

# Applying Domain Analysis to the Investigation of Web-Enabled Human Resource Projects

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## Abstract

*Designing a successful web project requires understanding not only of its owner's business and technological needs, as well as having the substantial management and development experience, but it also depends on a thorough knowledge of the system's application domain and of other existing systems in the domain. In order to gather such domain knowledge, it is necessary to identify the nature of the proposed web services venture with regards to other similar services offered in the domain, the business setting of enterprises that initiate such ventures, the various types of customers involved, and how these factors translate into requirements. In this paper, we present an approach to studying the domain of web-enabled Human Resource and payroll services with the aim of attaining design knowledge that would ensure customer satisfaction and could eventually pave the way to the successful implementation of web-enabled services.*

## Keywords

Domain Analysis, stakeholders, web-based information systems, web services.

## INTRODUCTION

In any web-based information system (WBIS) venture, the interaction between business partners is facilitated by a software-intensive system that serves as a shared repository of products and services, a communication medium and a common workspace. The effectiveness of such a system is a key determinant of e-business venture success (Carter, 2002). A well-designed e-business system could potentially give competitive advantage to the initiator of the venture by increasing sales and expanding the customer base, while reducing costs (Rayport & Jaworski, 2001). Gaining the competitive advantage, however, cannot be achieved simply by applying good design guidelines, but rather it has to be grounded in thorough knowledge of practices, products and services offered in a given application domain. In this paper we investigate methods of gaining domain knowledge of stakeholders, their requirements and concerns, as well as the knowledge of domain services. In the subsequent sections, we discuss the main concepts of stakeholder and domain analysis, which we also illustrate with examples drawn from the field of outsourced payroll and Human Resource (HR) services.

## STAKEHOLDER ANALYSIS

Within an organization, a stakeholder is any group or individual who can affect or is affected by the accomplishment of organizational goals (Freeman, 1984). As WBIS transcend the boundaries and are beyond the control of a single department or even an enterprise, the degree of complexity inherent in these systems is much higher than in systems used within a single organizational unit. One of the prime aspects contributing to this complexity is the presence of a heterogeneous set of multiple stakeholders. Sharp and colleagues (Sharp, Finkelstein, & Galal, 1999) have used the term "baseline" stakeholders to imply individuals or groups who are *directly* involved or interact with the information system, and have included users, developers, and decision-makers or initiators as belonging to this category. In this paper, the concept of "baseline" stakeholders has been adopted to refer to stakeholders

## DOMAIN ANALYSIS

A domain could be defined as a set of functional areas within relevant systems that have similar functions (Kean, 1997). A "domain" could also be considered a problem area or a class of problems, in which case it could be referred to as a "problem domain" (Arango & Prieto-Diaz, 1987). Arango and Prieto-Diaz (1987) introduce the notion of a "community" providing definitions of a domain based on a combination of technical, social, and

economic factors. The significant aspect of domain analysis lies in its being a key to software reuse (Neighbors, 1984). Basically, domain analysis is the systematic study of a domain with the purpose of developing software components for reuse. One of the most comprehensive definitions of DA is by Prieto-Diaz (1990) who explains the purpose of domain analysis as "a process by which information used in developing software systems is identified, captured, and organized with the purpose of making it reusable when creating new systems." In domain analysis, the commonalities and variability in a representative sample of systems in the domain are identified, accumulated, and then described into a formal representation, which forms the basis of reuse in the development of similar systems in the future. Prieto-Diaz relates this to a knowledge base for the domain, in view of the fact that domain analysis involves in-depth study of existing systems. There are numerous methods to conducting domain analysis. One of such methods creates a "features model", a domain model in which the commonalities and differences between the systems in the domain are captured, and represented as generic domain artefacts (Kang, Cohen, Hess, & Peterson, 1990; Kang et al., 1998). A feature basically relates to a particular functionality included as part of the application. While most domain analysis methods have focussed on more downstream aspects, such as software architecture, design deliberations, and code components, the earliest life-cycle artifacts, such as human skills and expertise, developmental experience in dealing with stakeholder issues and informal requirements are still largely unexplored, fuzzy and ill defined (Cybulski, 2001). Thus, the application of domain analysis to the experience of project teams involved with the diffusion of web-enabled HR and payroll services is the subject of investigation.

