Aspects for Information Systems Implementation: challenges and impacts. A higher education institution experience.

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Resumo. O desenvolvimento e implementação de Sistemas de Informação (SI) colocam às organizações importantes desafios. Além de questões tecnologicas de interoperabilidade entre múltiplos sistemas e integração com sistemas legados, os procedimentos organizacionais incluem frequentemente muitas práticas não formalizadas que tornam o levantamento de requisitos e a fase de desenho extremamente difícil, conduzindo muitas vezes às excepções nos fluxos dos processos de negócio. Neste trabalho são apresentadas as principais motivações e desafios para o desenvolvimento e implementação de SI. É apresentado um caso de estudo relativo à implmentação de um SI numa instituição de ensino superior portuguesa. É tambem abordada a temática das novas perspectivas na mitigação dos efeitos das excepções nos fluxos dos processos de negócio.

Palavras-chave: sistemas de informação, excepções em fluxos de trabalho, adaptação mútua.

Abstract. The development and implementation of Information Systems (IS) raises important challenges to organizations. Beyond technological issues related with interoperability and legacy systems integration, the organizational procedures frequently include many informal practices that lead to a poor requirements elicitation difficulting the design phase which typically lead to exceptions in business processes workflows. In this work the main motivations and challenges for the development and implementation of IS are presented. A

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case study describing an IS implementation in a Portuguese superior education institution is reported. It is also discussed the new perspectives regarding the mitigation of the effect of business processes exceptions in the business processes workflows.

Keywords: information systems, workflow exceptions, mutual adaptation.

1. Introduction

Information Systems (IS) development raises many important challenges to organizations. Nowadays, depending on the type of organization, to some extent business processes are supported by some kind of IS. It is not unusual to have in some organizations information and procedures islands lacking from a desirable integrated access to information. This work presents major motivations and challenges for an IS development/implementation project. It is reported an experience of an IS implementation in a public institution of higher education (Gonçalves, & Fernandes, 2007), which had, among other goals, the purpose of mitigate information islands by providing a central access point to information. The implemented IS is based in SIGARRA - Information System for the Aggregate Management of Resources and Academic registers (Ribeiro, & David, 2001) which is a stable, robust, widely tested and continuously updated, IS for higher education institutions in use in several Portuguese institutions.

SIGARRA's system architecture is based on a modular integrated web based information system that allows to be configured in specific institutions implementations. The system delivers a portal with a wide spectrum of functionalities ranging from easily obtain lectures schedule from students or professors, to online exams schedule management. The system also provides a workflow engine that supports business processes workflows like helpdesk trouble tickets process, student applications, projects and publications management, among others. A preliminary evaluation regarding end-user's satisfaction and perceived relevance of such implementation is presented.

Despite the reported advantages and concerning business processes workflow support, we still face to some extent a lack of flexibility to address unpredicted, not modelled, situations, that may arise for a number of factors (e.g. deficient

requirements analysis, circumstantial factors, external variables). In this paper we also present new perspectives in IS development to overcome such limitations and conclude pointing some further work directions framed in this research area.

2. Motivation and Challenges for IS development

The technological development had brought, over the last years, several challenges to existing organizations as well as new forms of organizations (e.g. collaborative networked organizations (CNO), virtual organizations (VO)). Information Systems (IS) that support their business processes are often information islands, usually not integrated. The actual perspective of IS is a holistic and integrated support to all organizations' processes and many times integrating with supply chain partners' processes.

Although we have been assisting to the proposal of several technologies and methodologies, over the last years, we still assist often to IS development and implementation failures. In (Charette, 2005) are presented some recurrent problems in IS projects: requirements capture and system specification, unrealistic and unarticulated goals, deal with project complexity, etc. leading often to systems with deficient support and usability for the required functionalities promoting users resistance in adopting them (in fact some are abandoned without being used at all). As many authors pointed out, many of the failures seen in IS development can be traced to lack of understanding of organizational culture or of the social factors that affect the ways that people interact and work together. As referred in (Markus, Majchrzak et al., 2002), once a new system is introduced to support a process the actual way of conducting that process changes. When systems are introduced in an organization environment, some tend to think that the work will be done fundamentally in the same way but more efficiently and quickly. This is rarely true, the work system changes often in an unintended, unanticipated and often undesirable way.

