 1998, and was signed in The Sorbonne with a declaration (Allègre et al, 1998) by the Ministers of Education of France, Germany, Italy and the United Kingdom, calling for the development of an area of common education. This declaration shows the need to create an open area of higher education, thus complementing the Europe of the Euro, the banks and the economy with a Europe of knowledge and learning.

The Sorbonne Declaration was, therefore, the first step in a long term process of political change, aimed at achieving a common frame of reference dedicated to improving external recognition and facilitating the mobility of students and increasing their employment opportunities: a framework where national identities and common interests can relate and reinforce each other in the benefit of Europe, its students and its citizens.

The holding of a new conference and the signing of the Declaration of Bologna (European Ministries of Higher Education, 1999) on the 19th of June1999, set out the bases of the project. The construction of the EHEA is organised around certain principles (quality, mobility, diversity and competitiveness) and is orientated towards the attainment, amongst other things, of two strategic objectives: an increase in employment in the European Union and the conversion of the European Higher Educational System into a focus of attraction for students and professors from other parts of the world.

This commitment consolidated the support of the previous Sorbonne Declaration towards making the various systems of European higher education compatible and comparable and stressed the need to meet again at a later date to evaluate advances made and any new measures that might have to be taken.

For this reason several Communiqués of the Ministries of Higher Education followed this Declaration, corresponding to different meetings held in: Prague (2001), Berlin (2003), Bergen (2005), London (2007) y Leuven and Louvain-la-Neuve (2009). These documents constitute a point of reference for Europe relative to the process initiated by the Bologna Declaration.

European Higher Education Area (I)

Lines of Action for the Establishment of the EHEA in the Bologna Declaration of 1999:

- The adoption of a comprehendible and comparable system of awards and the introduction of the official document European Supplement on Awards.
- An organization of studies based on three main levels: Graduate, Master and Doctorate.
- The establishment of a common credits system: the European Credit Transfer System (ECTS).
- The promotion of mobility and the elimination of obstacles in this area for students, professors and university administrative personnel.
- European Cooperation to assure a level of quality in the development of comparable criteria and methodology in the process of guaranteeing the quality of award assessment.
- The promotion of a needed European dimension to higher education, with particular emphasis on curricular development.

The Bologna Declaration established six objectives aimed at achieving an increase in the international competitiveness of the European Higher Education System:

- The adoption of a comprehensible and comparable award system. Through the introduction of the European Supplement on Awards, an official document aimed at improving employment opportunities for European citizens. This academic certification incorporates the qualifications obtained by the student, skills acquired and their participation in university activities, etc.
- The organization of studies into two main levels (Graduate and Postgraduate). This was later amplified in the Berlin Communiqué (2003) to three: Graduate, Master and Doctorate.
- The setting up of the European Credit Transfer System (ECTS), as a common tool for measuring students' academic dedication. This system of credits should also include their acquisition in other contexts, such as lifelong learning (whenever this is recognised by the university in question).
- The promotion of mobility through the elimination of obstacles to free movement of students, professors and technical-administrative personnel via the recognition of studies, exchanges, periods of research, etc. in a European context.
- The promotion of European collaboration in the area of guaranteeing quality through the design of comparable criteria and methodology.
- The promotion of a European dimension in curricular development, the collaboration between institutions. Mobility plans and integrated programmes of study, training and research.

These initial objectives were complemented by successive meetings of the European Ministers of Higher education:

- Prague (2001): At this meeting lifelong learning came to the forefront as element in improving the training of human resources to meet the challenges of competition, the use of technologies and creating greater social cohesion, equality of opportunities and quality of life.
- Berlin (2003): the communiqué from this meeting initiated the establishment of a European Framework for Qualifications, as a tool for recognising the achievements of students and the existence of flexible itineraries and grades. The need to deal with research and teaching was also brought to attention, bringing about the introduction of Doctorate as a third level of study.

- Bergen (2005): In this third meeting the system of European Standards for the Guarantee of Quality in studies was adopted.
- London (2007): The communiqué from this meeting highlighted the social dimension of the process of constructing the EHEA, as well as the need to improve the available information for assessing the mobility and social dimension of higher education, including the petition to the European Commission for the establishment of comparable indicators in these areas.

In the last meeting in Leuven and Lovain-la-Neuve (2009), the Ministers went over all the previous objectives and introduced some new aspects as challenges for the Bologna process over the next decade:

- Promotion of the social dimension of higher education, equality in access to university education and the finalisation of the studies.
- Promotion of social responsibility in lifelong learning, via alliances between Public Administration, higher education institutes, students, companies and employees.
- Commitment to insertion in the work place for graduates, providing students with the knowledge, competence and ability needed to find quality employment that is suited and adequate to their qualifications.
- Promotion of student centred learning with a new focus on teaching and learning.
- Development of an R+D capable of generating innovation and creativity in society.
- Promotion of internationalisation of university activities in the framework of global collaboration.
- Stimulation of mobility of students , researchers and administration and services personnel, for greater personal and professional development.
- Improvement of information relative to aspects of social dimension, employability, mobility and other policies with the aim of facilitating its collection and comparison of systems, including the development of multidimensional tools that aid transparency of that information.
- Maintenance of the main source of financing (public funds) and the search for new complementary sources of funding.

European Higher Education Area (II)

New Priorities for the New Decade in the Declaration of Leuven and Louvain-la-Neuve 2009:

- Equality of access and financing of studies.
- Lifelong learning.
- Insertion in the work place.
- Student centred learning.
- R+D that generates innovation and creativity in society.
- Internationalisation.
- Mobility.
- Improvement of available information.
- Search for new sources of financing.

All this process has been incorporated into the Spanish higher education system via legislation which has regulated the application procedure of the European Supplement on Awards (Royal Decree 1044/2003, BOE 2003a), the application for official titles of Master and Doctor (Order ECI 2514/2007, BOE 2007), the introduction of the European system of credits and qualifications (Royal Decree 1125/2003, BOE 2003b), la regulation of university studies at graduate level (Royal Decree 55/2005, BOE, 2005a) and Postgraduate level(Royal Decree 56/2005, BOE 2005b) and the organization of official university studies (Royal Decree 1393/2007, BOE 2007).

Andalusian Public Universities are presently in the final phase of adaptation to the offer of titles stipulated in the Royal Decree 1393/2007 (BOE, 2007), complying with their commitment to incorporate in the University System of the EHEA before 2010.

The majority of the elements considered crucial by the European Ministers for Higher Education in all of their meetings had technological implications. In table1.1 below, various aspects relative to the impact of the EHEA in university ICT services are shown. These elements have to be considered in the definition of the new Objective ICT Model in Andalusian Public Universities:

Table 1.1.
Impact of the EHEA on University ICT Services.
Source: compiled by author.

European Credit Transfer System	• Academic management systems should foresee the need for providing information regarding student credits in compatible and interoperable formats, as defined by international information and data standards.
European DS	• The incorporation of the DS, which provides information regarding a student's competences and participation in university life, will require the existence of an electronic register, of the activities carried out by a student, through the different channels offered by the university. • This information can be obtained from tools such as the electronic portfolio and web repositories, which facilitate access to documentation and services, and will allow automatic acquisition (through various sources) for the DS.

Guarantee of quality and accreditation.	• The demands of an internal system guaranteeing the quality of studies, in line with the directives of the European Association for the Guarantee of Quality in Higher Education (ENQA, 2005), requires the support of an information system that permits the verification of evidence that teaching is carried out in line with the objectives stated for a given award; via the availability of key indicators for granting awards and a mechanised quality control procedure (workflow).
Mobility	• The mobility of students, researchers and administrative and service staff, along with the relevant acknowledgement of their stay in another European university, requires the availability of information systems capable of interoperating automatically with other universities, starting from the existence of electronic support for personal and academic reports. • The exchange of information between institutions on a European level requires a guarantee of interoperability or the capacity for systems to communicate between each other within a secure framework, both at the internal level of the university (with appropriate identity management) and with other institutions.
Student centred teaching methodology	• The transition from an award system based primarily in the number of hours in attendance on a course to a model that facilitates comparability. This requires enabling the student's capacity for self learning with the use of tools such as virtual learning platforms, as well as management from teaching staff in this process. • The elaboration of coursework guides that regulate this process, as a resource available to students and the university community, needs the support of technologies for their elaboration, publication and management. The university community must also have the necessary technical preparation to make use of these resources. • The publication of such guides in the institution's portal facilitates students and teachers with the availability of valuable information about course content, program structure, evaluation criteria, etc. • Also, the development of new teaching content based on such guides and adapted to the EHEA should be used with the aim of continuous improvement and recycling, through its archiving, custody and management in repositories specifically created for these learning objects.
Transparency	• The new objectives introduced at the meeting of European Ministers of Education in Leuven and Lovain-la Neuve (2009), promotes transparency in universities, not only from the point of view of awards, credits and reports, but also in relation to data and information related to university management (accessibility, mobility, employability, etc.). For this end, systems that permit the automated gathering and presentation of this information are necessary.

European Research Area

European Research Area

In the year 2000, the European Union decided to create the European Research Area (ERA) with the aim of facilitating mobility and relations between European research workers, to enable them to share knowledge and use it efficiently for social, economic and political ends, and to initiate and optimise national and regional programmes of research, as well as develop links between institutions at a global level, promoting European leadership in the solution of major world problems.

The ERA has to contribute, as it was conceived to do, to capturing the best research talent, permitting researchers to develop their work and careers, and also to contribute to greater private investment, economic growth and increased employment. It is one of its main aims to increase the competitiveness of European research institutions through greater mutual collaboration.

The ERA has clear technological consequences. The need to employ electronic instruments such as virtual laboratories, remote control for experiments and almost unlimited access to complex databases was, in fact, already recognised in the first document produced by the commission. In this same document the internet was cited as a fundamental research tool in multiple activities involving information and communication.

In this context universities are strategically situated (Smith, 2008) in the relation between research and technological development, as well as with regard to public policy on educational material at both a national and European level. Universities are contemplated as areas where knowledge and interdisciplinary skills come together to meet the complex challenges of the twenty first century, as was recognised by the European Community Commission in its Green Paper on the Future of the European Research Area (COM, 2007), elaborated as review of the situation of the ERA and a proposal for the lines of action and topics of debate appropriate to this area.

This green paper sets out a series of characteristics that the European Research Area should conform to:

- The mobility of researchers, between institutions, disciplines, sectors and countries.
- World class integrated infrastructures of research, connected to networks, accessible to research teams throughout Europe and the rest of the world and based in the new generations of infrastructures of electronic communications.
- Excellent research institutions that carry out an effective task of cooperation and association between public and private sectors and that form the nucleus for teams of research and investigation and

The Green Paper of the European Commission establishes that the ERA has to consider:

- Mobility of researchers.
- Research infrastructure based in electronic communication.
- Virtual research communities.
- Transference of knowledge between the public and private sector.
- Coordination of part of public research at a European level.
- Opening the ERA to the rest of the world.

that also include virtual research communities, specialised mainly in interdisciplinary fields which also attract a critical mass of human and financial resources.

- Effective sharing of knowledge, especially between public and private research, as well as with the public in general.
- Coordination between programmes and research priorities, including a significant volume of investment in public research communally programmed at a European level which imply common priorities, coordinated execution and joint evaluation.
- Opening of the European Research Area to the rest of the world, making a special emphasis on neighbouring countries and a firm commitment to facing challenges at a world level together with our European partners.

In a way similar to the case with the EHEA, the effective attainment of this set of characteristics requires a concurrence of technologies capable of promoting the mobility of researchers (with tools such as electronic personnel files) along with empowering the processes necessary for research teams (virtual networks, secure access to information via identity management, electronic information exchange), the adequate transference of results (via the use of ICT for filing and management such as repositories of research objects) and the coordination of initiatives at a European level (through the exchange and gathering of information on research management). All these aspects have to take into consideration the definition of the new Objective ICT Model in Andalusian Public Universities, that is outlined later in this study.

Electronic Administration

The approval of the Law 11/2007 on electronic access of citizens to Public Services (BOE, 2007) has been a landmark in the way that public services are accessed and used. This law incorporates, amongst other things, the following premises:

- The recognition of the right of citizens to relate with Public Administration using electronic means.
- The obligation on the pat of Public Administration to provide the means and electronic systems needed for exercising this right.

As its name indicates, this law mainly regulates citizen's rights to the electronic access to public services, establishing different dispositions to provide identical guarantees in administrative procedures to dealing with users both personally and electronically. To this end it regulates diverse elements that have to figure in the Public Administration model for electronic operations.

Electronic Administration (I)

The new law on citizen's access to Public Services means:

- A new citizen's right: to relate with Public Administration by electronic means.
- An obligation on the part of the Administration to provide the means necessary to guarantee the exercise of this right.

Electronic Administration (II)

Obligation of the universities:

- Public universities enter within the scope of the law's application.
- The adaptation to the law is conditioned by the available budget of the corresponding Autonomous Community

Similarly, the law aims not only to facilitate an electronic relation between the citizen and the Administration but also provide a catalogue of rights that are inherent in and complementary to such a relation.

These rights are enunciated in article 6 of the law and stipulate correlative obligations for the Public Administration. This implies the evolution of a passive attitude on the part of the Administration, which determines how the citizens relate to it via electronic means, as set out in the previous draft of the law 30/1992 of the Judicial Regime of Public Administrations and Common Administrative Procedures, stipulating the obligation to apply these means.

Given the principles implied by this law, the question arises: with the obligations that it supposes, is it applicable to universities or not?

Article 2 provides a double criteria for determining the scope of the law's application:

- A subjective criterion, determined within the concept of Public Administration, as stated in section 1:

  "The present law, in the terms expressed in the first part of the final resolution will apply to the following:

  - To Public Administrations, understood as such by the General State Administration, the Administrations of the Autonomous Communities and the Entities integrated in Local Administration, plus the entities of citizen's rights linked to or dependent on these.
  - To citizens in their dealings with Public Administrations.
  - To the relations between distinct Public Administrations.

- An objective criterion, material or activity, excluding section 2 of the previously cited article the activities of the Public Administrations take place under the regimen of civil law.

In this way, with public universities incorporated within the concept of the Administration, the law's resolutions will apply fully to the exercising of its powers and responsibilities with respect to the public.

Nevertheless, the effective setting out of electronic relations and multi-channel services is conditioned by budgetary restraints as set forth in in Final Resolution 3, as a great part of the public universities' funding and resources have their source in the Autonomous Community where they are situated.

A synthesis of the rights of the citizen and the obligations of the Administration, as established by the law, are shown in table 1.2.:

Table 1.2.
Citizens' rights and the Administration's obligations according to the law 11/2007. Source: compiled by author.

Citizens Rights	An Administrational Obligation
To choose the technological channel through which to interact with Public Administrations from amongst those which are permanently available.	To provide information and form processing through those channels available to them.
To not provide information which is already in the power of the Public Administrations, which will be obtained electronically, with your prior consent, if they are of a personal nature.	To use interoperable electronic means to exchange citizens' information, allowing them not to present documents or data which is already in the power of the Administration.
To use electronic means to access public services provided by the administration, on equal terms.	To obtain the necessary means by which to guarantee electronic access to different collectives, especially people who lack the training or their own means.
To know, by electronic means, the stage which the interested party's procedure has reached.	To provide electronic mechanisms and the ability to consult proceedings (What about my case?).
To obtain electronic copies of the electronic documents which make up a dossier.	To provide mechanisms to obtain copies of electronic documents securely by electronic means, guaranteeing the veracity of the same.
The Public Administration shall preserve the electronic format of the electronic documents contained in a dossier.	To provide instruments which allow electronic registry and storage of all the documents in a dossier for subsequent consultation and printing.

To have access to the means of electronic identification and the use of other electronic signature systems, including the electronic DNI (National Identity Card).	To provide the mechanisms necessary for access to safe and confidential electronic means of communication with public services. To establish the electronic DNI as a generalised form of identification. To make available to the public by electronic means those advanced systems of electronic signature that are in use. To make available the use of other systems of identification / authentication.
To guarantee security and confidentiality of the information that figures in the Administration's files, systems and applications.	To manage all information on citizens with the maximum guarantee of security and confidentiality, in accord with the Law on Data Protection, guaranteeing maximum transparency and fidelity in communications.
To receive quality electronic public services.	To guarantee minimum levels of quality in public services that have been previously established by the relevant bodies, through the use of evaluations and the announcements of incentives or prizes for excellence and quality.
To chose the applications or systems through which one can relate to the Administration, always when standards of open software or other generalised standards are in use.	To promote technological neutrality towards the use of systems and applications using either open software or other standards of generalised use.

The definition of the Objective ICT Model must take into account the indications that are made with regard to these rights through a conceptual definition that, by implementing different functions, permits the maintenance of the guarantees of procedures and electronic services in the same way as the corresponding correlate (or administrative procedure) when dealing with real persons.

University Strategy 2015

The University Strategy 2015 is an initiative of the Spanish government geared towards the modernisation of Spanish universities, as such it represents the main strategy at a national level. The modernisation of the universities is proposed through the promotion of scientific and pedagogic excellence, the internationalisation of the University System and its implication in an economic change based on knowledge and the improvement of innovation.

In this way, the aim is to place the best Spanish universities amongst the top 100 in Europe, to promote the Spanish university campuses as being amongst the most competitive as well as an international reference point amongst the most prestigious institutions at a global level, and to help the whole Spanish University

System to improve in quality and promote teaching and research efficiency through the concentration on objectives and effort.

To achieve the aims set out in the framework of the University Strategy 2015, four strategic programmes have been identified:

- Campuses of International Excellence: this programme seeks to regenerate the concept of the university campus as a tool for modernisation of the system and the improvement of the internationally visibility of Spanish universities.
- Direction of Knowledge Transfer Plan: actions in this area aim to develop mechanisms that facilitate the transfer between knowledge generated in our centres of public research and private businesses, attracting investment to the systems of research, development and innovation.
- Statute of Teaching and Research Personnel (PDI): this aims at the drafting of a Royal Decree on the Statute of PDI in Spanish universities as a means to resolve the obsolescence and dispersion presently existing and to thus comply with one of the objectives of the University Act (LOMLOU).
- Statute of the Student: the development of this Statute has the aim of promoting the participation of students in university politics and, as such, will amplify university student's rights and recompense their active participation in university life.

Additionally, the White Paper on the Digital University 2010 (Laviña and Mengual, 2008) is an important reference point for the elaboration of this study, given that, starting from a process of joint reflection on six universities and companies, it defines the technological transformation that the Spanish University System has to make to face current challenges and meet its objectives.

University Strategy 2015

A national initiative that sets out four programmes:

- Campuses of international excellence.
- Direction of Knowledge Transfer Plan.
- Statute of Teaching and Research Personnel.
- Statute of the Student.

Digital University Programme

Within the scope of the autonomous communities we find the Digital University Programme, the main frame of reference in which the Andalusian Public Universities can define their collaboration with the Ministry of Economy, Innovation and Science (CEIC) and the necessary evolution of ICT to provide a response to the challenges that face the Andalusian University System.

From its outset, the Sectorial Commission for Information and Communication Technology (AUPA-ICT) of the Association of Andalusian Public Universities (AUPA) has been intensely involved in identifying topics and projects related to ICT in which the cooperation and the coordination of the Andalusian Public Universities would be of significant value. Various of these projects have received the support of the CEIC of the Andalusian Regional Government in the form of an agreement of collaboration with universities through specific subsidies. In this way we see the will of the universities to collaborate with regional government with the aim of assuming the role that corresponds to these institutions in the impulse to modernise the Autonomous Community.

On November 4th 2005 the CEIC and the Andalusian Public Universities subscribed to a general protocol of collaboration for the development of the Digital University. This protocol established the willingness to adapt university activity to the new realities of ICT and Knowledge Societies and to provide universities with the means to make this adaptation. At the same time certain projects were identified that were to be worked on jointly. The projects endorsed by this agreement are the following:

- The setting up of wifi coverage.
- The connection to the EDUROAM zone of wireless mobility.
- The setting up of the Andalusian Virtual Campus.
- Advanced teaching classrooms.
- The setting up of e-administration.
- The establishment of support services for the digitalization of contents.
- The expansion of digital classrooms with new tools.
- The expansion of the data warehouse in the universities and the CEIC.
- The realisation of a study on the evolution of ICT in universities with a view towards 2012 and the incorporation in the EHEA and the information society.

Digital University Programme

In this programme, started in 2005 between the Andalusian Regional Government and the Andalusian Public Universities, the following projects were proposed:

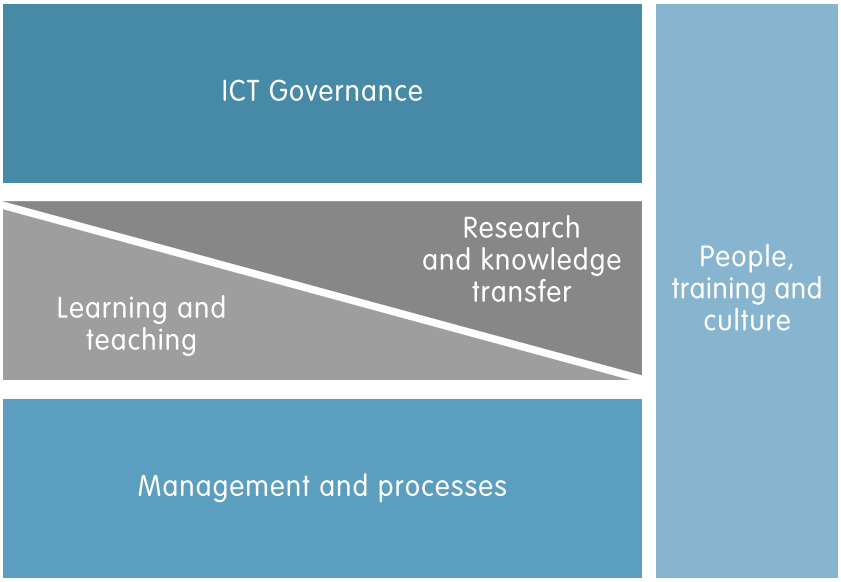
- Wifi cover.
- Conection to EDUROAM.
- Andalusian Virtual Campus.
- Advanced Teaching Classrooms.
- E-administration.
- Digitalization of contents.
- Digital classrooms.
- Data warehouse.
- Evolution of ICT.

1.1.2. Structure and Axes of Analysis

The analysis of the present situation in the Andalusian Public Universities, both from an external and an internal perspective, has been structured around the five Strategic Axes of university management that are presented in the introduction to this book (ICT Governance, Teaching and Learning, Research and Knowledge Transfer, Management and Processes and People, Training and Culture).

In figure 1.1 below we show a graphic representation of the analysis framework for this study.

Figure 1.1.
Structure and axes of analysis. Source: compiled by author.



In this figure the five strategic areas of university management are represented, along with its organisation, reach, strategic priority and level of relations between distinct areas.

In the first place, the activities of teaching and learning and of research and knowledge transference have been shown in the centre of the figure, given that they constitute central activities of a university, in fact, they are its principal aims and justification for its existence.

In the second place, ICT Governance determines the strategic orientation, the politics and the model for ICT services in the university, thereby forming a global framework where the remaining management activities can be carried out. Similarly, this axis refers to how the university governing body, in the sense of its

strategic orientation and high level management, can be supported by ICT. As such ICT Governance has been placed at the highest point in the figure, above the other areas of management.

On the other hand, the area of management and processes is found at the bottom of the figure, given that management in this area seeks mainly to guarantee operability and the proper running of the university through the optimization of all the key processes in university and support activities.

Lastly, the area of People, Training and Culture has a transversal character, given that the people who form the university community, along with their training and culture in ICT is, in the main part, determined by the model of government and the type of management it applies in the fields of learning, research and support processes.

Next, before starting the presentation of the results obtained in this phase of analysis and diagnosis, we describe in greater detail the five areas of university management where we have evaluated the grade of implantation, use, impact, and usefulness of ICT in Andalusian Public Universities (see table 1.3. Proposed Strategic Axes.

Table 1.3.
Proposed Strategic Axes. Source: compiled by author.

ICT Governance	This represents how ICT supports the execution and development of a university's fundamental strategies. Aspects such as finance, policy, social and the competitiveness of the universities themselves are considered. ICT Governance means considering ICT a key area within the structure and organisation of the university and, therefore, providing it with a clear and well defined role within the strategic planning of an entity.
Learning and Teaching	This area refers to the learning and teaching management processes, Which means that their evaluation is carried out from two perspectives, the professors' and the students'. Its analysis is based on the degree of ICT influence on the aforementioned processes, as well as the changes brought on by its incorporation.
Research and Knowledge Transfer	The situation and action taken, including indirect activities aimed at providing the necessary means, by universities regarding ICT in the management of the area and processes directly related to research, are considered in the axis. Therefore, ICT in this area will not only be evaluated as a support tool for research activities but also as a facilitating factor for the transfer of knowledge and of integration within society. Likewise, for the use made of ICT in continuous evaluation of research requirements and objective achievement.
Management and Processes	In the Management and processes area consideration is given to the way universities internally manage their ICT resources to obtain better results from the same. The use of ICT in the simplification, standardisation and evaluation of management processes and activities, is also considered. The incidence of ICT in the mechanisation of fundamental procedures and services (key university processes), such as administrative, support, economic/ financial or university personnel, is also evaluated. Aspects related with electronic administration are also analysed in this axis.
People, Training and Culture	The evaluation of this axis centres on three university management areas: People, Training and Culture. Regarding people, organisational focus in the ICT area is considered, to be able to offer efficient service in line with the first level of ICT Governance strategies. With regards to training, ICT training effort orientation is established, as is its degree of effectiveness for the use of ICT in university management processes. Lastly, concerning culture, the transversal integration of ICT, that is to say in all activities, be they teaching, research, administrative or managerial related in university culture through all the members of this community is taken into consideration.

1.2. External Analysis

ICT in universities has seen a growing development throughout the world. The change has been gradual but constant and, nowadays, ICT already forms part of ordinary university life and its integration in all ranges and levels is, in general, a reality.

In this sense, in this section we intend to point out the most important tendencies that can be identified in this area in so far as they affect universities, both national and international, that have formed the sample of our study, describing them in relation to the five Strategic Axes that have been defined above. Nevertheless, as a result of this analysis we have also identified technological tendencies, which, because of their transversal nature, are difficult to classify in any of the five axes, given that they apply to all. As such they have been included in an initial section dedicated to these cases.

With the aim of complying with the aim set out for this section, our study covers strategic plans, system plans, and practices in ICT that are being developed in the universities mentioned.

The following system of rankings for international universities were used: THE -QS World University Rankings 2008 (THE -QS World University Rankings, 2009), Top 500 World Universities 2008 (Shanghai Jiao Tong University, 2008), World Ranking of Universities on the web of the Consejo Superior de Investigaciones Científicas (CSIC, 2009) and the 2008 Performance Ranking of Scientific Papers for World Universities (Higher Education and Accreditation Council of Taiwan, 2007). The principal universities were selected through the definition of criteria based on the Strategic Axes that were the object of the study. For the selection of national universities other rankings were consulted too, such as the Campus Computing Project (2007).

The specific study of universities was completed by consulting the main reports existing in the field at a national level, such as: the White Paper on the Digital University 2010 (Laviña and Mengual, 2008), and at an international level, such as the Gartner Report(Gartner, 2008a, 2008b, 2008d, 2009) or the Horizon Report (EDUCAUSE, 2009), amongst others. Telephone interviews were also made with those responsible for ICT in some of the universities referred to in this section.

The analysis and description of these tendencies is highly relevant. In the field of ICT, at the time when we have to decide how best to invest in it, it is essential to know the steps that similar organisations are taking, along with their results, both close at hand and on an international level. It could be said that the selection of tendencies in the design and application of ICT, via the identification of repeated successes in different institutions, creates confidence for their further application in practice. As such, it can be understood that the results

of this analysis are a key source of information for carrying out any adequate planning in the field of ICT with respect to the Andalusian Public Universities. The conclusions of this section will therefore be a point of reference at the moment of analysing the present situation and the establishment and effective implantation of an Objective ICT Model in Andalusian universities.

1.2.1. International Context

1.2.1.1. Transversal Technological Tendencies

The analysis carried out of developments at an international level have yielded, as a result, the identification of a set of ICT tendencies that have a transversal character with respect to the university, given that their use is present on all the Strategic Axes of analysis identified. Therefore, in first place, this section deals with these tendencies, whilst international tendencies that can be identified with each of the five defined axes will be dealt with further on.

Main Transversal Technological Tendencies

- Interoperability.
- Identity Management.
- Service Orientated Architecture.
- Web based solutions.
- Wireless access to services.
- Social networking.

The first of these tendencies is the growing presence of applications designed with high levels of interoperability.

Interoperability permits different systems to be integrated and, therefore, to realise operations and data exchanges between each other. In this way the use of either proprietary or open source software for different applications ceases to be a critical consideration whenever such systems are prepared to be interoperable.

Related to this we find another tendency, that of identity management. This permits the ICT user, whether they be students or teaching, research or administrative personnel, to have easy, direct and secure access to all the university's systems of information, according to their profile and level of access. This also allows the regulators of ICT to have more control over user accounts and systems access (Crosier et al, 2007).

Thanks to identity management, a higher interoperability of systems can be achieved, which, in its turn, facilitates the mobility of students and teachers. As such , there is a general tendency towards identity management in European universities on the path to meeting the requirements of the EHEA.

As such, the identity management solutions adopted by the universities have to take into account standards of interoperability, security and auditing, as well as having to be in keeping with interoperability solutions based on web services or Service Oriented Architecture (SOA).

In this way it is possible to create highly scalable systems that reflect university activity. This also allows a well defined form of access to services and innovations in them (usually, but not always, web services) and facilitates the interaction between different systems.

Nevertheless, despite the growing use of interoperable systems in the leading European universities, it is worth noting the advanced level reached in this aspect by the Educational Technology Services in the University of Berkeley and the Network Operations Centre in Harvard.

Traditionally management tools are found physically installed in the university's servers and computers, nevertheless, we are seeing an increasing evolution towards the development of web based solutions, that incorporate interoperable interfaces and permit the flow of information between users and application across different systems.

Constant technological evolution and advances in cellular telecommunications have brought about the consolidation of wireless access to university services via portable computers and smartphones. The situation has been favoured by the constant evolution of technologies providing wireless internet access in line with the standard 802.11 (in its variants a/b/g/i and n), with bandwidths that allow students, teachers and general users to access a wide range of services. Furthermore, this increased bandwidth allows a new set of services to become available to the university community.

The growing importance of social networking as a new channel of communication and interaction between students, educators, researchers and other members of the university community is provoking an important effort in all universities (above all in the United States) to make use of the advantages it has to offer in this respect. As we shall see later on, these networks are being used in multiple fields: student selection, publication of contents, cooperation in research materials, amongst others, thus constituting a clear tendency of a transversal nature.

In universities in the United States, where each institution chooses the students that it accepts, social networking is starting to be used as a tool in the selection process of candidates wishing to study in the university of their choice.

The leading universities in the United States also point towards the integration of social networking in the university as a means of bringing it closer to the outside world. The Massachusetts Institute of Technology (MIT) has started the television channel, MIT TechTV, similar to YouTube, where the user can find videos classified according to category (science, events, engineering, news, humour, life at MIT, as well as conferences, experiments, etc.) providing a means of access to MIT generated material. There is also an increasing appearance of universities in the universe of Second Life. The University of Harvard was the pioneer is setting up

its own virtual campus (iCommons), but many other centres of learning are now following its example.

According to Gartner (2008c), the proper management of these networks by universities could have a positive impact on student performance, as well as their relationship with and integration into the institution, given that it allows an insight into needs of this collective, provides the opportunities for lifelong learning and the creation of a brand image for the university.

In a similar way, educators are now seen to be starting to use these networks as a tool to support and complement their teaching activities. ex students organisations, which have an important influence inside the university, are also starting to find it useful to manage their presence in networks such as MySpace, Facebook or Twitter (we can cite the case of MIT and Harvard University, where Twitter is used for the management of matters relating to ex students, whilst in Berkeley and Cambridge, this task is done via a support network).

In the context of research it is worth noting the use of such networks becoming almost universal as means of cooperation and diffusion of research results, though we still find this trend in its early stages.

1.2.1.2. Other International Tendencies

Technological evolution, the Information Society and the demand for more flexible and accessible teaching-learning systems are persuading universities to opt for ICT as a main element in management and service provision.

Technology is increasingly being used in a generalised way in the university context. The internet, for example, has found a position as the fundamental means of support for education at a distance which has permitted the improvement of educational programmes available on campus. The internet has also provided a means to attract and to cater for the needs of those students who are unable to personally attend classes.

With regard to teaching and learning models we are witnessing a transformation in the relationship and communication between students and teachers. We see a model developing that is both participative and collaborative, where students acquire knowledge through their interaction with their environment and their activities within it. According to the Trends Report V (Crosier et al, 2007), the university is opting for empowering virtual learning where the teacher manages both the content and pace of the student's learning experience. Whatever the case, it can be said that the use of ICT internationally in the university environment is very varied according to the way in which these technologies

give support to teaching, research, or to the provision of services to the university community.

With respect to the level of ICT training of different members of the university community (students, educators, researchers, administrative staff…) important differences have been observed which will be looked at in more detail later in this chapter.

The analysis of universities on the international level has shown that great efforts are being made to move from a model where the demands on ICT are almost exclusively centred on guaranteeing the provision of the necessary technological infrastructure to one where this field incorporates new functions and assumes a role of greater strategic relevance (Kirkup and Kirkwood, 2005).

ICT Governance

Amongst the main functions found in this area are the definition of the ICT policies of the university (normally this figures in a strategic plan for ICT), guarantees for the accomplishment of the strategy and policies defined by the various schools and departments of the university, and the establishing of minimum criteria for the quality of service in the management of the technological infrastructure.

In most cases this department is headed by a Systems Director whose role is similar to that of director in a private company or that of a CIO (Chief Information Officer), such as is seen in the strategic plans for ICT in the main universities in the USA (Harvard, Berkeley and MIT), Europe (Cambridge, University College of London) and Asia (Centre of Information Technology, Tokyo University) amongst others.

Over the last few years Asian universities have made a major effort towards the centralisation of all university activity in the field of ICT, aiming to achieve a clear and unique strategy of government (one example is the previously mentioned Centre of Information Technology at Tokyo University, which is an organized unit responsible for central management of ICT, from which all the ICT needs of the university are managed via a system of advanced ICT services).

On the other hand, in nearly all universities in Europe and the United States, internal policies related to the management and administration of information systems is moving towards Business Process Outsourcing (BPO). Despite the fact that the reach of this tendency includes processes pertinent to distinct areas of university management, the trend towards outsourcing is mainly occurring in transversal processes, such as corporate applications and system support,

Main International Tendencies (I)

ICT Governance:

- Organised units dedicated to a centralised management of ICT.
- Business process outsourcing.
- Use of standardised management models (CoBIT, ITIL u otros).

ICT incidents management and the management of matriculation payments, amongst others.

The analysis carried out has enabled us to see that those universities that have opted for outsourcing of certain processes or services have previously had the functions that have been subject to outsourcing solidly ordered through the use of standard management models (CoBIT, ITIL and others), as a frame of reference for the best practices in ICT Governance in the university environment. This can be seen in the reports ITGI (2006) and ITGI (2007a, 2007b), from 2006 onwards the universities started to pay a lot of attention to the use of CoBIT standards, though they are very orientated towards what actions need to be taken to correctly optimise the function of ICT Governance. In a similar way these reports emphasise how ITIL allows the attainment of excellence in the function of ICT Governance.

In this sense, following the EDUCAUSE Report (2009), most universities cited as references with respect to ICT Governance, used frames of reference such as CoBIT, ITIL or others.

Learning and Teaching

The evolution of the traditional one-way teaching model towards a more participative and collaborative one is a mature tendency that is generalised on the international level. This evolution has been accompanied by a change in the role of the educator and the firm decision of the universities to use technological support in both face to face and in virtual teaching too, supported by e-learning platforms. The use of such Learning Management Systems (LMS), as a tool of support for both teachers and learners has consolidated both learning at a distance and teaching done in person.

The choice of open source software in this field is, according to the Gartner Report (Gartner, 2006b, 2008e), already a mature tendency in line with the evolution of ICT in general, as can be appreciated in the extended use in United States universities of the e-learning platforms of Moodle and Sakai.

Also, according to the Gartner Report (Gartner, 2006b, 2009), there is a growing tendency in some universities to move away from commercial or self-made platforms towards Software as a Service Solutions (SaaS). The motive for this is essentially the complexity of maintaining a quality 24x7 service (24 hours a day and 7 days a week) and as such the university opts for outsourcing LMS services (Gartner, 2008e). It is worth citing the case of Blackboard, who offer this service now at an international level.

Main International Tendencies (II)

Learning and teaching:

- E-learning platforms.
- Open source software.
- Software as a Service Solutions (SaaS).
- Repositories of learning objects.
- Electronic text books.
- Mass notification software.
- Unique electronic record.
- Mobile slide show learning.
- E-Portfolios.
- Social computing.
- Cloud mail.

The grade of maturity reached has allowed initial discussions to be put aside (the choice of institutional platform to use such as Moodle, WebCT, Ilias, Blackboard, Sakai, Angel….) and to concentrate on how to preserve the educational content that these platforms generate (Gartner, 2006c). Universities are investigating the need to elaborate teaching materials that are of high quality, accessible, reusable and compatible across different platforms, an aspect in which the participation of all teaching personnel is required.

These requirements can only be met if learning objects are not tied to any particular e-learning platform. At present, according to the Gartner Report (Gartner, 2009) the main international educational institutions are seen to be utilising Learning Object Repositories (LOR), based on standards that were independent of any particular e-learning platforms. A further development of this tendency are the creation of federations of repositories from different institutions that facilitate the evolution of inter-university virtual campuses.

These developments promote the reusability of teaching materials and the ability to access them from different systems. The setting up of the aforementioned repositories allows the optimisation of resource allocation for educational purposes and facilitates these being shared by different centres or even different educational systems. As such, the incorporation of this tendency into the university allows the empowerment of knowledge transfer mechanisms, as well as, at the same time, reinforcing the institution's self image.

The constant evolution of technology and the advances in cellular telecommunications have brought with them the consolidation of access to the university campus network via wireless equipment (Gartner, 2009), such as laptop computers or smartphones. This advance has led to the utilization of electronic text books capable of being read on mobile equipment with a capacity for connection and relation with library systems or university documental repositories.

Mobile electronic equipment have also made possible the reformulation and creation of new services that have had a great impact on the university community based on mass notification software, which allows the university administration and others to send emergency messages (voice and/or data) that are independent of the mobile terminal being used (Gartner, 2009).

Another service that is narrowly related to identity management, is the tendency towards a unique electronic record, which would have the same validity as a traditional student record and would, eventually replace it.

On the other hand, there has been an evolution in the concept of personal identity towards a user centred identification, that proposes a new framework to facilitate the managing of the attributes and characteristics of a user identity, simplifying the registration and access to online services. This concept is what is known on internet as Identity 2.0. The development of usable components in this area has centred around initiatives such as Open ID (Gartner, 2009).

Given the variety of equipment that students can now use to access the virtual campus, mobile terminals would be the ideal mechanism for content sharing, especially as their price is becoming more affordable. Another positive factor is the many applications that are now available, giving users direct access to text books for example. Learning via electronic means therefore extends the limits of educational possibilities and m-learning (Mobile Learning) appears to be a trend that will gain in force and importance in coming years.