## THE EMPIRICAL DOMAIN

We applied the principles of domain analysis and stakeholder analysis to our investigation of web-enabled HR and payroll projects. Some of the projects were initiated by HR divisions within organizations for rendering services to personnel, while the others were adopted to provide payroll services to clients through the web. Despite the different business settings, projects in both types of organizations were undertaken in order to meet the strategic goals of overhead reduction, efficiency, and improving the quality of services. The domain was selected on the basis of its novelty and importance in Australia at the time the empirical studies were begun (Nixon, 2003), and the fact that it dealt with very critical business processes and involved a diverse base of users who were outside the influence of the HR divisions and payroll companies (Lapointe, 1997). Like all other WBIS, the solutions in this domain are developed using an incremental and evolutionary approach, where a requirements prototype is first launched for beta testing and then fine-tuned in accordance with the feedback received from stakeholders (Earl & Khan, 2001; Fraternali, 1999; Stevens & Timbrell, 2002).

Having selected the domain, we set out to investigate the kind of developmental experience we were interested in for the purpose of conducting domain analysis, which was the experience of project teams in dealing with the concerns of the user-stakeholders, namely clients of payroll companies, and supervisors and employees within organizations. This led us to selecting a multiple-case study (Benbasat, Goldstein, & Mead, 1987; Cavaye, 1996; Darke, Shanks, & Broadbent, 1998; Yin, 1994) as a tool to investigate HR domain spanning five projects undertaken in Melbourne, Australia. Over the period of one year, a series of in-depth interviews were conducted with web project teams within payroll companies and HR divisions within organizations. This was supplemented by the investigation of audiovisual materials, such as demonstration software and presentations. Although our interviews revealed many types of intra- and inter-organizational processes and the details of transactions between various business participants, in our work, we focused attention on the user/project team interaction, which are the sources of greatest concerns to the majority of payroll providers and HR divisions (that we have studied). The research design and methodology adopted for the study was a qualitative approach and based on an *interpretivist* perspective (Klein & Myers, 1999; Walsham, 1993) with the elements of *phenomenological* analysis of the empirical data (Moreno Jr., 1999; Moustakas, 1994).

However, for the purposes of triangulation, it was imperative to initiate two measures, one of which was to conduct follow-up interviews with some of the interview participants. The second measure to enforce triangulation of data was to simulate a problem-solving environment where the participants were provided the findings of the case studies, reflecting the experience of project teams in dealing with stakeholder concerns, as a mandatory assistance tool. Since, the interest was in validating the findings and understanding their perceived usefulness by the participants and the interactions taking place among them in their problem-solving tasks, quantitative methods are inappropriate as they are unable to account for interaction effects in social settings (Cronbach, 1975). Thus, the emphasis is on how the *domain experience* reflected the experience of project teams, not included as part of the case studies, and to evaluate its usefulness in problem solving.

## RESULTS OF THE DOMAIN ANALYSIS

The domain analysis process was begun with a pilot study of six web-enabled HR and payroll solutions. Of these, three were web-based employee support services adopted within universities, while the other three were

used as a medium through which outsourced payroll companies provided services to their clients. The sources of data included online demonstrations and policy manuals obtained from the organization websites as well as informal communication with web coordinators and Help desk staff via email. The selection of the pilot cases took place on the basis of convenience and access (through the Internet), as the study was at a preliminary stage at the time, and thus, the theoretical framework and research design were still undergoing evolution (Yin, 1994). The pilot case studies enabled us to categorize the prime features inherent in web-enabled HR and payroll solutions, and have been illustrated in Figure 1.

