Industry-oriented Education in Enterprise Systems

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Abstract

Enterprise Systems (ES) are comprehensive software solutions that dominate the IT landscape in many companies. Consequently, it is imperative for universities to explain the architecture, core functionality and consequences of this type of software. ES are still a reasonably new topic in the curricula of many universities. Furthermore, most ES-related courses focus on product-specific knowledge and lack a discussion of issues related to project management, system implementation and change management. This paper describes a teaching model, in which postgraduate students analysed selected ES-supported processes in a company as part of their study. The objectives, design, outline, first experiences and students' feedback are presented.

Keywords

IC Curriculum, MIS, Governmental IS, Human Resource IS, Requirements Analysis

INTRODUCTION

Enterprise Systems (ES) (synonymous to Enterprise-wide Systems, Enterprise Resource Planning (ERP), Integrated Vendor Solutions, Integrated Standard Software Packages and Enterprise Application Systems) are standard software solutions that automate and integrate business processes. ES incorporate the core functionality of organisations (materials management, production management, sales, distribution, accounting, human resource management) and use a single logical database to capture the data (Bingi et al. 1999; Gable 1998; Watson and Noguera 1999). Extended Enterprise Systems also cover the management of inter-enterprise business processes like Customer Relationship Management and Supply Chain Management and analytical applications like Data Warehousing and Performance Measurement (Rosemann 1999).

A range of influences such as increased globalisation, promotion of business process re-engineering and right sizing, as well as the perceived need to integrate business functions and the Y2K challenge, have led many organisations to adopt ES over the past decade. The Gartner Group (Gartner Group 1999) forecasts with a probability of 80 percent that the ES market will be larger than $20 Billion by the year 2002. They estimate that more than 90 percent of the fortune 500 companies have purchased a module or set of modules from an ES vendor. The Gartner Group anticipates an overall ES market growth of 22 percent for year 2000.

ES projects often represent the single largest IT investment in an organisation's history (Sumner 1998). One major contribution to these high expenses is the shortage and the associated costs of retaining expertise (Hawking and McCarthy 2000; Rosemann, Chan 2000; Sumner 1998).

Empirical data indicates that the ratio between software and consulting expenses is often between 1:3, sometimes even up to 1:5.

Enterprise Systems essentially change fundamental business processes. Thus, creating the need to change the design and development of the systems that support these processes. Yet, most curricula do not provide the required coverage of ES concepts in order to educate graduates who are knowledgeable enough about these systems (Watson and Schneider, 1999). This situation is a major new challenge for universities. An overview about the worldwide status of teaching Enterprise Systems can be found in (Gable and Rosemann 1999). Common weaknesses associated with many ES-related curricula are; the lack of integration and inability to align the curricula with the rapidly changing business environment; the lack of experienced lecturers and textbooks; and the complexity in implementing and maintaining ES solutions at universities.

The consequences of these deficiencies are paid by both key parties involved; the students and the industry. The students on the one side develop their expertise in a limited number of areas (such as financial accounting, materials management, human resource management) without understanding the interrelations between these, and often limiting their knowledge only to the theoretical foundations and the pure product functionality. The industry on the other side requires employees who have a holistic view of the overall business functions, with skills to help the organisation succeed across the rapidly changing business environment (Gable 1998; Elam et al. 1999; Hawking and McCarthy 2000; Scott 1999a).

Rosemann and Chan (2000) have identified and categorized five key knowledge types required for the successful management of ES software: business knowledge, technical knowledge, product knowledge, project management knowledge and company-specific knowledge. Most ES-related research and teaching has become rather product-driven, ignoring the importance of the other types of knowledge that are vital for the success of an ES project. While business and technical knowledge still can be taught at universities, project and of course company-specific knowledge is beyond the scope of an ES course at a university. Furthermore, Stewart and Rosemann (2000) argue that the role of a university is not to train in a particular product, but to educate students in the underlying concepts so that they may move effectively to accommodate future changes.