This modality of learning adopts different forms in function of the wide range of mobile terminals that are available, falling into two basic categories: those of low to medium price capable of transmitting voice or SMS (Short Message Service) texts, and those that admit networks and Java applications. In the first of these cases the teaching processes can combine the transmission of text messages with voice recordings. In the second case (higher quality equipment or smartphones) teaching can be based around a wide range of applications, including audio and video transmission, exploratory learning using augmented reality, electronic books, collective work projects, questionnaires, tests, feedback in real time and simulations.

In the case of teaching and learning resources the use of e-portfolios has become very widespread in recent years given that this can considerably reduce the amount of work taken up in filing and classifying information, whilst at the same time having the capacity to be used as an integrated evaluation system in the teaching and learning process (Barret, 2001).

An e-portfolio consists in a selection of evidence/samples (forming a file or dossier) that the student has gathered or provided over the length of a period of time and which responds to a determined objective. This evidence (certificates, credits, film clips, interviews, academic activities, notes, work and assignments, amongst others) permit the student to demonstrate what they have learnt, at the same time as allowing the teacher to follow and assess the overall learning progress made.

The evidence presented should be accompanied with proof of authenticity plus a reflection by the student that demonstrates the relation between the evidence and the learning process. This helps to make the student more aware of what and how they are learning at the same time as allowing them to regulate their own learning and study activity.

A tendency that is emerging in a marked manner is that known as Social Computing (Gartner, 2008a). Through social computing interpersonal relationships are facilitated, such as in the creation of problem solving teams, which leads to an increase in the efficiency and efficacy of work groups. The key for the correct use of this is to overcome the tendency towards control and protection of information. In general, the application of social computing is a way for students to interact using technology, creating communities and using tools for working in groups such as Google Spreadsheets (Gartner, 2009).

Another tendency that we see is the growing use of cloud mail, a concept that refers to the evolution of e-mail management towards open systems, where both students and teachers can save their mail files in multiple servers and locations, that are no longer part of the university and are often somewhat transparent to the end user (Gartner, 2009).

Research and Knowledge Transfer

The use of centralised systems of research management is worth highlighting as a major improvement in the activity of research and knowledge transfer, facilitating the interaction between those working in the area of research and those engaged in the dissemination of knowledge.

In the same line we find the more extended use of repositories of scientific work as a means of sharing information relating to the university's research activity through the storing of digital files of scientific publications, doctoral theses, research curricula and best practices. This tendency can be related to the recommendation of the European University Association (EUA) which in their 2007 report (Crosier et al, 2007) recommend the development of institutional repositories of scientific work, primarily as a means of making such results known but also as a means of preserving and dealing with research based information in a digital format.

Related to this last point is the use of digital filing technology for research results, which is transforming the management of research activity, given that access to this information from any location permits an optimisation of time and resources. Nevertheless, according to the Gartner Report (2009) the use of this technology

in universities is presently only in its initial stages, given that the digitalisation of research results is low. The report argues that the management of digitalised information could become problematic once this procedure becomes standard practice, for which it is necessary to have a system of research management that can prevent such situations arising.

Another development is the increasing use of research support technology (Grid Computing, Quantum Computing), which are still in their initial stages but have foreseeable importance for the future for enhancing calculation power and resolving complex problems, thereby greatly aiding research work.

In the last year a new development in Grid technology has appeared known as Computing as a Service (CaaS) or Cloud High-Performance Computing (Cloud HPC) (Gartner, 2009), this permits the use of massive computational capacity for research needs (not excluding educational use). This technology permits the sharing of the joint computational power of universities and other institutions.

The continuing incorporation of ICT into the university environment can be seen reflected in the appearance of an increasing number of collaborative work tools, according to Gartner (2009) . These serve as a technological support for the optimisation of relations between different members of the university community, facilitating the mobility of students and teachers, promoting student participation, making possible the coordination of different activities and the synergy between tasks. As an example we can cite the European Collaborative Networked Organizations Leadership Initiative (ECOLEAD) project, financed by the European Commission, which claims that, in response to the rapid evolution of technology, within ten years most institutions will be part of sustainable collaborative networks that will serve as environments for the formation of dynamic virtual organizations (ECOLEAD, 2006).

This project offers to the university flexible technological environments for the generation of virtual communities of researchers from diverse geographical locations, which facilitates and motivates the research process.

One of the ICT solutions that is most widespread as a support for collaborative work is the broadband IP videoconference, this allows the use of large screen, high definition video projection and gives support to the collaborative execution of applications of the AccessGrid type. The object of this technology is to improve the productivity of researchers by providing a work environment that allows the interconnection of a large number of groups that are geographically separated, thus facilitating not only the holding of videoconferences, but also creating an ideal platform for the shared use of grid type applications. This has become a widely used solution in teaching situations and applications because of the

Main International Tendencies (III)

Research and Knowledge Transfer:

- Centralised systems of research management.
- Repositories of scientific work.
- Digital filing technology.
- Research support technology (Grid Computing, Quantum Computing).
- Computing as a Service (CaaS).
- Collaborative work tools.
- Digital rights management.
- Semantic search applications.

above mentioned characteristics and the enormous flexibility in hardware and software configuration.

All of the technological advances in the field of research and knowledge transfer promote and expand the work of disseminating the results of scientific investigation carried out at the university, guaranteeing the preservation of this work in digital format, facilitating the mobility and universality of the scientific community and making it possible to access this information from anywhere, thus optimising the use of time and resources. In relation to this there is an increasing tendency towards digital rights management, owing to the growing interconnection of networks and systems that permit the widespread diffusion of research results over multiple channels and platforms.

Related to the concept of network semantics we are witnessing the development of applications known as semantic search, which facilitate both search processes and the spread of information.

Management and Processes

Amongst the tendencies indicated in the Strategic Axis of Management and Processes the adoption of Enterprise Resource Planning (ERP) is outstanding. These systems permit the integration of data from all the schools and faculties that make up the university, making it easier to track data and increase financial efficiency.

Similarly, other areas of university management such as the purchase of technologies or certain administrative processes are also incorporated in these global management systems. In this area the assurance of interoperability of systems and applications is a key consideration in the choice any system dedicated to the global planning of resources.

On the other hand, the progressive apparition of solutions based in open source software is also making itself felt in this field, given that these are highly adaptable to administrative applications in the educational field, though there is less incidence of use in this area than in teaching and learning, whilst this type of software has an almost null presence in the area of finance management (Gartner, 2008e).

Additionally, the internet, e-mail and other electronic channels have allowed universities to have access to information that was previously difficult to obtain and to put it within reach of the whole university community. In this way ICT allows the gathering and analysis of information for all the different agents present within the university (students, professors, researchers and admin

and service personnel) enabling one to distinguish their preferences and manage relations betweeen them. With regard to the evolution of technological environments and contents it is worth pointing out the virtual desktop applications to which Gartner (2009) draws attention. This tendency is directly linked to the management of identities, given that it guarantees correct access to information depending on the profile of the user, who only has to accede to that information in order to have permission to access it.

To illustrate the growing importance that this tendency is acquiring, Gartner (2009) gave the example of the availability of the web based office suites which allowed the simultaneous work and collaboration of various people on the same file.

In relation to the expansion of social networks previously mentioned, it is worth noting the growing use of personal webs by members of the university community, motivated by the availability and access to a set of tools that allow the user to adorn the content of their web, facilitating social, professional and learning activities, amongst others (EDUCAUSE, 2009).

Finally, a topic of growing importance for university management is the need to have a correct form of identity management that allows the PDI, PAS or student gain access to the information system in a fast and easy manner. This can be seen in a tendency towards Federated Identity Management (Gartner, 2006a, 2009). Using federated identity solutions a user can use the same personal identification (user name and password) to gain access to different departments, universities, research groups, etc. This permits the exchange of information without sharing technologies of directory, security or authentication, such as required by solutions like Single Sign On which require an efficient management of synchronisation of identification data, management of access or directory services via centralised management of user identity. To function it requires the use of standards that define mechanisms to enable the university and its services to share information between domains.

Main International Tendencies (IV)

Management and Processes:

- Enterprise Resource Planning (ERP).
- Virtual desktop.
- Web based office suites.
- Personal web.
- Federated Identity Management.

People, Training and Culture

Despite the growing development of the information society, one of the barriers that is still blocking the introduction of ICT in the university is the lack of training and involvement of the members of the university community.

In Asian universities it can be seen that the use of ICT already forms part of university culture. The use of wikis and other technologies is already a reality in the classrooms of these institutions. In the last few years numerous initiatives and

Main international tendencies (V)

People, Training and Culture:

- Wikis.
- Knowledge management.
- Customer Relationship Management (CRM).
- Open Course Ware.

applications have been developed to enable distance learning, the use of which has allowed the incorporation of new services such as curriculum visualisation, promotion of self-learning and the inclusion of more social and civil content into educational materials, according to the conclusions reached from a study of available data by the Centre of Information Technology at Tokyo University.

In this context the efforts made by leading international universities in the field of knowledge management have been directed towards the setting up of university network communities and towards achieving collaboration and communal work between different virtual universities. In this way a greater coordination and homogeneity in learning contents and management procedures is achieved in the university and in the different centres integrated in the system. To aid further development in this area work is being done on creating simpler and more accessible interfaces for the whole university community.

Ex students associations are acquiring increasing importance in university life, especially in the United States. One of the main functions of these associations is keeping track of graduates and their demand for services, such as lifelong learning and career management. This is a process where the use of technological tools of Customer Relationship Management (CRM) can be of great help, allowing the establishment of policies of attraction, management and building fidelity amongst this sector of members of the university community.

In the opinion of Gartner (2009) the correct strategy in this area is for the university to have available multi-channel communications and tools of management and reporting that allow the establishment and maintenance of close links with students.

Nevertheless, this type of system could also allow, in the future, the management of relationships with other agents that are either in or connected to the university community, such as businesses, local government and all other entities who habitually interact with the university.

Finally, a growing tendency towards Open Course Ware (OCW) can be observed in the university community as a means of promotion and recognition of quality on the part of society.

1.2.2. National Context

With the aim of knowing which of these tendencies are present in Spanish universities, as well as discovering any tendencies that could be different from those found in an international context, we finish our external analysis with a revision of the present state of ICT in national universities.

The methodology followed here is similar to that used in the international case: a selection of universities have been studied in depth and different reports and studies that deal with this area have been consulted.

As a result of this analysis we can comment that ICT in Spanish universities has experienced a constant evolution in the last few years, and now forms a natural part of all the tasks and activities that can be achieved through its use (learning, research, management, processes, promotion…) (Uceda and Barro, 2009).

ICT Governance

The establishment of specific and independent ICT Governance systems in the global strategy of Spanish universities is a tendency still in its starting phase and, as such, sufficiently removed from the level reached in this respect in universities in the United States.

Here it is important to note that a great part of the universities in the Spanish system have no strategic plans for the use of ICT, and the orientation in this matter is usually defined as just another aspect within the framework of the general strategic plan of the university (or, in some cases, the regional university system).

On the other hand, it is worth pointing out that there are Spanish universities, amongst them several in Andalusia, that are working on pilot projects (Uceda y Barro, 2009) of implanting standard management models (such as CoBIT, ITIL or others) which can, in itself, be regarded as a tendency (Laviña y Mengual, 2008). This step can be seen as one leading to embarking on future processes of outsourcing of services that would improve efficiency, cut costs and reduce technological risks (Fernández, 2008).

Main National Tendencies

ICT Governance:

- Use of standard management models (such as CoBIT, ITIL or others).

Teaching and Learning:

- Incorporation of ICT in classrooms and teaching activity.
- Repositories of learning objects independent of e-learning platforms.
- Digital libries.

Research and Knowledge Transfer:

- Provision of technical means and communication tools for research.
- Establishment of agreements of collaboration with other institutions.

Management and Processes:

- Use of electronic administration.
- Data warehouses for university management.

People, Training and Culture:

- Integral ICT training.

Teaching and Learning

Nowadays the results obtained in Spanish universities from the work dedicated to incorporating ICT in the classroom and in teaching activity is self evident. The panorama of teaching has changed radically in the last decade in this respect (Marqués, 2008). According to this author, by 2015 some 80% of university professors and lecturers will be applying new didactic models using ICT in their classes. Such models are also within the current paradigms for educational innovation and the methodological renovation of classroom practices.

- The efforts of the universities have centred around:
- The improvement of wireless connectivity through the availability of wireless access throughout the university community.
- Equipping students with the availability of IT resources, using means such as: increasing the number of computers for student use, incentives for students to purchase laptops.
- Increasing the range of subjects and teaching materials on offer on virtual campuses.
- Using digital whiteboards, audiovisual materials and video-teaching.
- Work in collaborative environments, such as bulletin boards, to share learning objects of common interest.

Presently, however, we can see that the rapid development of ICT in the management of teaching and learning has slowed down after several years of a high usage of virtual platforms as teaching supports (Uceda y Barro, 2009).

The evolution towards the availability of repositories of learning objects independent of e-learning platforms is one of the trends detected at an international level that is also starting to be seen in some Spanish universities.

In Spanish universities there has been a clear evolution of the concept of a library which has led to the transformation of the way in which this service is run. For two decades now university libraries have been successfully introducing a series of changes, mostly provoked by the incursion of ICT in this area.

The growing tendency to have available a digital library could suppose a radical advance in the management of resources and costs, leading to a superior means of information storage.

Concretely, the application of ICT in service of the traditional library has, on the one hand, allowed an improvement in the management of organization, storage and document access, both in paper and electronic supports, using, for

example technologies of Radio Frequency Identification (RFID) whilst, on the other hand, the range of educational material has expanded, coming not only from the university community but also from the business world (business schools, companies…) (Urkola, 2007).

Research and Knowledge Transfer

In the field of research the provision of technical means and communication tools (computers, e-mail and collaborative work tools) for use by the PDI is currently within normal parameters but is increasing on a daily basis. In the last few years universities have increased the provision of technical means of support to research if we take into account the growing intensity of the use of such resources in the research community.

According to the CRUE reports (Uceda and Barro, 2009) the majority of Spanish universities centralise information from their researchers and divulge it via the web, which gives a clear indication of the high level of use reached in these universities.

Within the traditional functions that the university assumes is the transfer of research results to the rest of society, and this is of increasingly growing importance. The area of ICT is not a stranger to this process and it has led to the establishment of agreements of collaboration with other institutions based in the exchange of technological experience, which has increased notably in the last year (Andalusian Regional Government, 2005).

Presently the university is facing a process of defining a model for knowledge and technology transfer towards all social agents (people, universities, technological centres…). In this transference model, the materialisation of these agreements of collaboration and the initiation of new forms of collaboration can give place to an improvement in the creation and transference of research results (Gartner, 2009).

Management and Processes

The two most relevant tendencies along this Strategic Axis in the national context have to do with electronic administration and the development of data warehouses.

The progressive increase in the use of electronic administration in the area of Public Administration (BOE, 2007) also has an effect on the university. The last few years have seen a continuous advance towards the computerisation of processes associated with the distinct areas of university management, nevertheless, it can be said that Spanish universities still have a long way to go in the implantation of electronic administration.

Also relevant is the future importance of the data warehouse for university management to consolidate and administer data taken from multiple sources and obtain, in this way, useful indicators for the making of decisions.

People, Training and Culture

In accordance with the CRUE reports (Uceda and Barro, 2009), Spanish universities continue training in ICT both for PAS and PDI personnel, as well as for students. Though training courses in ICT are not so prominent amongst other training courses offered by the university, the percentage of PAS that participate in them remains stable whilst the percentage of PDI has increased significantly. Such data indicates the need to maintain training up to date, with the aim that the university community increases and/or recycles its know how, to reach integral ICT training, intensifying and designing this via planning over a number of years in this type of training.

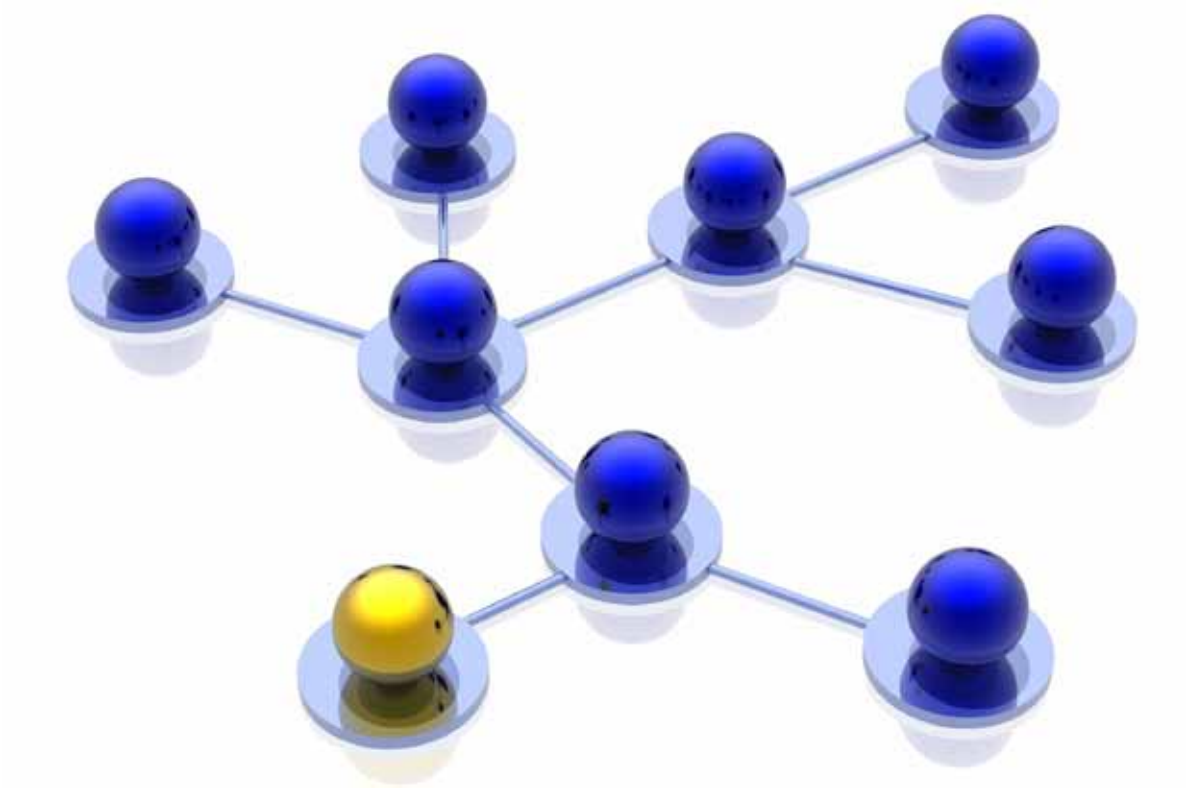
In the majority of the cases the internet is one of the tools most used by the university community as a complement to course content. This is an open and flexible means of diffusion and communication, using a very simple technology that has favoured the elimination of geographic, physical and temporal barriers of traditional learning schemes, favouring a peak in the growing model of mixed virtual/face to face teaching (Ayala et al, 2006 and EDUCAUSE, 2009).

In this sense, and centred in an analysis of training of personnel in ICT, there was a clear worry on part of the universities, not only to maintain the contents of specialised teaching up to date (observing a tendency towards a special interest in obtaining training certificates from software and/or hardware manufacturers) but also for personnel to acquire skills in management and group work.

1.2.3. Conclusions from the External Analysis

As has been mentioned previously the main tendencies detected in the process of revision and analysis of the state of ICT in the university context, both national and international, form part of a framework for the definition of the new Objective ICT Model proposed for Andalusian universities.

As such, one of the aims of the definition of the new model would be to give an adequate response to detected trends through the proposal of strategies that allow the planning of concrete actions in this material within Andalusian universities.



By way of synthesis, below we give table 1.4. Which shows the tendencies detected by the analysis made:

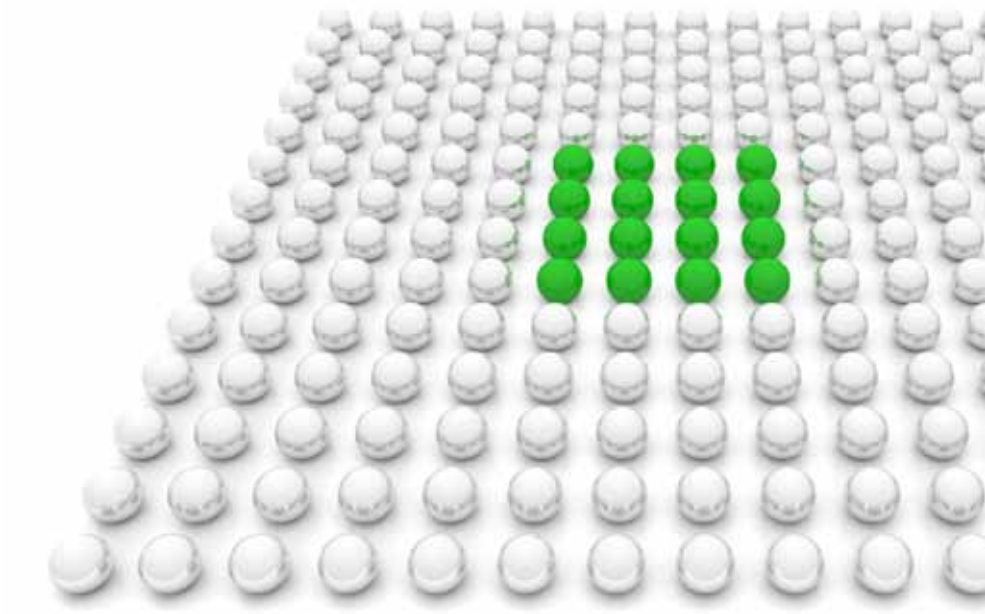
Table 1.4.
External Analysis: Main Tendencies. Source: compiled by author.

Transversal	Wireless access to services Service oriented architecture Interoperability Social networks Web based solutions Identity management.
ICT Governance	Outsourcing of support services Introduction of standardised management models (CoBIT, ITIL or others) Organisational unit in charge of centralised ICT management.
Learning and Teaching	Learning through mobile devices Digitalised libraries Social computation Cloud mail e-Portfolios Incorporation of ICT in classrooms and teaching Electronic text books E-learning platforms Learning Object Repositories Open source software Mass notification software Unique electronic report Software as a Service (SaaS).
Research and knowledge transfer	Intelligent applications with semantic search Computation as a service Provision of technical means and communication tools for research Establishment of collaboration agreements with other institutions Digital rights management Collaborative work management Technological research support tools (Grid Computation, Quantum Computation) Scientific production repositories Centralised research management systems Technical archiving and digital preservation techniques.
Management and Processes	Virtual desktop Introduction of electronic administration Data warehouse for university management Federated identity management systems Financial planning systems or resource planning modules or ERP Web based office productivity suites Personal Web.
People, Training and Culture	Open dissemination of informative, teaching, learning and cultural content Integral ICT training Customer information management or CRM Gestión de la información de usuarios o CRM Knowledge management Wikis.

With the aim of concluding the external analysis and advancing in the design of the new Objective ICT Model we have carried out an exercise in the categorisation of detected tendencies in function of the impact of their incorporation on the present ICT model.

The categories established in the exercise of prioritisation are:

- Transformation of the model: the impact is substantial and affects all the environment.
- High: implies an implementation of new processes and methodologies with a profound impact on efficiency and costs.
- Moderate: introduces improvements in operative processes, with an ensuing, tangible benefit in time and costs on a global level and an improvement in efficiency for users.
- Low: has no operative impact and it is difficult to estimate benefits or any reduction in costs, though it may improve the users experience.



In table 1.5. below the results obtained are shown:

Table 1.5.
Impact of detected tendencies. Source: compiled by author.

Transformation of the model	Service oriented architecture. Digitalised libraries. Unique electronic report. Collaborative work tools. Introduction of electronic administration. Learning Objects Repositories. Organisational unit in charge of centralised ICT management.
High	Intelligent applications with semantic search. Computation as a service. Virtual Desktop. Integral ICT training. User information management or CRM. Knowledge management. Technological research support tools. (Grid computation, Quantum Compoutation). Data warehouse for university management. Interoperability. E-learning platforms. Social networks. Scientific production repositories. Centralised research management systems. Financial planning systems or resource planning modules or ERP. Open software sources. Software as a Service (SaaS).
Moderate	Provision of technical means and communication tools for research. Incorporation of ICT in classrooms and teaching. Federated identity management systems. Web based solutions. Wireless access to services. Learning through mobile devices. Social computation. E Portfolios. Outsourcing of support services. Management of digital rights. Introduction of standardised management models (CoBIT, ITIL or others). Electronic text books. Mass notification Software. Web based office productivity suites. Archiving and digital preservation techniques. Personal web. Wikis.
Low	Cloud mail. Open dissemination of content. Establishment of collaboration agreements with other institutions.

1.3. Internal Analysis

The frame of reference for the definition of a new Objective ICT Model has to be completed with the analysis of the present situation of ICT in Andalusian Public Universities. As such, in this section we present the characterisation and diagnosis of the present state of ICT in said institutions. This analysis is based on one hand on the previously identified tendencies, and on the other in a review of information gathered from both primary and secondary sources.

Primary sources of information are based in direct observation of the real world. In these cases we have carried out personal interviews with those responsible for the area of ICT in Andalusian universities (at the level of vice-chancellor and director of information services and virtual education services). Secondary sources are based in books, reports, papers and other documentation that serves as a complement to the analysis of the previously mentioned material (primary information obtained directly). This secondary information has been obtained from the following sources: reviews of web sites, analysis of strategic plans, searches for documentation on the management of ICT in said institutions and analyses of recognised university reports on this aspect, such as the UNIVERSITIC report (Uceda and Barro, 2009).

Overall, the information considered in the development of this analysis has been the following:

- Strategic plans of institutions and the role of ICT as a means of making a diagnosis of the situation of ICT Governance in Andalusian Public Universities.
- The policies of ICT usage in these universities.
- The prospective for ICT in universities, based on interviews with people responsible for this area.
- The UNIVERSIICT report, edited by the Conference of Chancellors of Spanish Universities -CRUE (Uceda and Barro, 2009).

The UNIVERSITIC report (Uceda y Barro, 2009) constitutes one of the most relevant sources of information for the development of this analysis. It centres around an evaluation of the situation of ICT in the Spanish University System and proposes a model for planning in this area. The aim of the Objective ICT Model that is put forward in this white paper, is to provide Andalusian universities with tools and guidelines for action that can serve them in the process of individual planning.

Finally, the global outlook on the analysis and planning of ICT includes a set of objectives that can be roughly classified and prioritised into lines of strategy, complementary lines and recommendations, which can be shared by all universities. In chapter three the unfolding of these objectives is described.

Below we present a summary of the main conclusions derived from internal analysis, following the structure as defined by the five Strategic Axes of university management that sets a common framework for analysis in this white paper.

1.3.1. ICT Governance

Main Conclusions (I)

ICT Governance:

- SDetection of a greater relevance of ICT in the strategy of the university.
- There is, in a global manner, a defined organizational structure in the field of ICT.
- Strategic planning now exists in all Andalusian universities.
- Shortages are detected with respect to the plans for provisioning and distribution of human resources in ICT.

In general it is found that in Andalusian universities there is a growing importance in ICT within the overall strategy of the university, which translates to a series of changes in relation to the field of ICT: an increase in the budget allocated to this area, the optimisation of its management, the divulgation and promotion of its use by all members of the university community, as well as the greater relevance that is assigned to it in relation to other fields of university management.

In the majority of Andalusian universities analysed the area of ICT has a defined organizational structure and, at the same time, it is found to be represented in the structures of government.

It is also worthy of note that a Relation of Job Positions exists in the PAS that covers those positions related to the area of ICT. Evidently, this fact is important for the correct functioning of the organizational structure of that area.

With regard to the disposition of a plan of provisioning and distribution of human resources in ICT, it can be said that average for the Andalusian University System is below that of the Spanish University System, according to the UNIVERSITIC report (Uceda and Barro, 2009). This, a priori, demands an individual analysis on the part of each one of the public universities that takes into account the real ICT needs to which it has to respond together with a correct deployment of human resources, as well as the specialisation required in ICT by the team that works in that area.

With respect to the plans for development of ICT in the strategic context of the university, it can be said that the majority of the initiatives related to ICT, including those in the strategic plans of the Andalusian universities, have to do with distinct areas, that is to say that they acquire a transversal character. For example it can be seen that the aim of the "Impulse to the modernisation of the services offered via e-administration", found within the Strategic Axis "A

sustainable university that looks towards the future", is presented in a concrete, evaluated plan.

In this aspect, according to the UNIVERSITIC report (Uceda and Barro, 2009), the existence of strategic plans in all the Andalusian Public Universities is noteworthy, exceeding the average for the Spanish University System. This is a very positive and relevant element at the moment of drawing up plans of action to take the university towards the Objective Model for university ICT that is presented in the next chapter, given that the ability to depend on the support of commited university government is the primordial element in the success of the implementation of ICT.

Similarly both the strategic plans in the field of ICT and the directive plans of the information systems elaborated by Andalusian universities are generally found to be in line with present and future needs associated with ICT services.

With regard to funding, it is important to take note that the budgetary allocation in Andalusian universities is correctly distributed to provide those services that are in the domain of ICT. In this sense the ICT budget with respect to the total budget for Andalucian universities is below the average for Spanish universities, according to the UNIVERSITIC report (Uceda and Barro, 2009).

Nevertheless, there are other lines of funding that can complement the budgetary allocation of the Andalusian universities for the achievement of their strategic objectives in the area of ICT, where the Digital University programme promoted by the CEIC of the Andalusian Regional Government is outstanding.

This programme, by virtue of the agreement that exists between the CEIC and the Andalusian Public Universities, permits the development of ICT projects related to diverse Strategic Axes, as described elsewhere in this paper, such as: the installation of wifi coverage in Andalusian universities, connection to the EDUcation ROAMing (EDUROAM) area of wifi mobility promoted by RedIRIS, the setting up of the Virtual Andalusian Campus, the setting up of advanced study classrooms, the implantation of e-administration, the establishment of support services for the digitalisation of contents, the amplification of virtual classrooms with new tools and the augmentation of the data warehouse of Andalusian universities and the CEIC.

Only a very reduced percentage of the planned investment in ICT comes from outside sources. If one discounts the Digital University programme then this investment is practically non existent. There may be some Andalusian universities that start to obtain funding from other programmes, for example the Avanza programme of the Ministry of Industry, Tourism and Commerce, which would contribute to alleviating the situation. This is, evidently an area that needs improvement and requires the search for alternative sources of funding for ICT,

Main Conclusions (II)

ICT Governance:

- The existence of the Digital University programme, promoted by the CEIC of the Anddalusian Regional Government to complement the funding of Andalusian universities for the realisation of their strategic objectives in the field of ICT.
- The need to find alternative sources of funding for ICT in Andalusian universities.
- The promotion of the use of consortiums for the purchase of technologies and the use of the modality of equipment renting.
- The development of policies of outsourcing of services and infrastructure specific to ICT.

for example, through national and international research projects, collaboration with private companies, etc.

With regard to the management of ICT resources and policies of acquisition, in line with the information obtained from Andalusian universities, no definite policies for the management of ICT resources and their acquisition have been identified. Nevertheless, there are universities that participate in consortiums of purchase of technologies that utilise the modality of equipment renting.

As the UNIVERSITIC report indicates (Uceda and Barro, 2009), the average disposition to planned renovation of ICT infrastructures is lower than the national average. This demonstrates the necessity of planning with respect to the period of use and repayment of said ICT infrastructures and their renovation.

Alongside these considerations there is also the recommendation to carry out a policy of outsourcing of specific ICT infrastructures and services that supports the correct construction of a model for the use of such services. In other areas, for example that of Public Administration, this is already an extended practice.

It is interesting to note that Andalusian universities do have an adequate technological infrastructure on the university campuses, even though this has to adapt to the access to new contents and their transportability. Lastly, in terms of promoting the ubiquity of ICT services, there are already projects underway in some universities, though their implantation is not observed to be very extended.

In the concrete case of the infrastructure for external communications in Andalusian universities, their practical homogenisation is noteworthy in all of them, being managed by the Scientific Information Network of Andalusia (RICA) the bandwidth of which has recently been augmented. This shared infrastructure can be considered as an opportunity for future integrations or demands that require interoperability.

With respect to the use of good practices related to the management of ICT, it can be said that the majority of Andalusian universities use systems of incident management and maintenance procedures of ICT infrastructure. Approximately half of the universities make use of problem management, security management, management of service levels and management of availability. Less than half make use of configuration management, version management, continuity management, change management and risk management.

There also exists a need to promote the use of management solutions based on the Information Technologies Infrastructure Library (ITIL) that would assure the correct running of ICT services. These tools are considered fundamental to the monitoring of services of support and attention to ICT users.

The application of recognised standards are covered by legal and normative aspects, such as norms of corporate government of ICT ISO38500, systems of quality control ISO9001, systems of control of information security ISO27001 and systems of service management ICT ISO20000, amongst others; as well as there being security procedures and conformity with applicable standards. This is a very relevant area within the EHEA (Ministry of Education, 2009), given that it aims at the development of the use of quality control systems.

In this particular aspect Andalusian universities are generally behind the Spanish average, according to the UNIVERSITIC report, whilst the aplication of the ICT Governance norm ISO38500 is practically inexistent in Andalusian universities. The development of recognised standards such as ISO9001, ISO27001 and ISO38500, apart from being protocols that guarantee security and conformity with the norm, stands as a challenge in the short term for Andalusian universities.

In Andalusian universities the majority of the IT services have service charts or are in the process of elaborating them. Furthermore, we can see a clear tendency in all universities towards the use of the EFQM (European Foundation For Quality Management) model. This results in benefit of the previously mentioned aspects relating to the level of excellence of ICT services, as well as serving as a link between the area of ICT and the rest of the university organisation.

Main Conclusions (III)

ICT Governance:

- Promote the use of solutions in service management based in ITIL (Information Technologies Infrastructure Library).
- Implant the norms of corporate government ICT ISO38500.

1.3.2. Teaching and Learning

In these universities ICT is of growing importance in the teaching and learning process. ICT is used in the context of this axis in both activities, the situation in the Andalusian universities is given below, as a support to face to face teaching and as a fundamental support in virtual teaching.

The teaching practiced in Andalusian universities is characterised by the increase in ICT equipment in the classroom, though there are certain differences in this aspect, depending on the university or centre in question.

There are IT systems that expand and complement face to face teaching. In this sense, virtual teaching is used as a support, for example, with Learning Management Systems (LMS), such as Moodle, WebCT or Ilias, that are presently to be found in all Andalusian universities. These tools are used to support face to face teaching via the publishing of results, the realisation of tutorials based on forums, communication between students, the handing in of course work, amongst others.

Main Conclusions (IV)

Teaching and Learning:

- An increase in ICT equipment for development in use with face to face teaching.
- Platforms such as Moodle, WebCT or Ilias are used that expand and complement face to face teaching.
- Learning Objects Repositories (LOR) are in use that incorporate learning objects, authoring tools, publication, collaboration and administration.
- There is a notable use of other technologies to support face to face teaching, such as wifi connectivity or digital, interactive whiteboards.
- In various Andalusian universities there are plans for teaching innovation linked to the adaptation of subjects and methodologies to the EHEA.
- With regard to virtual teaching it is worth noting the use of correct scaling of IT support systems, as well as of infrastructure and content.

Some Andalusian universities are in a phase of evolution and installation of other ICT tools for face to face teaching such as the use of specific software to record live classes and the use of video to relay classes over the internet, making them available at any time.

The development of open, free contents is becoming generalised, associated with the initiative to publish study materials using OpenCourseWare, initiated by various North American universities (Universia, 2008).

Learning Objects Repositories (LOR) are being developed that incorporate learning objects, authoring tools, publishing tools, collaborative tools and their administration.

In the case of ICT equipment in traditional classrooms, according to the UNIVERSITIC report, the average in Andalusian universities is above that in Spanish universities in general, with regard to the number of multimedia projectors dedicated to classroom use and in the number of computers that are freely accessible to students (this figure is double that of the rest of Spanish universities).

With respect to the availability of other new support technologies for face to face teaching such as wifi connectivity or digital and interactive whiteboards, Andalusian universities are also ahead of other Spanish universities. According to the UNIVERSITIC report, the percentage of classrooms with wifi cover in Andalusian Public Universities is practically one hundred percent whilst installations of digital whiteboards or similar, triples the Spanish average. In the case of wifi technology this is one of the initiative promoted by the CEIC of the Andalusian Regional Government within the Digital University programme.

Also, in various Andalusian universities, there are plans for teaching innovation linked to the adaptation of subjects and methodologies to the EHEA (Ministry of Education, 2009), which include specific projects using ICT as a support for face to face teaching.

It is necessary to add here that the relevance acquired by course descriptions in the EHEA as being elements around which the whole process of teaching and learning pivots. In fact, in some universities applications are in use that allow the publication and proliferation of these course descriptions, linking directly to the system of content management of the university web page. In this way these can be published automatically in the portal and also incorporate the workflow of the administrative process of the Plan for Teaching Organisation (POD) and of the approval of these descriptionsby departments.

With regard to virtual teaching, this is found to be operating at the correct scale in so far as refers to IT support systems, such as infrastructure and content. In the Andalusian Regional Government's Contract Programme with the Andalusian Public Universities there are specific indicators included about this type of teaching and the CEIC has promoted the Andalusian Virtual Campus project within the Digital University programme. These measures are, without a doubt, fortifying this type of teaching in the Andalusian University System.

It is worth noting that there is already one Andalusian university that has its own set of norms for quality control of the digital content in the virtual classroom, as well as systems of quality control for its virtual teaching services.

In the area of virtual teaching various platforms are currently being used for the management of courses such as Moodle, WebCT or Ilias, but, in general, few other channels or learning mediums such as social networks or web 2.0 tools are being used. Nevertheless there is one example of an Andalusian university campus where Second Life is in use, which is in line with certain tendencies identified at an international level in the previous section on external analysis.

According to the UNIVERSITIC report it is worth pointing out that platforms of virtual learning are more used by students than by the university PDI, whose use of them is below the Spanish average. This could be justified if we consider that it is the courses where the student teacher ratio is highest where most use of these platforms are made.

On the other hand, the majority of Andalusian universities promote and support the effective integration of technology and teaching through the creation of centres or departments of virtual learning, which have the specific human resources necessary to carry out this function.

This allows the use of personalised services for the creation of virtual courses (digitalization of contents, tutorials using messenger services, chat, forums…) and for supporting the use of ICT in teaching, which is aiding teachers in Andalusian universities to make use of virtual campuses. These measures facilitate the use of virtual campuses by the PDI, given that, without the contribution of both students and teachers, it would be impossible for the use of these systems to become generalised and maximum advantage taken of the opportunities that exist, as indicated in the previous section on external analysis.

