

BUSINESS PERFORMANCE ANALYSIS OF AN INFORMATION SYSTEM IMPROVEMENT - AN ACADEMIC SYSTEM USE CASE

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Abstract

This paper shows the benefits of a real implementation of an information system in a state institution of higher education in Portugal. It starts by concentrating on the institution to which this real case refers, acknowledging its existing information system change and evidencing the improvement made on one process example. Some behavioral aspects are emphasized as well on this change. This practical system implementation was made under a quality standard framework. The article underlines the approach between information system change and quality perspectives. The convergence way is the same process point of view. A simple model of this convergence is proposed.

Key words: BPM-Business Process Management, Information System Implementation, Performance Analysis, Quality

1. Introduction

ISCAC¹ is an institution of higher education in Portugal, one of the IPC (Instituto Politécnico de Coimbra²) Schools, with extensive experience (31 years) in the teaching of science business; it is assumed as a school-business, putting emphasis on a theoretical / practical approach, tailored to an individual increase, and competitive labor market. It has about 2.500 students divided into 5 bachelor courses and 3 master courses. The administration of ISCAC is made by a board and several councils (scientific

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council, educational council and advisory board), commissions, support units and services. The body of teachers, with about 110 people, is divided into 5 scientific areas and the rest of the employees are more than 20 with the responsibility of supporting processes.

2. Performance and Improvement

Business performance has always been one of the most important concerns. Any organization wants to improve its level of service to its customers, reduce the costs, improve its profit or increase its efficiency. This can be done by a more radical approach, usually under the label of Business Process Reengineering (BPR) or by a more soft evolution, under what is usually called Business Process Improvement (BPI).

Hammer and Champy's view about BPR was a fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality service and speed. Nevertheless, these special words "fundamental", "radical" and "dramatic" influenced the re-engineering projects in the 90's and most of them failed due to their scale of change. Project objectives dimension add large impact on information, technological, human and costs management with lots of problems associated.

Other soft approaches appear, like BPI whose main objective is to optimize present processes usually helped by information technology improvements. According to one important and recent survey³, improving business processes remains a critical executive priority today, representing 65% of answers to the question about which initiatives are most likely to pursue over the next two years. This approach usually focuses on a part of the organization's needs (most important needs but not all), reducing the scope of the project and using no radical process redesign, but improving the existing one. BPI can be seen as a business process innovation, using Davenport's words. Usually this improvement is made by automating some activities in what is called the business process automation (BPA).

³ BEA White Paper, (2008) *The State of the BPM Market, Business and IT: Solving Process Problems Together*, BEA Systems, Inc.

Business improvement objectives may vary, depending on the perspective. Most important are the following:

- *Cost Reduction.* This objective is part of a "rationalization" approach. Cost is an important redesign objective but it should be combined with others. Excessive attention to this objective may result in tradeoffs usually unacceptable to process stakeholders.
- *Time Reduction.* Usually has been a secondary objective of traditional industrial engineering. Increasing numbers of companies however are beginning to compete on the basis of time. This aspect sometimes related to service quality aspects, so it cannot be seen alone as well. Design of information systems (hardware and software) must have this objective in mind.
- *Output Quality.* This perspective may be within a tangible product – or informational – such as in adding data to a customer file. Output quality is frequently the focus of any process. The measure of output quality may vary a lot and should be defined with the customer. Some common quality characteristics are efficiency, flexibility, integrity, interoperability, maintainability, portability, reliability, responsiveness, reusability, testability and usability. These views should be done accordingly ISO 9001 standard for global quality management and ISO 12207 standard (Software Quality Assurance Process) for software life cycle processes.

ISCAC, as any other organization, is not an exception and wants to improve its business performance. As an institution of higher education, the main objective of ISCAC is to provide a good education to its students. This main objective can be achieved by performing a set of groups of processes. Some of these groups of processes are the core of this activity; others are the support to the first ones. For instance, establishment and revision of academic courses is one of the main activities. Another one is the management of those academic courses. Support group of processes are budgetary management or human resource management. Annex 1 shows the group of processes that were identified at ISCAC.