However, most ES-related subjects are using a particular product, SAP R/3, as an example for a complex Enterprise System. The main reasons for selecting SAP R/3 are its status as the market leading solution, the comprehensiveness of SAP R/3, and the existence of reference process and data models. This situation is similar with using selected database management systems like Oracle in related database management subjects. In both cases it is important to stress that the courses are not about teaching product functionality. The selected software solutions just help to understand the discussed concepts (Lederer-Antonucci 1999; Watson and Schneider 1999).

This paper describes a novel initiative regarding teaching Enterprise Systems. It presents the design, first experiences and the feedback from the participants in a new subject, in which students worked collaboratively with industry to gain theoretical and practical exposure to real life ES issues (see also Hawking and McCarthy 2000). The paper first sketches the background of the subject, describes the objectives and introduces the key industrial collaborators. The next section illustrates the overall design of the subject and the students' perception. Finally, it concludes with an analysis of the benefits of the program and a brief discussion on future improvements.

BACKGROUND

Positioning the Subject

The presented new subject was embedded at the Queensland University of Technology (QUT), Brisbane, Australia, in a comprehensive ES-related curriculum. Built on an introductory course (Issues in IT Management), which explains the basics of Enterprise Systems and SAP R/3 as an example, two main streams are offered. In the more technical stream, students have the opportunity to gain knowledge in the areas of administering Enterprise Systems and ABAP, SAP's programming language. In a more business-oriented stream, Process Management represents besides Knowledge Management the main focus. A subject "Process Engineering" introduces the students to different approaches of process management like BPR or Process Innovation. It is explained how business processes can be modelled. Selected SAP processes are discussed and it is demonstrated how they can be configured and executed. This subject is a prerequisite for subjects covering extended ES concepts and workflow management. Figure 1 gives an overview of these process-related subjects within the ES-curriculum at the QUT.

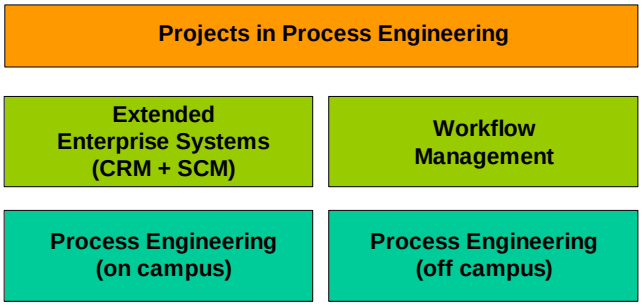

Figure 1: Process related subjects in the ES curriculum at QUT

The new subject being described in detail is titled “Projects in Process Engineering”. It extends the theoretical knowledge that the students get in the subject "Process Engineering" through the participation in a practical project. This unit concentrates on designing process models for a local organisation that is using an Enterprise System. The participants design as-is models describing the existing processes in the selected company. A comprehensive analysis of the current weaknesses of the processes completes these models and serves as the basis for the identification of ways to improve the process performance. In the second phase of this project, to-be process models depicting scenarios for alternative business processes are designed. The participants present their results to representatives of the organisation and develop an implementation plan for some of the suggestions. The upper CASE solution ARIS-Toolset (Scheer 2000) is used to model the processes and to conduct process simulations. The business process models are compared with ES-specific reference process models and other “best practice” approaches.

The *key objectives* of this subject are to:

- apply the prior knowledge of Process Engineering in a real life context,
- develop in students the capability to identify, model, reorganise, implement, and continuously manage processes,
- explain the relationships between the modelling, the customisation, the execution, and the redesign of ES-based business processes.

- provide students with an awareness of the organisational issues concerning the management of business processes,
- develop in students the capability to understand and customise the processes of a selected Enterprise System according to the given requirements in a specific business organisation, and
- to develop consulting skills in students.

Industry Partners

The subject Projects in Process Engineering was offered for the first time in the first semester 2000. The industry partners for this project were Corporate Services Agency, PriceWaterhouse Coopers and SAP Australia.