Despite the fact that the UNIVERSITIC report indicates comparatively less use of this type of virtual education platform on the part of the PDI in Andalusian

Main Conclusions (V)

Teaching and Learning:

- Promotion of the use of social networks and web 2.0 tools.
- The majority of Andalusian universities promote and support the effective integration of technology in teaching through virtual learning centres or departments.
- It is necessary to make available a unique, electronic, academic report, such as is mentioned in the context of the EHEA (Ministry of Education, 2009).
- In the area of academic management Andalusian universities have to continue advancing towards achieving interoperability.
- The use of ICT, for both face to face and virtual teaching, will contribute to the ability to respond to the challenge of the EHEA (Ministry of Education, 2009).

Public Universities, there are notable, specific programmes and actions in place to promote this type of use.

Amongst the initiatives intended to promote the use of this type of platform it is worth drawing attention to the those related to the creation of projects that involve various subjects and educators (that can be from different centres and with varying qualifications) and to the promotion of meetings and conferences where experiences from various disciplines can be shared, thereby promoting the knowledge of good practices. Other initiatives are direct incentives for the PDI, the creation of networks for the PDI and towards the participation in congresses. Initiatives to promote good practices and participation in congresses already exist in an important part of Andalusian universities.

Nevertheless, direct incentives towards the PDI are not found in all universities, neither for the use of the above mentioned platforms nor for the creation of content. This is an area that needs further encouragement, given the value to teachers of using these systems in the education process, which makes them, therefore, also of great importance to the student.

In the context of EHEA (Ministry of Education, 2009) it is necessary to have a unique electronic academic record or a centralised control of student's qualifications in format that is incompatible with other university systems in different European countries. This has an effect on the standardisation of records and in the movement towards student mobility which demands student records that can be used in different universities. Elsewhere the EHEA (Ministry of Education, 2009) posed the necessity to adopt a system of transparent, comprehensible and comparable awards as contemplated by the European Awards Supplement. This document, which gathers academic and professional information related to the students, including courses studied and skills and abilities acquired, has to be supported by ICT services in Andalusian universities in a near future. Closely related to this aspect we find the applications of e-portfolios, understood as a form of demonstrating the level of learning reached by students.

In the area of academic management, considering both the trends noted in the section on external analysis and the strategic frame of reference of the Andalusian universities, these institutions have to continue advancing towards achieving the aim of interoperability already mentioned.

Without doubt, in the last few years a progressive movement has taken place towards the use of more personalised and advanced ICT services applied to the different functions of the university. It is also worth noting the use of ICT in recent initiatives for improving the planning of teaching in Andalusian universities, as well as providing information about it, such as the use of web

services of information on POD in the university or the applications mentioned for the elaboration and diffusion of course descriptions.

Furthermore, other challenges posed by the EHEA (Ministry of Education, 2009) such as that related to a system based on two levels, graduate and postgraduate, are of increasing importance in the use of ICT as a support for face to face teaching. The thing is that although university teaching is mainly of this type the use of ICT gives postgraduate students the possibility to continue training after they have already found a place in the labour market. The use of ICT also needs to permit the attraction of new students, particularly in the postgraduate sector.

In a complementary way the use of ICT both for virtual and face to face teaching contribute to facing the challenge of the EHEA (Ministry of Education 2009), that consists in improving graduate employment possibilities, understood as the capacity to find a first job, to keep it and be competitive in the labour market, given that they have at their disposal the best specific professional skills.

Lastly, it is worth mentioning another area where work needs to be done in Andalusian universities, ICT support for lifelong learning, as this would provide a response to another of the challenges of the EHEA (Ministry of Education, 2009), which is the promotion of this type of education to improve knowledge, skills and abilities from a personal, civic, social and career perspective. This type of learning also permits a continuous renewal and recycling of knowledge.

1.3.3. Research and Knowledge Transfer

The use of ICT as a support for research is of increasing relevance in Andalusian universities. Some of these provide a unique window or portal to the researcher which combines specific services aimed at research work, such as the management of grants and access to economic management systems for research projects and contracts. Similarly, we find an adequate development in access to online documentation.

There are also other aspects, such as the facilitation of research work by relieving researchers of administrative tasks (project management, subsidies, etc.), through the incorporation of automated systems, the use of the internet to promote research work and provision of support for divulgation of its results. In the light of the results of this analysis we can also appreciate opportunities for improvements in this area, as there is of yet no general

availability of these systems of research support and promotion, neither are there available integral management systems whose functionality is directed to diverse profiles such as: managers, researchers, research programmes, etc.).

Noteworthy within the Andalusian University System is the existence of ICT services to support the development of research activity both in the assessment of acquisitions of specific equipment and information systems and in the area of their maintenance (corrective and preventive). Moreover, Andalusian universities have at their disposal the Andalusian Scientific Information System (SICA) which manages and maintains, in a centralised form, the scientific production of all research groups and their members.

With regard to the promotion of innovation in the area of ICT, there have been some notable developments in the panorama of Andalusian universities, such as one which specifically promotes projects of international research into the use of ICT in the field of education.

Another aspect of great importance for research work in the Andalusian University System over the next few years consists in making services of supercomputing available to researchers, along with the establishing of agreements for the use of these services in collaboration with other centres. Certain research activities are becoming increasingly complex and intensive, requiring the availability of such computational resources to support and facilitate their realisation.

In relation to the transfer of knowledge, in Andalusian universities work still needs to be done in promoting the use of ICT in this important field of university activity, developing virtual meeting points and facilities for collaboration with the socioeconomic environment. As evidence of this we can point to the example of an Andalusian university that already uses IT systems for managing the curricula of researchers and their availability for external consultancy, or to the web portals developed by the Office of Research Transference for universities (eOTRIs).

The use of social networks for the promotion of research also opens up numerous possibilities in this field.

Another area where ICT could play a major role is in improving the visibility of research results, which would, doubtlessly, facilitate their dissemination and make way for funding based on them, leading to contracts for specific research work. In this sense the development of systems of repositories of federated scientific production is necessary to make the work done in this field by university researchers both visible and available. It should also

Main Conclusions (VI)

Research and Knowledge Transfer:

- Some Andalusian universities provide a unique portal for researchers.
- The existence of the Andalusian Scientific Information System (SICA), which manages and maintains in a centralised form, the curricula and scientific production of all research groups and their members.

permit interoperability with other such repositories at a regional, national and international level.

1.3.4. Management and Processes

Firstly, we have to point out that in many Andalusian Public Universities the processes of management are already automated and integrated, though there are certain limitations at the level of interoperability, especially in external interoperability with the IT systems of other entities and public bodies.

According to the UNIVERSITIC report, practically eighty percent of university management processes are already done by computer in Andalusian universities, a figure that is above the Spanish average.

With regard to interoperability, its development is regulated in accordance with the Law 11/2007 (BOE, 2007), which insists on the availability of an interoperable platform for IT in public administration and other public bodies.

The integration of IT systems and internal interoperability, that is to say the use of common or shared data and IT systems within the university, are well developed within the Andalusian University System (a more detailed analysis of this aspect is included in another section in this chapter) though there is still a long way to go in this respect.

With regard to the possibility to share and integrate information between Andalusian universities, there are already developed processes in all of these institutions that are capable of generating interesting synergies, as is the case of the centralised application process, and at the Andalusian level there is the Unique Andalusian District, managed by the CEIC of the Andalusian Regional Government.

With regard to interoperability with universities external to the Andalusian University System and/or public institutions the level of development is still in its initial stages. Work has to be done on the integration of data and basic services, on the generalised use of standards (educational and technological), in guaranteeing the security of data and processes, and, lastly, in the development of interoperable services that are open and accessible with secure, personalised access in each case.

In this line of action some initiatives stand out that could be precursors of a future unique electronic academic record previously mentioned with regard

Main Conclusions (VII)

Research and Knowledge Transfer:

- To promote good practices such as: IT systems for researcher curricular management and their availability for external consulting, or web portals developed by the Office of Research Transference for universities (eOTRIs).
- The development of systems of repositories of federated scientific production to make the work done in this field by universities both visible and available and to permit interoperability with other such repositories at a regional, national and international level.

Management and Processes:

- In the automated processes of management of Andalusian universities there are certain limitations at the level of external interoperability with the IT systems of other entities and public bodies.
- The centralised application process is noteworthy with regard to the possibility of information sharing , whilst at the Andalusian level there is the Unique Andalusian District.

Main Conclusions (VIII)

Management and Processes:

- Promotion of the integration of data and basic services and the generalised use of standards (educational and technological) in guaranteeing the security of data and processes, and also in the development of interoperable services that are open and accessible with secure, personalised access in each case.
- The setting up within the Andalusian University System of a Federation of Identities system that is common to all Andalusian universities.
- Collaborative work tools are used, though generally this is restricted to e-mails and distribution lists.
- The virtual desktop is a reality in one Andalusian university and this practice should be extended to the rest.
- Promotion of the creation of centres of multi-channel attention to users, both internal and external.
- With respect to the development of electronic administration, Law 11/2007 (BOE, 2007), all Andalusian universities have initiated an adaptation process to bring themselves in line with this law. Towards this end they are using the W@nda platform of electronic administration provided by the Andalusian Regional Government.

to the axis of teaching and learning, examples are the e-portfolio and the centralised application process.

Presently, university management has available personalised web services for the user, accessible through a unique identity that is being integrated progressively with other services such as information on personnel, finance management of projects and research contracts, amongst others. ICT is also of great help in many habitual activities and processes of the daily running of a university, such as management of university access and attendance, the drafting, publication and inscription of cultural and sporting events, and the management of library archives, loans and requests.

In the area of privacy and access to ICT services, it is worth mentioning the effort of the Andalucian University System in creating a Federated Identity System common to all Andalusian universities.

Similarly, Andalusian universities are using collaborative work tools in their various management processes. Nevertheless these are restricted to mainly e-mails and distribution lists. The collaborative work tools used most extensively are Basic Support for Cooperative Working (BSCW) and Alfresco.

Another element is the virtual desktop, contributing to access to a desktop from anywhere, for work done by both PDI and PAS. This application is already in use in one Andalusian university and in process of implantation in another. It consists in a web based virtual desktop that offers users the possibility of saving files, creating documents and to work remotely with different applications. In fact, files can be accessed from any point, edited, saved and recovered. This system provides important benefits in the adaptation to the EHEA (Ministry of Education, 2009) which has amongst its challenges the need for greater mobility.

Despite the general situation in Andalusian Public Universities, the modernisation of process management and its operating is positive, though there are certain elements that need more work. One line of action that can be identified is the creation of multi-channel attention centres for internal and external attention to users. Presently there is already one centre for attention to users, but it cannot be classed as an integrated, multi-channel service (web, telephone, e-mail…) where any technical question can be resolved, both internally and externally.

Regarding the development of electronic administration, as expressed in the Law 11/2007 (BOE, 2007), all Andalusian Public Universities have started the

process of adaptation to conform with said law. The Andalusian Regional Government, through the CEIC, has put the W@nda platform of electronic administration at the disposal of Andalusian universities in the context of the plan of implementation of electronic administration within the Digital University programme.

Presently, the basic components of electronic administration, such as the digital signature, secure payment gateways, time stamping, processing engines, archived document control and content control, are already in use in all Andalusian universities. Nevertheless the possibility to handle administrative processes online is limited to only a few of these: in the main, to the downloading of forms. Some Andalusian universities have a telematic register that permits the presentation of general instances and the application for teaching merits.

In line with the UNIVERSITIC report, it can be said that Andalucian universities are above the national average with regard to the percentage of electronic administration technologies available, and in line with the national average in the use of applications for document control. The most notable difference seen is in the percentage of home grown technologies, specifically for electronic administration which has an average of around eighty percent in Andalusian universities, much higher than in other Spanish universities.

As a result of the internal analysis it can be deduced that the development of electronic administration is unequal between Andalusian universities (some initiated the process of incorporation later). On this point it is necessary to indicate the important part played by change management in the effective incorporation of electronic administration, as well as the necessary process simplification and rationalisation of administrative procedures. These factors are being dealt with in one way or another in all Andalusian universities as part of this process of incorporation.

Lastly, we have to point out that, although a commendable effort is being made by the Andalusian Regional Government and the Andalusian University System for the effective introduction of electronic administration into the Andalusian university environment, there is still a need for outlining a common strategy for the specific evolution of electronic administration in Andalusian Public Universities. This evolution would reduce costs and help solve integration problems and the removal of other difficulties resulting from the use of various systems and service providers.

1.3.5. People, Training and Culture

The growing level of IT skills amongst Andalusian students, who have, for the most part, been using computers in their previous educational experience, brings with it a gradual increase in the demand for the use of ICT services in response to the higher level of technological preparation found amongst this collective.

There is an increasing tendency to facilitate the access of university community members to the universities resources of tools and applications from external systems. In some Andalusian universities this access is limited to basic services such as electronic mail, whilst in others it is possible to perform more complex tasks when working outside the university environment. This has become possible thanks to the generalisation of the use of identification systems and secure access to intranets that include the use of private and secure virtual networks.

The existence of training schemes in ICT and virtual education can be found in all Andalusian universities, though, in some cases, these do not cater to all groups that form part of the university community (students, for example). In general there is no adequate policy aimed at lifelong learning through the use of ICT, which, if it did exist, would considerably improve the training received by technical staff and increase the skill level in ICT of both the PDI and the PAS. This, evidently, indicates a scenario where there is room for improvement in the area of organisation of human resources in relation to ICT use. For most students, ICT skills are acquired on regulated courses, but there are initiatives underway to introduce training in this area at the start of their university career.

In some Andalusian universities there are specific training schemes for developing skills in ICT for the PAS, with the average budget dedicated to this specialised training being around the Spanish average, according to the UNIVERSITIC report. With regard to certified technical training for ICT staff, in general it can be said that there is practically an inexistence of access to professional certification, neither from ITIL nor from hardware and software manufacturers (Oracle, Cisco, Sun…). In Andalusian universities there are few activities found in relation to the promotion and divulgence of ICT knowledge management, though certain initiatives related to the diffusion of free software or the internet can be identified. The development of specific activities to promote knowledge of ICT use in society contributes to the fulfilment of one of the aims of the EHEA (Ministry of Education, 2009), which is the improvement of employability for Europeans, understood as the capacity to find initial employment, to keep it and to be competitive in the labour market.

Main Conclusions (IX)

People, Training and Culture:

- Plans for training in ICT and virtual education are found to be in existence in all Andalusian universities, though in some cases these do not cover all of the groups that take part in the university community.
- In some Andalusian universities there are specific training schemes for technical staff working in the area of ICT.
- Access to the acquisition of professional qualifications in areas such as ITIL, or from specific hardware and software manufacturers, is practically inexistent.

With regard to the use of free software, Andalusian universities are slightly above the national average in the number of computers that have operating systems based on free software.

In the majority of strategic plans for Andalusian universities there are considerations for lifelong learning and support for insertion in the labour market through the promotion of an entrepreneurial spirit amongst students. Nevertheless there is no evidence of the use of ICT to contribute to reaching these objectives.

It is noteworthy that in Andalusian universities there are plans to promote the adequate and cohesive use of ICT, putting them above the Spanish average in this respect.

In the field of diffusion and promotion of culture we find the innovative use of ICT in the project CaCoCu (Channel for Contemporary Culture in Andalusian Public Universities) based in the use of multimedia portals.

The use of audiovisual materials in university campuses as a means to relay institutional messages is on the increase. These means include screens, multimedia information points and interactive kiosks for information and administrative procedures. Also different formats of audiovisual materials are starting to be used, with campus coverage for channels such as TV/radio, IP Video and digital newspapers, and means of promoting the use of these are being studied.

Another aspect of great social interest is the use of ICT to promote environmental sustainability which is presently being witnessed in the Andalusian University System in examples such as the employment on campus of home automation techniques in the management and control of energy saving in lighting, heating and air conditioning.

Despite the high level reached by Andalusian universities on this Strategic Axis, opportunities for improvement can be identified in the area of training, people and culture that could materialise over the coming years through the use of specific technologies:

- The promotion of activities with ICT content directed towards society, such as could be the application of ICT for finding employment for graduates and the management of the process of active job seeking (Virtual fairs for job seekers, reserve lists, etc.).
- ICT use as a platform for the diffusion and participation in important areas for the university community such as the development of the convergence process with the EHEA, particularly using technologies

Main Conclusions (X)

People, Training and Culture:

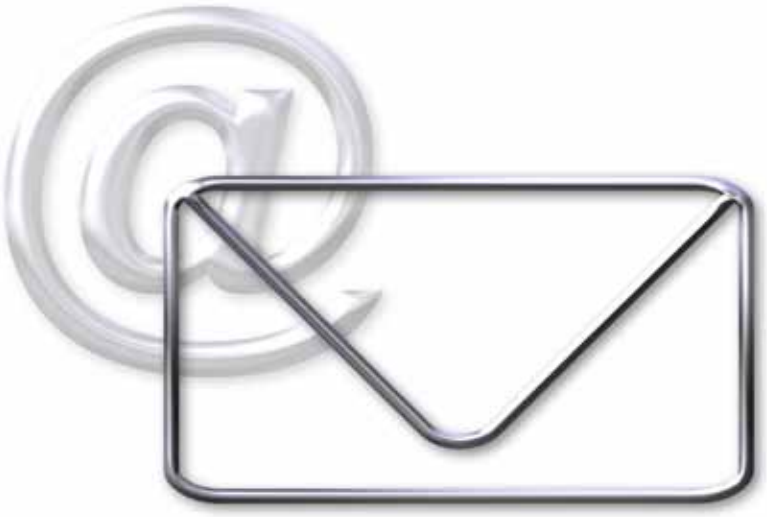
- Andalusian universities are above the national average in computers with freely distributed operating systems.
- ICT is in use to improve environmental sustainability in the university.

based in the internet, as is already being done in some Andalusian universities.

- The development of transversal initiatives in the university such as the design of training schemes for lifelong learning in ICT material and virtual education aimed at all members of the university community or people external to it.
- The provision of support and audiovisual materials in university campuses that permit effective and immediate communication between members of the university community.
- The spread of the use of collaborative work tools and systems of knowledge management that place value on the intellectual capital of the university.

1.3.6. The Challenge of System Integration

A study has been made of the depth of integration and internal interoperability of the main IT systems in use in Andalusian universities. The main solutions introduced (self developed or from third parties), their level of integration in each system and the mechanisms that make this possible have also been examined. At the moment the integration of systems is, without doubt, a growing and important challenge for universities having to meet the demands made by the EHEA (Ministry of Education, 2009).



This analysis was performed via a series of questionnaires given to directors and those responsible for ICT services in Andalusian universities. The basis for this was taken from a study made of the integration of systems in universities in the United Kingdom in the context of the MUSIC project (JISC, 2007).

The following systems were analysed:

Table 1.6.
Systems Analysed. Source: compiled by author

Financial Management
Human Resources
Heritage Management
Academic Management
Time Management
Library
Virtual Education
E-portfolio
Research Management

This study discovered that in most Andalusian universities the main systems of transversal information throughout an organisation, such as finance management, Human Resources and Heritage Management, are supported by just one provider. In this case it was OCU with the solution Universities XXI. In the case of functionality of training and evaluation the Meta4 solution, PeopleNet, is outstanding. In the case of libraries the most wide spread solution was Innopac Millenium. With regard to virtual education systems Andalusian universities tend towards the use of WebCT, Moodle or Ilias. Research Management relied mostly on self developed solutions. The functionality that IT systems provide for Heritage Management in the universities studied, is almost exclusively limited to the management of its material heritage of properties and their contents and their integration with Financial Accountancy.

Main Conclusions (XI)

The Challenge of System Integration:

- At the moment the integration of systems is, without doubt, a growing and important challenge for universities having to meet the demands made by the EHEA.
- In most Andalusian universities the main systems of transversal information throughout an organisation, such as finance management, Human Resources and Heritage Management, are supported by just one provider.
- With regard to virtual education systems Andalusian universities tend towards the use of WebCT, Moodle or Ilias.
- Research Management relies mostly on self developed solutions.

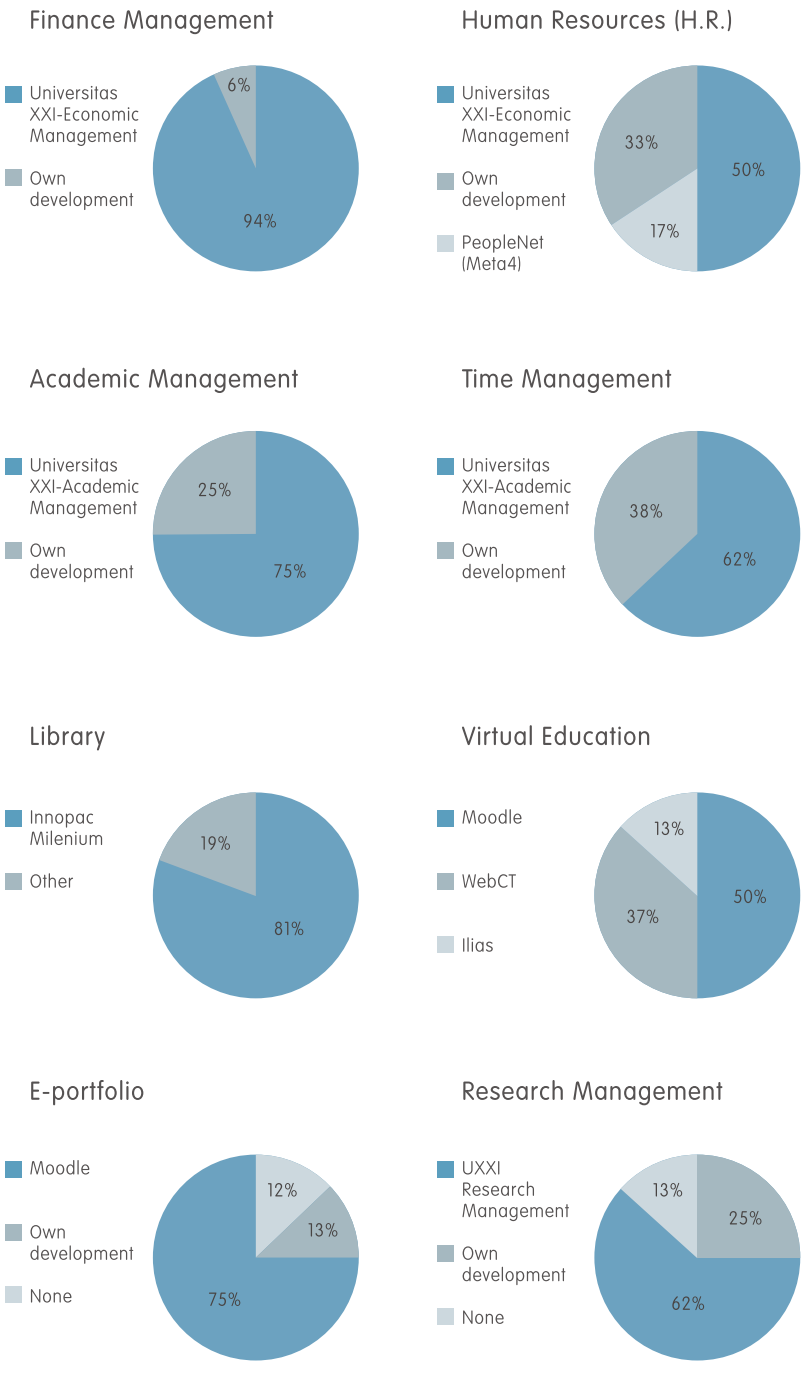
Below we show the principle providers of each of the systems analysed (only for those that provide more than one solution).

Figure 1.2.
Main providers. Source: compiled by author.

Main Conclusions (XIII)

The Challenge of System Integration:

- *Universitas XXI* (UXXI) es el principal proveedor para Gestión Financia, Recursos Humanos, Gestión Académica, Gestión de Horarios y Gestión de Investigación.
- *Moodle* es el sistema para la enseñanza virtual más empleado para la Enseñanza Virtual y el *e-portfolio*.
- Innopac *Millenium* es el proveedor más utilizado para Biblioteca.



The following table shows the percentage of Andalusian universities that acknowledge the use of some form of integration between information systems, being 100% equivalent in 10 universities.

Table 1.7.
Percentage of Andalusian universities that use some form of integration between the different functionalities analysed.
Source: compiled by author.

	Finance Management	H.R.	Heritage Management	Academic Management	Time Management	Library	Virtual Education	E-portfolio	Research Management
Finance M.	100%	75%	88%	75%	13%	25%	13%	0%	63%
H.R.	75%	100%	50%	88%	63%	75%	50%	13%	50%
Heritage M.	88%	50%	100%	50%	38%	13%	13%	0%	25%
Academic M.	75%	88%	50%	100%	88%	63%	88%	13%	50%
Time M.	13%	63%	38%	88%	100%	0%	38%	13%	13%
Library	25%	75%	13%	63%	0%	100%	13%	0%	13%
Virtual E.	13%	50%	13%	88%	38%	13%	100%	13%	13%
E-portfolio	0%	13%	0%	13%	13%	0%	13%	100%	0%

As can be seen in the previous table Academic Management is the IT system that is most integrates with other systems in the Andalusian University System and the e-portfolio is the least integrated, up to the point where the majority of universities returning questionnaires stated that they had no system available to support this function.

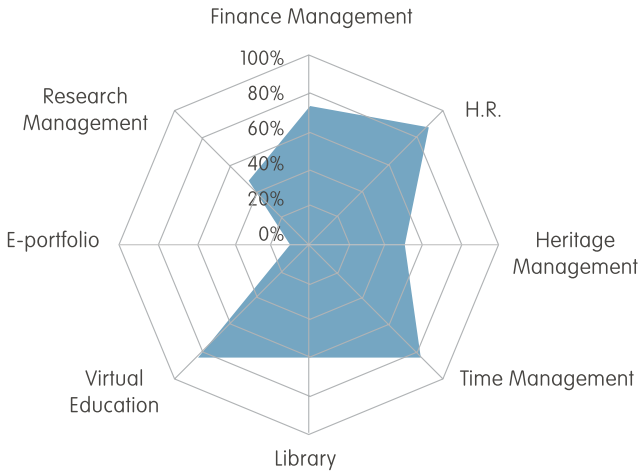
It is important to point out the relation between the IT systems used in Academic Management with other systems in use. Academic Management is normally considered as the nucleus of the integration model for the remaining systems.

Main Conclusions (XIII)

The Challenge of System Integration:

- Academic Management is the IT system most integrated with other systems in use.
- Academic Management is normally considered as the nucleus of the integration model for other systems in use.
- Little integration exists between the e-portfolio and Academic Management.

Figure 1.3.
Percentage of universities where Academic Management is integrated with other systems in use. Source: compiled by author.



It is found that nearly all the universities studied in one way or another integrate Academic Management with Virtual Education systems, Timetable Management and Human Resources. Especially notable is the low degree of integration between e-portfolios and Academic Management.

Below is an analysis of the integration of two other systems of special interest (finance management and Research Management) with other systems in use.

Figure 1.4.
Percentage of universities where Finance Management is integrated with other systems in use. Source: compiled by author.

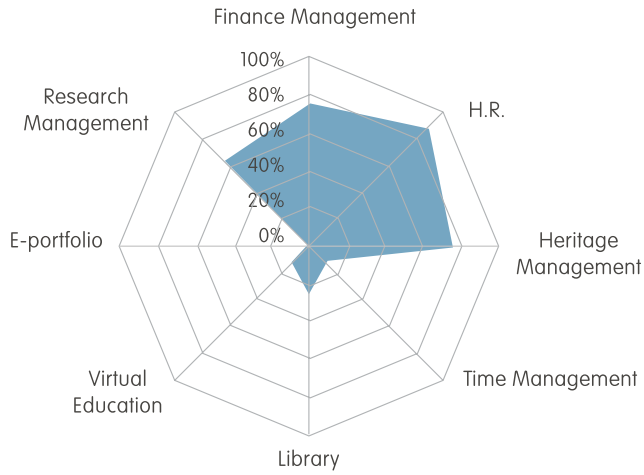
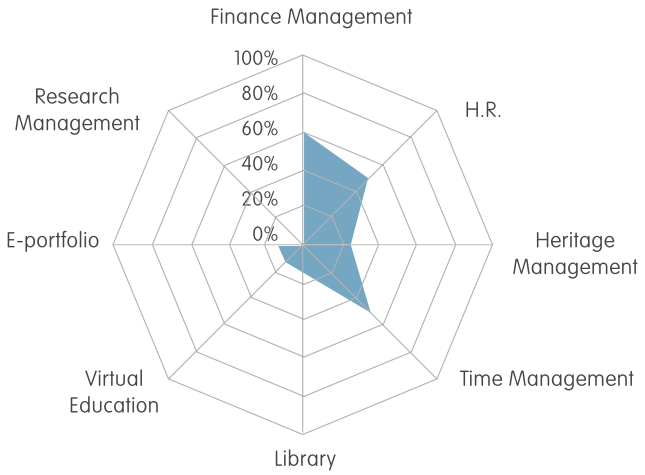


Figure 1.5.
Percentage of universities where Research Management is integrated with other systems in use. Source: compiled by author.



As we can see, in this last case the majority of the universities returning questionnaires stated that there was no integration of their system for Research Management with other systems in use.

With regard to the form of integration of different systems and the sharing of data between them we have analysed and tabulated different mechanisms that are described below. Each mechanism used has been assigned a weighting that represents the grade of integration related to it, in such a way that a higher weighting indicates a higher level of integration provided by that mechanism. The maximum weighting value is 50 which corresponds to the mechanism giving the greatest integration.

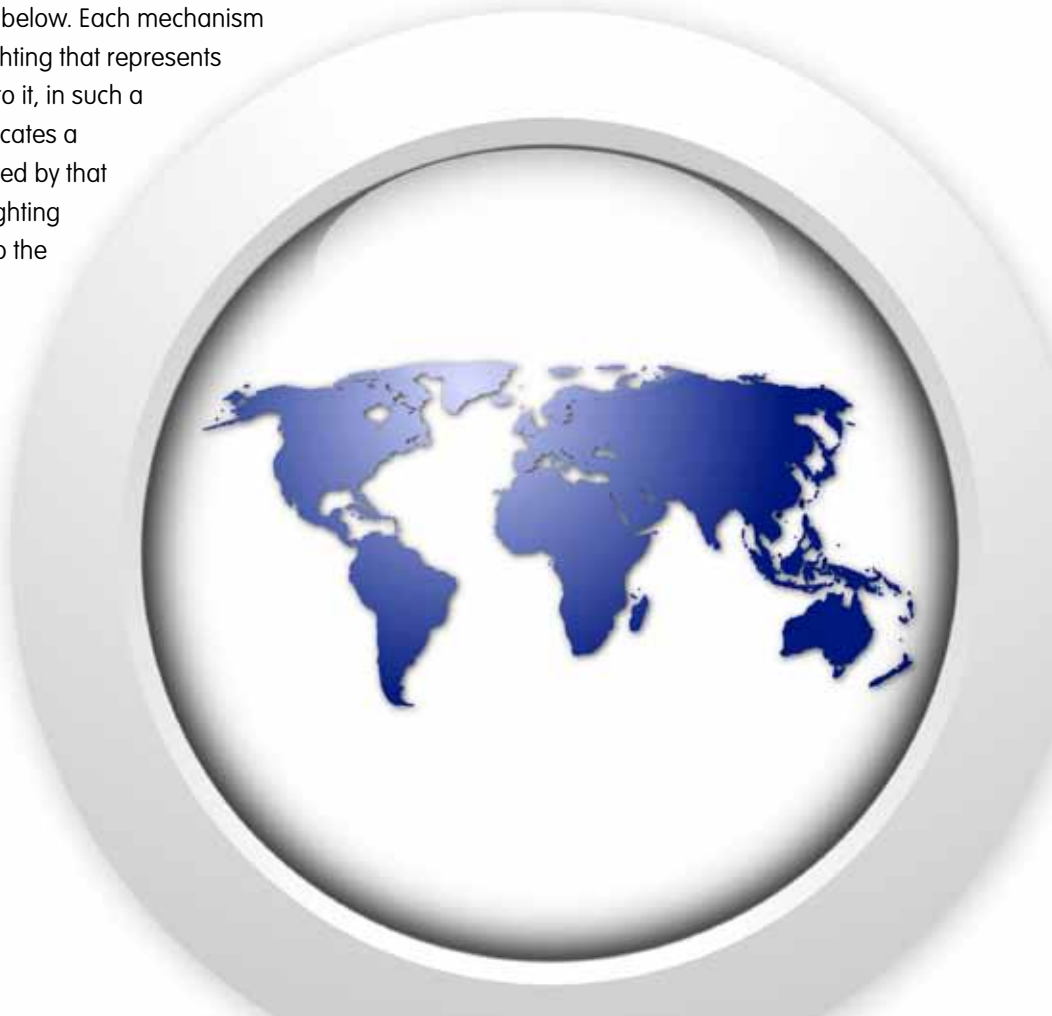


Table 1.8.
Mechanisms of integration in IT systems.
Source: compiled by author.

Level	Description	Weight
0	Unknown.	0
1	Not applicable: There is no need or no demand for integration between the two systems.	0
2	Not integrated: There is an existing need or demand for integration but the matter remains unsolved.	0
3	Manual integration: The required data are re-entered separately for each system.	1
4	Integration at presentation level.	5
5	Direct periodical synchronisation between systems.	10
6	Periodical synchronisation through a common repository or data warehouse.	15
7	Immediate and direct synchronisation between systems.	20
8	Synchronisation by means of universal adaptors.	25
9	Systems already with synchronisation or from the factory.	50
10	Other.	0

The integration mechanism most commonly used for each pair of systems analysed are given below. The mechanism that is most frequently repeated amongst the universities studied for each function has been taken into account.

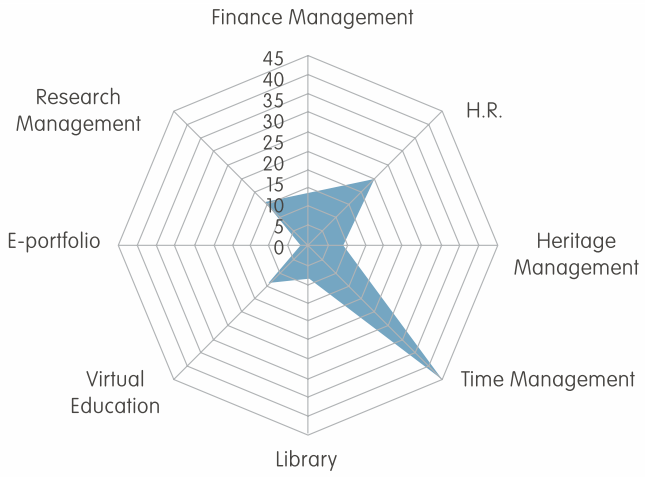
Table 1.9.
Mechanisms of integration most commonly used between the different functions analysed. Source: compiled by author.

	Finance Management	H.R.	Heritage Management	Academic Management	Time Management	Library	Virtual Education	E-portfolio	Research Management
Finance M.	-	9	9	1	1	1	1	0	10
H.R.	-	-	1	7	7	5	1	0	10
Heritage M.	-	-	-	1	1	1	1	0	0
Academic M.	-	-	-	-	9	5	5	0	10
Time M.	-	-	-	-	-	1	1	0	1
Library	-	-	-	-	-	-	2	0	0
Virtual E.	-	-	-	-	-	-	-	0	1
E-portfolio	-	-	-	-	-	-	-	-	0

As we can observe, the mechanisms most used in Andalusian universities to integrate distinct IT systems are direct periodic synchronisation between systems (5) and previous or factory integration (9).

Applying the weighting assigned to the different mechanisms available between systems of Academic Management and other systems in use, for each university analysed we see that the systems of Academic Management and Timetable Management are practically integrated, via previous or factory integration in all universities. On the other hand Academic Management and Virtual Education are scarcely integrated. This can be seen in the following figure where a value of 50 represents a complete integration between the pair of functions in question.

Figure 1.6.
Grade of integration between Academic Management and other systems in use. Source: compiled by author.



Main Conclusions (XIV)

The Challenge of System Integration:

- The mechanisms most used in Andalusian universities to integrate distinct IT systems are direct periodic synchronisation between systems and previous or factory integration.

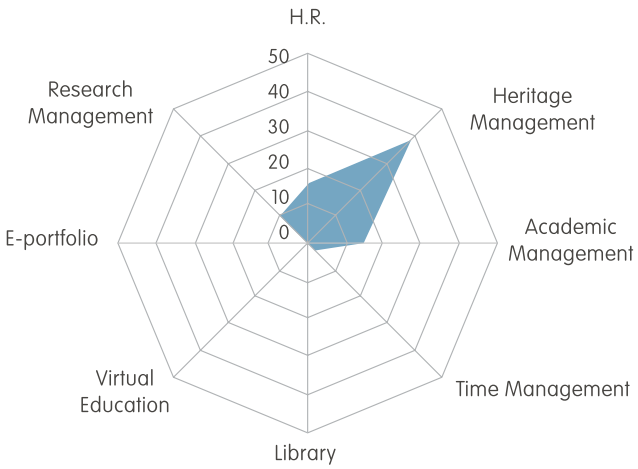
Main Conclusions (XV)

The Challenge of System Integration:

- Null integration between Research Management and other systems in use analysed.
- The majority of Andalusian universities analysed coincide in their agreement on the fact that integration between systems will become an increasingly important issue in the coming years.
- It is equally recognised that the absence of standards is the main barrier in the difficulties presented to systems integration in the university environment.

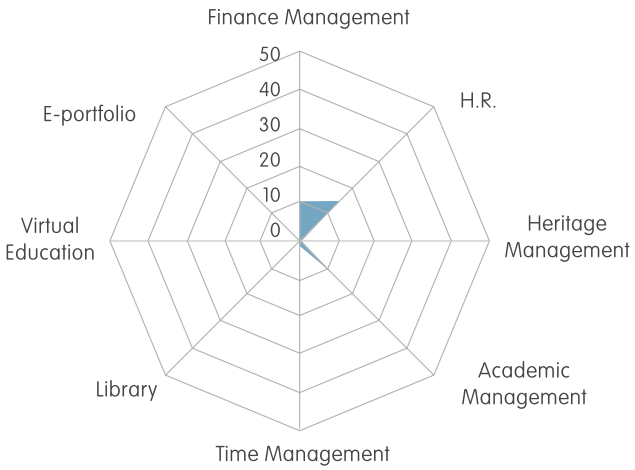
Two systems that have been particularly closely studied in regard to their integration with other systems in use are Finance Management and Research Management systems, as is shown in the following figures.

Figure 1.7.
Grade of integration between Finance Management and other systems in use. Source: compiled by author.



A strong integration can be seen between Financial and Heritage Management, which was to be expected given the functions that are common to both systems. With other systems, however, practically no integration is found to exist.

Figure 1.8.
Grade of integration between Research Management and other systems in use. Source: compiled by author.



It is clear, as can be seen from this last figure, that there is practically no integration between Research Management and other systems in use. As such, this is clearly something that needs to be improved in Andalusian universities.

The majority of Andalusian universities analysed coincide in their agreement on the fact that integration between systems will become an increasingly important issue in the coming years. This is a pressing concern given the increasing priority given to ICT strategy in the university. The difficulties presented by this integration are also recognised, as is the fact that the absence of standards is the main barrier to progress in this area.

1.3.7. Conclusions from Internal Analysis

The main conclusions from our diagnosis of the present situation of ICT in Andalusian Public Universities are presented graphically below. This diagnosis has been made by starting from an evaluation of the degree to which key tendencies identified at both a national and international level have been adopted, as well as from the research done on the five areas of strategic management in Andalusian universities. The result of this diagnosis forms the basis for defining a new Objective ICT Model.