3. Business background

ISCAC academic services have several processes to perform during one academic year. The main ones are related with courses management group of processes which are detailed at Map of documents of the courses management (PGQ 13) (Annex 2). Some of these processes are Academic Services mainly responsibility, like Contests and Special Schemes Transfer, Change of Course and returns, Enrollment - 1st time, Renewal of the Registration and Payment of Fees, Exam registration, Improvement of Note, Assessment of Knowledge, Final results of the Student, Certificates, documents and photocopies of diplomas, Local Competition for Access to 2nd cycle, National Competition for Access to Higher Education (CNAES), Various Requirements in Academic Services and Isolated discipline.

The work is usually made by phases, each one corresponding to an academic phase. At the beginning of each academic year enrollment - 1st time and renewal of the Registration and payment of fees are the main tasks. Then, as the year goes by, various requirements appear. At the end of the year, exam registration, improvement of grade, assessment of knowledge and improvement of grade are the main concerns. At the end of an academic degree there come certificates, documents and photocopies of diplomas...

There are 8 persons working at this support unit. ISCAC has courses running at night so there is a special concern about the working students. Once a week, academic services provide a special timetable at night for these students. Summer vacations must be planned carefully in order not to congest the enrollment phase.

Main problems were related with large student queues at enrollment or at exam registration phases. Some days before the last day of registration were chaotic in terms of volume of employees work and student queues. Assessment of knowledge process takes too much time to be completed. Managers wanted improvements in student and employees satisfaction, individual and corporate performance, and process effectiveness and efficiency. They decided to introduce a more integrated system.

4. Quality assurance and management

The school made an important effort and implemented the international quality standards. The Quality Management System adopted subsequently the provisions of the standard NP EN ISO 9001 9 and is designed to organize and systematize the activities of ISCAC - relating to areas of intervention defined in Section 2 of Chapter II of this document - and capable of ensuring the ability to provide services that consistently meet the relevant provisions, whether of law or the needs of customers.

The ISCAC, through the implementation of its Quality Management System, aims to create conditions from the organizational, management of its human and material resources and its processes and methods of work, in compliance with applicable laws, obtain and maintain the satisfaction of their customers.

In addition, through the processing of data and events associated with the operation of ISCAC, it also aims to create conditions for active participation of its employees in that system as a way to generate processes of continuous quality improvement of services and its overall performance and prevent the occurrence of non-conformities.

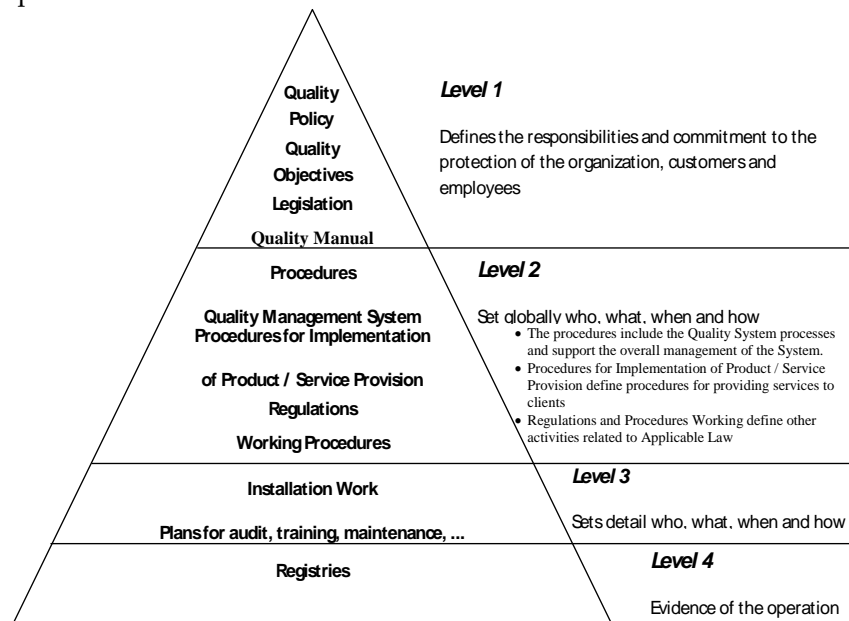


Fig. 1 - Quality Management System

ISCAC structured its Quality Management System and supports it through a hierarchical set of documents that are described in Fig. 1 - Quality Management System