Corporate Services Agency (CS Agency) is the industry partner for which the process analysis took place. CS Agency is a government agency established in July 1996, which provides the corporate services to both Department of Primary Industries (DPI) and Department of Natural Resources (DNR). CS Agency comprises three service areas; advisory, support services and corporate information systems. It delivers a range of corporate services under a service level agreement to DPI and DNR and parts of other public sector organisations. Currently, CS Agency has 270 employees and a financial budget of A$ 20 million. The main customers of CS Agency (DPI and DNR) have approximately 8,000 employees that utilise CS Agency's products and services. The CS Agency services cover many areas, described in the aspects of finance, human resources, administrative and corporative information systems capabilities. CS Agency is currently running a live SAP R/3 3.1h system. Its SAP R/3 Financial Accounting system has been up since 1998 (Andersen Consulting 2000). SAP's Human Resource Management solution went live in April 1999. The processes selected for the student analysis related to both the Financial Accounting (procurement and corporate card) and Human Resources (recruitment and leave request) modules.

PriceWaterhouseCoopers (PWC) contributed as an international consulting company to this subject in the form of consultants, who attended selected seminars as well as the milestone presentations. The participating consultants were available for discussions about benchmarks for the analysed processes. Moreover, they trained the students in typical consulting skills like interviewing people and presenting results. The PWC methodology for ES management was discussed and critical success factors like teamwork, and project organisation were analysed.

SAP Australia provides the facilities in the form of access to their software, further product information and a room for the milestone meetings. Representatives from SAP were available for presentations regarding new functionality (e.g. SAP R/3 4.6 and mySAP.com).

DESIGN OF THE SUBJECT

Learning Model

The sheer size and degree of integration in ES packages often results in a steep learning curve, leading to problems in both classroom and corporate training environments. Critiques argue that an ES teaching model should avoid information overload and provide a strong bridge between concepts and hands-on experience (Scott 1999a). Results from a worldwide survey conducted by Gable and Rosemann (1999) on ES teaching and research activities proved that hands-on

experience is the main success factor for learning ES software. Scott (1999a) has proposed five potential learning models that can be used to manage and enhance ES related education. Table 1 summarises the key features of these models.

Learning model	***Features***
Objective Model	The goal is to transfer knowledge from the instructor to the students. Assumes that the instructor has all the necessary knowledge, provides the stimulus and is in control of the material and pace.
Constructive Model	The students decide the focus and control of the learning material. The instructor provides support more than direction. Engagement and motivation of the students are usually high.
Collaborative Model	Prior knowledge and experience of the participants are shared to enhance interpretation and learning. The engagement is typically high.
Cognitive Information Process Model	Assumes the importance of individual's learning styles and suggests the need for individualised instructions.
Socio-cultural Model	Heterogeneity of the learners in terms of prior knowledge and social and cultural backgrounds is carefully analysed to adjust the teaching process to the students' background.

Table 1: Key features of ES learning models

The presented "Projects in Process Engineering" subject can be classified primarily as constructive and secondly as collaborative. While the general guidelines were provided, the students were given the independence to individually pace, control and define the scope of the processes. The course co-ordinator provided the feedback and support, but did not control the material or pace. The students were allocated to teams, where experiences and interpretations were shared to develop collaborative mental models.

Upon successful completion of this project, students were expected to:

- compare the business processes of an organisation with the corresponding reference processes of a selected Enterprise Systems,
- use the ARIS-Toolset to model as-is and to-be processes,
- manage a process modelling project,
- discuss the nature of process management and the possibilities and constraints of Enterprise Systems,
- align ES-projects to process management approaches, and
- to describe the functionality, the architecture and selected organisational structures and processes of SAP R/3 as an example of an Enterprise System.

The subject is open to all postgraduate students from Post Graduate Diploma level and Masters level courses across different Faculties (Information Technology, Business and Engineering), who have successfully completed the prerequisite "Process Engineering" or an equivalent in a previous semester. Students who have completed additional ES-related courses, for example Issues in Information Technology Management, ABAP or System Administration further benefited from their knowledge about related ES issues.