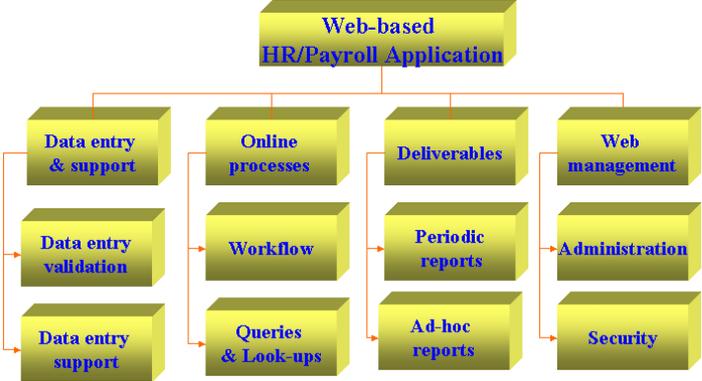


Figure 1. Hierarchy of Domain Concerns

This domain structure provided the relevant themes for the actual case studies conducted subsequently with the five web-enabled HR and payroll projects in Melbourne. From the in-depth interviews and the other sources of data, we were able to develop an understanding of the experience of the project teams in dealing with stakeholder concerns over the features illustrated in Figure 1. We define a *stakeholder concern* to be an issue voiced by a particular stakeholder with regards to some aspect of the proposed information system, which impacts the stakeholder’s involvement in this system and which when addressed will determine selection of the system requirements (Sarkar & Cybulski, 2002a; Sarkar & Cybulski, 2002b)

Evidence from the five separate projects revealed a number of concerns pertaining to each feature (see Table 1). The projects O1 to O3 were implemented as employee support services, also known as ESS, within organizations, while O4 and O5 were initiated by outsourced payroll companies to provide services to their clients via a web medium. Upon cross case analysis, we found out that the majority of the concerns had been confronted in all the five cases, which we refer to as the *commonalities* of concerns. However, some concerns had been voiced by stakeholders in some project but not in others, known as *variations*. The commonalities and variations, with respect to each of the prime features, have been discussed in the following paragraphs. For the sake of brevity, only a few of the key concerns have been stated in the tables and discussed. Each section also comes with a diagram that indicates the system requirements that were selected by the project teams from an *informal experience base* to alleviate these concerns.

<b>Data Entry Validation &amp; Support</b>	<b>O1</b>	<b>O2</b>	<b>O3</b>	<b>O4</b>	<b>O5</b>
1. Data integrity and accuracy of information.	Yes	Yes	Yes	Yes	Yes
2. Increasing technical support and training to the user community.	Yes	Yes	Yes	Yes	Yes
3. Minimization of data entry.	Yes	Yes	Yes	Yes	Yes
4. Knowing whether the data onto the web-based forms are correct and accurate.	Yes	Yes	Yes	Yes	Yes

Table 1. Data Entry Validation and Support concerns

## Data Entry Validation & Support

Table 1 contain a list of concerns and their existence in the five projects. From the table, it can be seen that all the concerns related to the entry and validation of data, and user support, were apparent in all the five projects, regardless of the organizational setting in which the projects were implemented. In fact, one can state that these concerns can be voiced with stakeholders involved with any kind of WBIS, such as student information systems, or Internet banking services. Thus, no variations in concerns were discovered across the applications when it came to this feature.

The case studies also revealed the actions taken by the project teams to alleviate the concerns. These actions were primarily in the form of system requirements that were inculcated after a review of the concerns gathered at the end of each evolutionary iteration of the web system. Figure 2 shows the system requirements that were selected to address these concerns. What was significant was the fact that these solutions were identical across all the five projects.