5. System description and implementation experience

Until the winter of 2005, management of the main academic data was carried out using different systems and much manual work. There was a homemade system, responsible for main academic information management. This system was maintained by an internal IT support that could not fulfilled the system's evolution anymore.

Data was often introduced twice with all time consuming and error typing problems. The main academic system used was an own development one and worked generally fine but had lots of difficulties to be expanded and integrated with other processes or activities.

In the winter of 2005, ISCAC decided that should shift to a system that could incorporate more flexible rules, curriculum plans and complex year transition. The decision was to acquire a new system from a firm that is specialized in academic solutions systems in Portugal. This academic information system, CIGES is a modular solution. At that time ISCAC bought CIGES - the implementation of modules CSE4 and CXA5 modules.

⁴ CSE - Education Control System

⁵ CXA - Monitoring and Treasury Management.

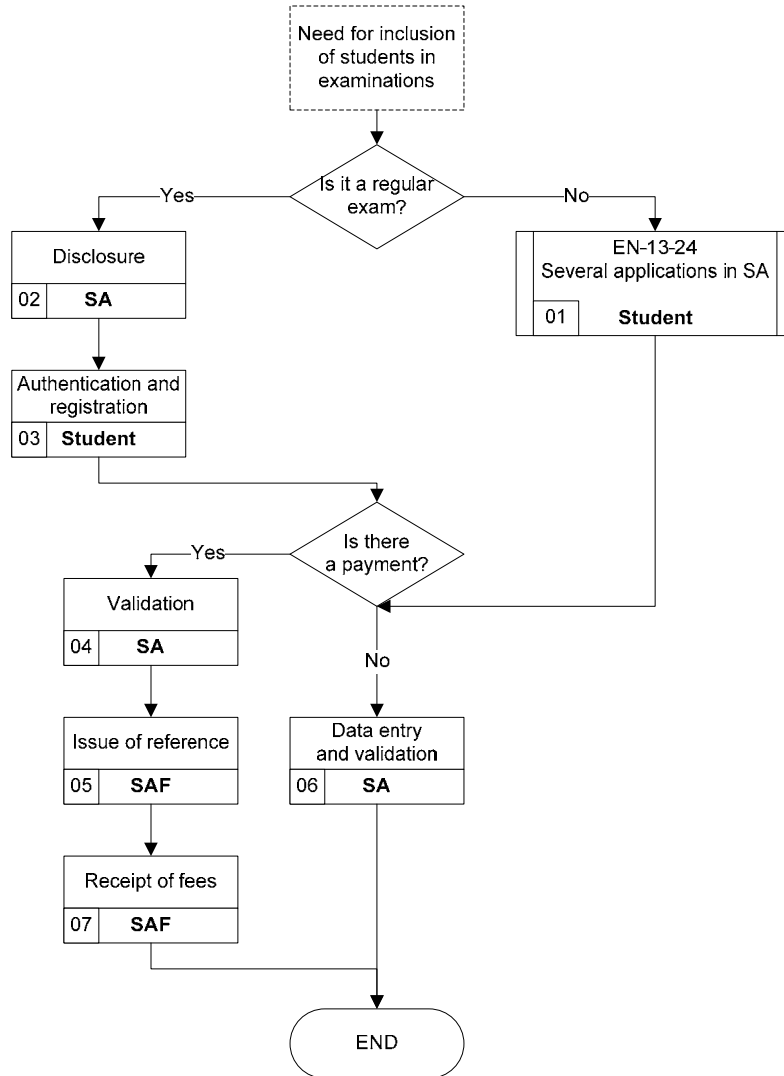


Fig. 2 - Exam registration process flowchart

As supplier says⁶, "in a single interface, simple, and the universally recognized reliability of the systems management of Oracle databases, Digital introduced the Integrated Management of Higher Education."