Study Outline

Similar to most course work subjects in Australian universities, this subject was designed for a 13 week period (one semester). The course commenced in mid February, scheduled to be held till early June, with three milestone events aligned through out the phase; the 'Kick Off' meeting held at the beginning of the semester, the 'Initial investigation' (as-is) presentation scheduled in the 6th week, the 'Interim Report' scheduled in the 9th week and the 'Final recommendation' (to-be) presentation scheduled in the final week. Figure 2 illustrates the organisation of this subject.

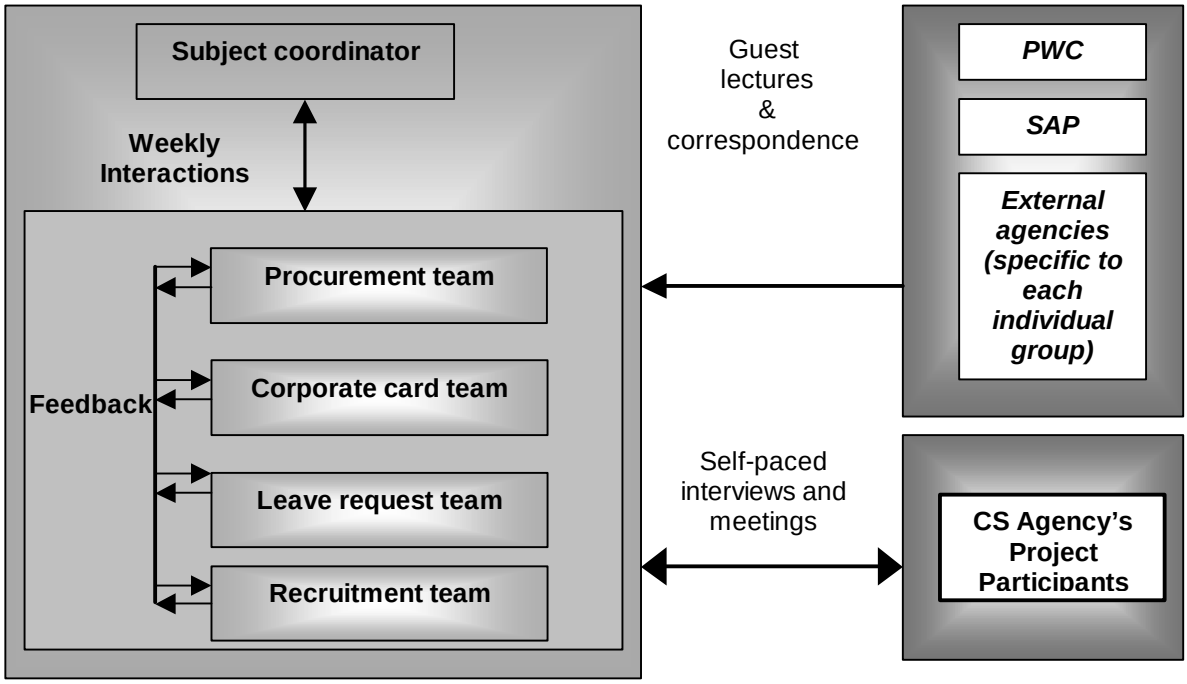

Figure 2: Organisation of the project

During initial meetings between the course coordinator and the executives of CS Agency appropriate areas at CS Agency for this project were identified. The following four processes were selected because of their separated nature, their existing problems and the likelihood of identifying weaknesses and possible improvements:

- procurement,
- corporate card,
- leave request, and
- recruitment.

The class of 16 students was divided into four project teams with each team assuming responsibility and ownership of one of these processes. The teams were defined, team leaders allocated and a process was assigned to each team at the first session. For each team CS Agency provided at least one contact person from both the IT and the business area.

All project members and the subject supervisor met face to face on a weekly basis. The progress and general issues pertaining to each team were discussed, followed by process-specific issues. These seminar sessions were mainly held to provide feedback and develop interactions between the teams and the supervisor. Occasionally, these meetings were held in classroom environments,

when a special topic common to all groups had to be discussed. For example, lectures were held to teach students how to conduct process simulations using the ARIS-Toolset, how to find and interpret benchmarking information and how to illustrate the use of the SAP reference models. In addition to this, web-based discussion forums were used for further interaction between the project participants. Each group was assigned to an on-line discussion forum available through the subject web page. This encouraged interactive participation within and across the team members.