In (Vyhmeister, Mondelo et al., 2006) are identified six organizational elements that could be affected:

1. The nature of work (quality, task specialization and temporal aspects);
2. The individuals (role identification, stress, perceived status, job satisfaction, and identity among others);
3. The organizational communications (communication efficiency, communication type between organizational levels, communication volume, job monitoring methods, and job perception);
4. The interpersonal relationships (social interaction quality and quantity, social reinforcement, number of sociometric relations and communication hierarchy);
5. The interdepartmental relationships (interdepartmental conflicts, cooperation, independence, and departmental limits);
6. The organizational structure and processes (physical limits and organizational adaptability).

To smoothly integrate both organization and technological systems mutual adaptation research works, suggests that the adaptation process is more related with work practices than formal structures (Bygstad, 2005). In IS projects introducing a new organization chart without changing the work practices has often proved unsuccessful. Mutual adaptation implies that it is possible to change structural properties of both the organisation and the information system, creating 'windows of opportunity'. Figure 1 (Bygstad, 2005), describes the main phases of the adaptation process.
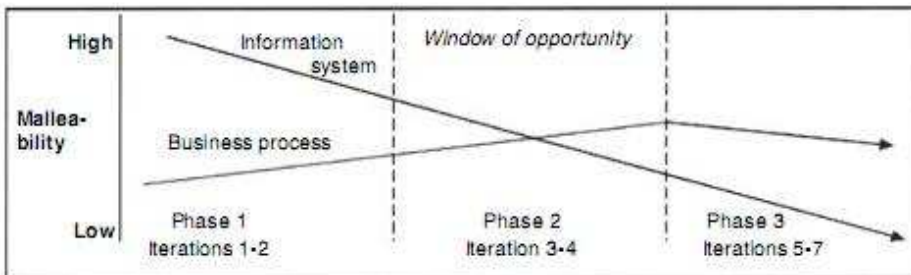
Figure 1: Information Systems and Business Processes mutual adaptation

3. SI-IPS Case Study

Setúbal Polytechnic Institute (IPS), a public institution of higher education, was created in 1979, and includes the Presidency Services, a Welfare Social Service and five Colleges that offer a range of graduate courses in different areas such as Technology, Education, Business Administration and Health Care. The institution has more than 6000 students, 505 teachers and 169 technical and administrative collaborators.

Five years ago, IPS evidenced that it was very difficult to gather integrated information from the students as well as from the teachers. IPS and the colleges needed to get management indicators and felt that information was spread on small non integrated information systems. All the stakeholders of the education process needed to have access to their information online and it was not possible to obtain that information without a new integrated system. Besides consisting in a central repository and unique access point, a web portal will allow to access information outside institutions facilities.

The students from IPS mainly reside far from the school and many of them work during the day and study at night. It would be a competitive advantage to give them access to lectures, as well as, all important academic data.

The idea to develop in house a new system was placed apart, because IPS did not have the sufficient skilled human resources to manage a project with all these requisites in useful time. All the systems with this kind of requisites usually take several years to become in production in a stable way. It was created a team that started to analyze all the available academic information systems all over the country. Two years later the team defined finally that there was only a really stable, solid and tested system that meet the identified requirements to be installed in IPS – SIGARRA.

SIGARRA - Information System for the Aggregate Management of Resources and Academic registers constitute a central tool to manage Superior educational establishments. The system development was started in Porto University in 1992 and has by now 13 collaborators. Nowadays it is in use on all faculties of Porto University and started its implementation in other public institutions of higher education such has IPS.

SIGARRA's system architecture is an integrated Web based information system, a student's management applications (GA) and human resources management application (GRH), its main characteristics are:

- Information integration;
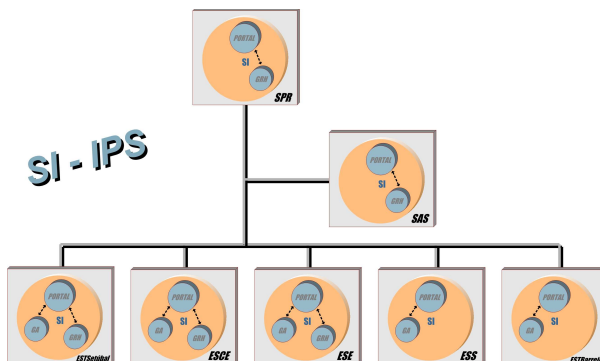- Web interface;
- Modularity and configurability

Figure 2: SI-IPS and its organic units

As IPS has five schools and two more organic units (figure 2), all of them used different procedures to the organizational processes. The main idea was to

standardize the processes in all the schools. The adopted implementation methodology consisted in the migration of the old systems at each school one by one to minimize the impact in services and increase the team expertise. Beside the lack of standardized procedures another challenge was the fact that the legacy systems didn't have enough documentation, so the migration process needed to be validated several times to assure data consistency. While the migration was in progress, the web portal started being installed and customized.