Table 1.10.
Internal Analysis: Conclusions.
Source: compiled by author.

ICT Governance	• Has a defined organisational structure with presence in university management bodies. • Has strategic ICT plans and information system director plans. • ICT services are generally aligned with present and future requirements. • Has an important multi-service infrastructure for data, voice, video, etc data support and a good external communications infrastructure and is integrated in external networks. Andalusian Scientific Information Network (Red Informática Científica Andaluza), RedIRIS). • There appears to be a lack of autonomy on the part of ICT area staff in producing ICT budgets in general, as well as low representation of the same in comparison with the university budget as a whole. • It would be necessary to find finance mechanisms outside the university for ICT projects. • Some universities do not have the necessary ability to dimension the ICT service provision model including policies such as service subcontracting, employment of qualified personnel, and service and infrastructure acquisition policies. • The application of the recognised standards: (ISO9001, ISO27001…), and the existence of protocols to guarantee the security and compliance with standards in becoming generalised. • It is necessary to improve both mobility and flexibility of access to ICT services by the university community and the use of multiplatform and multilingual information systems.

Learning and teaching	• Presence and generalised use of ICT equipment in face-to-face teaching. • Virtual teaching is correctly dimensioned both regarding information systems and infrastructure, content and introduction. • Generally speaking there are no learning content management systems which include learning object repositories, author, publishing, cooperation and administration tools. • The use of innovative information systems will complement and allow the enhancement of face-to-face teaching. • Progress should be made regarding the use of ICTin the support and promotion of lifelong learning. • A unique academic report is a necessity and as such universities must have interoperable academic information systems, adequate knowledge management and also conclude the EHEA adaptation process.
Research and knowledge transfer	• Availability of ICT services for the support of research, both for maintenance (corrective and preventive) and for specific equipment and information system acquisition. • There is an Andalusian scientific information system (SICA) which centrally manages and holds the curricula and scientific production of all research groups. • The use of web portals to disseminate university technology and research. • The setting up of an ICT knowledge management plan is required for research and knowledge transfer including, for example, the use of web 2.0 and social networks. • Integral research management with regards to project control, announcement management, expense management and, in some cases, scientific-technological dissemination still needs to be resolved. • Greater implication with society and enterprise through innovation applied to research through the use of ICT is needed for this research to benefit them.

Management and Processes	• The majority of university management processes are automated, integrated and interoperable, in one way or another. • The majority of the web services are personalised by the user and accessible via unique identification. • The Basic components for electronic administration are in place. • There is no multi-channel contact centre. • There is a lack of adaptation of ICT systems to the management policies for processes based on standards and/or good practice such CoBIT, ITIL, ISO 20000… Indicators to evaluate ICT service provision are not used either. • Compliance with the legislation governing electronic access by citizens to Public Services requires progress regarding the interoperability of university information systems with other organisations and administrations. • It is considered necessary to introduce ICT institutional collaborative work tools for university management processes.
People, Training and Culture	• Students' levels of computer awareness ever greater. • ICT related personnel competente levels evaluated. • Availability of access to, and use of, university ICT resources from external sites by members of the university community. • The existing ICT training plans do not cater for all the groups of interest in the university community. • There is not an adequate policy aimed at lifelong learning through the use of ICT. • The placement of graduates in the job market and active search processes using ICT is an interesting development. • The promotion of audiovisual media as a communication channel both on campus and on the Internet. • The ever greater proficiency of students in the use of ICT should be taken advantage of. This is an aspect that will, without doubt, be reinforced by the transversal nature that these competencies are set to acquire with the new EHEA degree courses.

As shown in the above table, based on the analysis made according to the four Strategic Axes, the main needs of the Andalusian University System in ICT material have been identified and are set out below in the form of conclusions:

1. To give greater importance to ICT within the global strategy of the university through:

- Active participation of those responsible for ICT in the elaboration of a budget for ICT technology (where, when and how to invest in it).
- Increased funding for ICT through, for example, the participation of external funding.
- The divulgation of and training in the use of ICT in all levels and areas of university life.

2. To improve the competitiveness and efficiency of the university by acting on the tactical component that proportions support to main university services. This can be achieved by optimising the management and organisation of ICT resources in the areas of standards, best practices and methodologies of management already established, such as, ISO20000 and ISO38500.

3. Though an adequate technological infrastructure may exist on the campuses, they still need the use of the best set of advanced ICT services with a high level of impact on the university community. A clear example of this is in the generalised lack of an centralised and personalised service of attention to ICT users, which prevents the same level of quality being attained in distinct services. Therefore, advancement is required in meeting user expectations through the definition of levels of service previously agreed on through consultation with users.

4. There are issues related to meeting the requirements of the EHEA that are still not conveniently resolved in the area of ICT. For example, lifelong learning, the full incorporation of ICT into face to face teaching and the complete adaptation to the current academic management processes of the EHEA, amongst others.

5. Interoperability, understood as the possibility to exchange data and processes between different systems, is relatively well achieved at the level of the university's internal systems but there are shortages in the capacity of interoperability between universities and with other entities. One example is in the management of a unique academic report. Work has to be done in at least four areas: technical, semantic, organisational and administrative.

   Another aspect related to interoperability is the need for the availability of Learning Objects Repositories (LOR) in response to the growing demand for the separation of platforms from contents, which requires the use of specific standards of interoperability.

6. Though research results and findings are currently stored in centralised databases, these are not available to third parties. It is necessary to promote Knowledge Management and the use of collaborative tools in order for information to be shared in the research community. Normally, decisions on ICT resources available to research are made separately from the ICT area of the university, making it difficult to carry out a policy of optimisation of ICT resources. Neither can integrated research management be achieved with

regard to the control of projects, announcements and spending.

7. Though still in their initial stages, there are IT systems that facilitate the communication of research activity but they require greater deployment and familiarity for them to serve as an impulse to scientific and technological research (specific web pages, scientific congress organisation, digital publishing, online repositories of results and findings…).
8. The deployment of electronic administration, regulated by the Law 11/2007 (BOE, 2007), is unequal in Andalusian universities and the strategies followed in this area differ from one to another. This indicates the need to make the existing systems adequate and/or develop new ones, making them compatible and interoperable.
9. Though recent initiatives have been put in place aimed at evaluating the abilities of persons working in the area of ICT, the training they receive in this field is scarce. This situation also affects the PDI.
10. With regard to the integration of universities with their environment, we see no planned use of ICT for improvement in this area. A clear example of this would be to facilitate the management of graduate employment and job seeking (Virtual fairs for job seekers, reserve lists, etc.).

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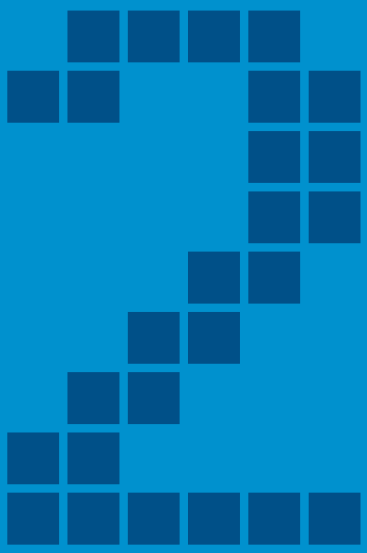


NEW ICT MODEL FOR ANDALUSIAN PUBLIC UNIVERSITIES

New ICT Model

The Objective ICT Model has two aspects to consider:

- The strategic and functional Model of the University.
- The entirety of technologies, systems and components which correspond to that Model.

At this point, the analysis of the strategic context of the university, the most important tendencies in the field of technology and the present situation in Andalusian Public Universities have to allow the introduction of a new ICT model for universities.

This model has to have two distinct aspects: Firstly, that corresponding to the strategic model and the functioning of the university, and secondly, one constituted by a set of technologies, systems and components which correspond to that model; both aspects are indissolubly united. The strategy and functioning of the University, as a training, knowledge and research Centre, are its fundamental elements. Nevertheless, nowadays there is no possibility to conceive of them without the presence of technology.

For that reason it is important to make a quick review, initially to propose a technological architecture for the strategic model and of the functioning of the world of the university. This chapter includes a description of the relations within the context of the university, an institution that is open to its environment, with multiple mechanisms to exchange information and other resources with different agents, that has to look for answers in technologies capable of consolidating and developing those relations. Later, the internal functioning, which is constituted by a complex catalogue of activities and functions, will be reviewed, also needing a strong presence of ICT for its optimum execution.

Once this exercise is carried out, it will be possible to propose an ICT Model which gives a response to all mentioned conditions. With the purpose of maintaining the axes of analysis implied in the previous chapter, this one includes a short section which explains the way in which the proposed model provides responses to all mentioned axes.

Nevertheless, the technical nature of the proposed model demands an explanation of its environment to the components which constitute it. Therefore, this chapter ends with a proposal for an architecture structured in a series of technological elements that constitute the set of systems and services of the new Objective ICT Model proposed for Andalusian Public Universities. In the next chapter the ICT action plan proposes a set of initiatives to put this model into practice, based on a series of actions and projects, which will allow its attainment.

Therefore, throughout the coming chapter, an Objective ICT Model will be described for presentation to the Andalusian Public Universities, starting from:

- The conclusion from the analysis of context and tendencies described in the previous chapter, which aims to show a global vision of how ICT is developing in the university environment.

- A map of agents related with universities which determines some of the requirements in the field of ICT, especially as a support for relations between those agents and those of the university community.
- A set of critical activities which comprise the functioning of the university in its main aspects (Teaching, Research, Management, etc.), and those where the integrated Objective ICT Model has to provide responses.
- Elements or inspirational principles extracted from the previous external and internal analysis which have to guide the design of the Objective ICT Model, and which, as such, provide an aid in the selection of different specific components to incorporate in the model.
- A response to the five strategic axes used in the analysis.
- Technical components which the proposed new Objective ICT Model has to contain.

2.1. A Model of Relations in the University

The University, as an Institution, has an fundamental role in its social and economic environment. In its origins it was created as a cradle of knowledge and culture, and it has always been a focus for social interests and economic development, being for many centuries an open system which was capable of influencing its surroundings whilst, at the same time, being affected by changes which were occurring in them.

So, the University has to fulfil its basic objective, which would be to find new ways to make its environment evolve by means of research (whose conclusions and discoveries have to be presented to the society) as well as the transmission and preservation of culture and knowledge through teaching.

This objective has to be understood from a global perspective, in which the university is an actor in a complex social and economic system. It can therefore be said that the university system has to be generally more capable of meeting the needs of the economic and social environment in which it finds itself, and also needs to reach higher levels of efficiency and quality in its services.

Chapter Structure

This contains the following:

- A quick overview of University working (a map of external relations and of critical activities).
- The Model's inspirational principles based around the Strategic Axes (ICT Governance, Teaching and Learning; Research and Knowledge Transfer; Management and Processes; People, Training and Culture).
- Technological Considerations.
- A set of technical components that constitute the proposed Objective ICT Model.

As such, with the aim of aiding the Andalusian Public Universities in their evolution, a supportive environment, where the university can carry out its activities and to which it can also relate, is necessary. Only a joint and planned action can create the University as a strong institution with opportunities, able to decisively cope with all appearing threats and to take effective advantage of given opportunities, overcoming its weaknesses and emphasizing its strengths.

With the objective of a systematic analysis of this environment, below is a review of different agents which, from the perspective of the value chain, belong to the university environment (nucleus of the value chain, suppliers, clients, competitors, and external influences) and with which, in the end, the university maintains relations (economical, teaching and/or exchange of information and knowledge).

The university is placed in the centre of the system as a nucleus of diffusion and knowledge, whose activities are mainly directed towards the university community and society. Nevertheless,a cooperation and aggregation of different Institutions and organisations is necessary to create and efficiently absorb this knowledge.

These organisations are also central to the system (actual actors), and are mostly oriented towards the research processes and knowledge transfer which unifies itself around Andalusian university campuses: public research organisations, university hospitals, centres of Innovation (technological parks and technological incubators) and scientific technological Installations, as well as innovative companies.

A series of external influences exist, which determine the process of evolution. These are present in the knowledge system in which the Andalusian Public Universities are situated. A clear example is the EHEA, which demands university adaptation to a new teaching model, together with the changes introduced by new regulations (BOE, 2007); the same is true for the set of tendencies in the international environment (as is detailed in the external and internal analyses), which determine the path for universities to follow in the near future.

The search for new synergies between all the agents around the university or various associations of them has the aim of providing the best quality and services, with the greatest participation and facilities in internationalizing and projecting the university. This implies the use of means of communication as a support and channel for diffusionand rapprochement between the university and social and economic agents.

In this sense, management models at European universities have evolved towards a scenario of global knowledge where other agents, competences and activities do not come from regional, national or European environments anymore, but instead from aglobal context in which the quality of the offer, the internationalisation of the university and the excellence of the educative product are some of the fundamental elements.

Thus, there are agents in the university environment which perform teaching activities that can replace (as well as complement) that of the university itself, and they are gaining importance, such as private teaching institutions, foundations or academies. Even if it were true that these agents are performing niche activities, they appear more frequently in the education of students and graduates. Universities must think about collaborative agreements and a different relation with these agents, in which ICT can be considered as a facilitating element.

Finally, it is necessary to determine the agents with whom the university maintains some kind of relation, in this casee as providers to the institutiion. These, as in other cases, will see themselves facilitated and strengthened by the existence of ICT to give them support. In this case, the agents are:

- The Autonomous Community, through the Program Contracts with the university where funding is fixed and common projects realised.
- General State Administration, through national plans and programs, through channels through which research groups can communicate and collaborate with commercial networks and technological agents (technologic centres, technology parks, etc.).
- The European Union, with other plans and programmes which permit the university to put into practice its strategy of internationalisation whilst at the same time collaborating with public and private agents in order to raise the level of cooperation and encourage technology and knowledge transfer to society.
- The private Sector, which provides financing through projects with research groups from different Universities.
- Other agents who can provide funding, such as venture capital, which helps to create companies based on technology and innovation that provide added value to commercial network of the region.

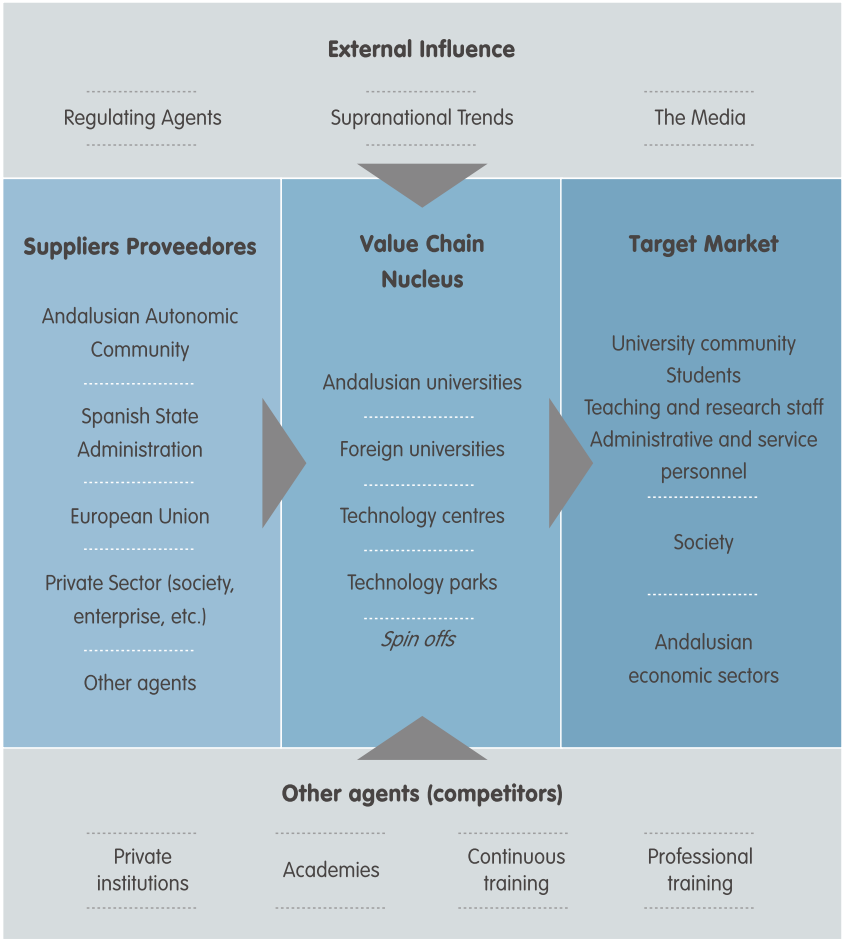
A Model of Relations in the University

The university is integrated within a complex environment, in which the following factors are present:

- External influences (regulation, international tendencies, social agents, mass media).
- Suppliers of training, service and economic resources.
- Central agents within the system, such as other universities, technology centres, technology parks, etc.
- Its own academic community and society, receptor of university services.
- Other agents that compete or complement activities of the university.

In the model of relations presented in the figure 2.1, a set of the agents described is presented:

Figura 2.1.
Modelo de relaciones de la universidad. Fuente: Elaboración propia.



In order to manage this complex set of relations it is necessary to deal with the benefits which ICT offers through appropriate communications networks, information repository models which permit information transfer and facilitate the knowledge generation and transfer process, adequate ICT Governance models which guarantee the availability of a technological infrastructure, the existence and correct working of interoperability protocols which guarantee full integration and university service consulting, to mention just a few such technologies.

Likewise, the presence of models based on centralized environments and systems of relation management for correct relation resources use (adequate

exploitation of knowledge databases for organization management, disclosure of university activities, management of relations with business spheres, etc.) stand out as main necessities for achieving that the proposed Objective ICT Model works correctly and promotes a system of sustainable knowledge.

Therefore, to stimulate university rapprochement with its surrounding environment (students and economic sectors), a set of agreements in matters of ICT made with relevant actors will also become of importance, increasing the prestige of institutions and the possibility of obtaining additional funds or taking advantage of cost cutting synergies.

2.2. A Map of Critical Activities in the University

It is necessary to identify the main set of activities which constitute university functioning to make sure that the proposed Objective ICT Model is complete and gives answers to all different functional necessities.

A functional analysis of the university was carried out in order to identify these activities, according to the five Strategic Axes mentioned before, and they have been grouped in different functional blocks (with a commonly shared objective), classified as either primary or supportive. It is important to point out that it is not about an organisational structure but a functional grouping of different activities. Therefore there is a possibility of cases of specific activity which develop in different departments or organisational units of the university institution.

Primary Processes are directly related to "critical" University activities (represented in the figure 2.2 as learning, teaching, research and knowledge transfer) and supportive processes are those which assist, support and back up these primary processes. Two other blocks are added to those already mentioned (existing in all entity types) related to the strategy and external projection of the university, completing the operative diagram of the institution.

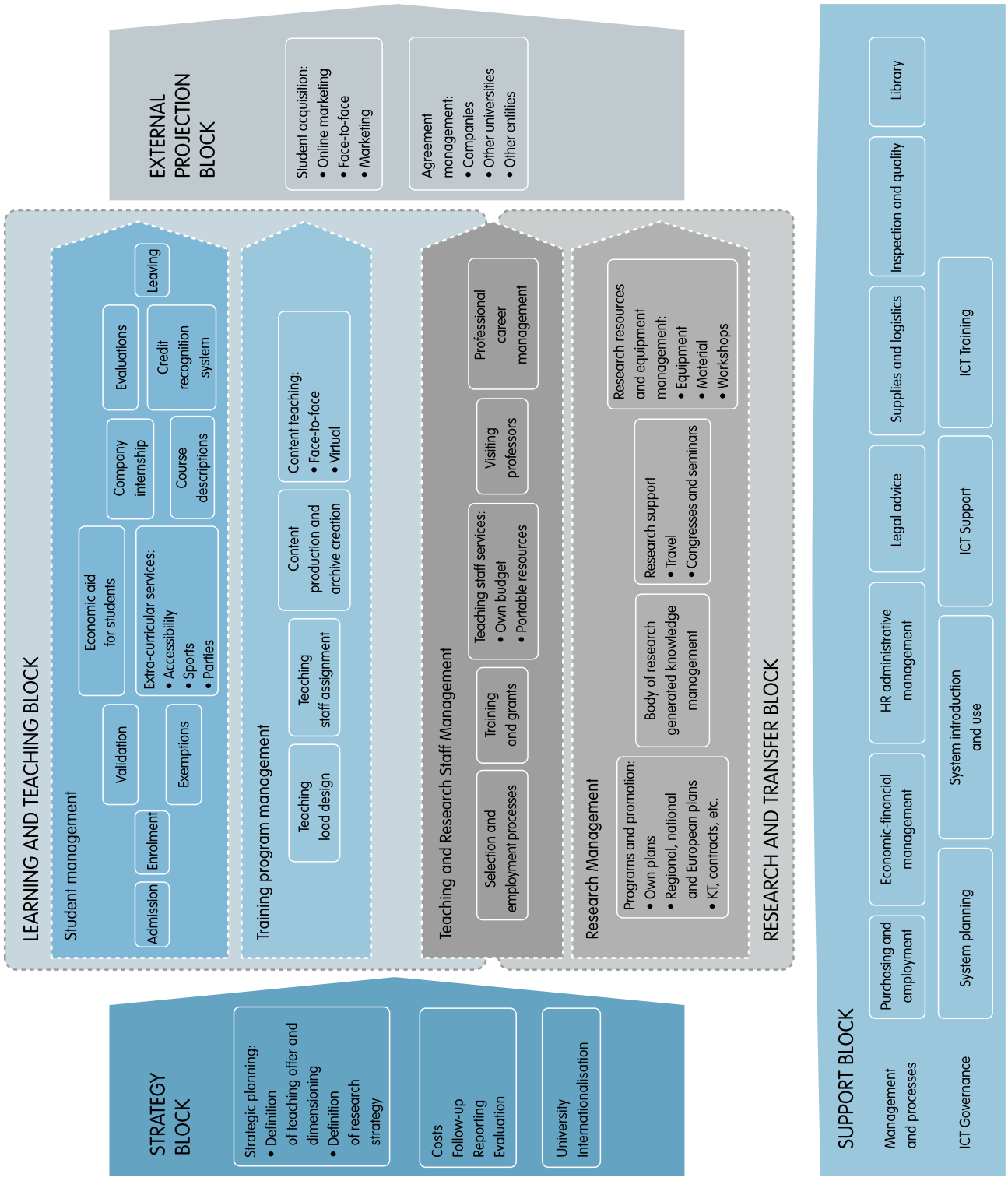
The objective of the diagram, as mentioned before, is to reflect graphically the main functions and activities which are developed in any university and which, in one way or another, require ICT support for their correct development. Above figure 2.2, which makes a summary of those activities, there is a explanation for each graphic element included.

Map of Critical Activities in the University

The map represents a set of functions which are developed in any university and is grouped in blocks which share a common objective:

- Strategy.
- Management and process.
- ICT Governance.
- Teaching and Learning.
- Management of training programs.
- Research Management.
- Exterior Projection.

Figure 2.2
Map of critical activities in the university
Source: compiled by author.



2.2.1. Strategy

The EHEA sets a new mark for universities, the search for their own strengths, scientific excellence, diversification and teaching reorganisation will affect university strategy in a significant way. This is why it will be necessary to adapt the teaching offer to social needs and to offer new training programs which will give an answer to present and future training needs (for instance in new emergent sectors such as renewable energies).

In this sense, the university has to be able to configure its academic awards system, defining those which have little social demand but which contribute to the generation and transmission of culture and knowledge as well as those which have a massive demand on the part of students and the world of work. For this reason, a correct strategic planning of teaching is necessary, that will help the studies offered to conform to this situation, not in function of detailed momentary needs, but by adapting itself to social aspirations, environmental demands, future productive sector needs and the generation and transmission of culture and knowledge.

Similarly, in relation with the area of research, it is this activity's competence to define fields of study or strategic lines that would manage such activity, as well as to provide correct management of research groups, providing them with the infrastructure and necessary means for research activity to be carried out.

As in any organisation, it is a strategic function to determine the criteria of costs, follow up, reporting and evaluation, through actions such as:

- Making revisions of the objectives and actions which form the strategic plan of the university, and to establish responsibilities and mechanisms for the setting up of the same.
- Evaluating the internal and external management of the university, emphasising the evaluation of the competence of each different profile, with special attention to the teaching staff, designing mechanisms which favour the process of continuous improvement and merit recognition.
- Harmonizing activities developed in different working groups or subgroups, avoiding duplications and overlaps and making most of all the possible existing synergies. This includes the revision of the level of progress in any planned work that is carried out, and the determination of existing and potential problems, pending points, etc.

Finally, it corresponds to the context of university internationalisation to define an international medium and long term policy which would permit advantage to be taken of factors of scale and favour the diversity and coordination of objectives by increasing the attractiveness and visibility of the university. On this point, functions linked to the strategy of student and teacher mobility gain special importance.

2.2.2. Management and Processes

Centralization of the management processes is a characteristic which has spread in the universities in the last few years. Management tasks cover a great majority of university functions and areas, this is why the functions included in this block constitute one of the main concerns of the teams entrusted with running universities.

Thus, sets of processes are grouped here which relate to:

- Purchase and contracting, including management functions which derive from public acquisitions (outside the university, for example, tenders), as well as management of all internal purchases (material petitions, etc.).
- Economic- financial management, which contemplates, not only common functions in the financial sphere but also, amongst others, those which derive from the registry and billing of ordinary working costs, registry and inventory consulting, payments, salaries, assistance on boards of teaching positions and doctoral theses, conference costs or teaching collaborations from visiting professors, accountancy and financial management of research projects from different university research groups etc.
- Administrative and human resources management, covering the management functions of PAS, PDI and all the functions of the human resources department of any institution.
- Legal Consultancy, which centralizes consultancy functions and provides opinion in legal cases, including those functions related to consulting and the resolution of legal enquiries formulated by the university about aspects related to institutional management. It also involves the elaboration and endorsement of contracts and agreements which the university signs with third parties, formulating

and endorsing normative contracts as well as giving an opinion about those submitted for consideration.

- Supplies and Logistics, which contemplates functions related to supply chain management (orders, stock management, storage, reception, distribution, shipment, etc.).
- Inspection and quality, including, amongst others, functions for the measurement, examination and contrasting of the quality of services, to determine their conformity with specified requirements (in short, to verify conformity with the corresponding norm). Similarly, it includes functions for access to information relative to schooling, information management, etc. in order to examine and validate decisions made by the universities regarding various aspects (investigations, place reservations, etc.).
- Library, which considers, among other things, all those management functions related to the documental reserve of the university. Additionally it may include functions of information disclosure, by elaborating lists of consignees, making bulletins, etc, as well as the supply of services in the lecture hall (including location and delivery of original documents or copies for consulting and assistance to the student or user), or services of traditional and computer aided searches, etc.

2.2.3. ICT Governance

In this block the following functional groups may be found:

- System Planification, including, among other things, functions of design for university ICT strategy, the provision and availability of IT systems, service level management for different IT systems in the university, security management, plus the prioritisation of actions to be performed, etc.
- Implantation and Exploitation of Systems, including, among other things, all functions derived from the setting up of new technologies and systems for the use of academic personnel (PAS and PDI), as well as students and third parties (companies, visiting professors, etc.).
- ICT Support, which considers all support functions and incidence resolution derived from the work and use of IT systems, resources, services and technologies which are present in universities.

- ICT Training, which covers all training variants present in universities, plus proceedings and processes which support it (virtual and face to face teaching), as well as training assistance functions, management and resource availability to users (PDI, PAS or students).

2.2.4. Learning and Tteaching

Inside this functional block it is necessary to distinguish between the management of teaching and learning process and academic management, which includes all functions related to a student' period of study at the university (beginning with the application form, and ending with graduation), such as:

- Admission, including, among other things, all functions derived from different actions initiated with the process student admission to a specific university course.
- Enrolment, including the standardization of processes and norms related to enrolment, academic record, study certificates and other such processes. Similarly, this block includes functions related to:

- The planning, organisation and execution of the enrolment process for graduate and postgraduate students.
- The optimisation of enrolment processes, emission of acts, study certificates and generating statistical information.

- Validations, including functions related to credits and the conversion of both external qualifications (other universities) and the university's own internal qualifications. Likewise, it covers the definition of the execution of validation agreements with other universities.
- Exemptions, which covers the use of extraordinary processes for the exemption, either partial or total, of the payment of public fees for academic services.
- Economic help for students, including all functions derived from the execution of policies on scholarships, aid and credits for students.

- Extracurricular services, including functions relative to control of access to determined services, for example sport activities, parties, etc.
- Company Internship, including functions for the selection of and contact with companies, the emission of documents to formalise these, the emission of access requirements and evaluations of student performance, etc.
- Evaluations, including, among other things, all functions derived from the setting up of evaluation mechanisms for subjects.
- Graduates, including management functions for graduate databases, their use, as well as all actions performed for tracking graduates.

In relation with the teaching management block, it is important to point out two areas which, owing to the EHEA implantation, will affect in a significant way the processes of academic management, as was described in previous sections:

- Course descriptions, recognised as key documents in the process of planning student learning, following the principles which guide the implantation of EHEA.
- Credit recognition systems, closely connected to mobility processes. According to the law (BOE, 2007a) , such systems introduce, as an important novelty, the possibility to validate, in academic terms, either work or professional experience, following the criteria and recommendations of European declarations As such, it includes functions related to the definition of general recognition criteria and the validation and adaptation of studies carried out in both Spanish and foreign academic centres; the conditions for the declaration of equivalence with Spanish university awards or other official awards, conditions of validation, at an academic level, of work or professional experience, and the regime for validation between university studies and other higher education studies (BOE, 2006).

2.2.5. Management of Training Programmes

This block includes the main functions responsible for generating content for use in the teaching process, such as the distribution of the teaching load and its posterior allocation. It consists of the following groups:

- Teaching load design, consisting of functions for the establishment of the various norms and criteria which form the basis on which the officially recognised qualifications of graduate, master and doctorate are evaluated; defining both core subjects and obligatory and optional ones in function of specific, main modules for each plan of studies. Additionally, the block includes those functions linked with planning teaching and classroom use.
- Teacher assignment, which consider functions related to the definition and application of criteria for establishing the teaching hierarchy corresponding to different subjects and qualifications.
- Content and Archive generation, which generally consists of all functions included in the process of generating the educational content that will make up part of all training programs.
- Content impartation, whose main functions contemplate the establishment and application of methodology for the impartation of content (face to face or virtually by means of the computer network).

2.2.6. Research Management

This block covers the main functions directed at channelling the research process and the use of research results in the university environment, as well as both the management of generated knowledge, and that of resources destined to research, including the management of the qualifications obtained by the researcher. The blocks considered are:

- Programming and promotion, this involves the actions and functions to be implemented in universities in relation to their own research plans, as well as national and European ones, as well as relations with OTRIS, and the generation and ratification of research contracts, etc.
- Research generated knowledge management. Contemplates functions associated with the channelling of knowledge generated by research and its correct transfer, for its incorporation into university teaching activity.

On the other hand, inside the block are included those functions which orient themselves towards the updating and specialization of the researcher's educational career . Finally, in this block could be also be included those functions which relate to the management of knowledge transfer to a third party (contracts) although given the centralization of administrative and management processes, it is situated in the management and processes block.

- Support for research, this consists, among other things, of the management of complementary support for the researcher, which could be for travel, congresses, seminars, etc.
- Resource management and adequate research equipment, this involves those functions specific to equipment management and laboratory and workshop material, etc.

2.2.7. Management of Teaching and Research Personnel

Given that in the universities any professor dedicated to teaching also does research, both areas coincide in the same collective, and for that reason, this area is divided into teaching and learning as well as research and knowledge transfer.

In this sense, the main blocks which form part of this area, for instance selection and contracting processes, differ from those for administrative personnel, even if in essence they keep the same schema of processes in the selection and contracting of human resources, they have a different treatment, given the nature of the PDI.

Similarly, this area includes functions relative to training and the concession of scholarships; services to the teacher (such as budget management for the PDI and its portable resources).

Those linked to the administrative process of visiting professors, including, among other things, transfer models, diets, management of teaching activities in other universities, etc. as well as researchers' qualification management, which considers the professional trajectory of the researcher, leaving the researcher's evolution inside the structure of the university personnel to the block on human resource managemen.

2.2.8. External Projection

This area will be dealt with according to its main, overall features, that is the main functional groups related to the aspects of projection and promotion of the university.

- Student catchment, including, among other things, those functions related to the image of the university in the external world, for the identification and selection of potential students through promotional actions supported by marketing mediums, both in person and online. As was stated in the section on international tendencies, in this area those processes will be considered which are linked to the use of a platform or management module for relations with users or CRM.
- Management and follow up of graduates, including, among other things, specific university functions for the recruitment of graduates (either to incorporate them into the university as teaching personnel, or to continue with the process of lifelong learning), as well as all functions derived from the follow up and management of graduates.
- Agreement management, collaborations with either companies or research institutions (universities, public organisations, foundations, etc.) , incorporating all functions derived from the management of such agreements, management of company professorships, etc.

As was mentioned before, this set of functional and activity blocks requires the response of a technological model able to facilitate and promote the development of all these tasks, such as that proposed below.

2.3. Main Inspirations for the Model

To define the ICT service provider model applicable to Andalusian Public Universities it is not only necessary to take into consideration the ICT tendencies in the university environment, the blocks of critical activity in the university, its location in the social-economic environment and relations with external and internal agents, but also the needs of agents related to the university and its legislation. (BOE, 2007).

This model has to respond to the main needs derived from the functional analysis of the Strategic Axes previously described, as shown in table 2.1.

Tabla 2.1.
Fundamentos del nuevo Modelo TIC. Fuente: elaboración propia.

ICT Governance	• Availability of standardised management models (CoBIT, ITIL) establishing a general framework for governance. • Availability of qualification quality guarantee follow-up systems as well as Contract Program completion indicator information.
Learning and Teaching	• Availability of EHEA adapted learning management tools. • ICT fully introduced in the academic offer.
Research and Knowledge Transfer	• Availability of university research process management applications. • Availability of standardised scientific research repositories. • Develop and promote collaborative environments through ICT (eg. PVCs, virtual professional teams). • Develop inter/intra university knowledge management.
Management and Processes	• Eliminate information islands interconnecting all management systems (teaching, research, support, etc.) through evolved university ERPs. • Develop electronic administration before the law comes into force.
People, Training and Culture	• Establish incentives to encourage the use of ICT by the university community (students, teaching and research staff, administrative and service personnel). • Develop training in technological device use and promote training process support tools, job searches, etc.

From the point of view of the ICT Governance, the technological architecture proposed should make available normalized management models that establish a general governance of technologies, along with support for the strategy and management of the university. Similarlly, the model should provide continuous information about university systems, as well as permitting the outsourcing of support ICT services.

In the Learning and Teaching area, the present context and implementation of the EHEA requires the Objective ICT Model to provide applications of academic management which would be completely adapted to it, as well as full implementation of ICT in the academic offer, by introducing learning through e-learning platforms.

Regarding the Research and Knowledge Transfer axis, the Objective ICT Model should meet the need to provide applications of integral management for the research process, as well as provide access to scientific production repositories to the university community. In the same way, it should anticipate the use of team work tools which let researchers promote the use of collaborative environments through ICT.

On the Management and Process axis, in relation to electronic administration, the task of the model is not only to tackle the management of change in universities, it is also necessary to carry out a simplification and rationalisation of university administrative procedures. In the same way, the new plan has to provide a progressive elimination of information islands, interconnecting all systems of university management (teaching, research, support, etc.), around the evolution of university ERPs towards global solutions which incorporate multiple locations.

Finally, in relation to the People, Training and Culture axis, the model has to provide the possibility of response to the growing necessities of training in the area of technology, as well as to boost training in process support tools, job searches, etc. For this, it will be necessary to establish incentive measures for ICT usage inside the university community (students, PDI, PAS).

The Analysis and disaggregation of these directives constitute a base over which the foundations of the proposed objective model are designed. In order to make the technological architecture both flexible and adapted to the stated requirements, the realization of a series of technological considerations that are also contemplated with respect to their future development, is indispensable.

2.4. Technological Considerations for the Design of an Objective ICT Model

In accordance with these necessities, the tendencies presented in the international, national and Andalusian spheres, and the legislation applicable in the university context, it is necessary to construct a new model for IT systems which will respond to the following characteristics:

- **Scalability and Modularity**, adapting the solution to different scenarios, the design of which has to prioritise modular solutions which adapt both to present and future requirements. This model has to permit a progressive increase of functionalities and services, in accordance with the necessities of a system subject to continuous evolutional changes. Equally, it has to be scalable to be able to incorporate with relative ease and in the least possible time, any new features necessary to attend to any increase in services and the number of users with access to them.
- **University Personnel Training**, raising the level of ICT training and minimalising the barriers to the adoption of new technologies in the university. Rapid technological evolution requires increased efforts to

update knowledge through specific training plans in ICT for university personnel.

- **Service personalisation**, making students, PDI, PAS or any other user (including those in public administration) the central core of such services, which would be adapted to real needs and provide the adequate degree of specialization required.
- **Multi-channelling**, offering to different members of the university community the possibility to relate with the institution and access the services which it offers, through both in person and electronic channels.
- **Integration**, providing levels of service coverage, quality and reliability which must tend towards homogeneity, whoever the user may be (student, graduate, professional, company, external user, PDI, PAS, etc.), the same is true for the channel and unit in use.
- **Service Accessibility**, permitting use of accessible services to all citizens of the society (especially students), giving special attention to the handicapped and disfavoured.
- **Structuring of the services offered by the university**, with the aim of achieving that the multiple services and contents available to users (students, PDI, PAS; companies, etc.), are adequately documented, catalogued and organized to guarantee their accessibility.
- **Simplification of management procedures**, speeding up services by avoiding unnecessary procedures.
- **Automated services**, by introducing the provision of services which can be initiated and resolved immediately, without times of delay and with minimal need of human interaction.
- **Efficiency and improvement of services**, with the aims of achieving an improvement in the cost structure of channels of attention to users and making the migration of services to those channels as cost effective as possible.
- **Environmental flexibility**, to attract graduates and professionals, permitting a response to the needs of continuous training and deep professional restructuring which the changing IT society imposes on society in general. In this sense, given that such new students need to combine studies with work, they need to find environments in the university which allow them to combine both activities.
- **Maximum reutilization of components**, through the construction of a model in which (whenever possible) the reutilization and integration

Technological Considerations

- Scalability and modularity.
- University personnel training.
- Service personalisation.
- Multi-channelling.
- Integration.
- Service Accessibility.
- Structuring of the services offered by the university.
- Simplification of management procedures.
- Automated services.
- Efficiency and improvement of services.
- Environmental flexibility, to attract graduates and professionals.
- Maximum reutilization of components.
- Model based on Enterprise Service Buses.

of existent logical solutions prevails. With this a cost reduction in the implantation of the model can be achieved which would facilitate a better acceptance of it on the part of universities.

- **A model based on Enterprise Service Buses**, Service Oriented Architecture (SOA), and web services.

Once these technological considerations are established, it is possible to develop the characteristics of the proposed model.