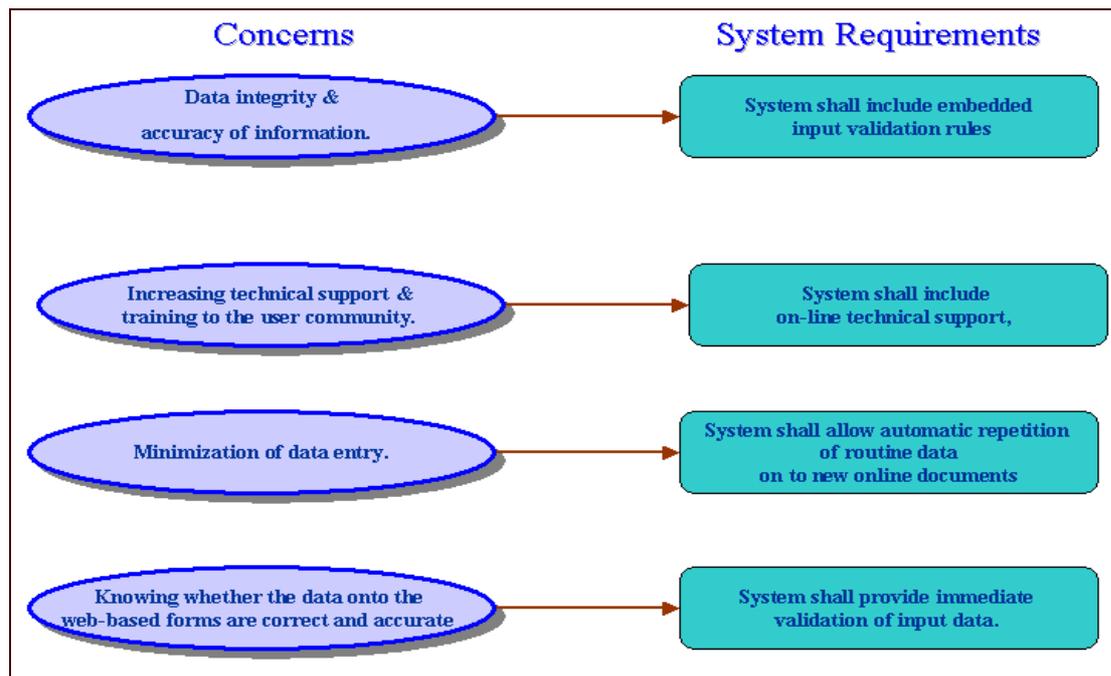


Figure 2. Requirements for Data Entry Validation and Support

## Workflow

Users undoubtedly hold concerns over the workflows associated with timesheet and leave applications, except that variations were discovered across the projects. One such variation is the first concern in Table 2 where supervisors, a prime stakeholder group, expect the documents arranged in their web profiles in the same manner as they are done on their desks, i.e. one tray for leave applications, one for timesheets, and another for purchase orders. While this was a concern in university projects (O1, O2, and O3), it was not found in O4 and O5, which were projects undertaken to introduce services via the web by payroll companies. In universities, one of the aims for the diffusion of web-enabled HR services was the automation of routine work processes. Timesheets and leave applications, which used to be submitted by means of paper-based forms by employees and stacked on the respective trays, now have to be checked and approved or rejected online. Thus, supervisors voiced their concern about the organization of the documents in their web profiles. This was also in line with the general web enabling of all the relevant work processes, such as approval of purchase orders, meetings, and seminars.

However, in the case of web-enabled services offered by outsourced payroll companies, clients would themselves or through their administrative assistants enter the already pay data onto web-based timesheets and submit them to the payroll companies. Thus, they would login to the payroll website only when they needed to do payroll work, which was why they did not express such a concern.