Technological Aspects

In SIGARRA the information is stored in servers of clustered relational databases (Oracle). The interface for the user is Web based, which, by its easiness of use, versatility and generalization, was selected to constitute the agglutinant element of some components of the system. The system holds one component of data not structuralized, as for example personal pages of the responsibility of the proper owners. The technology that supports the system is:

- SuSE Linux Enterprise Server 9 SP3,
- Oracle Application Server 10gR2;
- Oracle Database Server 10gR2;
- Oracle Clusterware 10gR2;
- Oracle Workflow

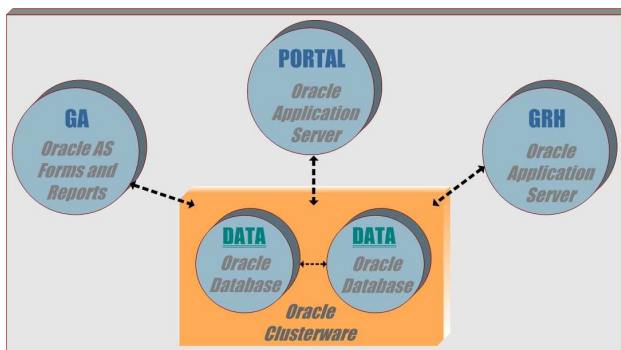Figure 3 illustrates the SI-IPS logical architecture.

Figure 3: SI-IPS Logical architecture

The used technology relies in Oracle HTTP Server (one derived from apache 1.3) with modplsql, Oracle Forms and Reports (BackOffice), PL/SQL, Java, XML, HTML and SVG (for graphical representation).

Main functionalities

SI-IPS currently allows the management and integration of information on the courses and the student's registers, the management of human resources and installations, register of the scientific activity and diverse mechanisms of communication, among others. Table 1 summarizes the web portal main functionalities divided in four areas: pedagogical process related, human resources management related, communication related and workflow based processes support.

Pedagogical process related	Human resources related
• Courses info	• Institutional page for

• Teaching services distribution; • Lectures schedules; • Students registrations; • Lecture plans and materials; • Student fees management; • Exams booking; • Student results; • Pedagogical surveys and statistical results	collaborators; • Collaborators info; • Projects management • Publications Management; • Thesis supervising
Communications related	**Workflow**
• Dynamic e-mail; • Web forums; • Institutional news; • Legislation	• Helpdesk trouble tickets process • Student applications • Projects management • Publications management • Resources booking

Table 1: SI-IPS Main Functionalities

With the SI-IPS portal, it is now quite easy, for instance, to obtain the lectures schedule from a student or professor, obtain the room of an ongoing class as well as the building plant. For students it is possible to obtain all their marks online, and to manage all their exams schedule online also. Professors now can obtain the student pictures and obtain all students' plan all over his course. Figure 4 shows portal's layout.
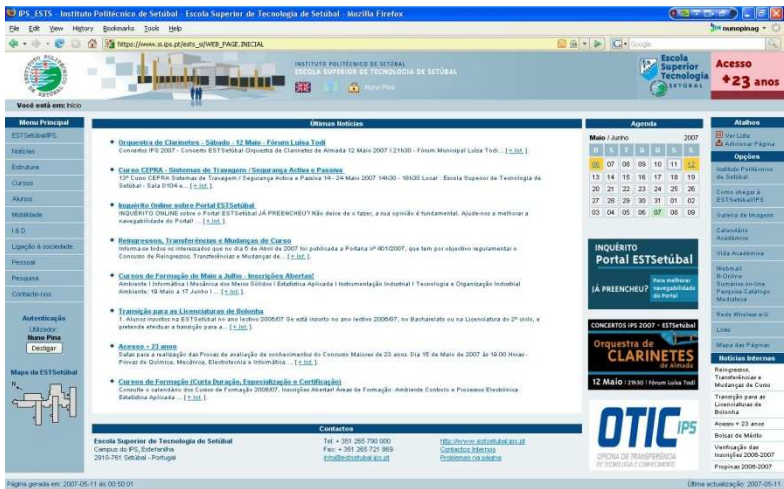
Figure 4: Web portal's layout

Evaluation

In order to gather information from the users about their satisfaction regarding the new web portal of the SI-IPS, an online survey was conducted. The users classified a set of SI-IPS characteristics in the following scale:

- not satisfied at all;
- not much satisfied;
- satisfied;
- very much satisfied;
- completely satisfied.

Figure 5 illustrates surveys layout in SI-IPS. Bellow we enumerate the set of characteristics prompted to the users.