2.5. Proposed Objective ICT Model

It is possible to define the technological architecture which responds to the needs planted by a model structured in layers, indicating in each of them those characteristics which will constitute the solution to all aforementioned requirements, at the same time as being in line with identified tendencies and the present situation of ICT in Andalusian Public Universities. Figure 2.3. represents graphically, in a resumed form, this model of various levels:

Figure 2.3.
High level scheme of the proposed Objective Model of ICT, in layers.
Source: compiled by author.

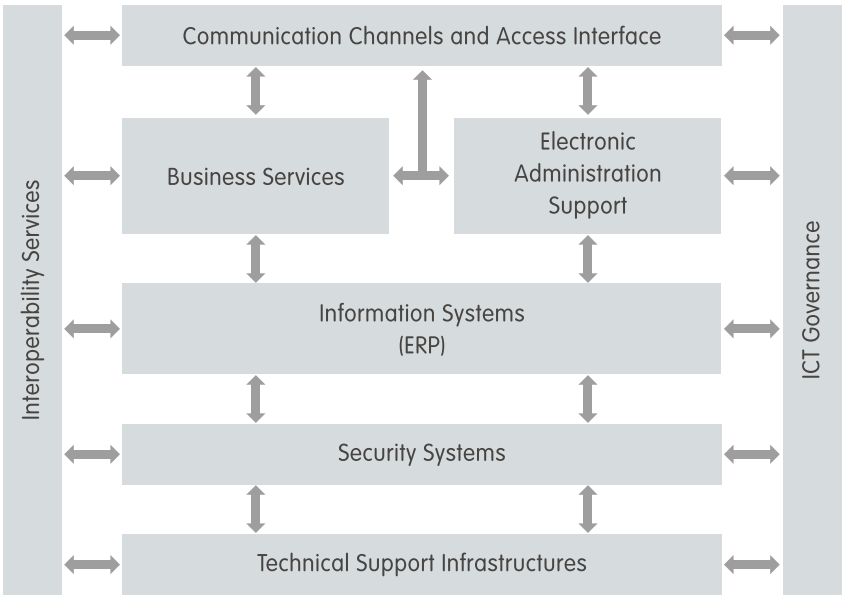


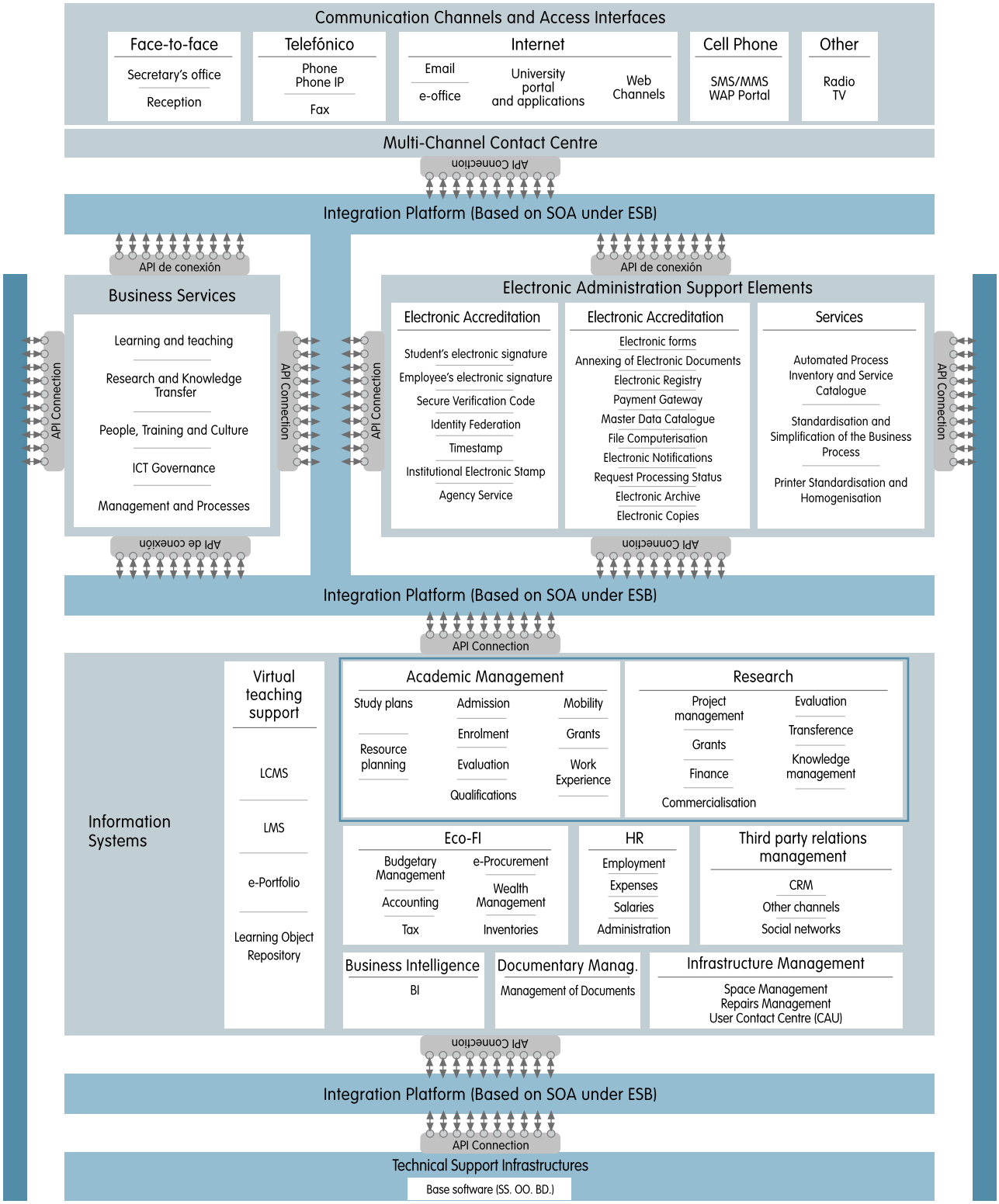
Table 2.2 shows the blocks into which the model may be divided, with the aim of explaining each one individually.

Table 2.2. **Blocks of the Objective ICT Model.**

ICT Governance	Functional layer providing management of all ICT services provided by the university.
Interoperability Services	Software support to guarantee communication between university IT applications and inter-university communications.
Channels of Relation and Access Interfaces	These include all the university's communication mechanisms.
Business services	Inventory of information system support procedure function requirements.
Electronic Administration Support	Services provided to guarantee telematic processing of university procedures.
Information Systems	IT applications providing technological support to business processes.
Security Management	Procedures and systems guaranteeing, application security, transactions and data.
Technical Support Infrastructures	Business application base hardware and software platforms.

To complete the proposed ICT Model there follows a detailed set of services and/or applications which form part of each of the proposed layers, as shown in figure 2.4.

Figure 2.4.
Proposed Objective ICT Model. Source: compiled by author.



2.5.1. ICT Governance

To manage the strategy in matters of ICT throughout the university, as defined in the homonymic Strategic Axis, a layer is created transversally across the whole model, the efficiency of which is based on the fulfilment of the following premises:

- It is the organ responsible for decision making on ICT policies in the university, based on a strategic plan for ICT (within a standard framework of reference, such as ITIL, CoBIT, ISO38500, etc.) (Van Bon, 2005) (Brand et al, 2007) which is aligned with the global strategy of the university.
- The existence of a route sheet to guarantee correct functioning of ICT services.
- The elaboration of an ICT service provider model, based on the best existing practices, which adapts processes to the needs and requirements of the university community in ICT matters, reaching their full satisfaction through efficient and quality service provision.
- The outsourcing of determined processes, focused on guaranteeing the correct working of ICT services.

To facilitate the development of competent ICT governance, decision making and labours of control and their monitoring, ICT governance functions should be provided with support systems (developed further below in the IT systems layer) such as:

- Enterprise Resource Planning (ERP) (Lowendahl et al, 2008), which integrates finance planning, human resources management, administrative management, etc.
- Community Relations Management (CRM) for the university, facilitating the identification of tasks of promotion and the creation of fidelity to the university community. Furthermore it will permit the management of relations with external agents, such as graduates, companies, etc. defining the campaigns, communications and all aspects susceptible to being systematized.
- Business Intelligence (BI) / Balanced Scorecard (CMI) The function of ICT governance will rely on intelligent business tools to improve the development of its proficiency and on a balnced scorecard system in order to carry out the work of controlling and monitoring of short, medium and long term strategic goals.

ICT Governance

This layer permits management of ICT strategy in function of existence of:

- A organ responsible for ICT matters.
- An ICT route sheet.
- An ICT service provider model.
- Outsourcing of determined ICT processes.

2.5.2. Interoperability Services

The proposed model contemplates an integration layer which provides the technological support necessary to guarantee communication between IT applications within the university. Similarly, it considers future communications with systems from other universities, public administrations and other external agents with correspondent interoperability services. The creation of this specific layer responds to the need to guarantee communications in a changing and heterogeneous environment.

In their beginning, IT systems were defined and developed to respond to the precise needs of organizations. For instance, if an area required a client register, a special database was created to do so without taking into account that other units of the IT system would need to use exactly the same information.

Undoubtedly, the appearance of ICT as a support to practically all organizational processes generalized the need to dispose of just one set of information to refer to the same entity (employee, client, etc.) and to use systems that interact between themselves (in response to transversal processes which implicate different organisational units of an entity). Nowadays there is no unique system which would give an answer to all requirements of an organization, furthermore, the diversity of existing applications and competition between their manufacturers is one factor of continuous ICT improvement.

For this reason it is indispensable to dispose of a framework which allows substitution, improvement or adaptation of existing systems, minimalizing the necessary effort to integrate with the rest of the systems. Such a framework is named Service Oriented Architecture and will be explained further on.

Similarly, the interaction with external systems, above all those motivated by the adaptation to the EHEA, which prioritises the mobility of students and professors, and to information transfer between universities, will be a reality in the near future.

Integration

The proposed Objective ICT Model aims at total integration and flexibility between each of the layers and elements which constitute it. As was described previously, the proposed model is organized in a series of layers in which a series of components exist, which, in turn, are associated with specific technologies and/or products.

The proposed concept of integrated architecture has to be totally aligned with the strategic principles defined for the model, especially those of scalability and modularity, maximal reuse of components, non intrusion and economic and technical sustainability. Such a model has to guarantee that all universities wishing to adopt it will have the possibility of defining its proper implementation and its own "route sheet".

Interoperability

It is important to define an integration architecture for components inside the model, though this is more for guaranteeing the model's interoperability with the exterior, allowing interaction between said model and all the universities which implement it as well as with other entities (other universities, public organizations, companies, etc.) which likewise offer interoperability mechanisms and scenarios. This layer will be composed of the instruments needed to guarantee the exchange of information and the adaptability of the model.

The interoperability schema proposed is directly connected with a Service Oriented Architecture (SOA) (The SOA Forum, 2008). Over this architecture a specific implementation based on an Enterprise Service Bus is proposed (ESB) (Arias, 2005). In this way, the scalability and growth of the set of interoperable systems is guaranteed.

The interoperability layer is transversal to the whole model. This means that its definition has an effect on the other layers, which has to be considered when designing and defining these and their components, participating actively in the form in which they all relate to each other.

Service Oriented Architecture (SOA)

SOA Architecture offers the capacity to optimize university processes thanks to service orchestration and choreography. This allows the creation or modification of existing services through the combination of elements of present processes, providing support for new necessities:

- Service Orchestration allows new university services to be composed from other services or systems that already exist. It therefore provides a way to describe internally what each service needs in order for them to work together and to create new services based on the originals, which can be executed and managed in a centralized way.
- On the other hand, Service Choreography allows the specification of the rules for collaborative work and the union of different web

Service Oriented Architecture, SOA

SOA is a conceptual work framework which allows an entity to combine its strategic and functional objectives with an ICT infrastructure, by integrating information and logic from activities that reside in different systems. This is done using techniques such as:

- Service Orchestration.
- Service choreography.
- Process abstraction.
- This framework allows:
  - Component reuse.
  - Increased system flexibility.
  - Improved process automation.
  - Improved software development.
  - Increased usability of different systems.

services (understanding collaboration as functions that emerge from the cooperative interaction of numerous actors). This offers an external vision which is more abstract and descriptive of agents that interchange messages to execute various particular processes.

- The key to all of this is the abstraction of processes, by which university processes are extracted from different IT systems and presented directly to the exterior. This means that the management of such processes can be performed at a higher level, instead of being directly included in the different systems.

Service Oriented Architecture allows, therefore, an optimum uncoupling of the model's layers (Channels and Interfaces, University Services, Supportive elements for electronic processing, IT Systems, etc.) and a grater level of interoperability and standardization between each of them. The benefits from a technological point of view are clear:

- It increases the degree of component reuse, by increasing the independency between the layers of a specific application. This allows the reuse of existing IT systems, through service orchestration; using third party services and bi-directional information sharing with the exterior (interoperability with systems from other universities).

- It increases flexibility, through the improvement in adaptation to existing systems and the avoidance of an ad hoc development of interfaces between systems.

- It improves the level of process automation, allowing better monitoring, analysis and process evaluation through the use of Business Intelligence tools.

- It improves the development of new systems of software, by means of improved specification of service requirements, which also leads to a philosophy of common development in all systems and channels.

- It increases the use of different systems, thanks to the use of a Service Oriented Architecture (SOA) which permits providing the user with information from different systems in a much more integrated and centralized way.

Enterprise Service Bus (ESB)

The proposed model, based generically on Service Oriented Architecture, includes, as a technologal proposal, the construction of a layer of interoperability

based on of the use of ESB. With this, the Centralisation and Management of different SOA processes is simplified, allowing a better scaled architecture if necessary.

An ESB offers, on one hand, a scalable messenger service of high availability, which guarantees communication between different services and systems of one or various organisations and, on the other, a mechanism that easily allows the definition of new processes and later modification through orchestration and choreography of existing services.

Essential functions which require an ESB for their complete integration in a SOA Architecture are:

- Distributed messenger service.
- Location independence.
- Multiprotocol Support.
- Service Quality.
- Message exchange pattern.
- Routing based on content.
- Communication security.
- Possibilities to transform messages.

Standardization of the Interoperability Model

The proposed SOA architecture for the model has to be based on standards which guarantee complete interoperability of the model with other external organisations. For that, the Objective ICT Model has to fulfil a set o standards that:

- Are sufficiently complete to give response to any implications derived from the implantation of an Service Oriented Architecture.
- Are sufficiently extended and contrasted to guarantee interoperability with the highest number of possible systems.
- Are supported by some body of standards, manufacturers, etc., which guarantee their level of implantation and future evolution.
- Are supported by the defined technologies.

By basing the interoperability layer of the model on SOA architecture, as well as the implementation of the same through services web or web services (WS) by means of an Enterprise Service Bus (ESB), it becomes logical to use the main standards established for this type of architecture.

2.5.3. Channels of Communication and Access Interfaces

This layer is constituted by infrastructures and resources which are necessary for the collectives related with the university to be able to use functions in an integrated and homogeneous way via any available channel:

- Interpersonal Channels: through offices which provide access to the university, such as schools, faculties, departments, etc., as well as other centres. Including secretaries, student attention offices, etc.
- Other channels: basically of information access, but they can also be used to carry out administrative procedures, teaching activities, collaboration and participation.

Other channels include some already traditional ones such as telephone, fax, mail, and those supported by software platforms. This type of channel would be the internet in most cases: by means of corporative web and the webs of centres and departments, new diffusion channels, such as Youtube, Second Life, or TDT, as well as channels based around mobile equipment.

Carefully consideration has to be made of those channels which will be used in non personal communications at the time of computer CRM tools selection. Once communication channels are defined, and the business processes to which they make access possible, the CRM tools will be the receptors or sources of relations between the university and exterior agents for many of those processes (Stojanosky, 2007). Therefore the system's functional capacity can be considered as determined by the existence of different communication channels.

Another layer which is also considered as influenced by channels of relation is that of support for electronic administration, in which the necessary mechanisms for electronic transmission of administrative procedures are established. It will be necessary to carefully analyze the channels by means of which administrative processes will be handled in order to guarantee a complete implantation of such services.

Channels of Relation and Access Interfaces

This includes the set of resources needed to access the functionality of the Objective ICT Model via different channels:

- Interpersonal.
- Others: telephone, post, institutional web, social networks, TDT, channels for mobile equipment.

2.5.4. Support for Electronic Administration

The instruments of support for electronic administration have been organized methodologically into three areas: services associated with electronic administration; electronic accreditation tools destined to manage the identification and accreditation of integrated parts of a service (applicant or managerr), and components of electronic handling of administrative processes

destined to manage common posterior actions pertaining to instructions for procedures which manage the requested service. (fee payments, notification, etc.).

Electronic administration services

This component includes the complete, updated inventory of procedures and services that are automated in the university, as well as the process simplification and normalisation framework, together with the methodology of standardization and homogenisation of forms associated with electronic procedures.

Electronic accreditation

This aims at guaranteeing that in all telematic interactions between two or more parts it will be always the case that every person or participating entity, whatever it may be, will have the relevant permission to carry out all those activities and processes which they execute, and moreover will handle different elements (forms, documents, etc.) with constant veracity and validity.

Basic services related to electronic acreditation are:

- Authentication of users.
- Certification of actions and documents, validated or generated by different users.
- Certification of the exact day of presentation or submission of a determined document or service.

To make possible and guarantee electronic accreditation, given the legal importance associated with this process, there are a series of components and technologial platforms (promoted in part by different public organizations) orientated at satisfying these services in an adequate way.

In this way, the use of different systems to confirm user authenticity: identity federation mechanisms, digital certificates to validate or certify processes carried out by an applicant-user or manager inside the system, interaction with timestamp systems, validation of the entry date of determined documents or services and electronic stamps to give legal validation to determined documents, are some of the main components contemplated in the electronic accreditation block. As regards alternative available technologies, all of them can be implemented by using open source or self produced software technologies.

Electronic Administration Support

This refers to elements and tools which are necessary to guarantee the adequate telematic interaction between two or more parts. It includes:

- Services of electronic administration (inventory and process simplification, form normalization).
- Electronic accreditation tools (user identification, certification of dates and actions).
- Components of electronic administrative processes (digital headquarters, processing desktop, workflow management, form creation and management, telematic exchange of safe documents, payment gateway, electronic archives, emission of telematic notifications).

Similarly, the setting up of electronic accreditation, user identity accreditation, the validity of signed documents and the entry date of a determined document, have to be verified through an accredited certification authority.

In this sense, the evolution of technologies which support the mechanisms of electronic accreditation (such as the appearance of the electronic ID card) and the different components developed to meet these needs, require constant evolution to be able to adapt themselves to new necessities. For this reason, the institutional support of public administration to the strengthening of such evolution is the only way to guarantee systems to be longlasting and sustainable.

Electronic administrative processing

The main aim of this layer is to implement all university processes through their electronic administration platforms in such a way that it contributes to the promotion of ICT culture in the university environment and especially in all processes of university management.

This focus is centred on offering a quality response to different members of the university community and to companies and administrations able to generate service improvements to different users. Totally supported by the ICT, it not only requires a revision of administrative procedures of each university, but also the development or setting up of a series of fully integrated subsystems which allow, from a multi-channel environment, a totally electronic processing of each of the implanted services.

The main components which have to be contemplated inside this layer to be able to offer different services of electronic administration, are (BOE, 2007) (Government of Spain, 2007, 2007a and 2007b):

- The components of electronic accreditation previously described.
- Digital headquarters to centralize all services of electronic processing offered to different users.
- A processing desktop for the internal management of different administrative proceedings.
- A management component for workflows, for the modelling and management of all proceedings.
- Authoring tools and form management which allow proceedings to be initiated using electronic forms.
- Exchange of documents through telematic means with guarantees of integrity and confidentialiy.

- Payment gateway.
- Electronic archives.
- A telematic system of emission of notifications through different channels of competence authorized in the model.

All of these components, in constant renovation and evolution, are actually available at different Andalusian Universities to be used and implanted directly, thanks to the use of different components of electronic administrative processing in the model developed by the Regional Government of Andalusia (Trew@, Model@, Apply@, Alfresco, @Sign, Porta@Firmas, Notification, etc.) Regional Government of Andalusia, 2007.

The economic benefit that this entails is remarkable, united with the implantation of several already mature systems, as well as the existence of a solid institutional support for its future development and its perfect coupling inside the proposed model (component interoperability, security mechanisms, multi-channel , service composition and orchestration, etc.).

2.5.5. Business Services

University services can give the upper layers of the model (relation channels and access interfaces and supportive elements to the electronic proceedings) specific functionalities to offer to university users (members of the university community and citizens in general). It will include different services developed inside the model, which will have to be scalable and reusable. This layer defines the interface between user and university and determines the services to be accessed and how this is done.

Similarly, this layer develops the university's inventory of procedures and ensures that it keeps aligned to the strategy described by ICT governance. It contains the functional components which have to be implanted in IT applications to provide services to the whole university.

Service organisation inside the model

University services have to cover and respond to the necessities of services inside each of the different Strategic Axes defined for the university:

- **Teaching and Learning**: Services oriented to guarantee teaching quality, based on new participative models and oriented towards the student as the centre of the educative process.
- **Research and Knowledge Transfer**: Services oriented towards internal researchers and transfer of knowledge generated in the university.
- **Management and Processes**: Servicesof support for all the administrative management of a university.
- **ICT Governance**: Services which define and control strategic, organisational, operative and support strategies for ICT.
- **People, Training and Culture**: Services related to internal training, graduate management, Personnel Capacity Management, etc.

2.5.6. Information Systems (ERP)

This layer is constituted by all those information systems and platforms which facilitate the daily operation of university personnel and the processing of services requested by students, or the management of other support processes which are necessary for the adequate functioning of the university.

This layer implements all the processes defined in the business service layer over IT systems. This alignment between layers facilitates system identification which give IT support to each of the Strategic Axes, maintaining the aforementioned classification. Undoubtedly, there is no one to one correlation between IT systems and business processes. A business process may require the participation of various IT systems for its development from the beginning to the end, and similarly, just one application may give support to various university processes.

In this sense, ERP is marked as a fundamental platform that supports processes of global management in the university which, by means of integration of different modules or specific management blocks, allows a response to the specific needs of the university community. These modules will be detailed further (Lowendhal et al, 2008):

The Academic Management Module is oriented in response to all those processes which derive from academic activity, principally towards the educational information of the university and to student management. The revision of current systems or the adaptation to the business processes which derive from the EHEA requires an exhaustive study and revision of the capacity of available IT tools. The most important processes included in the module are, among others:

- Study Plans and Course Descriptions.
- Resource Planning.
- Admission.
- Registrations, Validations and Exemptions.
- Company Internships.
- Systems of credit recognitions (mobility).
- Awards (graduates).
- Grants and Scholarships.

Information Systems

This layer includes systems and platforms which allow the daily operation of the university and has to coinclude modules for the following areas:

- Academic management.
- Research.
- Economic-finance Management.
- Human Resources.
- Relations with third parties.
- Virtual Teaching Support.
- Business Intelligence.
- Infrastructure Management.

Research Module, centred in the management of all activity done by the PDI in the research projects area at university level and the posterior exploitation of these research results. Some processes integrated in this model are:

- Project Management.
- Training and Scholarship.
- Financing.
- Commercialisation.
- Evaluation.
- Scientific Production and Knowledge Transfer.
- Knowledge Management.
- Technical Reports.

Economic-Finance Module, including all those processes which allow controlling and administrating the university budget, as well as economic movements generated by these. Some processes contemplated in this module are, among other things:

- Purchase and contracting, online shopping or e-Procurement.
- Budget Management.
- Accounting.
- Tax Regulation.
- Heritage Management.
- Inventory.

Human Resources Module, oriented towards the management of all aspects related to the university personnel, this allows human resources administration in a centralized way, with access from anywhere. Some processes contemplated in this module are, among other things:

- Administration.
- Wages.
- Expenses.
- Contracting.
- Performance Assessment.

Management of relations with third parties, this establishes a series of channels and processes by means of which it is possible to maintain communication with external agents through the following methods. (Drakos et al, 2008):

- Management of the relations to clients (CRM).
- Social networks.
- Other channels: Youtube, Television, etc.

This module begins to gain special relevance with the integration of more agents in the complex map of relations with the university. The implantation of the CRM System, should, for instance, contemplate the associated functionality, not only in the management of relations with the student or graduate, but it should also take into account the participation of the business world in teaching and research. (Greenberg, 2009).

Virtual Teaching Support Modul, centred in the management of functions which allow students and university teaching personnel to dispose of a web space where they can find all necessary information, as well as an area of communication and relations with the rest of the university community (Rozwell et al, 2008). Some processes or functionalities which it incorporates are, among other things:

- LCMS.
- LMS.
- E-portfolio.
- Learning Objects Repository (LOR).

Business Intelligence Module, by means of which the university disposes of a set of strategies and tools directed to the administration and creation of knowledge through the analysis of data existing in different information repositories.

This module needs connectivity with all databases of the applications which give support to university processes, with the aim of making information available for strategic decision making. For this reason, system performance and the quality of information extracted would be the key (Richardson et al, 2009).

Document Management Module, through which the university has systems available which are capable of managing the enormous set of documents associated with different processes of university activity.

Infrastructure Management Module, in which all those information systems are defined that, without providing support to the different activity blocks of critical

activity inside the university environment, serve as support for daily university management. In this sense, it is possible to include a diversity of systems oriented towards management of areas or systems such as:

- User Attention Centre.
- Space Reservation.
- Reception Management.
- Warehouse/spare parts management.
- Vehicle pool management.
- Gardening.
- Cleanliness.
- Maintenance: plumbing, electricity, bricklaying, general repairs management.

2.5.7. Security Management

Security Management

This layer contains instruments needed to guarantee system integrity and information confidentialiy:

- Security in communication (confidentiality, integrity, no repudiation).
- System availability.
- System access control.
- Stored information protection.

To guarantee the correct management of security and the continuity of systems and communications, the function of ICT governance should define the pertinent security processes according to a guide of good practice such as the one described in ISO/IEC 17799 e ISO27001 (ISO, 2009).

This layer consists of the instruments needed to guarantee the integrity and confidentiality of IT systems, and to identify possible unwanted accesses (intrusions) in systems and communications.

- **Security in Communication**: through the management of encoding mechanisms which ensure that communications are inaccessible to intruders (confidentiality), that the information is not altered in transit (integrity), and that users cannot deny their specific transactions (no repudiation).
- **Availability**: systems should prevent possible functionality failures in a way that does not interrupt the services offered by critical systems, for which redundant configurations may be established (clustering or high availability) even using replica CPDs and communication diversion (system of business continuity).
- **Access Control**: it is possible to support this with different means of authentication (storage of user names and passwords in a directory system, digital signatures, etc.). The security platform will carry out a

centralized management of users (identity management, including mechanisms of unique session access or Single Sign On (SSO) in a way that guarantees security and confidentiality for users and the applications they access.

- **Content protection**: stored information has to be protected against possible corruption problems (integrity) and, in any situation, information protection will be guaranteed through correspondent and already existing back-up policies in the university.

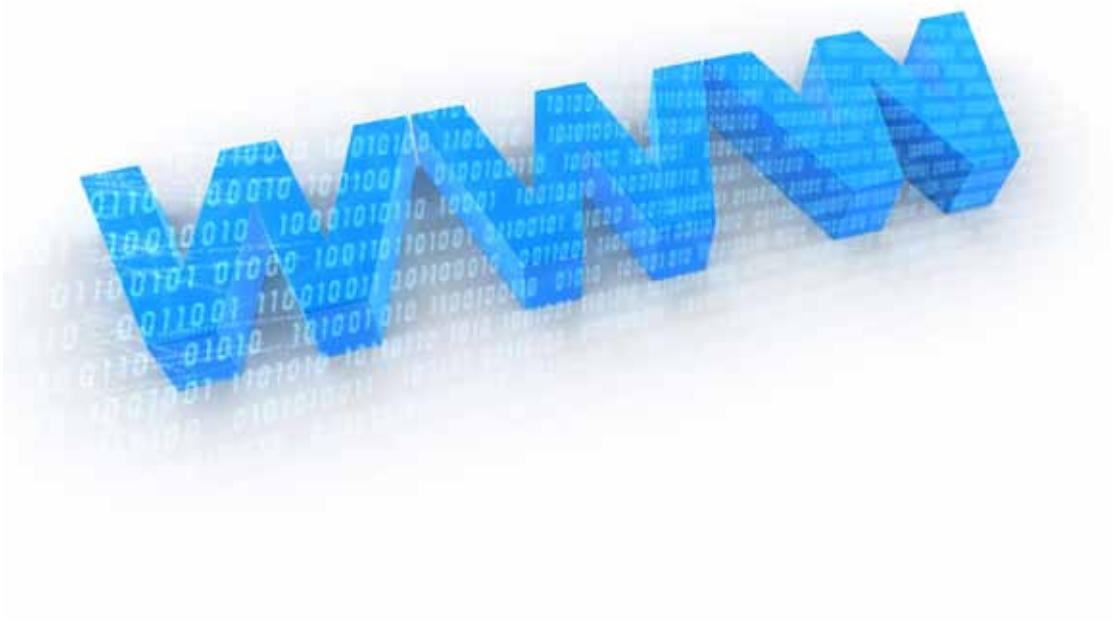
2.5.8. Technical Support Infrastructures

This model layer is made up of the LAN/WAN network infrastructure existing at the university, the architecture of servers and devices for the exploitation of systems and the existing software platforms for the development of said IT systems.

This layer is of the highest diversity and heterogeneity of components. This is due to the fact that it contains different infrastructures as a base on which the whole model is built and that its components differ considerably (in numbers as well as typology) for each specific university.

Technical Support Infrastructures

- This refers to main infrastructures such as: LAN/WN net, server architecture, and the exploitation of system devices and software platforms.



2.6. Conclusions

This Objective ICT Model is definitively proposed to respond to the set of strategic necessities of the Public Andalusian Universities, starting with the present situation in the ICT field and making use of the tendencies and experiences of success in other higher education and research centreson at a national and international level.

Logically, the level of individual development of each Public Andalusian University in the ICT area will be different when considered independently. In the next chapter a plan of action is proposed, to be followed by all Andalusian Public Universities, through the formulation of series of strategic objectives and the proposal of some specific lines of action which will accomplish this aim.

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PROPOSALS FOR A PLAN OF ACTION LEADING TO A NEW ICT MODEL: THE PLAN

Strategic Objectives and Lines of Action

Plan of Action Outline:

Strategic Lines; Functional Analysis

Chapter References

3.1. Strategic Objectives and Lines of Action

As previously mentioned, the securing of the new ICT model described in the previous chapter is vital if Andalusian Public Universities are to establish themselves on a technological level which will allow their strategic aspirations to come to fruition, and also to respond to the demands of an ever-changing environment (EHEA, ERA, electronic administration…).

This chapter, under the title Plan of Action, deals with a series of proposals aimed at contributing to the evolution of the current ICT situation in Andalusian universities towards the new model defined in the previous chapter.

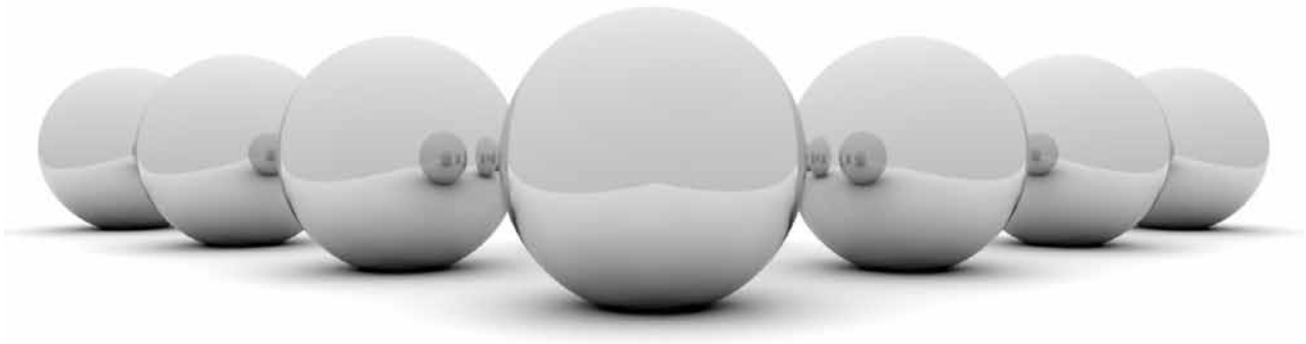
The strategic objectives proposed for the implementation of the Objective ICT Model for Andalusian Universities are presented in table 3.1.

Table 3.1.
Proposed strategic objectives. Source: compiled by author.

ICT Governance	A university in which ICT plays a central role
Learning and teaching	A university with the most advanced technological systems.
Research and knowledge transfer	A university where research and knowledge transfer are supported and enhanced by ICT
Management and processes	A university with advanced and efficient management processes due to complete incorporation of ICT
People, training and culture	A university staffed by motivated professionals who are well trained in the use of state-of-art ICT

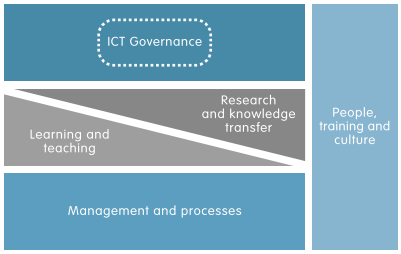
There is a direct link between these objectives and the conclusions of the external and internal analyses carried out. The proposed objectives are intended to bridge the gap existing between the ideal situation described in the Andalusian University System Objective ICT Model and the conclusions of the external and internal analyses carried out. Strategic lines allowing the implementation of these objectives have subsequently been identified. Other, less urgent but equally relevant, complementary lines and recommendations have also been.

Included. The result of this process, which is the layout of the plan of action divided into Strategic Axes as was previously mentioned, is as follows. Each objective contains an explanation of the objective itself and of the strategic lines, complementary lines and recommendations for their attainment. The details for the implementation of the strategic lines are included in a later section.



ICT GOVERNANCE

Objective 1:
A University in which ICT plays a Central Role



Nowadays, it is difficult to find an activity, a process or a service which does not require the intervention or support of some technology or other. ICT has invaded our daily life and that of all advanced organisations. Almost all the critical processes of a university, be they strategic, educational, research or management, rely on them to a greater or lesser degree.

As is the case with students, professors, academic contents, and research programs, which are traditionally and naturally considered a priority by university governing bodies, so should technology take its rightful place. As the external and internal analyses show, this is the case in the most prestigious, higher education, academic institutions around the world.

Andalusian universities have already gone a long way towards achieving this. All Vice-Chancellors' teams now have a member in charge of new technology to reinforce the importance of ICT in university life and also in medium and long term strategies.

The first objective of this commitment is to; consolidate and reinforce the position of ICT as a strategic, essential and determining factor in all the steps taken by the university towards the future. These include the necessary reinforcement of internal computer system management and maintenance departments.

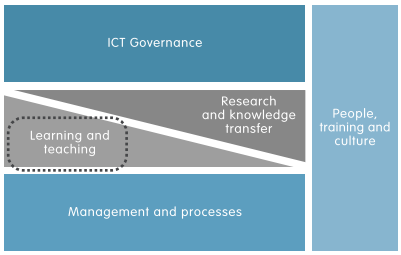
Table 3.2.
Objective 1. Source: compiled by author.

A University in which ICT plays a Central Role

OBJETIVE 1
STRATEGIC LINE 1.1.
To enhance information systems for university governance. It is necessary to develop information based management support systems based on systems such as the Balanced Score Card (BSC), which must be orientated towards the monitoring and follow-up of university strategic objective achievement. This field will include all university services, as well as ICT services, university community user results and orientation and budgetary and financial plans.
STRATEGIC LINE 1.2.
The application of methodology and standards to ITC management. The objective is to put into practice ICT management models based on internationally recognised methodology and standards such as ITIL, CoBIT, ISO9001, ISO27001 and ISO20000 with the aim of rationalising and improving the strategic design, implantation and subsequent management of all the information systems involved in all university processes.
COMPLEMENTARY LINE 1.1.
The achievement of excellence in ICT governance systems. This line reinforces the second level of development of strategic lines one and two and is based on the application of standardised ICT governance systems (including ICT service planning), Models of excellence such as the EFQM adapted to the framework laid down by the Andalusian Regional Government, the establishment of evaluation mechanisms for this management and the relevant legal and regulation compliance audits.
COMPLEMENTARY LINE 1.2.
To develop a bespoke and integral ICT service provider model. Special attention must be paid to subcontracting as well as to the regulations governing specific service and infrastructures in the integral ICT service provider model.
RECOMMENDATION 1.1.
To develop an ICT business plan. Have an ICT strategic or business plan at each of the universities which is aligned with its directives for mid-term evolution. .
RECOMMENDATION 1.2.
Carry out general actions in relation with management by objectives. It is important to stress correct planning, setting of benchmarks, and the monitoring of the effectiveness and efficiency of the most relevant ICT service projects. This involves a clear focus on results for said projects on the part of the people responsible for their management and execution. This is related with the use of indicators and their proposed measurement, as well as with the models of excellence considered.

LEARNING AND TEACHING

Objective 2:
A University with State-of-the-Art Technological Systems



It is no easy task, in just a few lines, to stress the importance of higher education for the human resources of a region in terms of its social, economic and external development in every field. To this aim, Andalusian universities have been constantly adapting not only their contents but also their teaching methods to the requirements of their surroundings. This ongoing evolution has been intensified by the introduction of the EHEA, which has involved the construction of an open teaching and training environment free of obstacles to students, graduates and professors alike in all the participating countries.

ICT can contribute to providing the solutions to this requirement for constant change in the field of learning and teaching. This is understood from an integral point of view (as reflected on the activity chart of the university included in the Objective ICT Model approach. That is to say that, on one side, student management (admission, enrolment, validations, exemptions, grants, extracurricular services, work experience and evaluations) should be considered in this field. On another, we should consider training programmes (teaching staff organisation, teaching plans, production and content management and teaching). Lastly, teaching and research staff should be considered (employment and selection, training and grants, teaching personnel services, etc.).

Therefore, this second strategic objective is a critical field in which existing systems must be developed in a way that is related to the management of students and teaching and research staff as well as the teaching offer and to the production of course content and its subsequent management and teaching, until this important activity has been totally catered for by the most advanced information systems available.

The transformation of ICT associated with teaching and learning will definitely not mean the substitution of face to face teaching by virtual or distance learning (based on e-learning systems). On the contrary, ICT will be an aid to teaching staff and, when it is considered appropriate, the base of virtual teaching that is complementary and relevant for new degree courses, ongoing training of teaching and research staff and administrative personnel, among others.

TTable 3.3.
Objective 2. Source: compiled by author.