<b>Workflow</b>	<b>O1</b>	<b>O2</b>	<b>O3</b>	<b>O4</b>	<b>O5</b>
1. Supervisors expect the web system to organize documents awaiting approval in the same way that's done on their desks.	Yes	Yes	Yes	No	No
2. Users prefer to see a list of applications that have been approved, disapproved, or need attending to.	Yes	Yes	Yes	No	No
3. Users expect transparency of the process in a web environment.	Yes	Yes	Yes	Yes	Yes
4. Users may be late or forget to submit documents on time.	Yes	Yes	Yes	Yes	Yes

Table 2. Workflow concerns

The same situation applied to the second workflow concern. Only in projects that involved the adoption of web technology in HR workflows did users, namely supervisors and employees, have concerns about being able to view a list of documents and their status in the workflow, i.e. approved, rejected, or pending. Employees need to know the status of their timesheets and leave applications. Likewise, supervisors are keen on being able to login to the WBIS at a later date and find out the documents that they had approved or rejected in the recent past, as well as attend to those pending upon their decision. On the other hand, in the case of clients whose interactions with the payroll provider were through the web, this was not an issue as the former only submitted documents that they had already approved. Besides, in both O4 and O5, the individual employees in the client firms were not involved or not given access to the WBIS.

Despite the variations, commonalities in concerns over the workflows were present. Stakeholders in all the five projects expected transparency in the workflows. In organizations where administrative tasks are carried out through the Intranet-supported WBIS, supervisors expect to gather a full account of the status of documents they have made decisions on and submitted to HR. Similarly, employees expect to find out through the employee kiosk whether their timesheets have been approved, and pay slips published. In fact, in the case of O1, O2, and O3, this concern was related to the previous ones. This concern regarding transparency was also evident in the projects initiated by outsourced payroll companies. Indeed, clients expressed concern about “what will happen” one they submitted all their employee timesheets to the payroll companies via the web.

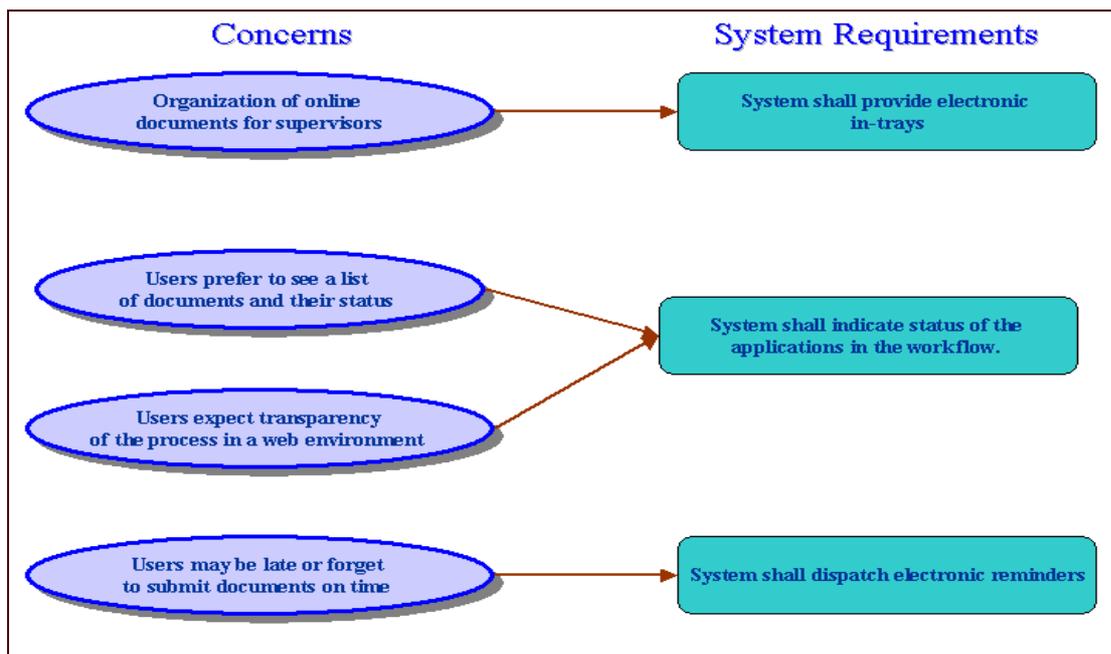


Figure 3. Workflow Requirements

The fourth concern about users forgetting or being late in submitting relevant web-based documents on time is more an issue with the project initiator, i.e. HR divisions and payroll companies. Late submissions mean late processing of the documents, thereby delaying final outcomes, such as the granting of leave to employees or payment of wages, a matter that will, in turn, cause concern for employees.