The student teams were officially introduced to the relevant CS Agency members at the "Kick-off meeting" held in the second week of the semester. From then on, the teams interacted with these key contact people independently, at their own pace, to gather and confirm information related to their processes. All students were provided with access to CS Agency's SAP R/3 system to study the configuration of the processes. The student teams also approached other external organisations that were of potential interest or relevance to the processes.

Subject Assessments

Assessments are an integral part of the learning environment. They must be designed to measure the students understanding of the content in a valid, reliable and feasible manner. As Table 2 illustrates, there were three key assessments associated with this project. Identical copies of these management reports were handed in to both the course coordinator for assessment and to the CS Agency, for reporting purposes at each milestone event.

Type of assessment	Marks allocated		Total
	Report	***Presentation***	
❑ Initial investigation (as-is) report and presentation	20%	10%	30%
❑ Interim report and presentation	20%	10%	30%
❑ Final recommendation (to-be) report and presentation	25%	15%	40%

Table 2: Associated assessment

The as-is report and presentation was designed to enable the students to clearly identify the goals and scope of the individual processes, and to critically evaluate the current status of these. All teams modelled the "current situation" (as–is) of the sub-processes using the EPC (Event-driven Process Chain) methodology and the ARIS-Toolset. The weaknesses of the current processes were identified and possible solutions briefly introduced at this stage. Findings of each team were documented in an 'Initial investigation' report and presented to the supervisor and the relevant contact people from CS Agency. A team representative also presented the findings in an presentation that took place in front of CS Agency, SAP Australia and PWC members, addressing any issues that the audience put forward. The students were evaluated on a team basis, with both quantitative (for example, the semantic correctness of the models) and qualitative (for example, the presentation style) factors assessed.

The 'Interim' and 'Final recommendation' (to-be) assessments were designed in a similar manner. The interim assessment was designed as a quality control mechanism to enable the students to clarify and confirm the key areas and concepts that the organisation wished to address. The 'Final recommendation' assessment was designed as the overall outcome of the project. The proposed reengineering solution was to be addressed in detail, depicting its flow

with Event-driven Process Chains together with statistical information (for instance, from benchmarking, process simulations and organisational reports) on the solution's feasibility and appropriateness. Organisational constraints such as governmental regulations and availability of resources were also carefully considered when developing these solutions.

OVERVIEW OF THE PROCESS TEAMS

This section discusses briefly the methodologies and the results of the four teams. The constructive-collaborative nature of the unit design provided the students with the flexibility to select and utilise various methods that best suited the individual context of their process.

Procurement

The procurement team analysed the entire procurement process from the requisition to the invoice verification. They identified high cost per requisition line, increased time delays, poor communication across the key parties (clients, CS Agency and suppliers) and a large number of redundant and repetitive suppliers as the key weaknesses of the procurement process at CS Agency. The use of ES functionality that wasn't used so far such as Vendor Evaluation and an ABC classification of the vendors were provided as immediate recommendations for CS Agency. For an evaluation of the benefits from an electronic procurement solution, the functionality of the planned upgrade SAP R/3 4.6 and the functionality of SAP's Business-to-Business solution, were analysed together with market-leading electronic product catalogues and electronic procurement vendors such as ARIBA. The procurement team suggested an integration of the corporate card process by providing a cost benefit analysis on how a higher corporate card usage would reduce the overall procurement order instances and, in turn, the overall procurement costs of CS Agency.

Corporate Card

The corporate card process team decomposed the core process into ten sub-processes and categorised these either as an administrative process or as a transaction reconciliation process. Weaknesses of each individual sub-process were identified and prioritised. The main weaknesses of these processes were; many manual tasks, a high number of transactions and many interfaces. The corporate card team collected relevant information through literature reviews and interviews. They consolidated literature on how other businesses, for example PriceWaterhouseCoopers and the MIT, practised the implementation of corporate cards as a means of benchmarking CS Agency's corporate card process, and justifying their recommendations. They also analysed SAP's Payment Card functionality in the Sales and Distribution module and evaluated the ANZ software. Based on the information gathered, this team recommended the following as the key solutions; on-line card applications, appropriate validation for posting, formal training for data processing officers, default values to minimise errors and default account changes, as the key solutions to improving the corporate card process at CS Agency.