A university with state-of-the-art technological systems for teaching

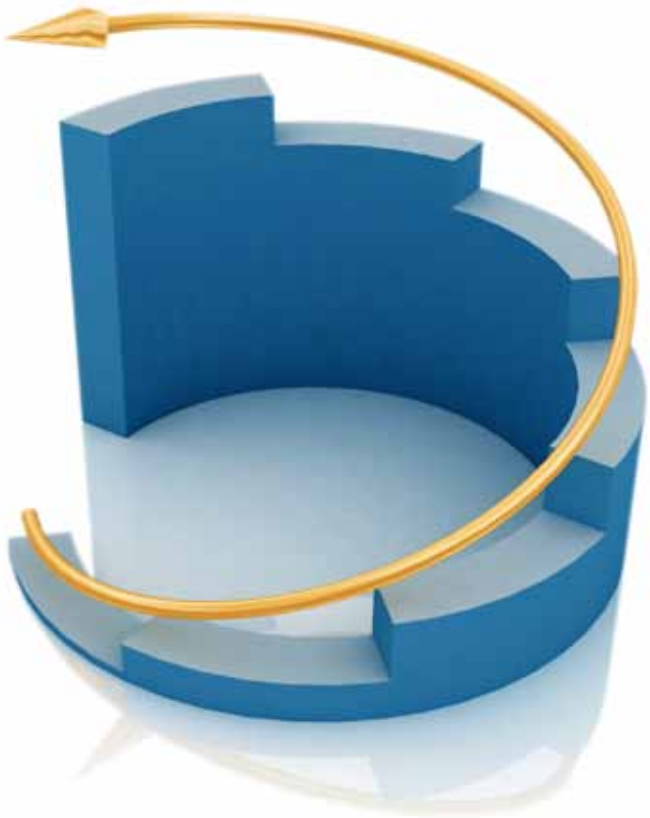
OBJETIVE 2
STRATEGIC LINE 2.1.
The adaptation of academia management to the EHEA. The availability of a complete information system, as well as covering the most traditional requirements, allows the management of: • The unique electronic student record as part of an ERP and the keystone for providing the transfer and recognition of credits between universities. • The e-portfolio as a base for new continuous and historical assessment of acquired abilities, as well as complementary student activities (student representation, cultural and sporting activities, volunteer work.). • Management of the Teaching Staff Organisation plan adapted to new teaching activities with the possibility of calculating teacher dedication. • New module and subject evaluation synopses with curricular evaluation.
STRATEGIC LINE 2.2.
Achieve total implantation of ICT in teaching/learning processes. Total ICT implantation is understood from the following points of view: • Promote the virtual campus platform as a medium and channel for student-teacher relations. • Promote the preparation and pooling of quality teaching materials through the development of learning object repositories (LOR). These systems must be compatible with the different Learning Management Systems such as Moodle, WebCT or Ilias. They must also promote the knowledge value generated by the university so allowing its reuse (independently of the systems used for their subsequent management.
STRATEGIC LINE 2.3.
Improve the integration of learning platforms with the ERP academic management platform. Academic management must be interoperable with the Learning Management System (LMS) platforms. Both applications must be integrated at organisational, semantic and technological levels.
COMPLEMENTARY LINE 2.1.
Promote and encourage the adaptation of information systems to aid both face to face and blended teaching. To achieve this, these systems need to be more available so teacher and student can carry out the teaching-learning process (both in situ and at a distance) with the help of ITC, as opposed to a more traditional way of teaching.

COMPLEMENTARY LINE 2.2.

Establish the use of new learning channels and mediums. Examples such as the use of virtual spaces for academic activities and others related with the university in Second Life, the use of channels such as YouTube and iTunes-U among others available on Internet as well as the incorporation of TDT as a possible complementary channel for teaching. .

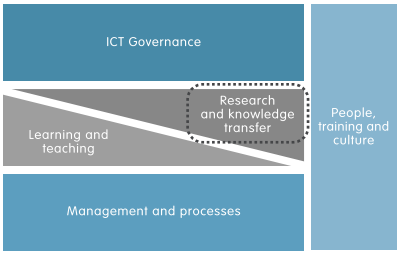
RECOMMENDATION 2.1.

Encourage the dissemination of open educational contents. To carry out this recommendation the use of web standards is advisable, paying special attention to the management of intellectual property for educational contents. The development of plans to eliminate barriers to creativity, for example, using Creative Commons (a not-for-profit NGO which develops projects to reduce the number of legal problems hampering creativity, by means of new legislation and new technology).



RESEARCH AND KNOWLEDGE TRANSFER

Objective 3:
A University where Research and Knowledge Transfer is Aided and Enhanced by ICT



Research is another university activity which has a great impact on the economic and social development of a region. The creation of knowledge at the university, as a hub of scientific activity, and its transmission to society and the business network are essential for the promotion of this progress.

Although ICT is present in practically all the processes and services of any entity, as has been mentioned, it is even more noticeable in research. The nature of this activity involves the need to make information available, to share it, and to and manage it, be it inside the university or outside. This requires cooperation among various experts and the systemisation of both the process and the results. Therefore, ICT can. without a doubt, enhance and multiply the benefits.

The progress made over the last few years, thanks to the increased bandwidth in academic networks, is unquestionable. Access to complete texts at online reviews and databases is widespread, as is the availability to the university community of supercomputing services for research.

In this field it is a strategic objective for universities to accelerate the availability of ICT tools designed to facilitate the organisation of research activities, encourage individual work and to promote, disseminate and share its results in every field (universities, scientific communities, business networks and society as a whole).

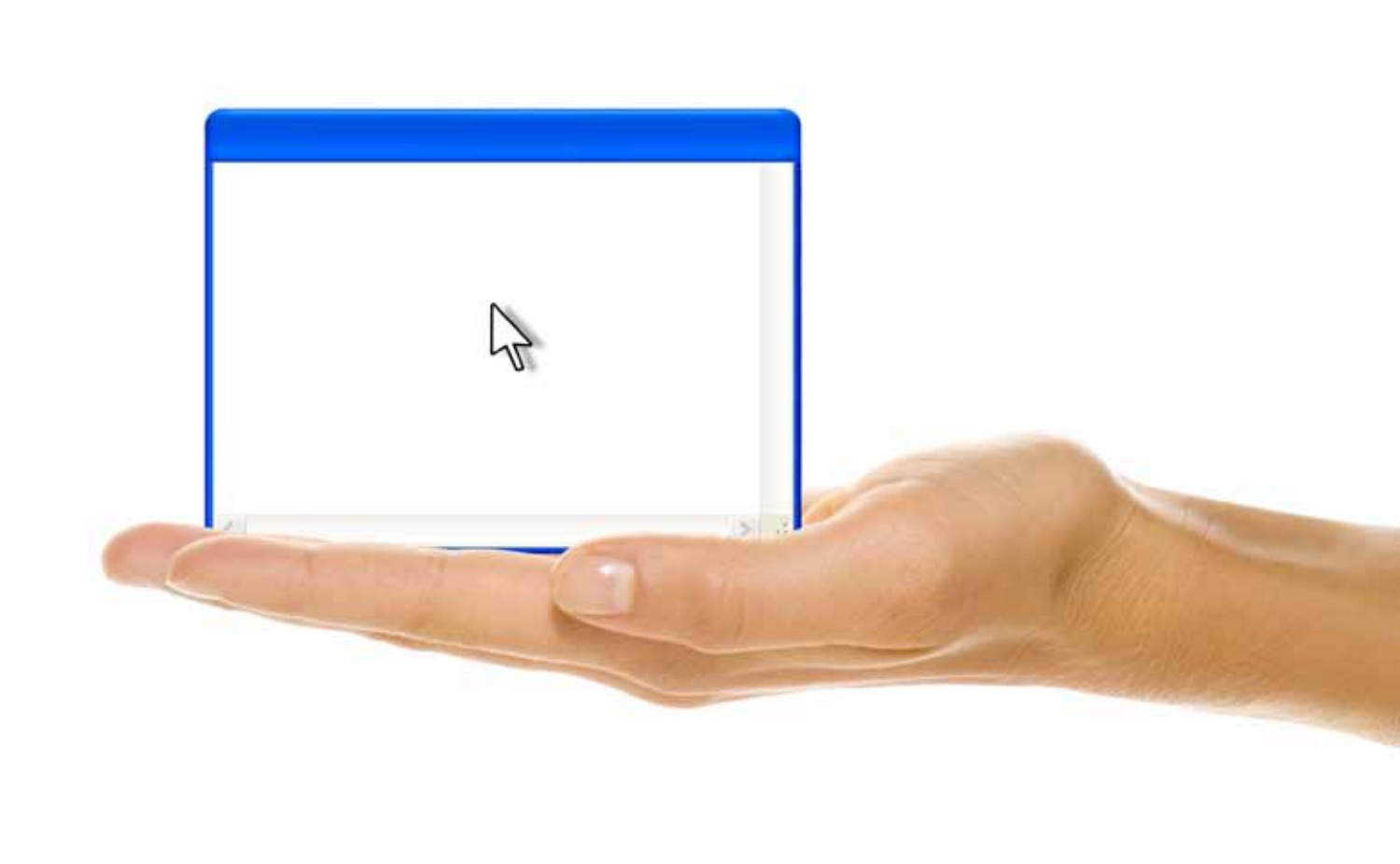
Table 3.4.
Objective 3. Source: compiled by author.

A university where research and knowledge transfer are aided and enhanced by the use of ICT

OBJETIVE 3
STRATEGIC LINE 3.1.
To develop an integrated research management system. The objectives to be achieved, by means of an integrated research management system which includes finance and project execution review management, are detailed in this strategic line.
STRATEGIC LINE 3.2.
To develop and consolidate the management of research activity knowledge. The aim is to use ICT to improve knowledge, both internal and external, of research carried out at universities. Internally, there are no systems that cater for what was mentioned in the external analysis in chapter one, regarding the evolution towards digital repositories for published content which, would provide centralised access to unique digital documents. The integration and interoperability of digital publishing systems belonging to private companies or subscription managing institutions such as the Andalusian University Library Consortium (CbuA) would be required in the external sphere.
STRATEGIC LINE 3.3.
To create, in a similar way to in the field of teaching, institutional repositories for scientific production independent of the platforms used for its pooling and management. A complete management plan for research and knowledge transfer must be drawn up by the different Andalusian universities based on ICT, these are in turn to be based on the use of the existing scientific production repositories of each university.
STRATEGIC LINE 3.4.
To promote the use of technological applications to favour relations with companies. University-enterprise relations must be promoted, it is therefore essential to increase the use of university research online search tools by companies. Help tools for research contract preparation between different profiles (researchers, companies and (OTRI) Research Result Transfer Office managers) must also be provided.
COMPLEMENTARY LINE 3.1.
To implement actions of scientific content dissemination through ICT. The need for dissemination of research carried out in Andalusian universities has led to the appearance of a number of scientific diffusion portals. This line defends the need to improve and enlarge these systems at all Andalusian Public Universities. .

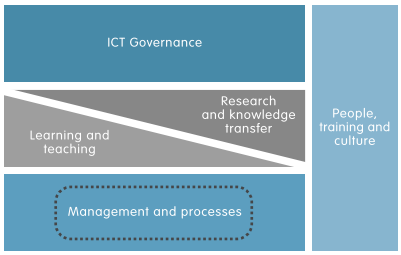
RECOMMENDATION 3.1.

To establish global tracking systems for researchers' publications. For this recommendation to function properly the interconnection of databases containing all the information regarding a certain researcher's publication, such as: Scopus, Emerald, Web of Science…, is necessary. That way, information about scientific diffusion by Andalusian Public Universities is both optimum and global, thus contributing to enhancing the value of this activity. This complements the proposal regarding the scientific production repository.



MANAGEMENT AND PROCESSES

Objective 4:
A University with Advanced and Efficient Management Processes through Total ICT Incorporation



A complex entity, whatever it may be, requires a series of resources and support processes which, although they are not an intrinsic part, are essential for it to work correctly. Excellent management of these elements allows an organisation to concentrate on its core activities (in the case of a university these would be; the teaching and learning, research and knowledge transfer).

Furthermore, intensive ICT use has become consolidated in activities such as the control and follow up of the running of a university, financial resource management, equipment and HR, employment and legal advice. As the external and internal analyses showed, it is important for Andalusian Public Universities to come into line with the requirements governing the electronic access of citizens to public services.

The strategic aim in this field is to achieve the consolidation, and if possible, the development and establishment of a group of support systems which would provide Andalusian public universities with advanced and efficient university activity management and support systems.

Table 3.5.
Objective 4. Source: compiled by author.

A university with advanced and efficient management processes through total ICT incorporation

OBJETIVE 4
STRATEGIC LINE 4.1.
Towards the evolution of existing ERP management from a functional and technological point of view. Andalusian Public Universities require a technological evolution of the existing ERP (or development of a new one) towards an integral ERP containing and incorporating all the necessary modules in a functional way (amongst which: HR management, financial management, purchasing and inventories, customer relationship planning (CRM), research management and teaching management).
STRATEGIC LINE 4.2.
To fully develop electronic administration by means of the progressive mechanisation of all internal and external university administration. To introduce electronic administration mechanisms and technology designed to comply with processes allowing: • Full compliance with the requirements of, Act of Law 11/2007 Electronic Access of Citizens to Public Services (Official Gazette (BOE) 2007). • Achieve a better external perception of services provided to the various members of the university community. • Achieve an improvement in the internal perception of the day to day management of university processes through their optimisation and automation.
STRATEGIC LINE 4.3.
To develop and implement a Multi-channel Attention Centre. Universities require centralised university community attention systems which allow the unification of communications, electronic processing procedure attention, attention to all kinds of incidents (not only technological), follow up of processing and incidents and posses unified notification systems. .
STRATEGIC LINE 4.4.
To make cooperative work environments available to the university community. The new university model being promoted by the EHEA encourages cooperation at all levels and among all the members of the university community. The adaptation of the cooperative model should be assisted by the information systems in every field, especially research and knowledge transfer, with the aim of providing a meeting and cooperation point for Andalusian universities.

COMPLEMENTARY LINE 4.1.

The incorporation and use of the services offered by different public entities of interest to the university. It must be carried out by means of the corresponding agreements and the development of the necessary interfaces allowing the interoperability of the systems involved. One example would be the agreements between Andalusian universities and the Regional Government Ministry of Justice and Public Administration regarding the electronic signature.

COMPLEMENTARY LINE 4.2.

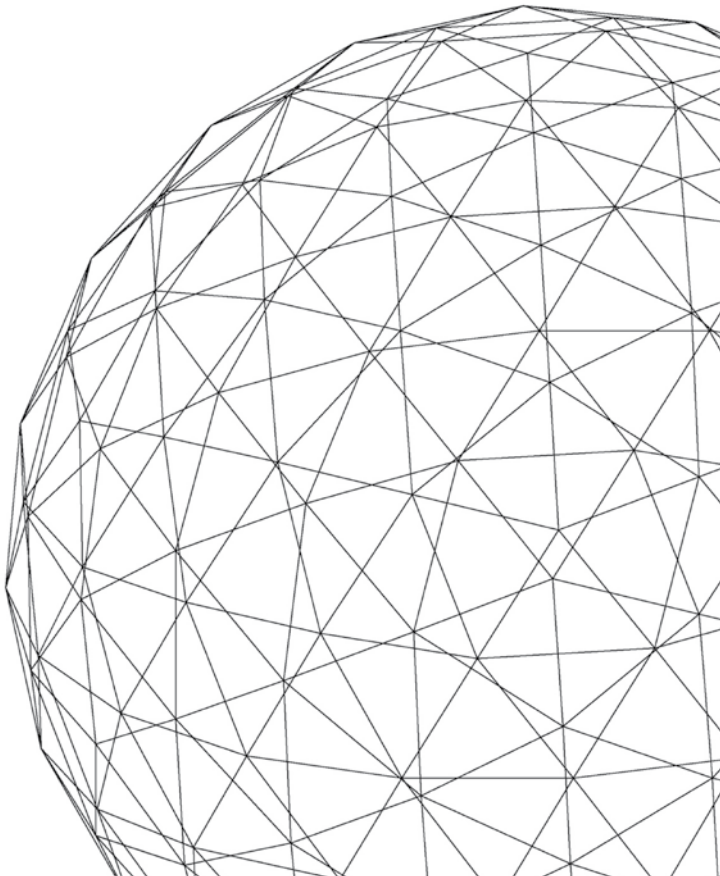
To guarantee the integration and external interoperability of integral management modules belonging to the evolved ERP. To develop the organisational and technological mechanisms which guarantee that the integration of university systems and external interoperability work correctly at all times.

RECOMMENDATION 4.1.

To establish a global change management plan to include dissemination and communication actions aimed at easing the transition towards the proposed Objective ICT Model. To set up the Objective ICT Model it is necessary for each university that so decides to develop a communication plan designed to promote and disseminate all the actions included in said model and orientate it towards the whole of the university community.

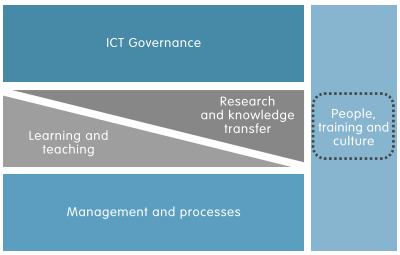
RECOMMENDATION 4.2.

To develop follow-up systems for the Andalusian University System, which guarantee that electronic administration is correctly developed and introduced. Said system must be made up of Andalusian Public Universities and the CEIC. The objective is for all Andalusian University System users, within the independent framework of their university, be able to benefit from similar electronic service coverage at all the institutions involved.



PEOPLE, TRAINING AND CULTURE

Objective 5:
A University with a Team of Motivated Professionals Trained in the use of the Most Advanced ICT



Nowadays, any technological transformation process which does not consider people, their training and their organisational culture as the central element is inconceivable. This is especially true in the case of universities, institutions in which people are involved, more or less in terms of time but with total relevance regarding management responsibility and decision making.

It is not possible to imagine teaching without teachers or research in which the human factor is not decisive. It's the same when it comes to management processes, in which automation can be virtually total for repetitive tasks or those with little added value, but non-existent in processes which involve decision making.

For these reasons, the fifth strategic objective (the last but by no means the least) is to achieve a team of professionals convinced of the strategic importance of ITC in every sphere of university activity. Adequately trained professionals who are able to make the most of the possibilities offered. This requires the execution of plans designed to achieve this aim.

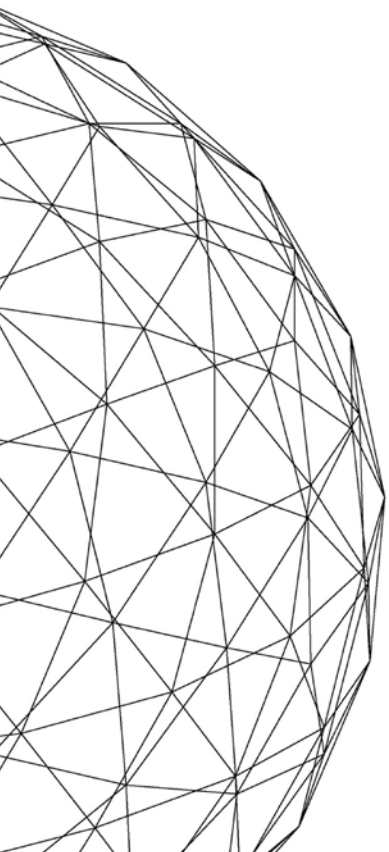


Table 3.6.
Objetive 5. Source: Compiled by author.

A university with a team of motivated professionals trained in the use of the most advanced ICT

OBJETIVE 5
STRATEGIC LINE 5.1.
To improve the ICT competence and training of the university community. These actions have to take into account both transversal techniques (user level) and specific techniques (for ICT managers). Aspects concerning ability and competence in the use of ICT should also be taken into account.
STRATEGIC LINE 5.2.
To take measures to encourage the use of ICT by the university community. System introduction drawing attention to ease of use and recognising active participation in the introduction, use of, and the training actions carried out.
STRATEGIC LINE 5.3.
Develop Customer Relationship Management CRM aimed at efficiently managing relations between members of the university community and society. The stakeholders, both external and internal, participating in the university of the future are numerous. To attempt to interact with them without an adequate technological platform would be an extremely difficult task. CRM systems provide solutions with well defined processes adapted to the individual circumstances of each university.
COMPLEMENTARY LINE 5.1.
To encourage the use of audiovisual media so allowing the dissemination of university activities. The installation of computer hardware around the campus is noteworthy (screens, multimedia information points, information and form processing kiosks) as is the production of content for audiovisual media (TV channels, IP video, press and digital radio).
RECOMMENDATION 5.1.
To have mobile ICT services which take advantage of multiplatform and multilingual capacity. The use of mobile connection tools is recommended as well as the social networks which encourage the ubiquity of university services. In short, they should be accessible by as many communication media as possible.
RECOMMENDATION 5.2.
To encourage the creation of a social network specifically designed for ex students. The objective of this recommendation is to consolidate a lifelong relationship between the university and its graduates; providing relevant information regarding knowledge and the job market.

3.2. Plan of Action Outline

The following table provides a schematic layout of the strategic lines, recommendations and projects as detailed in the functional analysis.

Table 3.7.
Plan of Action Layout. Source: Compiled by author.

ICT Governance

A university in which ICT plays a central role

Strategic lines	SL1.1. To promote the use of information systems in university governance. SL1.2. To apply methodologies and standards to ICT management.
Projects	P1.1. To develop a CMI for the university. P1.2. To evolve the Information System to Management or Data Warehouse. P1.3. To introduce ICT management systems.
Complementary lines	CL1.1. To achieve excellence in the governance of ICT systems. CL1.2. To develop a bespoke and integral ICT service providing model.
Recommendations	RE1.1. To develop an ICT master plan. RE1.2. To carry out general actions related with objective management.

Learning and Teaching

A university equipped with the most advanced technological systems for education

Strategic lines	SL2.1. To adapt academic management to EHEA. SL2.2. To achieve full introduction of ICT in learning-teaching processes. SL2.3. To improve the integration of learning platforms with academic management ERP
Projects	P2.1. To develop existing academic management ERP. P2.2. To introduce an internal quality guarantee system for qualifications. P2.3. To establish Learning Object Repositories (LORs). P2.4. Integration and interoperability. P2.5. To develop the Andalusian Virtual Campus.
Complementary lines	CL2.1. To encourage and promote the adaptation of information support systems for face-to-face and blended teaching. CL2.2. To introduce the use of new learning channels and media.
Recommendations	RE2.1. To encourage the dissemination of open educational content.

Research and Knowledge Transfer

A university where research and knowledge transfer are supported enhanced by the use of ICT

Strategic lines	SL3.1. To develop an integral research management system. SL3.2. To develop and consolidate knowledge management and research activity systems. SL3.3. To create, in a similar way to the field of teaching, institutional repositories for scientific production independent to those used for its pooling and management. SL3.4. To promote the use of technological applications to facilitate the relation with companies.
Projects	P3.1. Improvement to the Andalusian Information System (SICA). P3.2. A knowledge management system which is interoperable with the Andalusian Scientific Information System (SICA). P3.3. Digital preservation projects. P3.4. The creation of scientific production repositories. P3.5. Contract and project management systems based on web services (e-OTRIs). P3.6. Customer Relationship Management systems for university- enterprise relations
Complementary lines	CL3.1. To implement scientific content dissemination actions through ICT.
Recommendations	RE3.1. To introduce global tracking systems for researchers' publications.

Management and Processes

A university with advanced and efficient management processes due to the the full incorporation of ICT

Strategic lines	LE4.1. To develop the existing ERP management from a functional and technological viewpoint. LE4.2. To fully develop electronic administration by means of progressively mechanising all internal and external university administrative procedures. LE4.3. To develop and implement a Multi-channel Attention Centre. LE4.4. To make cooperative work environments available to the university community.
Projects	P4.1. To develop the existing ERP management from a functional and technological viewpoint. P4.2. Re-engineering procedures. P4.3. To promote form processing platforms. P4.4. Set up a CAM in every university. P4.5. Virtual desktops.
Complementary lines	LC4.1. To incorporate and use the services offered by different public entities of interest to the university. LC4.2. To guarantee the integration and external interoperability of the management modules making up the evolved ERP.
Recommendations	RE4.1. To introduce a global management plan which includes dissemination and communication actions designed to facilitate the transition towards the proposed Objective ICT Model. RE4.2. To develop follow-up systems for the Andalusian University System to ensure that electronic administration is correctly developed and introduced.

People, Training and Culture

A university staffed by motivated professionals who are well trained in the use of state-of-art ICT

Strategic lines	SL5.1. To improve ICT competence and training of the university community. SL5.2. To introduce measures aimed at encouraging ICT use by the university community. SL5.3. To introduce Customer Relationship Management (CRM) with a view to efficiently managing relations with members of the university community and society.
Projects	P5.1. To produce and/or update ICT competence charts for teaching staff and administrative personnel and its inclusion in the training plan. P5.2. ICT training offer for students. P5.3. Implant global follow up systems for research publications. P5.4. The development of a CRM for the university community and the society as a whole.
Complementary lines	CL5.1. To promote the use of audio visual media which allow the dissemination of university activities.
Recommendations	RE5.1. To have mobile ICT taking advantage of multiplatform and multilingual capacities. RE5.2. To encourage the creation of a social network aimed specifically at graduates.

3.3 Functional Analysis of Strategic Lines

Taking into account the available information, a strategic line functional analysis was carried out. The definition of each of them was included, in relation to the Objective ICT Model, Current Situation and Justification with regards to the external and internal analyses in chapter one and what their implementation would be in the case of Andalusian universities.

Strategic Line 1.1. To promote information systems for university governance

Definition

A balanced scorecard (BSC) (Kaplan y Norton, 1999) is a management model which helps organisations transform strategy into operational objectives. These become a guide for the obtainment of results and strategically synchronised behaviour of individual in the organisation. The BSC requires systems of information on objectives, indicators, deviations, etc.

For the development of the global BSC for university governance we propose the use of the Kaplan y Norton (1999) methodology. Thanks to this tool the achievement of strategic objectives, and their synchronisation with the university's mission and vision, are continuously monitored and evaluated.

Current Situation and Justification

At present, as can be observed in the internal analysis carried out, it is necessary to know the real ICT requirements to be able to tailor the services correctly and face the university's present and future needs successfully. Furthermore, all the strategic plans of Andalusian universities have transversal ICT objectives and/or initiatives for the implementation of said plans. For several years now the Andalusian Public Universities have been developing an Management Information System (based on Oracle) within the Digital University projects and the contract program of the Andalusian Regional Government Ministry for Education, Innovation and Science (CEIC). It is, therefore, a starting point to be taken into account in the proposal for a BSC which would allow the university governors to carry out a global follow-up of their strategic plan and a continuous evaluation of the levels of ICT service provided, by means of indicators which monitor the state of ICT objectives or initiatives.

To finish, it can be said that the management information system based on a data warehouse for the construction of a BSC is one of the technological options of the ICT models being considered by Andalusian universities.

Implementation

The setting up of this strategic line includes the two following projects:

• PROJECT 1.1.

The development of a BSC for the university.

Deep reflection is required for the design of a BSC, in which the perspectives proposed by Kaplan y Norton(1999) in their methodology, are taken into account, logically adapted to the university environment.

The steps to be taken to carry out the design of the BSC are as follows:

- The establishment of objectives and/or initiatives for the correct execution of ICT services. These must be in line with the university's strategic plan.
- The design of the indicator system to continuously monitor the state of objectives and/or initiatives.

• PROJECT 1.2.

To develop the Management Information System of data warehouse.

The inclusion of data mining tools is proposed to allow connection with the data warehouses to extract the necessary information for the indicator panel. A tool like this provides a control and an efficiency or performance management system by means of a series of indicators. These show objective and/or initiative development and performance state.

The following are the basic characteristics this type of tool should possess:

- **Analytic data processing**: this allows the definition of parameters and checks as well as statistical calculation. The user may obtain information either from a data origin or a data warehouse.
- **Compatibility with multiple data sources**, consequently it can work with multiple databse servers such as: Oracle, DB2, Microsoft SQL Server, MySQL, PostgreSQL, etc.
- **Scalability and high performance**: allows calculation of large volume of information.

- **Integrates with other systems** by means of Simple Object Access Protocol (SOAP): allows the sending of statistical information via web services to other systems.
- **Security**: it allows user identification either through login or via Lightweight Directory Access Protocol (LDAP), profile assignation and also restricts data access to those profiles according to consultation parameters.

Strategic Line1.2. Application of methodology and standards to ICT management

Definition

Current Situation and Justification

The ability to speed up the decision taking process, especially those of a strategic nature, is becoming ever more important in universities. All this is due to the current trend in which universities have to prove their ability to react to a constantly changing environment. Likewise, the progressive digitalisation of universities is having an impact on governance and internal management systems of institutions and there is a progressive introduction of technology in these areas. ICT must not stand aside but must become an instrument of support facilitating the taking of the right decisions by the governing bodies in both an agile and efficient way.

It is, therefore, necessary to have standardised, bespoke services and processes using internationally recognised standards and/or methodologies. As well, the possibility of facing future outsourcingprocesses with the consequent improvements in efficiency, cost saving and risk reduction adds to the advantages of this aspect. Moreover, ICT governance is becoming one of the hot topics in organisation information systems, including university resource planning systems (Kwon, 2008). ICT governance guarantees the achievement of objectives in this area and reduces the risks, providing technological value to the whole organisation. ICT management at organisational level pursues the following objectives: (Kwon 2008): synchronisation of ICT with university processes, the creation of opportunities for the development of new services through ICT, the execution and maximisation of expected use, adequate ICT related risk management and responsible use of ICT resources.

Regarding the establishment of ICT governance in a university environment, a given reference framework including a group of structures, mechanisms and processes to be carried out is used (Fernández, 2008). Due to the growing importance of ICT at corporate level (Government ICT) there are numerous examples of international system implementation using various reference frameworks, amongst them, CobiT and ITIL. These have been mentioned as having obvious characteristics for external analysis of universities by Gartner (2009), and constitute a good starting point for the introduction of an ICT Governance model (Laviña y Mengual, 2008).

Andalusian universities are immersed in ISO9001 certification processes for its services, including those specifically related with ICT. Some are working on the application of better practices within the ITIL framework but without applying the rest of the methodologies or standards mentioned, especially the ISO38500 standard. However, they have committed to applying the European Foundation For Quality Management (EFQM) standard, as is mentioned in the internal analysis carried out. This is a model for business excellence management, however, and therefore it is understood that the efforts should be redirected towards the standardised ICT management models mentioned. When all is said and done, the application of these methodologies could be the base for the application of ICT measurement systems such as found in CobiT.
(Gartner, 2009).

Implementation

• PROJECT 1.3.

The Introduction of ICT management systems.

The adoption of methodologies and standards for ICT management in the heart of the university, goes through four fundamental stages; training and awareness of the management team and ICT staff of the benefits, to know and evaluate the starting point for each university (maturity), definition and identification of the improvements to be obtained as a result of the application of the same and the production and deployment of a realistic plan for its introduction. It is also possible that some of the systems identified will need certification.

The sector ICT Commission of the CRUE (The Association of Spanish University Vice-Chancellors) (Fernández, 2008; Uceda y Barro,2009) is promoting the adoption of a culture of ICT governance in Spanish universities This strategy requires the adoption of a model of self-appraisal and the creation of the tools to enable it. Andalusian Public Universities have an excellent opportunity

to take the lead in this process by actively participating in the definition of, and helping to steer this model.

Strategic Line 2.1.
The adaptation to EHEA academic management

Definition

The map of critical activity in the university described in the Objective ICT Model description shows the great diversity of processes directly related with academia management:

- **Student management**: Admission, enrolment, validations, exemptions, grants, extracurricular services, work experience, e-portfolio, evaluations y follow-up alter finishing their studies and mobility.
- **Training program management**: The drawing up of teaching plans and archiving, creation and management of teaching guides, follow-up of face-to-face and virtual teaching, accreditation management and the European Diploma Supplement.
- **Planned teaching**: Gauging, timetables, tutorials and mobility.

The EHEA has led to the modification of the majority of the current academic management processes, which rely heavily on different information systems and allow more agile management. In the external analysis it was found that internationally there is a tendency to make these systems more interoperable with each other. This, together with the setting up of the EHEA, as mentioned, has incorporated or raised questions regarding the concepts to be taken into account. The existing academic management systems and technological environment need to adapt, in a big way.

Current Situation and Justification

The keystones upon which the new model of the EHEA teaching paradigm rest come from the Bologna Declaration (1999) and the Prague Communiqué (2001).

- A two tier education system: Graduate and Postgraduate.
- European Credit Transfer System.
- The European Diploma Supplement.
- Student, teaching staff and administrative personnel mobility.
- Quality assurance systems.
- The European Dimension of Higher Education.
- Lifelong learning.

The use if ICT in this process must be strategic and not tactical because nowadays ICT offers technical solutions for the ambitious objectives of the EHEA framework. The massive use of ICT management is necessary to provide the desired transparency and quality of the Bologna process (Camarillo, 2006).

The new requirements imposed by the EHEA mean, therefore, the need for an in depth overhaul of the existing academic management systems in universities.

According to the internal analysis carried out it was found that the Andalusian universities are already considering the integration and external interoperability (also detected as a trend) requirements for these systems. To sum up, there are several lines derived from the need to develop the existing academic management systems. It is for this reason that it is convenient to consider all these requirements jointly and define a global scenario which will allow universities to have a complete academic management ERP at their disposal which complies with all the requirements. Said ERP will have to be developed to bring it in line with the EHEA and to comply with all the integration requirements of the remaining management systems as well as being interoperable with other external systems.

Implementation

• PROJECT 2.1.

The development of the existing academic management ERP systems.

The two possible alternatives open to universities are: developing the existing academic management ERP to adapt them or develop a new ERP. Each university will have to decide which option to choose.

The first step towards implementation is to carry out a preliminary audit to analyse the various academic management systems, and other possible management systems currently in use at the different universities (Swartz y Orgill, 2000). The objective of this study is to identify; the degree of effort required by each of these systems to fully adapt to the demands of the EHEA, the capacity of each of them to fully develop the interoperability mechanisms required and their suitability for introduction in any Andalusian university, their ability to provide support for any existing processes, and their degree of compatibility with, or proximity to, other platforms used on a European level.

Once this has been completed an initial solution could be identified upon which to base all the proposed requirements. This solution could be based on widely available commercial options, together with the development of freeware for more specific modules. The development of these functions must be based on technological trends detected, such as the use of standards to guarantee data interoperability (essential for e-portfolio management or the European DS); mobility support technology, i.e. multi-channel platforms (web, cell phone, TV TDT, etc.) and full integration and academic management for environments heavily dependent on distance learning platforms.

After this point we would reach the system development phase. The experience gained from the introduction of information management systems based on ERP leads to the identification of a series of critical factors which guarantee the success of a process (Whang, 2003). The need to concentrate more on people and the process than on the technology itself was observed.

• PROJECT 2.2.

To introduce an internal quality assurance system for qualifications.

The aim is to facilitate the registry of valid evidence for ongoing and periodical evaluation for qualifications included in the AUDIT program of the National Agency for Quality Assessment and Accreditation (ANECA) of the Spanish Ministry of Education. The EHEA framework and the new changes introduced in Spanish regulations, have established that universities must guarantee the compliance with the objectives associated with their teaching, working

to achieve their continuous improvement. Therefore, universities must have formally established and publicly available policies and Internal Guarantee Systems. In order to comply with the aforementioned ANECA and other agencies have developed the AUDIT program.

It is hoped that this initiative, which targets university centres, will include all the areas involved in teaching quality guarantee within Internal Guarantee System. Although these orientations are aimed at the centres, there are transversal elements directed at the university as a whole (e.g. those referring to academic staff, material resources and services, etc.).

Strategic Line 2.2.
To achieve the full introduction of ICT in teaching-learning processes

Definition

This strategy proposes the introduction of ICT at every level in teaching-learning processes. This includes both face-to-face and virtual teaching. According to the internal analysis report there are many possibilities for the use of ICT in this field which are currently not being used for a number of reasons; difference of technology used by professors and students, lack of integration between technology and systems. Another possibility would be to develop joint initiatives for success among Andalusian universities, such as the Andalusian Virtual Campus. Therefore, this strategy, based on the development of the Andalusian Virtual Campus, would improve the virtual campus at each university, the follow-up of student work (as an aid to face-to-face and virtual teaching) the reduction of differences between professors and students and between technical and non-technical degrees, continuous training, and the improvement of tutorial actions to prepare for adaptation to the EHEA virtual education processes.

Current Situation and Justification

As has been mentioned in other sections, it is necessary to promote the Andalusian Virtual Campus (AVC) as a technological base both for face-to-face as well as virtual teaching. This is linked with the inclusion of the Andalusian Virtual Campus in the Andalusian University System under the auspices of the Andalusian Regional Government Ministry for Economy, Innovation and Science, which has led to the improvement of the universities' virtual campus due to the fact that their virtual teaching units are coordinating the AVC directly with the

Ministry. This trend has also been included in the external analysis of the White Paper in the Gartner Report (Gartner 2009) and in the Digital University Report (Laviña and Mengual, 2008). This campus may evolve towards web tools 2.0, which would mean improved follow-up of students, as an aid to face-to-face and virtual teaching.

Secondly, the differences between professors and students and technical and non-technical degrees must be reduced. The way students and professors perceive technology is increasingly different as is the way the see and use it, as the Horizon Report indicates (Gonick, Johnson et al, 2008). Students have embraced social networks such as tuenti, Facebook and other similar platforms in droves while this technology is still not even used on many campus yet. Thirdly, technology is giving rise to other training models and is evolving into a continuous training or life-long learning scenario (Universia, 2008). Together with all this there is an evolution towards free content online, available on the net and as shareware. The OpenCourseWare initiative was possibly the leading generator of this trend. In 200, the Massachusetts Institute of Technology (MIT) offered its training program content on Internet. In the Latin American area Universia, by means of a cooperation agreement with the Polytechnic University of Madrid promoted the development of OpenCourseWare through the OCW Universia consortium (Universia, 2008). The constitution of open research, resource, activity and content communities, with the educational field in mind, such as Eduforge, is also occurring based on freeware: Connexions, of Rice University in the United States, Ednagroups in Australia, and Intute, created by a network of British universities (Universia, 2008). The number of universities getting together in networks is also noteworthy. The Universidad Virtual Mediterránea, a consortium of universities which offers different training programs on the web, is one of the best known. The student selects a program of the university of their choice but it is carried out under the support, channel and shared accreditation of this virtual university.

Implementation

Amongst the actions to be carried out:

- The promotion of the use of virtual university campus, with incentives for professors and students who use them.
- The promotion of quality teaching material production. The need for visibility and use of content generates the requirement for repositories for learning objects which, in turn, must also be compatible with the different content management systems or virtual campus (Moodle, WebCT, Ilias) which enable the content produced by the universities to be reused.

- To reduce the difference in ICT use between professors and students and between technical and non-technical negrees.
- To promote continuous training enhanced by ICT. Continuous training involves providing learning opportunities to citizens of all ages and in numerous contexts; at work, home, through leisure activities, not just through formal channels such as school and higher education. That way, the education model with free content available online or with shareware becomes more and more relevant (Universia, 2008). According to the Digital University Report (Laviña and Mengual, 2008), these processes must increase the competitiveness of education in institutions in the search for students independent to their place of residence, which will become especially relevant with lifelong learning. It is precisely with continuous learning where ICT, and virtual training solutions in particular, will come into their own.
- To use ICT as a medium to facilitate the development of the teaching-learning process regarding tutorials. ICT must be an aid to face-to-face teaching and must also be the base for the establishment of on-line training processes and above all facilitate tutorial action, which is paramount in the EHEA (Laviñe and Mengual, 2008).

• PROJECT 2.3.

The Introduction of Learning Object Repositories.