⁶ Digitalis, SIGIS presentation. Available via <www.digitalis.pt> [accessed May 26, 2009]

Created in 1994 from the central application for managing student CSE, the SiGES has been since a subject of continuous development and optimization, is currently composed of a set of applications, engine applications for Oracle databases and libraries of routines BD-Interface integration. The 18 administrative and management applications of knowledge that make up the executable of SiGES is now a computer management system fully integrated, collaborative, comprehensive and secure stable, whose modularity also translates a high capacity for adaptation to the case.

The SiGES architecture is a client-server integrated platform based on Oracle and IBM / Lotus. The system is aligned by two major areas: Academic and Human Resources.

The Academic area includes various academic applications that relate to the management of the student body (applicants and students) and teachers, in terms of academic management. The area of Human Resources as application is designed to manage personnel either teacher or official.

Apart from academic applications and human resources, the SiGES also has two satellite systems, autonomous but complementary to SiGES that supplement: @NetP and IDOC. Also, within SiGES there is a sub-group of academic preparation of applications for use via web: the system of automatic registration via web (SIAnet) and the Release Notes for the Teacher web (LNDnet).

Lately, other important effort has been made by the ISCAC institution, through the improvement of the information system and documentation for quality. A decision of buying a new academic platform was made and all the consequent aspects appear. The computers, software applications and actual communications capabilities offer innumerable possibilities. These possibilities, linked to implementation of quality, opened business process redesign opportunities. At middle 2008, manager decided to buy @NetP subsystem to complement and increase information system features.

According to Digitalis, assuming again the task of translating the reality technology to the Portuguese Higher Education, netP@ represents a vision of the Virtual Campus: is the generator of interactive portals for institutional care, consultation and education in the dynamic Web. Based on a repository of intelligent information SiGES about the reality of each

member institution of Higher Education, the Institutional Portal netP@ allows Students, Faculty, Staff, Alumni and Candidates access - no physical barriers or time - a comprehensive set of services devoted to consultation and implementation processes via Web.

Beginning with initial registrations using the web, through a range of other features that enable reduction of costs and operational complexities, benefiting the return on investment, netP@ is the e-business portal for Digitalis translated by the reality of higher education.

Let's take a closer look to an example of a process, an exam registration, see Fig. 2 - Exam registration process flowchart (better described in Fig. 2). Before the last system implementation (netpa@ module), students should download a document from the internet that should be fulfilled with the disciplines they wanted to be examined. After that, they should make a presence delivery, going to the academic services. At last 2 or 3 days (about 80% of students come at that time), it creates an enormous queue that make students wait for their turn more than 1 hour. Nowadays students can make their registration anywhere, anytime (during the period allowed). Before, presence validation took time from the services and students, because it should be conferred if the student documentation was alright and if he was allowed to do the registration (for instead, check if the number of disciplines allowed for that season was not exceeded).

Nowadays, validation only takes some few minutes from the students and do not take any time from officials.

Before, the payment was mainly made with money (essentially using coins, which took considerable time and patience from officials with an end day procedure to close cash – sometimes it took more then 1 hour on worst days). After that, Academic services went and give the cash to finance services that checked again those numbers and money. Today, there is a daily procedure that generates all references for payment automatically (small human validation). Students can pay anytime and anywhere, using any automatic bank machine box or internet home banking at any computer with internet. It may take about 3 minutes for the student.