The first workflow concern, from Table 2, regarding the organization of documents in the supervisory web environment, arose in projects O1, O2, and O3, and was addressed by the requirement statement “system shall provide electronic in-trays” as illustrated in Figure 3. This requirement appeared as a feature in all the three applications. Workflow concerns related to the status of documents in the web pipeline and transparency were both addressed by the requirement that included status indicators for each document in the pipeline, in the cases of O1, O2, and O3. Even though the second concern was non-existent in O4 and O5, the web teams set the same requirement to alleviate the concern of transparency in the workflows. The fourth concern was present in all five projects, and was thus dealt with by implementing electronic reminders, which were dispatched to the relevant users a few days prior to the pre-determined due date for submission of timesheets and leave applications.

**Deliverables**

When it comes to deliverables, HR divisions and payroll companies expect to gain cost savings as a result of adopting WBIS, as reports and pay slips no longer need to be printed on paper and mailed out to clients, supervisors, and employees (see Table 3). Rather, all reports and outputs are made available on the web for the users to peruse, as indicated in Figure 4. However, organizations that have adopted such services to cater to their employees don’t need to attach a price to the kinds of reports published online, but this is an issue that concerns the providers of outsourced payroll services and their clients. The outsourced payroll providers promoted the web services by offering incentives such as certain cost savings for the clients. Since, the payroll companies don’t have to spend money on paper work and dispatching the deliverables by courier services or postal mail, the clients will expect the savings to be transferred to them as well.

<b>Deliverables</b>	<b>O1</b>	<b>O2</b>	<b>O3</b>	<b>O4</b>	<b>O5</b>
1. Cost savings owing to the WBIS	Yes	Yes	Yes	Yes	Yes
2. Fee placed on ad-hoc and additional reports	No	No	No	Yes	Yes

Table 3. Deliverable concerns

However, clients often request ad-hoc and additional reports, which incurs a charge even if the payroll companies put these on the web. In other words, there is a cost involved with processing the reports and publishing them. However, our investigation of O4 and O5 brought to light the fact that clients were not willing pay extra charges for using the web services, in line with the promotional programs undertaken to motivate them. To alleviate this concern, the payroll companies put up a report template on the web that enabled the clients to choose the field they wanted and customize the format of the routine reports, thereby eliminating the need to order additional reports. This is shown in Figure 4, as the requirement statement “provide customisable reports on the web”.