Recruitment

The recruitment team modelled the current recruitment process of CS Agency using detailed EPC. They also used 'cause and effect' charts to cluster the weaknesses of each sub-process. The key weaknesses that were identified included governmental restrictions, lengthy processing time, lack of process monitoring, inconvenient SAP screen sequences and the not appropriate integration of the vacancy reference number (VRN) in the SAP data model. This team conducted

a comprehensive literature analysis in order to comprehend the recruitment process thoroughly. They also conducted an analysis of the recruitment processes of the top ten companies in Australia. The team's final recommendation was to implement on-line recruitment and modify the SAP tables and screens. Detailed suggestions for the modification of the related cardinalities in the SAP data model were developed. The team analysed the feasibility of an Employee Self Service (ESS) solution as a long-term option. Moreover, material was provided that proved the negative effect of existing governmental constraints on the overall recruitment process.

Leave Request

The scope of the leave request team included two key tasks: the integration of the current leave request process and the identification of possible improvements and the critical analysis of the leave request workflow specification proposed by DNR. The team identified the following weaknesses; increased time delays due to the paper-based sub-processes, increased resource intensiveness as administrative overhead, and a 'late' use of available resources as only the process results were logged into the SAP system. Their overall recommendation was to change the design of the process, automate and implement ESS software and introduce risk management. This team utilised three key methods to identify their solution. They conducted literature reviews and gathered cost-benefit analysis and benchmarking information from the Hunter Group. They also interviewed reference customers of targeted ESS solutions and finally analysed and compared the functionality of ESS solutions specifically in SAP, PayConnect and Edify.

BENEFITS OF THE SUBJECT DESIGN

Past project evaluations show that most ES implementations and development projects do not reach defined project goals in time and within the calculated budgets (Bingi et al 1999; Holland et al. 1999; Murphy and Staples 1998; Scott 1999b; Sumner 1998). A number of tools and methods, such as process management, have been developed to overcome these issues. These tools and techniques, however, address only one side of the coin. In reality, often 'soft issues' such as organisational culture and communication form the most critical barrier to the project success (Victor et al. 1999).

The overall design of this subject enabled the students to apply the theoretical concepts of Process Engineering and Enterprise Systems in a real life context. The students developed presentation, interviewing and teamwork skills. They gained practical consultancy experience in addressing organisational issues, generating ideas and providing evidence to justify their recommendations. These skills assist the students' capacity to comprehend complex ES projects and to manage them efficiently.

In order to receive structured feedback from all participants, a questionnaire was developed and distributed to the students in the last two weeks of the semester. In analogy to the Delphi method, this survey took place in more than one round. In the initial round the participants were asked to answer the following questions:

- Describe the critical success factors of the project.
- List and describe the skills you learnt.
- What is the main difference of this subject in comparison to other subjects?
- List the perceived weaknesses of the project.

- What suggestions do you have for further improving this subject?
- How efficient did you perceive the teamwork? Do you think that CS Agency would implement these ideas?

The answers were consolidated and ranked in the second round (one week later). All participants were asked to comment on this ranking. This approach was used to produce a consolidated opinion. The main output of this study is described in Table 3, which depicts the top five issues of five key questions (n/x; where n = number of responses, and x = weighting, which ranges from 1 (least important) to 5 (most important)).