According to this process change, it is possible to make an analysis of this business process evolution. Table 1 synthesizes average time for each activity, according to officer's responsible time evaluation, before and after

last system change (implementation of netpa@ module). Each activity is measured in terms of time consuming (minutes), either in respect of officials time spend either in terms of final clients (students)⁷.

Activity	Description	Time before		Time after	
		Officials	Students	Officials	Students
1	Several applications in SA (EN-13-24) PT-13-24	-	-	-	-
2	Disclosure	0,01 min	0,00 min	0,01 min	0,00 min
3	Authentication and registration	5,00 min	90,00 min	0,00 min	3,00 min
4	Validation	4,00 min	3,00 min	0,50 min	0,00 min
5	Issue of reference	0,25 min	0,25 min	0,02 min	0,00 min
6	Data entry and validation	0,11 min	0,00 min	0,11 min	0,00 min
7	Receipt of fees	0,43 min	0,43 min	0,00 min	2,00 min

Table 1 – Compariosn of exam registration time

Note that activity 1 (several applications in SA (EN-13-24)) is not considered here because it is a special case, detailed in another process (or PT⁸).

Is there a payment?		Time before		Time after	
		Officials	Students	Officials	Students
yes	41%	9,69 min	93,68 min	0,53 min	5,00 min
no	59%	5,13 min	90,00 min	0,13 min	3,00 min

Table 2 – Time consumes division in what payment need is concerned

Process improvement analysis can be made in a time reduction

⁷ We took into consideration effective times. For example, if it is a season with fees associated (not a regular one), after making the registration application, these are in state pending until the SA (Academic Services) make them valid. Annex 4 - Activity set description of registration in examination processes. Before the electronic implementation, students may have been waiting about half a day until they were able to pay the fee. Nevertheless, effective time is considered as zero, because students do not need to wait all that time and can do other things meanwhile.

⁸ PT – “Processo de Trabalho” means work process.

perspective at a first stage. The calculation made is just for the cases related to appeal and employee student exams. Normal exams maintain the past procedures and did not have significant differences. Table 2 presents average time consumes by student, before and after the improvement implementation.

	Time before		Time after		Global Time Gain		Improv. Ratio	
	Officials	Students	Officials	Students	Officials	Students	Officials	Students
2.100 stud								
41%	20.358 min	196.728 min	1.122 min	10.500 min	19.236 min	186.228 min	94,5%	94,7%
59%	10.770 min	189.000 min	270 min	6.300 min	10.500 min	182.700 min	97,5%	96,7%

Table 3 – Global analysis performance improvement (total time consumed each season)

Table 3 shows global analysis performance improvement. This table presents global time gain (total time consumed each exam season) and an improvement ratio calculated based in time cut gain. We can conclude a significant process improvement, of more than 90% in any circumstances.

After these sums are computed is possible to estimate the efficiency in terms of number of personnel gain. Total numbers of hours estimated as gain by season are 496 h. If we consider 2 seasons per year, each season with 2 special exams (appeal and employee student exams), it gives 1.982 hours. Each month 165 hours will be gained which correspond to a 0.2 official. This value could be easily converted into costs improvement. But the main improvement is at quality service level and that is more difficult to be measured. And this is just one process analysis.

6. Modeling Quality Management and Academic System integration

After this improvement experience others are being prepared by same team, composed by business responsible, internal IT support team and maintenance IT support team. Next process improvement analysis will involve the automation of the validation of certain criteria students must

make special exam registration. This may reduce to zero the validation time consumed by officials in the near future.

This approach is following a process opportunities prioritization analysis based on complexity and value 1. Getting mixed teams, with both business and IT sensibility to work through this exercise helps establish agreement on the most effective use of everyone's time. This first less complex projects gives teams the opportunity to move quickly, early wins while learning about the best technological and organizational approaches.