After the initial phase in which LMS platform introduction became widespread in all universities we are now entering a stage of technological maturity the discussion regarding which type of platform to choose, be it an open source; (Moodle, Sakai, etc.) or owned.

(WebCT, Ilias, Blackboard, Angel, etc.), is clearly a foregone conclusion. The factors of success in training are, on one hand, the teaching staff, and on the other, the content. Therefore, a great effort is required when it comes to producing quality content that is stored and visible in **Learning Object Repositories**, compatible with the different course management platforms, so separating course management from the content itself. The introduction of these repositories will no doubt help to facilitate the creation on inter-university networks for professors to cooperate in the development of quality teaching material. Examples of professors, even in the same department, who have duplicated effort producing material of very similar content which could have been reused had they been accessible in a repository, are frequent.

The typical scenario, which is shortly expected to be achieved by a number of universities, will be a **network of federated repositories** with learning

objects both visible and accessible to the teaching staff of said universities. Therefore, before beginning the content production process they will browse the repositories for content produced by other professors with the corresponding permission for use and/or modify it.

Strategic Line 2.3.
To improve the integration of virtual teaching platforms with academic management ERP

Definition

The integration of what are in many cases heterogeneous information systems is a requirement that has become more urgent for universities, due to the commitments derived from the EHEA. Universities use a great range of management systems based on their own, or third party, development which implies the adoption of integration mechanisms to comply with this challenge. There is a problem of integration; LMS don't understand their own university's academic management systems.

The teaching method must be transparent to the university's management processes in such a way that, for example, the pre-enrolment processes, admission and enrolment and assessment must be completely integrated, both for face-to-face and for virtual teaching. All this must be integrated with course descriptions.

Current Situation and Justification

The majority of Andalusian universities have declared that both of these IT systems are integrated but not directly. As the internal analysis report mentions, in some cases, there is a periodical exchange of data.

The truth is that, in spite of having an initiative like the Andalusian Virtual Campus, made up of the virtual campuses of Andalusian universities, it is still not possible to manage the whole academic management process virtually. For example, in the case of a student who enrols in a subject via a virtual teaching platform the professor giving the subject cannot sign for it electronically.

Implementation

These challenges require a wide and open viewpoint. Service Oriented Architecture (SOA) will be the key to the next generation of scalable, adaptable and interoperable LMS (Álvarez, Paule, Ruiz and Gutiérrez, 2008) which allow the definition of a series of layers of services with the aim of improving the development of virtual teaching platforms and facilitate the integration with the academic management systems.

It is very important, therefore, to work with an educational service support system which is based on the standards allowing the incorporation of tools and services to a platform, so responding to the requirements of academic management which also allow the abstraction of the platform itself with regards to the new applications and functions to be incorporated.

Interoperability in a university context, has three dimensions; organisational, semantic and technical (Laviña and Mengual, 2008). To apply these dimensions to this strategic line the following must be taken into account:

- **At the organisational level**. The distance between the university teaching management area and the virtual teaching area, which are usually in different services and in most cases belong to different vice-rector's offices, should be reduced.
- **At the semantic level**. Universities must ensure that names, concepts, documents, registers, the unique electronic academic report, etc, have the same meaning in the academic management tools as in the LMS. This involves the introduction of management models that have traditionally been unimportant on the most widely used LMS platforms, such as Moodle.
- **At the technical level**. Once the importance of using the same symbols for academic management and face-to-face and virtual teaching support platform has been dealt with, it is necessary to develop the specific tools involved in:
  - **Student enrolment**. Automatic access to the platform is to be given to the student according to the specific enrolment per subject.
  - **Academic management**. Integration must solve the challenges posed by EHEA with regards to the production and approval of course descriptions and their integration into the plans, which should be directly reflected on the LMS platforms used.
  - **Evaluation**. The professor must have a common set of tools on both the virtual teaching platform and the academic management platform. That is to say that when the follow-up of a student is

carried out and a mark given, the tool used must be common. The electronic signing of the marks must also be possible from the virtual learning platform. This must also be the communication link with the student, without the need for other applications as is the case today.

- **Leaver's curriculum**. The student's activity must be positively evaluated by the proffesor and should be accompanied by the unique electronic academic report through the e-portfolio tools already mentioned as trends in the external analysis carried out.

• PROJECT 2.4.
Integration and Interoperability.

In the initial phase the LMS platforms will be integrated with the academic management ERP. Once the question of **integration in the context of the university** had been dealt with, the second phase would begin **the interoperability with LMS systems with several universities**. Obviously, a common integration project could be worked on from the beginning which could act as a base and guide for individual projects.

• PROJECT 2.4.
The development of the Andalusian Virtual Campus, including:

- **Training of personnel involved**, to improve the utility and use of the Andalusian Virtual Campus.
- **New functions**, using web 2.0. The proliferation of tools which allow the creation of mashups and instantaneous publishing, permitting greater student implication. To explore its integration with virtual worlds.
- **Creation of knowledge capsules** aimed at providing training for society and enriching the web with verified quality.
- **Inter-university cooperation** for the creation of digital content to improve the Andalusian virtual campus.
- **Internationalisation of the Andalusian Virtual Campus** by linking it to the European and Latin American university systems.

Strategic Line 3.1.
The development of an integrated research management system

Definition

The objectives to be complied with, by means of an integrated research system involving finance management and project execution follow up, are outlined in this strategic line.

Current Situation and Justification

At present there are no systems in place which allow the integrated management of research regarding curricular content, announcement information, project follow-up and assessment, use of patents, utility models, agreements and contracts, etc. The majority of Andalusian universities meet these requirements with independent applications with scarce or non-existent integration.

Implementation

The implementation of this strategic line involves the following functions derived from research management:

- Announcement management; with personalised information and profile sensitive alerts: project leaders and research groups, researchers, project managers and evaluators.
- Integrated project management; providing researchers with the project management tools they require to facilitate task planning and intermediate objectives.
- Finance management; the system must provide the tools required for the management of project budgets and research grants (in the corresponding formats for each announcement), prior cost calculation and control of said costs and management of research personnel involved in each project.
- Research contract management: it will allow the follow-up of framework agreements and company and institutional cooperation frameworks, research contracts and the legal aspects derived from the clauses of the same (intellectual property, patent use, etc).

- Curricular management: In public Andalusian universities, centralised curricular management and scientific production carried out through the Andalusian Scientific Information System (SICA), currently in the evolution stage, as will be described in the following project.

- Scientific production dissemination: alignment with international trends detected and with the recommendations of the European University Association (EUA, 2007). Introduction of strategies by universities aimed at making their scientific production more accessible by means of an institutional repository or participation in international thematic deposits. An area in which Andalusian universities can establish their own institutional, scientific production repositories (as is already the case with some of our universities), interoperable with the new SICA centralised repository. Research activities carried out in the Knowledge Generation Centres (amongst which, universities) of the Andalusian Knowledge Centre (BOJA, 2007), will become innovation and technological development in the Knowledge Application and Transfer Centres (Amongst which OTRIs and university-enterprise foundations), by means of the pooling which takes place in the Spaces for the Generation and Application of knowledge (Scientific and Technological Parks). The dissemination of these activities will be carried out, either through the implementation of the mechanisms of the necessary interoperability between the management systems of each of the agents or by means of web dissemination of the Scientific-technological offer managed by SICA.

Every university will be integrated in this integral research management system through the external **interoperability** layer defined by the new Objective ICT Model for Andalusian universities. SICA will publish the service allowing the interoperability amongst universities.

• PROJECT 3.1.

Improvements to the Andalusian Scientific Information Service (SICA).

This system is currently being re-introduced, to solve some of its performance problems, under the name of **SICA2**. The development and evolution proposed is not based on evolutionary maintenance providing the system with additional functions. It is designed to carry out innovative development providing a modern, agile, flexible system based on standards which permit **integrated research management. SICA2** also includes a production repository which will be a showcase for scientific activity in Andalusia.

SICA2, as a **curricular management system** at the service of the Andalusian research community, must be able to process the curricular merits of any researcher or technologist working in Andalusia. Therefore it must allow the management of any curricular merit (academic, research technical, health or management background). As a consequence, the evolution of the system must be intimately linked to research initiatives such as the **Normalised Curriculum Vitae** (NCV) and the **Common European Research Information Format**, CERIF. The innovative model the SICA offers should be compatible with the aforementioned so as to encourage and facilitate the exchange of curricular information with other national and international systems.

Increasing research efficiency whilst reducing the time required to keep curricular information up to date: This proposal is in line with the current trend of providing society in general, and researchers in particular, the tools required to maintain their relationship with the university community. In the case of **SICA**, this evolution should provide the mechanisms required to facilitate the accreditation of curricular elements, so saving the researcher the task of providing data or documents which are already in the possession of Andalusian universities or other agents of the Andalusian Knowledge System (BOJA, 2006). It is for this reason that the system must include interoperability characteristics in line with the new Objective ICT Model for Andalusian Universities.

Strategic Line 3.2.
To develop and consolidate research activity knowledge management systems.

Definition

The objective is to use the ITC to enhance both external and internal research knowledge carried out by universities. Internally, there are no adequate systems capable of covering the requirements considered in chapter one, regarding the evolution of digital published content repositories, which provide access to centralised, digitalised unique documents. Externally, the integration and interoperability with digital publications systems of private enterprises or subscription managing institutions, like the Consortium of Andalusian University Libraries (CbuA), is necessary.

Current Situation and Justification

Technological evolution, the information society, the tendency to trade in knowledge and the demand for more flexible teaching-learning solutions are causing universities to turn increasingly to ICT as the key to providing their services. In the field of research, the availability of technical means and communication tools (computers, email, team-working tools, etc.) can be considered normal, although their use is slowly on the increase. Knowledge management is amongst these. There are currently curricular management systems which share research knowledge in a centralised way, as is the case with the **Andalusian Scientific Information System (SICA)**. However, it is necessary to develop the existing systems to provide better research information search results and gradually introduce knowledge management tools (Document management, Content management, Groupware, etc.). Furthermore, knowledge data bases must open up to the business world. The Research Results Transfer Offices (OTRIs) should channel information between universities and enterprises, supported by cooperative tools. Research work information is currently available but rarely to third parties.

With regards to scientific research and its dissemination, one of the most important developments are virtual meetings (videoconferences, etc.), which allow project organisation and development at a distance, sharing net space, exchanging documents, results, work, debating ideas, etc. Another great step forward is the possibility to access facilities (and/or resources) which enable research activity to develop.

Implementation

Amongst the actions to be carried out:

• PROJECT 3.2.
Knowledge management system able to inter-operate with the Andalusian Scientific Information System.

This is a knowledge management system which works at every level of Andalusian universities, supported by ICT, for research and knowledge transfer (KT) which includes the use of web 2.0 and social networks, among other aspects. This system must be interoperable with SICA development.

• PROJECT 3.3.

Digital preservation projects.

This refers to long term storage and the recovery of, mainly, research data (Gartner 2009). Its objective is to achieve the same archive and recovery standards as hard copies have had for centuries. The technology in this area has been evolving slowly, due to the total perceived costs required to carry it out, as well as due to the lack of a clear return on investment (ROI). In theory, there has been great progress in the area, in practice; this has not been the case. However, there has been a certain degree of development based on cooperation models and freeware management, of which DuraSpace, made up of the repository communities known as Fedora Commons and DSpace Foundation, can be found. These foresee the development of a web-based service called DuraCloud, based on shared solutions known as cloud computing.

Strategic Line 3.3.

To create, in a similar way to the teaching environment, scientific production repositories independent of the platforms used for their pooling and management

Definition

A scientific production repository is a bank of digital documents and virtual objects which are the fruit of scientific production of an institution. This repository enables any researcher to access it and to use the material published within. Furthermore, it can publish new material and carry out searches using multi-criteria search engines. The repository's mechanisms can import, identify, store, preserve, recover and export a collection of digital objects, normally from a web portal. The repository is really a content management system containing the sum of an institution's intellectual knowledge and which allows it to be used flexibly to support a variety of processes. These intellectual collections may include scientific production such as papers for journals, working documents, presentations and papers for congresses, theses, and so on. Learning objects and complementary research materials can also be included, as well as interactive simulations, tutorials, presentations, audiovisual recordings, etc.

Current Situation and Justification

In the various research units of Andalusian universities there are numerous digitalized research articles and publications in various formats and for different uses, they are usually disperse, unclassified and lacking a unified system that facilitates their storage, search and reuse. In addition, all the universities belonging to the Andalusian University System have a web portal for technology and research dissemination. However, the services (digital publishing, online repository, etc.) and appearance should be improved and its profile raised, for it to become better known, not only to the academic community but also to society as a whole. Due to the above, it is necessary to further the development of Virtual Object Repository Research Systems, which allow said objects, produced by the researchers at the various Andalusian universities, to be stored in an orderly way.

Implementation

These repository systems should be equipped with an **intuitive interface** to consult information through the web and capable of taking into account user profiles.

- For document and virtual object producers feeds of produced materials must be made available allowing continuous improvement and updating.
- Researchers should have easy access to use documentation and virtual elements for their subjects of interest and should also be able to select, and reuse digital material for future projects and research, safeguarding intellectual and industrial property rights.
- There are management tools available to protect these rights DRM (Digital Rights Management) (Gartner, 2009). In a given repository there may be content with copyright, General Public Licences and European Public Licences (GPL, EUPL), and completely open and free content. Among the contents under copyright there are also several categories, those belonging to the institution, for instance, projects and theses, and those belonging to groups or individuals such as papers and other publications.

An **optimisation of processes and procedures** by means of standardisation, streamlining, integration and treatment is required. Furthermore, in general, it must be ensured that said repositories are appropriately structured so as to be able to cater for the **incorporation of future requirements** and that the quality of the information stored within can be guaranteed, without forgetting

the necessary interoperability between systems which allows the federation of repositories belonging to different institutions so facilitating the transfer of information between them. Once these centralised deposits come into being at each university a unique, common repository at Andalusian University level could be created, alternatively the information could be shared by cloud with other universities. This cloud sharing is already being used for digital preservation at universities, for instance, with the DuraCloud project backed by two of the repository manufacturers; Fedora and DSpace (Gartner, 2009).

The implementation of this strategic line can be summarised in the three following phases:

- Establishment of a conceptual framework upon which to work, in which the terms, interfaces, interoperability mechanisms, possible products to be introduced (be they commercial of freeware), the necessary hardware structure, etc are defined. The preparation of this framework could be entrusted to the Andalusian University Library Consortium (CbuA) together with the Andalusian Regional Government Ministry of Education and Science.
- Implementation of these repositories in the different universities. The management of these would logically be entrusted to the libraries at each university.
- Digitalization of materials and collections of documents coming from the scientific production of the different universities.
- The compilation of all digitalised material for sorting into the different repositories.
- The federation of the different repositories of the Andalusian University System, which could also include the development of the cloud repositories mentioned earlier.

• PROJECT 3.4.

The creation of scientific production repositories.

Repositories help to **support research tasks** whilst **building the community** around the reuse and exchange of ideas and virtual documents and objects between the scientific and research community.

The incorporation by universities of this trend will allow the **promotion of KT mechanisms** whilst reinforcing the image of the institution, providing the scientific community at Andalusian universities with quality information which is precise, trustworthy, detailed, timely, accessible, integrated and safe.

Strategic Line 3.4.
The promotion of the use of technological applications to favour relations with enterprises

Definition

The promotion of university-enterprise relations aimed at encouraging technology transfer, will have positive effects when it comes to achieving external finance for universities. To achieve it, the use of ICT is paramount to facilitate the search for research lines and specialisations of university research groups. Assistant tools should also be used for the management of research contracts between the different profiles (researchers, enterprises and KT managers), as well as for the follow-up of work carried out.

Current Situation and Justification

According to the White Book; University 2010 (Laviña y Mengual, 2008), the model the university of the future should strive for has, among other objectives, a greater connection with the production network and the improvement of KT channels. According to the external analysis, included in the previous chapter, of research and knowledge transfer and more precisely support solutions for the same, it is very important to take into account the United States university model of interaction with its surrounding environment which is very proactive regarding research promotion and KT. This model supports very close cooperation in which the university receives part of its finance in exchange for tangible results obtained through the development of university-enterprise cooperation projects. Furthermore, there is a transformation underway at operational level in the research community, affecting researcher-enterprise and researcher-research group relations.

It is necessary to provide the universities with the information management tools they require to access and share information amongst enterprises and research groups. Collaborative tools based on web 2.0 which allow dynamic information exchange between universities and external agents. The role played by the OTRIs (Research Results Transfer Office) in the creation and accompaniment of new, technology based, companies based on the results of university research is

noteworthy. The OTRI must be the information catalysts between universities and enterprises and provided with all the co-operational tools to make research work information accessible to external agents.

Another type of activity encouraged by the EHEA is the promotion of university-society relations, above all with the business community which is the natural next step for higher education students. It is for this reason that it is essential for cooperation with enterprises, business associations, chambers of commerce and technology centres, to start while the student is still at university and ICT is the ideal vehicle to achieve this. Enterprise can and must benefit the research work carried out at universities for which adequate KT cannot be contemplated without an adequately used ICT dimension.

Similar analyses to this white paper, as is the case with the White Paper of Catalonia (Catalonian Association of Public Universities, 2008), propose the improvement of the ability to manage research institutionally, by means of coordinated management and a research information system. These are systems which allow research assessment and the promotion of business ventures.

Implementation

The following are some ICT activities which favour university-enterprise relations:

- **Enhancing the external image of the university by using social networks or multimedia communication tools (eg YouTube) to promote spaces for university-enterprise cooperation**. The objective is to develop online monitoring systems of information available on those networks on the university.
- **Using ICT to support clusters of innovation in the context of the Andalusian Knowledge System**. The use of ICT tools is the key to providing the medium for actions carried out in knowledge transfer, ICT initiatives can be included within a very broad group, ranging from the creation of job search portals for researchers, to systems for the management of knowledge in clusters made up of agents from the university and the business network. The aim is, therefore, to develop innovation portals of specific clusters made up of Knowledge Agents (universities, enterprises and other institutions) which would be integrated in networks such as the Andalusian Technological

Space Network (RETA). To that end specific tools would be used such as the dissemination of news articles and events using RSS technology, specific forums, a repository for contents of value to innovation and centralised access to applications for grants for joint projects.

• PROJECT 3.5.
Contract and project management systems based on web services (e-OTRI).

These are applications which assist researchers and enterprises alike to access information regarding their contracts and know their status at all times, in an integrated way, i.e.; general contract information, associated documentation, processing status, financial information and invoicing situation.

• PROJECT 3.6.
Customer Relationship Management (CRM) systems for university-enterprise relations.

As is the case in the private sector, companies manage their customer relations more and more with the help of technology. Universities must, if they wish to locate financial opportunities within these relations, contemplate the use of ICT as a channel for interaction. A clear sign of how ICT can strengthen this relationship is the sending of selective information,(newsletters), continuously informing about ongoing research in the sphere of universities, and as a means of contact with companies which have signed contracts with the university.

Strategic Line 4.1.
To develop existing ERP management from a functional and technological point of view

Definition

Enterprise Resource Planning (ERP) systems are information systems which integrate and manage all the information and functions of different areas of an organisation to speed up tasks, improve processes and reduce costs. With the development of this strategic line it is intended to integrate the information, communication and management systems at Andalusian universities and create a technological platform similar to an ERP, linked to the university management to enable it to:

- Optimise activity management processes and resources.
- Access reliable information for decision taking.
- Achieve data integrity (unique data which are accessible from different modules).
- Create a solution which can be modularly enlarged in the future.
- Allow accessibility in a web environment.

All this plus improving control and quality of information, facilitating access to information and offering bespoke services to different users.

Current Situation and Justification

In a scenario where the EHEA is going to lead to stiff competition in the higher education market, it is essential to rethink the roles, processes and methodologies needed to take full advantage of available technology and face up to the changes, innovations and re-engineering which will make Andalusian universities more efficient and competitive. The university world, due to its magnitude and idiosyncrasy, is an unquestionable reference point for the possibilities offered by new technology for the improvement of management processes and relations among the different actors.

In Andalusian universities today the use of niche solutions can be observed. This leads to the existence of multiple, unintegrated, systems in which information

duplicity is commonplace and the emphasis is more on internal management than as part of the university community. In this new context, the following aspects affecting the university world can be stressed:

- The growing importance of technological resources.
- The capacity to analyse and evaluate information.
- Information ethics.
- Universalisation of portals, web pages and other elements and technology fundamental to information management and validation of actions.

The trend towards standardisation, the establishment of technological patterns, student oriented models and integration, together with the need to provide high levels of service and self-service make it important to rethink the ERP model in use in Andalusian universities today. These systems are characterised by being made up of different software models and services integrated in a unique application. The modular design allows the adding or reconfiguring of modules and services (including those from different suppliers), preserving the integrity of the data and the concept of unique data on a shared database which could be centralised or distributed. The current trend is to offer specialised applications for different sectors. These are the so-called sectorial versions or sectorial applications, especially recommended or designed for business processes of a certain sector (the most commonly used). The university world is not oblivious to this trend and the incorporation of ERP services is more and more commonplace. Furthermore, university specific products have been on the market for several years now.

Implementation

ERP, known as information systems, are the nucleus of the proposed Objective ICT Model. The functional requirements that ERP management should consider are the following:

- **Integration**. To allow the control of the different processes of the organisation, understanding that all the areas are interrelated, that is to say, that the result of one process is the starting point for the next.
- **Modularity**. ERP understand an organisation to be a group of areas which is interrelated by the information shared and which is produced by their processes.

- **Adaptability**. ERP are designed to adapt to each entity's idiosyncrasy. This is achieved by the configuration or parametrisation of the processes according to the number of outlets required by each of them.

The main technological requirement of said ERP is availability in a web environment based on Service Oriented Architecture (SOA). ERP solutions are sometimes complex and difficult to introduce, this is due to the fact that they require **personalised development** for each environment, starting from the initial parametrisation which is common to all. When it comes to modelling all the business processes of each institution, the personalisation and bespoke development at each university can be very time consuming.

• PROJECT 4.1.

To develop existing ERP management from a functional and technological viewpoint.

The successful introduction of a new ERP depends on the correct use of methodology and other aspects which should be taken care of before and during the introduction process and even when the system comes on line. The aspects to be considered are therefore; results to be obtained by the introduction of the ERP, business and management model, introduction strategy, evaluation of opportunities for ERP complementary software, alignment of technological structure and platform, analysis of organisational change, the presentation of a complete overview of the solution to be introduced, system introduction, quality controls, technical environment and development environment audits and introduction benchmarking.

The main functions an ERP should offer are as follows:

- Finance-economic management system: Accounting, treasury, payment management, taxes, budgets, fixed assets, expenses, etc.
- Human resource management systems, amongst which: Salaries, personnel selection, training, responsibility management, professional career plans, trade relations and personnel register.
- Management control/Analytic accounting.
- Logistic management system (purchase and inventory centre).
- Integration with other elements such as: CRM, cooperative spaces and portals.

Strategic Line 4.2.
To fully develop electronic administration through the progressive mechanisation of all the university's internal and external administrative procedures

Definition

The Act of Law 11/2007, of 22nd June, governing the electronic access of citizens to Public Services (BOE, 2007), stipulates that a new framework is necessary in response to the need to offer electronic administration mechanisms which guarantee citizens the access by electronic means to information and administrative proceedings.

Current Situation and Justification

The internal analysis in chapter one considers how Andalusian universities are already working on the introduction of electronic administration. It was described how the various electronic administration authorising systems, such as on-line registration, electronic signature and electronic notifications have already been introduced in different universities.

Furthermore, article one of The Act of Law 11/2007, of 22nd June (BOE, 2007) recognises the citizens' right to interact by electronic means with the Public Administration and regulates the basic aspects of ICT use in administrative activities. In line with said law, and due also to other public service modernisation initiatives, such as the Andalusian Innovation and Modernisation Plan (PIMA), the Andalusian Regional Government Ministry of Education, Innovation and Science in collaboration with Andalusian Public Universities who have promoted a project for the incorporation of ICT in universities with a program called the Digital University.

One of the lines of action of this program is to introduce the use of electronic administration in Andalusian universities. This introduction of electronic administration in the university environment must align itself with the management of corporate identities, detected as a trend in the external analysis in chapter one, as well as with the authentification mechanisms based on electronic certificates and/or the electronic ID card.

Implementation

For full development of electronic administration to be achieved and therefore for the setting up of this strategic line, it is necessary to carry out the following projects:

• PROJECT 4.2.
Re-engineering of procedures.

Standardisation, simplification and procedure re-engineering. To be able to offer the entire university community all administrative procedures online, it is necessary to have previously established what they are. It is also important to take into account the **different channels of access to the same** (face-to-face, phone, web, etc.). In order to achieve this it will be necessary to produce a complete catalogue of existing services, processes and procedures at each university, as well as guides defining the way in which each of them will be offered online. Each procedure must be revised taking into account all possible access routes.

• PROJECT 4.3.
To promote form processing platforms.

The form processing platform is the technological backbone or group of systems which supports electronic administration. Apart from the necessary components to cover the functional requirements of this type of system, **all the authorising systems required to guarantee the legal factors determining the process** (authorising system and electronic signature, notifications and timestamping). The functions required for this platform are the same for all Andalusian universities; it is therefore advisable to define a program which could be common to all. This form processing platform should be based on the components derived from the W@ndA project by the Andalusian Regional Government (Trew@, Model@, @firma, Port@firmas, etc.).

For these projects to be set up the following actions would be required:

- Procedure development. The objective would be to develop and set up on the platform each and every university procedure online. This process could be carried out in stages, taking into account that the similarity between procedures and the base platform which would allow their re-use in all Andalusian universities. To this end, a procedure repository, including models, developments and user and technical manuals for each of them, should be set up.

- The platform and the procedures introduced must focus on their interoperability with systems belonging to other public organisations. That way, part of the data or documentation required for a certain procedure could be recovered and sent automatically without having to be requested by the end user. This would facilitate the development and procedure automation involving different universities, such as the transfer of a file, or the handling of a European DS.
- Development of common additional components: The university environment requires a series of additional components to be incorporated onto electronic administration platforms such as; a BSC and statistical exploitation module which focuses on follow-up and management of university services. The global design and development of these modules would allow each of the universities to use and personalise every one of them.
- Changeover management: The setting up of electronic administration implies a great change in the internal management model and service providing. For this reason, it would be necessary for each university to carry out a specific, training and information action plan designed to achieve the best possible adaptation of the new model by all the system's users.

Strategic Line 4.3. To develop a Multi-channel Contact Centre

Definition

A Multichannel Contact Centre is understood to be a complement and an additional tool for a Customer Relationship Management (CRM) system which unifies customer management and information analysis and two way communication with the same. This Centre would be internal (for teaching staff, administrative personnel and students) and external (for the remainder of actors related with the university). There is also a clear trend, in traditional user/customer attention centres or call centres, towards centres able to channel responses to requests, applications and requirements of the university community and the generate a record of relations to provide the university with relevant information for strategic planning and for its information systems.

Current Situation and Justification

A Multi-channel Contact Centre (MCC) allows the improvement of internal and external university service providing quality and the maintenance of constant and effective communication among all the members of the university community. This way, through multiple channels such as internet, mobile and land line phones, email and online communication including instant messaging, questions and incidences, not necessarily involving ICT service use, can be dealt with. There are some Andalusian universities developing Contact Centres but they are oriented towards electronic admission. The availability of a contact centre would solve the challenges derived form the introduction of the EHEA, such as student and teacher mobility. It is also related with several trends identified by Gartner (2009), for example, it is in line with Unified Communications and Collaboration, (UCC) which contemplates the progressive incorporation of communication capacity and collaborative technology. It can also incorporate Emergency Notification Systems (ENS) and Mass Notification(MN), which are automatic notification systems for events such as natural disasters, emergencies, etc.

Implementation

Upon setting up an MCC the following phases can be discerned:

- An initial phase in which available contact databases at the university are updated from, for instance, the CRM. The technological infrastructure required for the MCC will be set up in parallel.
- Alter a period of steering, the users requirements will be attended to; admissions, enrolment, timetable requests, subject registry and readjustment.
- At a later stage the available services will be increased.

• PROJECT 4.4.

The setting up of a CMM in each university.

Due to the complexity of the Objective ICT Model proposed a CMM will be necessary to respond to the users demands and will allow the **centralisation of certain common university services**.

Strategic Line 4.4.
To make a collaborative work environment available to the university community

Definition

Collaborative work is defined as the set of intentional processes of a group to achieve specific objectives, together with a series of tools designed to support and facilitate that work. Within the framework of an organisation, online collaborative work, a set of strategies which tend to maximise the results and minimize the loss of time and information, benefits organisational objectives in such a way that all the participants work, collaborate and help each other to achieve their objectives.

The biggest challenge for collaborative work is to achieve the motivation and active participation of people. Other factors to be taken into account are technological, economic and political aspects of an organisation.

Current Situation and Justification

The use of collaborative work environments for teaching-learning tasks is appearing as a concept, which could transform the traditional concept of education. This is because it allows students, guided and oriented by the professor, to learn from each other, without having to coincide in time and/or place. The appearance, use and universalisation of social networks and other collaborative work tools, such as collaboration and research result dissemination mechanisms and the exchange of technological and scientific experience between researchers, is also becoming commonplace, although it is still early days.

There is, therefore, a need to improve the collaborative work tools of Andalusian universities for the creation of real Collaborative Working Environments (CWE), based not only on the development of applications and platforms but also on the experience of the professionals.

These Collaborative Working Environments may also be the way to carry out coordinated work not only in the field of research but also the internal management of the university. (Committees, Departmental meetings, etc.), making it available to the whole university community.

Implementation

An online collaborative work environment is based on shared work spaces and allows researchers to share information and resources in an integrated communication environment, receiving information of the movements of their colleagues in said environment. Each of the group members can revise, adapt, qualify and/or modify documents as well as access any of the different versions produced and the date of last modification will be registered.

These environments have **real time communication tools** (chats, audio-conferencing and videoconferencing) and pre-recorded ones (email and forums) together with the shared diary tools, which allows the programming of meetings with group members or other people. The methodology for the introduction of a collaborative work platform is to first define ideal scenarios which constitute functional specifications for the concept or pilot tests which can be constructed using models and elements as well as platform software and hardware. Simultaneously, the scenarios also help to focus the search, survey, evaluation, development and integration of platform models and as feedback for the functional specifications of said modules.

The objective is to design a **virtual organisation solution** capable of adapting to multiple scenarios without the need for great changes, neither in participants' procedures nor in the organisations to which they belong. Wikipedia, the encyclopaedia dedicated to the free dissemination of knowledge, through the hard work of millions of users who update it on a daily basis, is a good example of a collaborative platform. Another interesting example is Google Wave, a set of protocols, platforms and open source products, which allow the combination of services which allow people to create and share content as well as show their applications to each other using open web programming standards.

Within the architecture of a collaborative web environment the following functions are required:

- Representation and management of the virtual organisation. A virtual organisation can be defined as a group or organisations or people who share resources and abilities for the execution of a task. A virtual organisation its own structure and hierarchy. Within certain organisations, different businesses are sometimes organised like virtual corporations which copy the company structure, at a different scale, in one division or specific business line. By enlarging IT terminology, we could talk of a grid as a structure for sharing common resources used for the achievement of a common goal.

- Repositories integrating document or other digital object management systems with all the properties of the same.
- Workflow management systems to connect people, processes and information which allows efficiency optimisation, the application of policies, the automation of redundant tasks and acceleration of procedure application.
- Synchronous collaborative systems: Chats or instant messaging, videoconferences, audio conferences, desktop sharing, application sharing and shared virtual blackboard.
- Asynchronous collaborative systems: e-mail, forums, wikis, information aggregators Real Simpleshared diary, blogs and group task management or planners.
- The integration of the different collaboration components and the heterogeneity of the different components require an integration layer for all the tools to connect to. With architecture designed for collaboration it is essential to define in detail the services to be used as well as the protocols required for component integration.

Online collaborative work helps enhance **emotional and motivational aspects** as well as attitudes and produces positive effects on learning and objective attainment(Martí, 1996).

• PROJECT 4.5.

Virtual Desktops.

The objective is to develop hosted virtual desktops (Gartner, 2009), for the university community, and the Andalusian University system has had some experience in this matter. The virtualisation of the desktop describes the process of separation between the desktop (which includes the data and programs used to work with), from the physical machine. The virtualised and personalised desktop is stored remotely in a central server instead of on the computer's hard disk. This means that when the users work on their desktop from their laptop or personal computer all the programs, applications, processes and data are centrally stored and executed. This allows users to remotely access their personalised desktops from any device able to connect to it; laptop, PC, smart phones among others.

The main characteristics of these desktops are: file saving, shared document creation, referencing and linking up with online databases, etc.

The only program that needs to be installed is a navigator such as Explorer or Firefox. Applications such as Zoho, Google Docs or Acrobat.com, amongst others are web pages and can be used for writing texts from the navigator and save them on Internet. The same system can be used for spread sheets and presentations such as Power Point and even for pictures because they are accessed via the navigator and saved in a space which the user has reserved on the net for filing documents.

Strategic Line 5.1.
Improve competence and training in ICT in the university community

Definition

ICT should be regarded as a transversal responsibility for all posts of work at the university. In the same way, Andalusian university training plans should be adapted to include the knowledge of ICT by teaching staff and administrative personnel alike, as well as the people responsible for the management of ICT services.

Current Situation and Justification

As was found during the internal analysis presented, there is a list of jobs/ posts which includes a list of ICT related jobs and an ICT training plan, too. The progressive increase in computer literacy of Andalusian students was also remarked on. This also brings a steady increase in the demand for ICT services and utilities. This means that the university must be prepared to provide innovative solutions and, ICT is the ideal tool for that. Therefore, teaching staff and administrative personnel must keep their knowledge in this area up to date. ICT management personnel should be correctly qualified, both in software and in hardware as well as aquiring specific ICT service management skills.

Implementation

Two very different initiatives are developed in the strategic line.

• PROJECT 5.1.

The Production and/or Updating of an ICT Responsibility Map for Teaching Staff and Administrative Personnel.

Where those aspects related to the use of ICT by the PDI and PAS are structured transversally it has to be taken into account that the process of implementation of ICT competencies has to start with the identification and signalling of training needs (UNED, 2009). Those that are transversally multifunctional (Villa and Poblete, 2007) and common to all branches of learning in faculties and universities have to be implemented as generic competencies. Such generic competencies could be (University of Deusto, 2007): abstraction, analysis and synthesis, organisation and timetable planning, knowledge on the areas of study and professions, oral and written expression, second language use, research, learning and continuous updating, and a commitment to quality.

This must be implemented, as a specific responsibility of each branch of knowledge, adapted to the requirements of each faculty or university. One example is the knowledge and management of specific technology by teaching staff and administrative personnel and another, the development and maintenance of that ICT technology.

Regarding ICT planning and training, a training plan must be drawn up which is in line with the new map de competencies, where continuous training is the base for the improvement of teaching staff, administrative personnel and ICT managers' ICT skills.

Regarding the ICT service management team, they must be encouraged to acquire official, specific, qualifications such as: Linux Professional Institute (LPI), Sun Microsystems, Oracle…

• PROJECT 5.2.

ICT offer for students.

Be they face-to-face or virtual, training courses should be offered to the students in the use of technology offered by the university. This should take place during the whole degree course but preferably in the first years as this is knowledge that the students will require throughout the duration of their studies. The implementation of ICT competencies in university training allow teaching possibilities to go beyond specific professional competencies and provide the individual with an integral education.

ICT as part of university training would help to avoid that the university training possibilities remain restricted solely to specific professional competencies, but provide part of an individual's integral education.

Strategic Line 5.2.
Implanting means to encourage the use of ICT by the university community

Definition

This strategy considers ICT handling in general by the whole of the university community, through its use in their everyday activities. Its implementation will mean the availability of information wherever one may be and the possibility of being universally connected both on and off campus.

Current Situation and Justification

Over the last years, the results obtained by Andalusian universities from the work carried out incorporating ICT into the lecture halls and classes, and in the teaching itself, have been clear to see. This effort has not only concentrated on field of teaching but it has touched many other areas as can be seen in the Digital University program carried out under the auspices of the Andalusian Regional Government Ministry for Education, Innovation and Science:

- The improvement of wifi connectivity through wifi access points for the use of the university community.
- The IT resources made available to students, through measures such as increasing the number of terminals for use by students, incentives for the purchase of laptops by students.
- The subjects and learning materials offered via the Andalusian Virtual Campus.

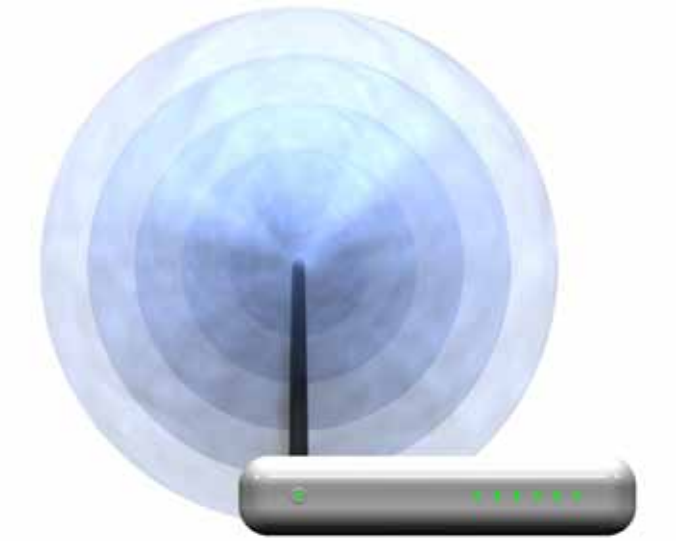
These initiatives have contributed to the incorporation of ICT in the university community. Even so, more efforts are still required in this direction, as has been mentioned in other sections of this chapter, there is still a gap between the different members of the university community regarding the use of ICT. The increasing use of social networks, such as tuenti, facebook, etc. by young people means that when they get to university they expect to carry on using the

same technology which, as was mentioned earlier, is not so commonly used by the professors.

Furthermore, there is a progressive digitalisation of the university. Universities are more and more digital not only due to the teaching programs based on web environments or in advanced software, but also due to the use of innovative technological infrastructures which turn the campus into an environment with easy, and well connected, access to networks. This digitalisation must come together with measures to encourage the use of technological tools by the university community. This is connected with the way people work, collaborate, and communicate, which evolves as borders become more flexible and globalisation increases.

This trend has a lasting impact and continues to increase the posibilitéis for creativity and learning. (Gonick, Johnson et al., 2008). With the growing availability of tools to connect with students and academics all over the world (online collaborative work environments, social network tools, cell phones, Skype and others) it is more and more common to see international students get together for online courses or connect to classrooms in other parts of the world.

All this leads to a wide range of possibilities to encourage the use of ICT in all university processes and by all the university community.