- the portal design;

- adequacy of the main menu structure;
- data actualization frequency;
- easiness of navigation;
- quality of portal's information;
- utility of the contents;
- clarity of the contents;
- adequacy to the education necessities;
- access speed to the portal;
- advantages comparing the new portal with the old existing system;
- general opinion of the web portal.

Figure 5: Survey Layout

The survey was online for one month and every user that logged to the portal would see a text message that invited him to fill the survey. The survey was not mandatory, so only users that really wanted, would fill it.

The survey results are displayed in figure 6, and were obtained from 528 user's answers to the online survey from a universe of 2305 users – 23% of the universe. Analyzing globally, 86% of the users are globally satisfied with the portal in general. It can be detached that 82% is the average of satisfaction from all the answers. Only 2% of the answers were left in blank.

Analyzing figure 7a graph, it is possible to detach that the answers "portal design", "utility of contents", "access speed to the portal" and "quality of portal's information" have a high percentage of satisfaction from the users (higher than 80%). It is possible to highlight the answers that obtained a high percentage of users which are very much satisfied are in figure 7c.

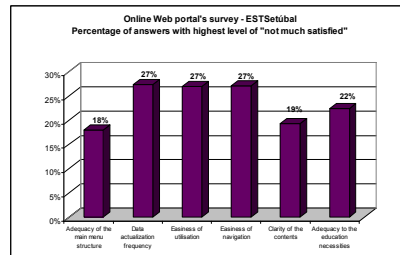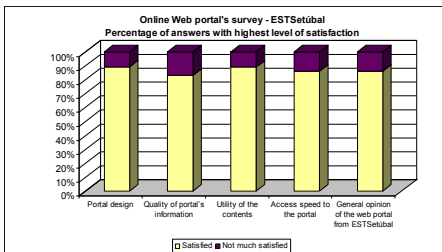It is also possible to analyze the answers which obtained less percentage of satisfaction. In this case it is possible to analyze in figure 7b that the adequacy of the structure of the main menu, data actualization frequency, easiness of utilization, easiness of navigation, clarity of contents and adequacy of education necessities are the questions that obtain the lowest percentage of satisfaction, with an average of 24%.

Online Web portal's survey - ESTSetúbal		
Questions	**Satisfied**	**Not much satisfied**
Portal design	89%	11%
Adequacy of the main menu structure	82%	18%
Data actualization frequency	73%	27%
Easiness of utilisation	73%	27%
Easiness of navigation	73%	27%
Quality of portal's information	83%	17%
Utility of the contents	89%	11%
Clarity of the contents	81%	19%
Adequacy to the education necessities	78%	22%
Access speed to the portal	86%	14%
General opinion of the web portal from ESTSetúbal	**86%**	**14%**

Questions	Yes	No
Advantages comparing the new portal with the old existing system	83%	17%

Figure 6: Survey Results

Online Web portal's survey - ESTSetúbal	
Questions	**Very much satisfied**
Portal design	33%
Quality of portal's information	31%
Utility of the contents	37%
Access speed to the portal	35%

Figure 7: Survey Results (graphical) a. Satisfied answers b. Not Satisfied answers c. Very Much Satisfied answers

4. Other perspectives to IS development

Existing work processes in organizations are supported in a continuum of structured and unstructured activities (Sheth, Georgakopoulos et al., 1996; Bernstein, 2000). Unstructured activities usually emerge from a lack of support of existing IS and/or organizational procedures to deal with unplanned/unpredicted situations. The most common approaches to IS development focus on identifying the structure of work processes (actions, action sequences, roles, responsibilities, resources allocation, etc.) to produce a system specification. However, many unknown *a priori* variables, both external (e.g., market dynamics, natural disasters) and internal (e.g., latent problems or work structures/processes) are among the factors that may promote the emergence of unstructured work activities. Within these unstructured activities we include business processes exceptions handling, business process reconfiguration and crisis management scenarios which may in fact accomplish a learning mission.

To get the work done when facing such unstructured scenarios, people usually engage in informal relationships and make use of their tacit knowledge and experience in an opportunistic manner, which quite often reveals as a source of innovation, creativity and flexibility.

The traditional approaches and systems had revealed limited for the support to the operations in emergent situations (Markus, Majchrzak et al., 2002a) defended that a new approach in IS design is needed to a new class of systems. They call this class Emergent Knowledge Processes which contains processes characterized by:

- No best structure or sequence
- Typically distributed
- Dynamically evolving
- Actor roles unpredictable
- Unpredictable contexts

As referred also in (Markus, Majchrzak et al. 2002) the adaptation of existing methodologies will serve specific problems and what is needed is to develop a new theory and methods to deal with this class of processes.