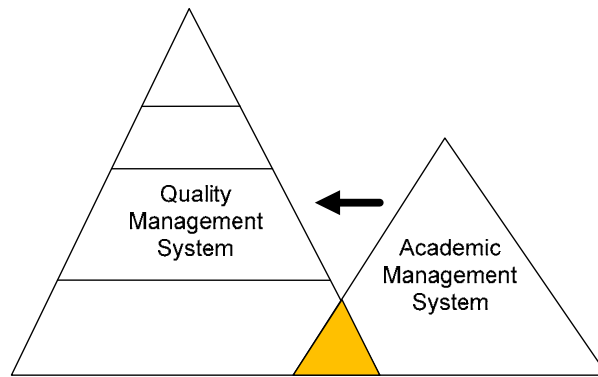


Fig. 3 – Modeling integration between Quality Management System and Academic System

In terms of the Quality Management System, aspects like some working procedures, installation work and registries are taking into account at the academic management system. These considered aspects are from the second to the fourth level of the quality management system (according to those defined at Fig. 1). First quality level aspects, like quality and objectives policies definition, are probably more difficult to be initially integrated into this particular academic management system, but can be used in a global view of the organization.

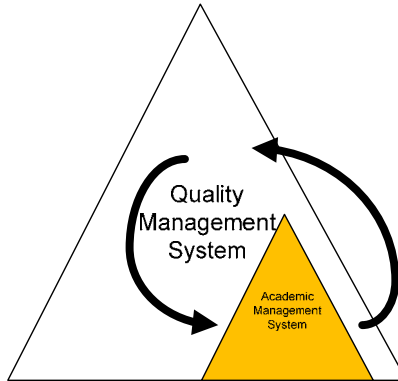


Fig. 4 – Modeling Quality Management and Academic Systems Integration and Interaction

The idea is to push this academic system into the global quality perspective and objectives. The more integrated these systems are, the higher level academic system incorporates policies and strategy level definition, relating to policies. This integration would allow a better business performance analysis and understanding. This unique perspective makes an easier converge of metrics from both systems. In a certain way, this approach is the establishment link between quality standards like ISO 9001 and software life cycle processes like ISO 12207.

On the other hand, this approach allows the development of a unique framework, with automatic flow of figures, with the same concept behind. For instance, the measure of student's evaluation about academic services could be done at the academic management environment, before or after some important student activity at the system. These forms could have a posterior treatment at the quality management system, in a complete automatic way.

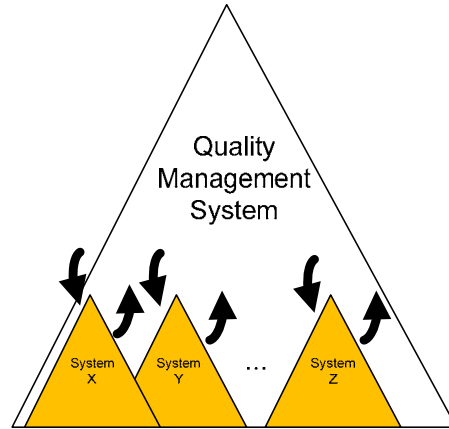


Fig. 5 –Modeling Quality Management System Integration with other information systems

Ideally, the organization could try to get a global model for the other systems integration, taking all of them into the quality objectives and system quality perspective.

This is really an incremental approach to global integration, instead of a process reengineering view. These can be done by phases and not at once, reducing dimension of the project problems and people resistance to change.

7. Conclusion and overview

The analysis and design of work flows and processes within the organization made by the quality certification process was the seed to a business process management [BPM]. Business process can be transformed using information technology [IT]. This transformation can have a mutual influence and can be seen as a recursive relationship.⁹ IT is one of the main supports of business process redesign [BPR]. Business process can be redesigned by using new IT approaches. On the other hand, information

⁹ see the survey of Thomas Davenport and James Short, *Information technology and business process redesign*, Sloan Management Review, 1990.

systems can be designed or configured according to the business needs and business process definition. It is a recursive relationship.