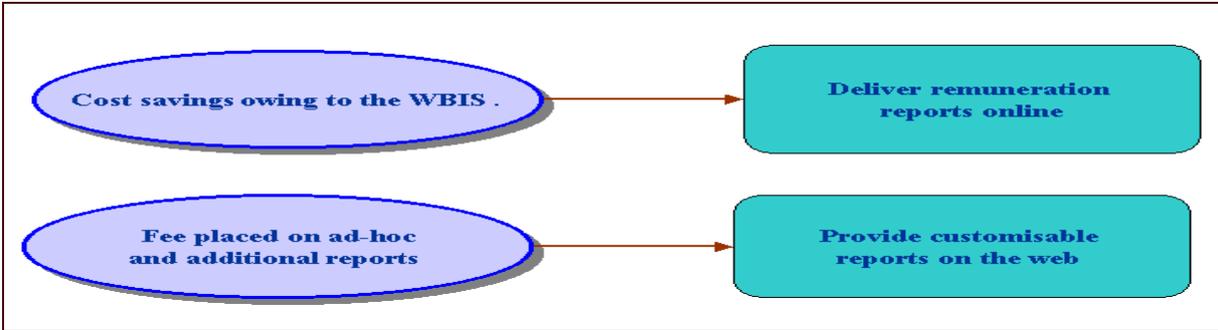


Figure 4. Requirements for Deliverables

## The Implications

Having analysed these commonalities and variations in concerns and resultant system requirements across projects in the web-based HR and payroll domain, we were better able to understand possible relationships between concerns voiced by stakeholders and the requirements of the deployed systems in the domain. This is especially significant in light of the fact that WBIS are multifunctional systems involving a very broad and diverse base of stakeholders (Carstensen & Vogelsang, 2001; Isakowitz, Bieber, & Vitale, 1998; Sarkar & Cybulski, 2002b), and thus pose challenges to the deployment of web-enabled HR and payroll services. Added to this complexity are the incremental nature of web applications, thereby necessitating frequent iterations of the modification and updating of system features (Carstensen & Vogelsang, 2001; Ginige, 1998; Siau, 1998; Standing, 2001). This can prove to be a costly endeavour if project teams need to constantly upgrade the system to cater to concerns not anticipated before, as was the case, in varying degrees, in the projects that we investigated. In this regard, (Ginige, 1998; Standing, 2001) argue that the development of WBIS can be improved by “learning from experience”. Thus, domain analysis, applied to web-enabled services, can establish a mechanism for formalizing this learning. The variations in the concerns also provided us with an understanding of how different business settings (HR division within an enterprise vs. outsourced payroll company), and differing stakeholder relationships (supervisor, employee, and HR vs. payroll and client) can bring about different issues.

Our cross-case analysis of the five projects involving the diffusion of web-enabled payroll and HR services enabled us to induce that most of the concerns, voiced by the baseline stakeholders, and the system requirements selected to reduce the effects of these concerns can be generalized. Hence, our investigation can be used as a learning tool for new project teams working on the implementation of such services. In fact, this is exactly what we did to evaluate the “perceived” usefulness of our findings with a group of web developers in an organization that was not part of the case studies.

We presented our findings, packaged as *requirement patterns* (Alexander, 1979; Coplien, 2000; Fowler, 1997; Sarkar & Cybulski, 2002c), to a team of five developers who were involved with the further roll over of web-enabled HR services within the organization, and asked them to solve a case study, designed by us with advice of expert practitioners. The team was asked to identify the major problems in the case, and suggest solutions on the basis of the patterns. The exercise was designed to simulate a problem solving session that web design teams frequently engage in to figure out solutions to project problems, and discussion among the participants was strongly encouraged. One of the authors was involved in directly observing the group as set about to solve the case problem. The exercise confirmed the usefulness of the domain experience, as perceived by the team in their problem-solving task. Moreover, they validated the fact that the issues discussed in the case study findings did indeed reflect their own experience with the project they were working on. This qualitatively indicates that domain analysis of web-enabled services, such as HR and payroll, can produce outcomes, which can be used as learning and problem-solving tools by web project teams.

## CONCLUSIONS

Our empirical work in the domain of electronic HR and payroll services in Melbourne provided us with an in-depth understanding of the relationship between the concerns of the stakeholders involved, namely the clients, supervisors and employees, and HR/payroll, and the consequent selection of system requirements. From this relationship, we were able to establish the emergence of common concerns system requirements and the variation in the user needs. Furthermore, the characteristics of stakeholders and the factors surrounding their work environment explained the reasons behind their concerns. The inclusion of requirements as a result of the consideration of relevant stakeholder concerns can lead to the design and development of applications that are able to engender customer satisfaction and secure expansion of the client base. This indicates that domain knowledge can enable an enterprise to foster synergistic relationships with its customers through the e-business system, and thus, bring forth competitive advantages. Moreover, such knowledge could support development of industry-specific web-enabled service models based on distinct domain characteristics (Magal, Feng, & Essex, 2001). Therefore, our approach, presented in this paper, can serve as learning tool for researchers and practitioners alike, and contribute to the development of domain-specific e-business application models.

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