We still can't provide flexible/agile software tools that may be reconfigurable at run-time to accommodate unpredicted requirements, emerged in the dynamic real life situations. Technological systems still face several challenges, to accommodate properly:

- Group memory management (learning from experience)
- Knowledge acquisition, representation and dissemination
- Organizational culture
- Shared semantic
- Social environment
- Contexts representation

5. Final remarks and Future Work

We presented an overview of IS implementation motivations and challenges illustrated with a case study in a higher education institution. The presented SI-IPS is now stable and in production at IPS. Users are satisfied with the portal's design, functionalities and contents and state that information has quality and usefulness. In short time the e-learning platform Moodle will be integrated with SI-IPS. We will also consider some changes inferred from the evaluation survey.

Despite the major improvements that SI-IPS brought, we still experience some problems regarding business processes workflows exceptions raised from unpredicted situations. Framed with authors research interests, as future work we intend to further develop a groupware module to address workflow processes exceptions. We conducted a review of research works addressing the gap from fully structured formal activities to ad-hoc informal unstructured activities, e.g. (Dourish, Holmes et al., 1996; Bernstein, 2000; Mourão & Antunes, 2007). These works studied how to bring IS back to model guidance after deviations caused by unpredicted events. Nevertheless, we intend to go beyond this perspective towards the support of new emergent and collaborative work structures, where models do not serve as prescriptions but rather as artifacts that may help getting the work done (Suchman, 1987; Gasson, 1999). According to the Computer Supported Cooperative Work (CSCW) works (Bolstad & Endsley, 2000; Gutwin & Greenberg, 2002; Neale, Carroll et al., 2004; Storey, Cubranic et al., 2004) involved

stakeholders should be able to monitor, analyze and anticipate requirements to mitigate emerged exceptions. Thus to improve problem solving and decision-making in such scenarios we defend a situation context characterization in a phenomelogical perspective which regards contexts as relational entities relating all involved actors, actions and objects, and evolving dynamically as actions unfold (Borges, Brézillon et al., 2004) opposing the positivist perspective, traditionally adopted by the engineering field that regards contexts as stable information entities and separable from actions.

References

Bernstein, A. (2000). *How can cooperative work tools support dynamic group processes? Bridging the specifity frontier.* CSCW.

Bolstad, C. A. & M. R. Endsley (2000). *Shared displays and team performance. Human Performance, Situation Awareness and Automation*.

Borges, M. R. S., P. Brézillon, et al. (2004). *Groupware system design the context concept.* CSCWD.

Bygstad, B. (2005). *Managing the Dynamics of Mutual Adaptation of Technology and Organisation in Information Systems Development Projects*.

Charette, R. N. (September 2005). *Why software Fails.* IEEE Spectrum.

Dourish, P., J. Holmes, et al. (1996). *Freeflow: Mediating between representation and action in workflow systems.* CSCW, USA.

Gasson, S. (1999). *A social action model of situated information systems design.* The Data Base for Advances in Information Systems 30(2).

Gonçalves, N. & Fernandes, J. (2007). *Portal Implementation in Superior School of Technology in Setúbal - Key issues and evaluation.* EUNIS 2007, Grenoble, France.

Gutwin, C. & S. Greenberg (2002). *A descriptive framework of workspace awareness for real time groupware.* CSCW(11).

Markus, M. L., A. Majchrzak, et al. (2002). *A design theory for systems that support emergent knowledge processes.* MIS Quaterly.

Mourão, H. & P. Antunes (2007). *Supporting effective unexpected exceptions handling in workflow management systems.* SAC, Seoul, korea.

Neale, D. C., J. M. Carroll, et al. (2004). *Evaluating Computer-Supported cooperative work: Models and frameworks.* CSCW.

Ribeiro, L. & David, G. (2001). *Impact of the information system on the pedagogical process.* EUNIS 2001.

Sheth, A., D. Georgakopoulos, et al. (1996). *Workflow and process automation in Information Systems.* NSF Workshop.

Storey, M.-A. D., D. Cubranic, et al. (2004). *On the Use of Visualization to Support Awareness of Human Activities in Software Development: A Survey and a Framework.*

Suchman, L. (1987). *Plans and Situated Actions: The problem of human-machine communication.* Cambridge University Press.

Vyhmeister, R., P. R. Mondelo, et al. (2006). *Towards a Model for Assessing Workers' Risks Resulting from the Implementation of Information and Communication Systems and Technologies.* Wiley InterScience (www.interscience.wiley.com).