In the future, several perspectives could be used to help ISCAC organization to improve its global service level. Business process modelings used are still in flux and are not really integrated with IT services. The next step should be done and it consists of making an evolution to a business process modeling supported by a Web-based workflow (see www.ebpm.org). Actual business process languages perspectives (like BPML, BPEL4WS, EDOC, XPDL and UML 2.0) allow the interaction between Web-based services and manual business processes. This unique framework will gradually come to be critical to business process management and improvement.¹⁰

Another area of interest that can be developed in the future is the enhancement of business process management with adequate simulation. ISCAC is running the third year of ISO quality implementation. Benefits are coming now. Some workflow has already changed and some may change on the near future. Some changes are being study by a special team, but eventually without the right tools to do it. Studies say that is better to do process simulation before real implementation. This could be an interesting area of study and development at ISCAC as well.

Business process management approach could be used to improve quality management process in general. This is currently the process with more problems to be managed and, on the other hand, the relation between these two areas is an interesting field of research. Today, at ISCAC, almost all quality forms are made with a spread sheet, with no automatic interaction with other parts of the information system. This integration is a hard way and, even if from a logical point of view integration between quality system and other systems can be done, in practice it is difficult. One way to implement business process management can be done using an approach which leverages agent technology¹¹, to obtain agile business process behavior.

¹⁰ see the survey of Jon H. Weyland and Michael Engiles, *Towards simulation-based business process management*, Winter Simulation Conference 2003, p. 3.

¹¹ Birgit Burmeister, Felicia Copaciu and Giovanni Rimassa, *BDI-Agents for Agile Goal-Oriented Business Processes*, AAMAS '08: Proceedings of the 7th international joint conference on Autonomous agents and multiagent systems: industrial track, 2008. pp. 37-44.

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Annex 1 - Group of processes that were identified at ISCAC

PGQ ¹²	Denomination	date of last revision	responsibility of preparing ¹³
01	Planning and Review of the Quality Management System	04-03-2009	CD
02	Establishment and Revision of Courses	12-01-2009	CC President
03	Human Resource Management	24-03-2009	SAF
04	Supply	23-09-2008	CD
05	Management Information System and Documentation for Quality	17-03-2009	CD
06	Management of infrastructure and working environment	27-01-2009	GI
08	Management of Measurement and Monitoring Devices	05-03-2009	CD
09	Management of non-conformity, corrective and preventive actions	05-05-2009	CD
10	Management audits	17-11-2008	CD
11	Budgetary Management	26-11-2007	SAF
12	Management Library	17-09-2008	SAF
13	Courses Management	13-04-2009	CD
14	Advanced Training Courses and Supplementary	10-11-2008	ISCAC BS
15	Continuing Education Courses	30-10-2007	CentroForma

Annex 2 - Map of documents of the courses management (PGQ 13)

Work Process	Denomination	date of last revision	responsibility of preparing ¹⁴
13-01	Distribution of Teaching Service	07-07-2006	CC
13-02	Contests and Special Schemes Transfer, Change of Course and returns	25-07-2007	SA
13-03	Certifications and Recognition of Qualifications	06-03-2009	CC
13-04	Enrollment - 1st time, Renewal of the Registration and Payment of Fees	11-09-2008	SA
13-06	Registration and Control of Abstracts and the diligence	17-03-2009	CD

¹² PGQ – “Procedimento de Gestão da Qualidade” means Quality Management Procedure

¹³ CC-Scientific Council, SA-Academic Services, CD-Board, GRI-International Relations Office, GI-Office of information technology, ISCAC BS-Business School