Implementation

Amongst the actions to be undertaken:

- The fostering of general dissemination and promotional initiatives centred on ICT use. The idea is to encourage the varied use of ICT by means of educational workshops, seminars, campus internet parties, freeware, etc.
- Promote the production and dissemination of videos produced form the base. The greatly reduced production and distribution costs of videos has meant that many of the barriers to their creative and academic use have disappeared. As a result students have access to an enormous amount of educational content videos ranging from mere snippets of information to whole conferences available online. Nowadays videos can be produced with all kinds of affordable devices, phones, pocket cameras, etc. Professors have more options than ever now to incorporate videos into their study plans.
- Incentives for the acquisition of laptops and other IT equipment and the promotion of their availability on campus. The objective is to extend the initiatives of programs such as the Digital University and make technology universally available. Regarding availability on campus, IT hardware should be able to be rented or borrowed easily.
- Promote the use of broadband cell phones. The fact that most students have mobile phones is a key factor regarding their potential for educational purposes. The combination of social networks and mobility allows students and friends to collaborate wherever they are. If we add the multimedia capacity of their phones to the connectivity and the storage capacity for podcasts, videos, photos, pdf files and even documents and spreadsheets, it is not difficult to understand why cell phones are a more and more popular choice as a portable tool.

• PROJECT 5.3.

Plan of Incentives to the PDI and PAS for the use of ICT.

Promotion of precise improvement actions, both regarding teaching-learning processes (mentioned earlier in the incentive plan in the context of a strategic line related with said processes), and in ICT use management. For example; by means of direct incentives for the virtualisation of subjects in the case of teaching staff and administrative personnel.

Strategic Line 5.3.
Implanting CRM (Customer Relationship Management) aimed at efficiently managing the relations between the university community and the rest of society

Definition

Customer Relationship Management (CRM), refers to a management model based on customer service and orientation (or market orientation according to some authors) with the help of new technology. It is a very similar concept to relational marketing and is closely linked to other concepts such as clienting, one to one marketing, direct marketing, etc. However, in this context, CRM refers more to the information systems used in relation management support of university community members and their environment and the commercial and marketing actions that universities may carry out with them.

Current Situation and Justification

In organisations CRM is part of a business strategy centred on the client. It's main task is to collect as much information as possible about clients, using knowledge bases to achieve this aim, to be able to give greater added value to the offer.

Organisations must work to get to know their clients and so come up with an offer and improve the quality of their attention, providing solutions for their clients which suit their requirements perfectly. The appearance of CRM is starting a revolution in services provided. This is spreading less quickly, but constantly, to teaching institutions considering that the traditional concept of the client must be modified to adapt it to the educational context.

In the university environment the ex students associations are fast becoming a force to be reckoned with in the university itself. The incorporation of client information management technological tools or CRM, will facilitate the task of following up graduates so as to establish policies aimed at attracting, managing and gaining the loyalty of these members of the university community.

The graduates are, however, not the university's only clients. In the university world there are two types of clients; internal clients (teaching staff,

administrative personnel and current students) and external clients, such as future students, companies, graduates and society as a whole. The use of ICT to increase the number of new student enrolments is a growing trend. (Gartner, 2009).

The actors, both internal and external, participating in the future university model are, therefore, numerous. Attempting to interact with them without a adequate technological resources could prove very complicated. The CRM systems used in the field of business provide solutions, with well-defined processes but adaptable to the individual circumstances of each university, although their application may be much more complex due, precisely, to the diversity of the target customers.

Implementation

• PROJECT 5.4.

The Development of CRM for the University Community and Society as a Whole.

There are currently, many systems in the business world which allow the automation of customer relations and place the commercial and marketing tools at the disposal of the system managers. The introduction of a university CRM system must have the emphasis on the identification and distinction of the target clientele, to be able to offer attractive and personalised services and products to each type of client. This way it will be possible to attract and retain students and increase their satisfaction.

Due to operative reasons it is easier to introduce CRM to offer services to members of the university itself (teaching staff, administrative personnel and students) because both the users and the services are very well known. The CRM should then be applied to the remaining agents who are related with the university: graduates, companies that work with research groups, or take part in the continuous learning courses(classes for the elderly, summer courses, etc.). Lastly, it could be applied to attract new students and so reach the whole society. User orientation is more and more important. The main problems for the introduction of a university CRM are not the cost in IT and telecommunications infrastructure and software but training (both the initial and the constant updating) of service operators due to the high level of specialisation and number of services on offer as well as the variety of client types. However, by means of the follow-up tasks provided by CRM, more efficient policies aimed at attracting and managing clients and earning the loyalty of all the members of the university community can be put into practice.

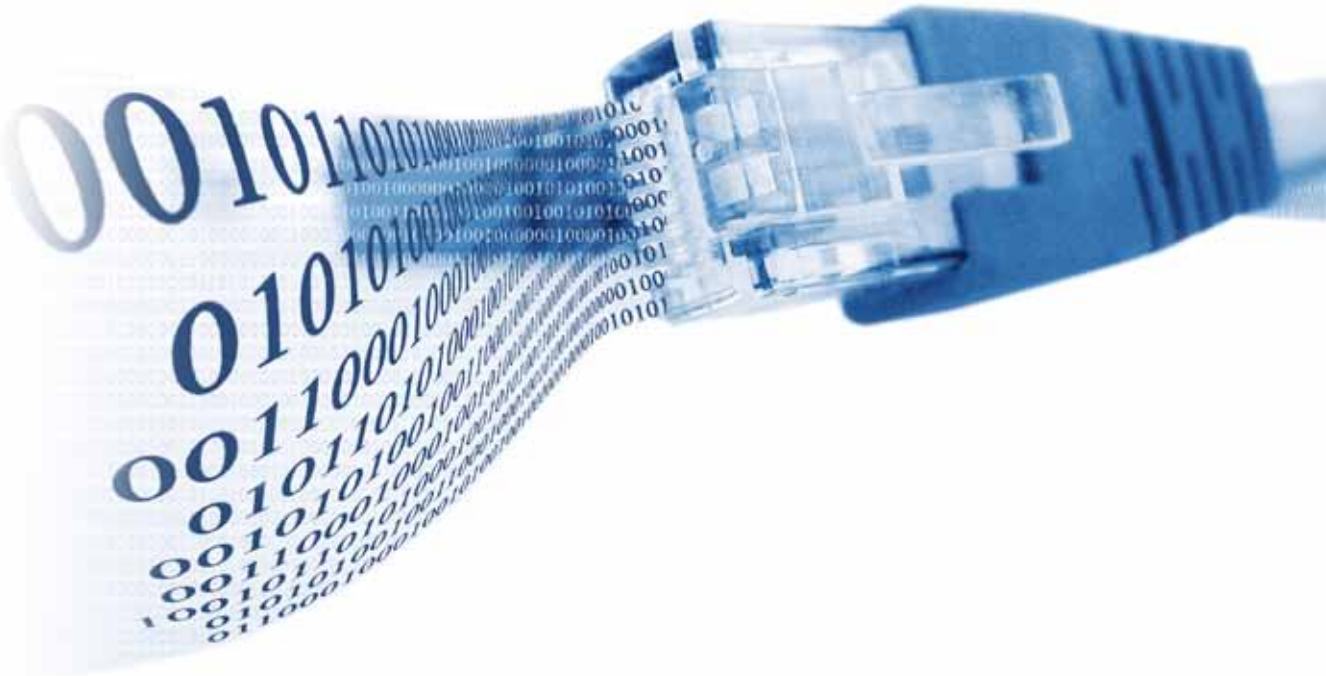
3.3 Following up the Plan of Action

To realise an assessment and follow up with regard to the achievement of the objectives stated in the plan of action, a Balanced Scorecard has to be set up, to provide the information necessary for an evaluation of the state of evolution of the plan.

To decide which indicators are most adequate for this, the best strategy is to utilise ones that are already in use, such as those featured in the UNIVERSITIC Report (CRUE, Uceda and Barro, 2009) or in the contract programs of the Andalusian universities with the Andalusian Regional Government.

Each university should specify their own route sheet, prioritising the proposed Strategic Lines, basing their selection on their initial situation and the detailing of their own strategic plans.

Putting this follow up system into operation will require the leadership of those responsible for ICT in the management teams in each university, with the aim of assuring correct monitoring and follow up of the objectives identified in this plan.



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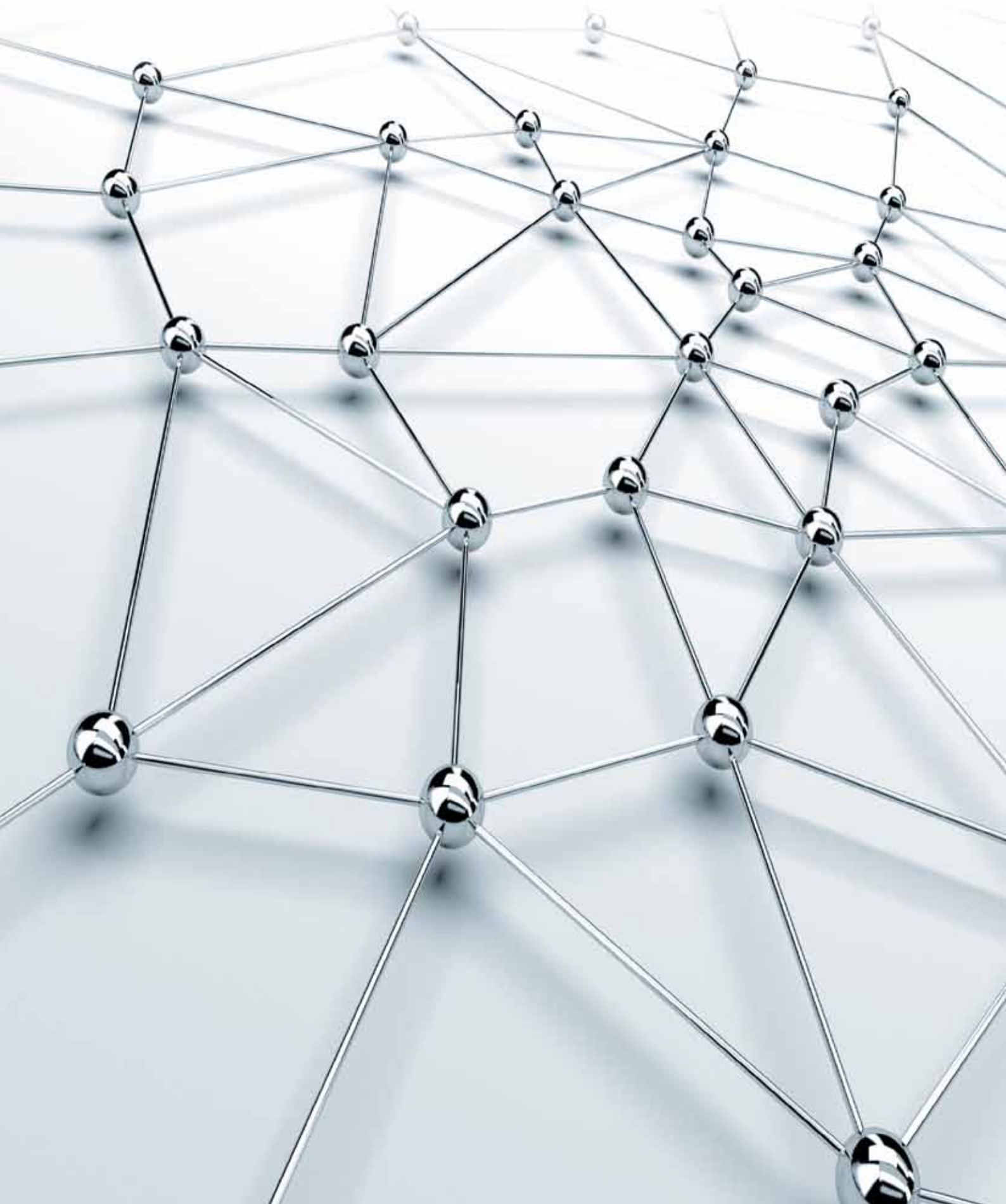

APPENDICES

I. References

II. Glossary of Terms Used

III. List of Acronyms

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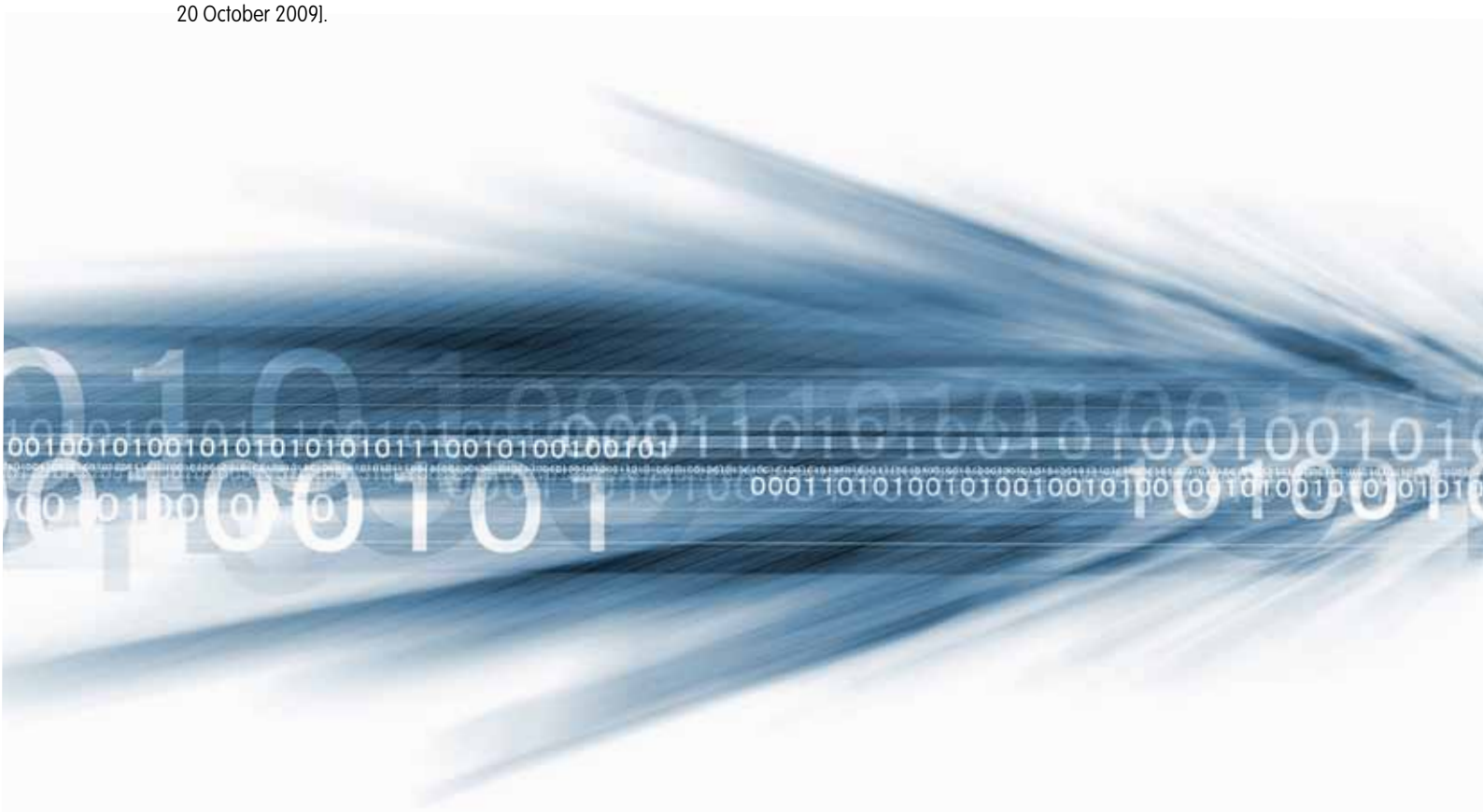

II. Glossary of terms used

802.11: Refers to the technology commonly known as Wi-Fi (Wireless Fidelty). Protocols of the type 802.x define the technology of local area networks and metropolitan area networks. The terminology used in the 802.11 standard uses a single letter to categorize ranges and transmission speeds. For example, the standards 802.11a and 802.11b refer to maximum transmission speeds of 54Mbps and 11 Mbps respectively, whilst 802.11n indicates a maximum speed of 600 Mps.

Advanced computing: Computing tasks that demand a high level of calculation, and therefore a sizeable infrastructure.

AGREGA: A developmental project within the framework of the Plan Avanza financed through the Program, Internet in the Classroom, via a collaborative agreement between the public business entity Red.es, the Ministry of Industry, Tourism and Commerce, the Ministry of Education, Social Policy and Sport and the governments of the autonomous communities. This is essentially a federation of repositories for educational digital objects with nodes in all the autonomous communities and in the Ministry of Education, Social Policy and Sport. The educational content that can be found in Agrega are organised according to curriculum in such a way that they can be used in structured education outside of the university.

Augmented reality: where virtual information is combined with existing physical information. This is the main difference with virtual reality, given that it doesn't substitute physical reality, but superimposes information on the real world.

BackOffice: Those areas of a company's affairs that require no direct relation with the client. For example, computing and communications tasks such as the running of computer and telephone networks, the running of the accounts department or personnel.

Balanced Scorecard: System whereby a set of indicators allow the assessment of the evolution of the fundamental parameters of the institution, facilitating control and decision making. Another definition, given by the Balanced Scorecard Institute de EE.UU., describes it as "a system of administration of performance that can be used in any organization, big or small, to focus its vision on its clients' requirements, its daily tasks, the administration of the institution's strategies, as well as on monitoring improvements in operational efficiency, creating organizational capability and communicating the progress made to all personnel".

Bibliometrics: Discipline that applies mathematic and statistical methods to the study of scientific literature and the authors that produce it with the aim of studying and analysing scientific activity.

Blended Learning: A teaching and learning style in which the teacher makes use of both on-line and in person teaching methods to create a more efficient training programme for both student and teacher.

BPM: Business Process Management, a business method focused on improving efficiency through the systematic management of processes, in this case related to the

university sector. The processes are continuously modelled, automated, integrated, monitored and optimised using evaluative standards that are previously determined.

BPO: Business Process Outsourcing. Understood here as the subcontracting of those functions of management tasks and processes that are not directly related to the main activity of the company, giving responsibility for such services to agents that can be either internal or external to the institution (company or university). This allows the institution to concentrate its efforts on those activities that are directly related to academic management and strategies, bringing about a lowering of costs.

Broadcasting: The transmission of audio or video signals from one point to many; to a determined audience, the general public, or to a relatively large sector of the public.

Business Intelligence: Collection of methodologies, applications and technologies that permit the gathering, filtering and transformation of data from transactional systems and from unstructured internal or external information, converting it into structured information for the company's direct use as well as for analysis, study and knowledge gathering, thus giving support to the taking of management decisions.

Business Processes: A set of tasks that can be logically related and that can, once put into action, produce a definite result. All business processes have their inputs, functions and outputs. The inputs are the necessary requisites for a function to be applied. When a function is applied to the inputs of a process then certain outputs occur as a result.

Andalusian Virtual Campus: The Andalusian Virtual Campus (www.campusandaluzvirtual.es) is an inter-university initiative between the ten Andalusian universities, allowing an interchange of students, teachers, information, resources, and knowledge, as well as the transference of technologies, joint management, evaluation, improvement, etc. between all the participating universities. The most visible part of the project is that of subject sharing.

Cloud Mail: The evolution of mail systems towards open management, where files and information are stored in servers distant to the company and managed by third parties. This consists basically in the subcontracting of the management and storage of an institution's electronic mail.

Computer Supported Cooperative Work (tools for): Those systems which permit access to services of cooperative work and communication, without the need for those taking part to be in the same physical space. With these tools information can be shared in various formats, such as audio, text or video, and also new material can be produced collaboratively. Many of these tools provide advanced functionality that enable tasks such as publication, filters, searches, access, privileges…

Connected digital classroom: Any classroom where elements of ICT have been installed, including computers, interactive whiteboards and internet connections.

CoBIT: From the English, Control Objectives for Information and related Technology. The best practices in the management of information as compiled by the Information Systems Audit and Control Association (ISACA) and the IT Governance Institute (ITGI) in 1992.

Content Management System: A Content Management System (CSM) consists in software that implements a support structure for the creation and administration of contents, mainly for web pages, alleviating the administrators of tedious and repetitive tasks of creation and maintenance. A CMS permits a technical separation between design elements that allows them to be updated and modified independently.

CRM: Costumer Relationship Management. A business model based on the strategy of focusing the institution's resources on serving clients and their necessities.

CRUE: Conference of Chancellors of Spanish Universities, a non profit making association formed by Spanish universities. There are currently 50 public and 24 private members.

Data warehouse: A collection of data, usually related to a specific enterprise (business, organization…) that is integrated, neither volatile nor variable with time, and that is of help to the user in the decision making process, forming, effectively, a complete dossier on an organization, containing not only transactions and operations but also holding a data base designed to favour the analysis and efficient divulgence of information.

Digital library: A library where a significant amount, if not all, of the information is held in digital formats (pdf, doc, etc.) and can be accessed via a computer using the adequate information retrieval software.

Digital natives: People born in the digital era that have developed a great ability in and attraction for the use of IT for their entertainment, leisure, communication and information.

Digitalization: Term used to denote the transformation of a resource to an electronic format.

EBS: Enterprise Bus Service consists in a software architecture that provides fundamental services of connectivity and communication in complex systems of information. The bus is constructed using standard communication protocols and uses a system of messages that responds to events that originate in in different components of the architecture.

EDI system: Electronic Data Interchange, or EDI, is a middleware software that allows connection to distinct business systems such as ERP or CRM. Electronic Data Interchange can be done in different formats: EDIFACT (Electronic Data Interchange for Administration, Commerce and Transport), XML, ANSI ASC X12, TXT, etc.

EDUROAM: Eduroam is an initiative within the project RedIRIS whose aim is to coordinate the initiatives of various organizations at a national level, creating a unique space of mobility at that level. This space consists of a wide group of organizations based on a policy of usage and a series of technological and functional requirements, permitting users movement within it, whilst, at all times, having available to any mobile service they might need. The ultimate aim of this system is that, in the most transparent way possible, users have, via the internet, a virtual access to the services and resources of both their own organisation and the organisation they are visiting in that moment.

EHEA: European Higher Education Area. An area of educational organization initiated in 1999 with the Declaration of Bologna that aims at harmonising the differing educational

systems within the European Union, providing an efficient form of exchange between the students. It also aims at providing an unprecedented space and agility to the process of change taking place in European Universities.

E-Learning: Education and training via the Internet. On-line education allows interaction between the user and the educational material through the use of various IT tools, consisting fundamentally of the following:

On the pedagogical side, Instructional Technology has emerged as a discipline within the educational sciences, linked to technological means, educational psychology and didactics.

On the technological side, Information and Communication Technology plays its part via the selection, design, personalisation, implementation, hosting and maintenance of solutions, where both proprietary and Open Source technologies are integrated.

E-Portfolio: An electronic portfolio, also known as a digital portfolio, is a collection of proofs and evidence gathered and maintained by a user, usually on the web. These electronic notes could be texts, files, images, blog entries, links. An e-portfolio can be used, in a broad sense, to show the personal ability of the user, and, if on-line, it can be maintained dynamically.

An e-portfolio can be seen as a type of learning register which indicates the progress level of the student. The registers used are concordant with the learning schedule and can refer to any agent in the educational community including staff and teachers/ professors.

Electronic processing: Consists in the ordinary processing of a procedure but telematically.

Electronic Signature: a term used in computing for the association of an electronic document with the identity of a person, computer or server.

Electronic text books: These have the possibility to be edited, to have content added from other sources, to allow multimedia presentations of information and exercises as well as permitting the introduction of notes and diagrams to aid study.

E-Procurement: The cybernetic version of a cooperative. In this modality of electronic commerce, entities come together to buy on the internet non strategic services or products that they need for their activities. For example, office furniture or stationary: chairs, pens or paper. By grouping together their demands, organisations have better negotiating power and can bring prices down. The use of the internet also allows a better channelling for offered goods and services.

ERA: European Research Area, its aim is to increase the competitiveness of educational institutions through multinational cooperation.

ERP: Enterprise Resource Planning, an integrated system of business management that is designed to model and automate the majority of the activities of a business or institution: finances, commerce, logistics, production… Its aim is to facilitate the planned usage of the resources of an endeavour (business or university). The ERP is a tool that implements a great part of the functionality necessary to comply with the methodology of BPM.

EU2015 (University Strategy 2015): An initiative of the Spanish government aimed at the modernisation of Spanish universities and the promotion of excellence and internationalisation.

Federation of Services: this is the coordination of services of heterogeneous systems with the aim of achieving interoperability between them and new collaborative functionality.

FrontOffice: tasks related to a company's departments of sales and marketing, or any other that has an interaction with the client. In the field of information technology, frontoffice is often identified with the model of Customer Relationship Management.

Grid computing: According to the Grid Computing Information Centre, this refers to computation carried out on "a type of parallel and distributed system that allows the sharing, selection and bringing together of geographically disperse resources in a dynamic form at run time, depending on the availability, capacity, performance, cost and quality of service required by its users". This allows the coordinated use of all types of resources that are not subject to central control.

Groupware: A set of programmes that allow various users to work together on a shared project over a network although working from independent workstations.

Hosting: As applied to the Internet, the placing of a web page in a server, permitting it to be viewed from any part of the world with an internet connection.

HW: Hardware (HW) or the physical support for the collection of material elements that form part of a computer.

IAM: Identity and Access Management, a collection of business and IT processes that facilitate the use and management of digital identities. IAM allows the assignment and use of identity credentials for employees, suppliers, partners and clients. It is able to manage a life cycle of identities and implement business processes that take into account aspects of government, organizational structure, roles and responsibilities. On the level of information processing this permit's the carrying out risk management policies, along with controls, dataflow and reports. On the technological level it has the capacity to define requirements and model the design and configuration of the technical infrastructure.

The IAM methodology is a framework that permit's the integration of different accounts (usersID) in the applications, security solutions and network architecture.

Information islands: The different systems of IT that give support, in an independent way, to each area of an organisation. Such systems don't allow an efficient flow of information, allowing duplication and redundancy to occur. Thanks to their interconnectivity, however, present information handling systems integrate, unify and centralise all data, allowing its use in all areas of an organization.

Institutional electronic stamping: Timestamping is an online mechanism that makes it possible to verify that a chosen set of data has existed without being altered since a specific time. This protocol is described in the RFC 3161 and is in the registry of Internet standards. With this technology a user can solicit an authoritative timestamp

for any electronic document, and have the hour and date validated with the electronic signature of a reliable source.

Interoperability: The capacity of a programme to access and exchange information with multiple different systems.

IP telecommunications: set of new functions that traditional telecommunication has acquired owing to the services made available via the IP protocol in data networks.

IP-Video: IP-Video has become the most common format for systems of video broadcasting by subscription over broadband connections using the IP protocol. This is often provided together with the internet connection service, providing the operator with a bandwidth over the infrastructure as well as a reserved bandwidth.

ISO/IEC 38500: International standard for cooperative governance of information technologies that provides a frame of reference that directors can use as principles in evaluating, directing and monitoring the use of IT in their organisations.

ITIL: Information Technology Infrastructure Library, the most used and best accepted set of practices for IT services administration in the world, developed by the UK's Office of Government Commerce from a study of the technology being used internationally in the vanguard of IT practices in both the private and public sector. The use of the ITIL is relevant to organizations throughout the world, given the growth in dependence on quality IT services.

LAN: Local Area network. A system of communication between computers that allows information to be shared with the condition that the distance between the computers is small: typically from 200 metres to a maximum of 1 kilometre. Such networks are often used for the interconnection of personal computers and work stations inside a building or organisation. They are characterised by their restricted size, their high speed, the transmission technology that they use - generally broadcast - and their topology. These are networks operating at speeds of 10 to 100 Mbps with low latency and a low error margin.

Law 11/2007, 22nd June, citizens' electronic access to Public Services: Sometimes referred to by the initials LAECSP, this is a Spanish law that recognises the citizen's rights to have an area of electronic access to public administration, and sets out the obligation of such bodies to provide this service. Work on establishing this standard started in spring 2006 with the collaboration of representatives from the private sector via the Consejo Asesor de Administración Electrónica (Advisory Council for Electronic Administration); from citizens via participative spaces in the Red (network) 060; as well as from political parties and members of other public administrations.

LCMS: In contrast to an LMS (Learning Management System) an LCMS (Learning Content Management System) is responsible for the creation, reutilization, localization, development and management of the contents used in training and education. These are usually stored in record filing system in the form of unique and self-explanatory learning objects, each one of which satisfies one or more well defined educational objectives.

Learning Object Repositories: A Learning object is a set of digital resources that are self contained and reusable, with a learning purpose and at least three internal

components: contents, learning activities and elements of contextualisation. A learning object has to have a structure of external information (metadata) that facilitates its storage, identification and recovery. Such repositories are managed using an LCMS.

LMS: LMS (Learning Management System) is a software application installed in a server that is used to administer, distribute and control the activities of distance learning or e-learning of an institution or organization. The main functions of an LMS are to manage users, resources, materials and learning activities, as well as to realise tests, create reports and manage communication services such as discussion forums, videoconferences, etc.

Lifelong learning: Lifelong learning is the voluntary search, throughout one's life, for knowledge, whether it be for personal or professional motives. This process not only helps to improve social integration, public spiritedness and personal development but also fosters competitiveness and employability. The term implies that learning is not only for the young, nor takes place only in the classroom, but takes place at all stages of life and in diverse situations.

LRC: Learning Resources Centre. A new type of environment where all the university services are integrated, providing support for both learning and research. Such environments create new spaces for learning.

Management of digital rights: a group of technologies orientated towards control of the restrictions of access of users to the system, or to reclaim the rights of the author to commissions independently of the wishes of the user of the system. Generally these are installed as a previous condition to distribution of software that is not free, musical works, electronic books or any other type of archive subject to the author's rights. In some cases the restrictions applied have a wider extension than to just the archives they are intended to protect, adding to this other restrictions over the use of documents or applications that are present in the computer.

Management standards for administration (Web Administration Suites): A web administration suite is a group of on-line programmes that support the tasks of management, sharing data between each other and having the same user interface.

Metadata: Metadata consists in information that characterises data. Metadata is used to provide information about other data that has been produced. Essentially, metadata makes an attempt to respond to questions such as who, what, where, when, why and how, relative to all of the facets of the data that is documented in a project. Who created this set of data? With what aim? When? etc. Metadata indicates what a set of data can show, the quality of the data, its history and availability.

Middleware: Software that permit's the functioning of applications across heterogeneous platforms. It works as a distributed layer of abstraction set between the applications and the lower layers (operating system and network). Middleware abstracts the complexity and heterogeneity of the underlying communication network, as it does for operating systems and programming languages, providing an interface for easy programming and application usage.

Moodle and Sakai: Platforms for virtual education based in open source software.

Multiplatform systems: These are those programmes, applications, programming languages, or any other class of software that can run on different platforms. These systems are capable of operating using different standards and combinations of hardware and software.

Open Source software: this is defined by the licence that accompanies it, guaranteeing anyone the right to use, modify and freely redistribute the code.

OTRI: From the initials for the Spanish 'Oficina de Transferencia de Resultados de la Investigación' (Office for the Transference of Research Results). This is the organism responsible for technology transference in the university. Its fundamental aim is to promote relations between research groups and the business world.

Payment gateway: A provider of e-commerce services that authorises payment to electronic businesses. It is the electronic equivalent to the Point of Sale (POS) terminal found in most stores. Payment gateways codify sensitive information, such as credit card numbers, to guarantee that such data passes securely between clients and sellers.

Programmed Contract: Document that formalises a framework of relationships and sets out the commitments and compensations of the parties involved (in the context of the university) and which includes a system of revision, checks and evaluations with regard to the fulfilment of the established conditions over a predetermined time period.

PVC: A virtual team of professionals (PVC) is usually a multifunctional group of professionals that are geographically separated and work towards the achievement of a common goal. Usually there is some type of limitation - of space, time, or organisation - and those involved relate through technologies of information and communication.

Quantum computing: A computing paradigm distinct to the classical one, based on the use of qubits rather than bits, and using new logical gates that make new algorithms possible. Using a particle description of light, values and states can be ascribed to the polarisation of the photons.

Records manager: A tool designed to share, distribute and manage the records of an organisation in a digital format. This system allows the storage and recovery of electronic texts, images and videos.

RICA: Acronym taken from the Spanish 'Red Informática Científica de Andalucía', Andalusian Network of Scientific Information. This is integrated within the Spanish academic network RedIRIS (network of Interconnected IT resources). As such RICA forms part of the Internet and offers its users access to widespread services at a global level.

RFID: Radio Frequency Identification. A system of storage and recuperation of remote data that uses devices known as interrogators and tags. The main aim of RFID technology id to transmit the identity of an object (similar to a unique serial number) using radio waves. RFID technologies are grouped under those denominated as Auto ID (Automatic Identification).

SCS: Space Collaboration System, a system based on satellite communications for the exchange of educational data between Japanese universities.

Security code verification: Electronically produced element that incorporates the electronic signature generated by the system, allowing a check of integrity and authenticity.

SOA: Service Oriented Architecture, an application architecture in which all functions are defined as independent services with well defined interfaces that can be invoked in set sequences to form business processes.

Social Learning Platform: Learning system that incorporates collaborative tools such as diaries, blogs, alerts, messages, collaborative documents and shared agendas. These systems allow learning to take place across a social network, facilitating personal contact, mutual support, joint problem solving, shared experiences, etc.

Social network: These networks offer collaborative work services to users such as blogs, message sending or picture sharing. The users themselves are the agents of the portal and use it as a place of communication and/or shared work. The main networks worldwide are: MySpace, Facebook y Twitter.

SSCI: the Social Sciences Citation Index is a database that provides access to information on authors, references etc. in the library of 1,700 world leading academic publications on the social sciences, covering a field of more than 50 disciplines.

SW: Abbreviation for Software, referring to the logical equipment or support of a digital computer. The SW consists of the set of logical components needed to accomplish any specific task, as opposed to the physical components of the system (hardware).

Tablet – PC: A hybrid between a portable computer and a PDA where it is possible to enter information via the screen without need of a mouse or keyboard.

UNIVERSITIC: Annual reports on the situation of ICT in Spanish universities, elaborated on the basis of information gathered from the universities themselves and from the Conference of Chancellors of Spanish Universities (CRUE).

Virtual desktop: A virtual desktop is an integrated system of communication, information and interaction between users for the exchange of information, opinions and other data. It allows access to archives from anywhere, permitting editing, saving and recuperation, and also making it possible for users to have a personalised interface independent of the network or point of access, given that it is centralised in a server.

VPN: Virtual Private Network: a virtual network created within another, real network, such as the Internet: a corporative network structure implanted on a network with resources that are publicly available, using the same system of management and access policies that private networks use. Essentially it is the creation, within a public network, of a confidential and private environment that allows the users to work as if using their own local network.

VSAT: Very Small Aperture Terminals are private networks of satellite data transmission for the exchange of information, either point to point or point to multipoint (broadcasting) or interactive.

WAN: Wide Area Network, one that extends over a wide geographical area, including countries and continents. For example; Internet.

WAP portal: Wireless Application Protocol or WAP is an open international standard for applications that use wireless communication, such as an access to internet via a cell phone.

Essentially, this is the specification for an application environment and a set of communication protocols to standardize the way in which wireless connections can be used to access e-mails, news groups etc. A WAP portal is a web page that is built using this standard for use by wireless devices.

Web 2.0: This term refers to the second generation in the history of the development of web technology, characterised by the user moving away from being a passive consumer of contents towards becoming an agent that actively participates in their creation. As such Web 2.0 is based in user communities and collaborative services, such as social networks, blogs, wikis, etc.

Web services: a set of protocols and standards designed to permit the interoperability between computers and applications in a network. Generally these services are only web interfaces that can be accessed via a network, such as internet, and executed on a remote hosting system, allowing communication between different machines, platforms and programmes. This communication is achieved with the adoption of diverse open standards.

WIFI: Wireless Fidelity (Wi-Fi). A group of networks that requires no cables and that functions according to previously established protocols. Though initially created for use with local wireless networks, it is now frequently used for establishing Internet connections. WiFi is a trade mark of the company, Wi-Fi Alliance, which provides certification that these devices comply with the current standards, which, in the case of this technology, is that of IEEE 802.11.

Wikis: A collaborative networked system that facilitates and automates the creation, exchange and revision of information on the web. It allows multiple users to create, modify and erase entries when working on the same shared text. A wiki allows the rapid and efficient creation of web pages, and automates the creation of links between articles, thus increasing the comprehension of the text and the terms it contains. It allows the inclusion of texts, hypertexts, digital documents and links, all in a very simple way. The aim of a wiki is that various users create a web page on some theme and each user adds from their own knowledge to make the result more complete, thereby creating a community that shares contents about the same topic or category.

Workflow documental: Systems of workflow documental are those that allow the implementation of flows or processes that allow a document to pass through distinct phases and through the hands of various persons.

XML: XML is the abbreviation of Extensible Markup Language, a simple, standard system for the creation of languages of this type. Unlike HTML with its fixed set of elements, XML provides a more flexible scheme for describing data structures. By permitting designers to create and define their own personal and specific elements, XML facilitates the interchange of a wide range of data across the web.

III. List of acronyms

ALCUE: Latin America and the Caribbean – European Union.

API: Application Programming Interface.

AUPA: Association of Andalusian Public Universities.

BI: Business Intelligence.

BPO: Business Process Outsourcing.

BS: Balanced Scorecard.

BSCW: Basic Support for Cooperative Working.

CEIC: Ministry of Economy, Innovation and Science.

COBIT: Control Objectives for Information and related Technology.

CRAI: Resource Centre for Learning and Research.

CRUE: Conference of Chancellors of Spanish Universities.

CRM: Customer Relationship Management.

DB: Data base.

ECTS: European Credits Transfer System.

EDUROAM: Education Roaming.

EDI: Electronic Data Interchange.

ERA: European Research Area.

EHEA: European Higher Education Area.

EIC: Ibero-American Knowledge Area.

ERP: Enterprise Resource Planning.

ERA: European Research Area.

ESB: Enterprise Service Bus.

EUA: European University Association.

HW: Hardware.

ICT: Information and Communication Technology.

ILIAS: Integriertes Lern-,Informations- und Arbeitskooperations-System.

IP: Internet Protocol.

ITIL: Information Technology Infrastructure Library.

LAN: Local Area Network.

LCMS: Learning Content Management System.

LMS: Learning Management System.

LOMLOU: Act on the Modification of the University Act.

LOU: University Act.

MMS: Multimedia Message Service.

OCW: Open Courseware.

OEI: Organization of Ibero-American states.

OS: Operating System.

OTRI: Office for the Transfer of Research Results.

PAS: Auxiliary and Service Personnel.

PVC: Professional Virtual Communities.

PDI: Teaching and Research Personnel.

PIMA: Plan for Innovation and Modernization in Andalusia.

POD: Plan for Teaching Organization.

QMS: Quality Management System.

RFID: Radio Frequency Identification.

RICA: Andalusian Network of Scientific Information.

ROA: Repositories of Learning Objects.

SAC: Andalusian Knowledge System.

SCS: Space Collaboration System.

SEGIB: Ibero-American General Secretary.

SICA: Integrated System for Andalusian Scientific Research.

SMS: Short Message Service.

SOA: Service Oriented Architecture.

SUA: Andalusian University System.

SSCI: Social Sciences Citation Index.

SW: Software.

UDIMA: Open Universidad of Madrid.

UOC: Open University of Catalonia.

UNED: National Open University.

UPA: Andalusian Public University.

VSAT: Very Small Aperture Terminals.

WAN: Wide Area Network.

WAP: Wireless Application Protocol.

WIFI: Wireless Fidelity.

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