Key Issues	***Rating***
Q.1. Describe the critical success factors of the project	
▪ Team members' involvement (7/5, 6/4, 8/3, 7/2, 1/1)	98
▪ CS Agency members' involvement (5/5, 6/4, 3/3, 5/2, 0/1)	68
▪ Clearly defined project goals (2/5, 4/4, 4/3, 2/2, 1/1)	43
▪ Prior knowledge (on the processes, modelling and the ERP software) (2/5, 0/4, 1/3, 1/2, 2/1)	17
▪ Availability of information (0/5, 0/4, 0/3, 1/2, 12/1)	14
Q.2. List and describe the skills you learnt	
▪ Hands-on experience (10/5, 8/4, 5/3, 0/2, 0/1)	97
▪ Consultancy skills (4/5, 1/4, 8/3, 2/2, 2/1)	54
▪ Integration of theory and practice (1/5, 4/4, 2/3, 6/2, 7/1)	46
▪ Teamwork (1/5, 2/4, 1/3, 6/2, 7/1)	35
▪ Improved modelling skills (0/5, 1/4, 0/3, 2/2, 0/1)	8
Q.3. What is the main difference of this subject in comparison to other subjects?	
▪ Hands-on experience to real life issues (8/5, 7/4, 5/3, 2/2, 0/1)	87
▪ Increased interactivity (3/5, 2/4, 5/3, 6/2, 0/1)	50
▪ Highly based on individual motivation (3/5, 5/4, 2/3, 1/2, 5/1)	48
▪ Unstructured objectives (1/5, 2/4, 3/3, 6/2, 8/1)	42
▪ Higher workloads (1/5, 0/4, 1/3, 1/2, 3/1)	13
Q.4. List the perceived weaknesses of the project	
▪ Limited time frame (2/5, 8/4, 7/3, 6/2, 0/1)	75
▪ Difficulty to gather information (6/5, 4/4, 5/3, 6/2, 1/1)	74
▪ Possibility of scope creep (4/5, 3/4, 3/3, 4/2, 3/1)	52
▪ Lack of knowledge on the organisational constraints (2/5, 0/4, 1/3, 0/2, 8/1)	21
▪ Loosely defined goals (2/5, 1/4, 0/3, 0/2, 4/1)	18
Q.5. What suggestions do you have for further improving this subject?	
▪ Increase the involvement of external collaborators (3/5, 7/4, 8/3, 0/2, 0/1)	67
▪ Extend the project (4/5, 3/4, 3/3, 8/2, 7/1)	64
▪ Moderate on a higher level (5/5, 3/4, 2/3, 3/2, 3/1)	52
▪ Provide the knowledge on "soft" consultancy skills at an earlier stage of the project (2/5, 1/4, 1/3, 5/2, 6/1)	33
▪ Develop a method to improve team participation (2/5, 2/4, 2/3, 0/2, 0/1)	24

Table 3: Students' feedback

Twelve students (75 %) stated that they enjoyed the teamwork effort, and ten of these (63 %) stated that they would like to continue working with the same team. The average workload per student was 15 hours weekly. Eleven students (69 %) stated that they believed CS Agency would implement (at least partially) the process improvement recommendations they provided.

The outcome of this study shows similar results to major ES success research. Issues mentioned in these studies (Bingi et al. 1999; Holland et al 1999; Murphy and Staples 1998; Scott 1999b; Sumner 1998) are typically project management, knowledge management, top management

commitment. These factors are similar to the students' feedback on the critical success factors of this project (i.e. time management, teamwork, scope and goal identification; availability of information and relevant knowledge; and top management support - CS Agency's and supervisor's involvement).

CONCLUSION AND FURTHER DEVELOPMENTS

This paper presented an industry-oriented way of teaching Enterprise Systems with a focus on organisational issues and project management. Overall, this collaborative approach has been a successful attempt to maximise the synergy between the teaching and industry requirements of ES-related issues and Process Engineering. All students were highly motivated and enthusiastic in participating in this novel theory-practical binding project. They enjoyed the teamwork, supervision and the input from the involved industry parties. The experiences in all four project teams are currently consolidated in ES-related teaching cases, so that, the ES-related teaching and learning experiences obtained from this initiative will be documented and can be reused by other institutions. This subject has potential to develop further, enabling the students to configure and customise implemented Enterprise Systems in order to accommodate the process improvements they have suggested. Furthermore, the project can be extended to collaborate with other universities conducting similar courses (Rosemann, Scott, Watson 2000) and other industries, thus enabling the students to share and generate Process Engineering concepts from multiple perspectives.

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