¹⁴ CC-Scientific Council, SA-Academic Services, CD-Board, GRI-International Relations Office

	of students		
13-07	Exam registration	05-01-2007	SA
13-08	Improvement of Note	16-06-2006	SA
13-09	Assessment of Knowledge	24-06-2008	SA
13-11	Final results of the Student	16-06-2006	SA
13-12	Certificates, documents and photocopies of diplomas	24-05-2007	SA
13-15	Socrates-Erasmus - mobility of students - outgoing	14-01-2008	GRI
13-16	Socrates-Erasmus - mobility of students - incoming	16-06-2006	GRI
13-17	Sócrates-Erasmus - Mobility of Teachers - outgoing	05-09-2006	GRI
13-18	Socrates-Erasmus - Mobility of Teachers incoming	16-06-2006	GRI
13-19	Definition of criteria and vacancies within the CNAES	02-05-2006	CD
13-20	Local Competition for Access to 2nd cycle	16-06-2006	SA
13-21	National Competition for Access to Higher Education (CNAES)	16-06-2006	SA
13-23	Definition of timetables	24-04-2008	CD
13-24	Various Requirements in Academic Services	16-06-2006	SA
13-25	Definition and Criteria for vacancies Outside CNAES	02-05-2006	CD
13-26	Capacity evaluation tests for the frequency of courses for the ISCAC (more 23 Years)	25-07-2008	CD
13-28	Isolated discipline	04-09-2006	SA
13-30	DPCC - Curriculum Stage's in Administration and Solicitadoria	20-03-2009	Director of Course
13-31	Applications for Masters	01-10-2008	CD
13-32	Establishment of the Unit Curriculum Dossier	21-10-2008	CD
13-33	Application and Registration for Technology Specialization Courses (CET)	27-01-2009	CD

Annex 3 – CSE, Control System of Education

Existing resources in the implementation of the central academic area is the interface of high returns associated with the resources of the parameterization and maintenance reports of the application.

The application allows control of several schools or centers, which can manage cross-curricular plans, trunks or common areas, systems of credits, mixed systems and a full range of rules of transition from years of calculations and the Graduation.

The work of the users is facilitated by using a system of wizards associated with many of the repetitive tasks, such as registration, placement assessments, classes and curricula.

Security and control are provided by the constant registration of all transactions of users, similar to what happens in all modules SiGES.

CXA - Monitoring and Treasury Management

The new version CXA resulted in implementation of cash management truly complete.

The CXA can manage the account of students, candidates, officials and others, issuing invoices, receipts with or without fragmentation, credits and debits.

The CXA allows the calculation of fully configurable tuition plans and fines. The export of data to accounting systems is possible, grouping them by the two common classification systems, and provided that the application POCP Education allows reading text files, delimited or HTML. It should also be noted CXA enforcement's ability to generate invoices for payment of fees for MB. The imported files from SIBS are treated dynamically, thereby generating a log for consultation and post.

Features	Description
Type of Application	Intranet (Client-Server)
Client Platform	Windows 9X/ME/NT/2000/XP/Vista
Prerequisites for Client Software (licensing)	Oracle 9i Client License
Base Technology	Borland Delphi and Oracle PL/SQL

Annex 4 - Activity set description of registration in examination processes

1. The student may request enrollment in the regular examination or examination not regular. If the desired entry is not in regular review, the process is defined in the EN-13-24 - Various Requirements in Academic Services, followed by section 3 and then following this procedure to work.
2. In the case of regular reviews, the disclosure is made (by issuing a warning) the terms and conditions of entry in examinations. This disclosure should be based on the school calendar and maps of examination proposed by the Pedagogical Council and approved by the Board in accordance with the Rules of Frequency, Evaluation, Transition Year and of Course

Completion of the 1st Cycle of Studies (RG-13 - 12) and the Regulation of Access to Special Investigations (RG-13-19).

3. All entries in tests at the time of appeal and student workers are made in academic portal <http://netpa.iscac.pt>. To register, students log in the system and follow the instructions.

4. If it is a season with fees associated (not normal one), after making the registration application, these are in state pending until the SA (Academic Services) make them valid.

5. After validation, the reference is issued for cash payment of registration, which can be found on the APS intranet user.

6. In the case of the normal season, there is no way to pay for registration. The SA perform the input of data in the system SIGES and validate the legality of the application.

7. The Administrative and Financial Services (APS) receive the fee by downloading the files from SIBS. If the student wishes to get a receipt, he/she should request it in SA.

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