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Authors:
Pradipta K. Sarkar
Jacob L. Cybulski

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Pradipta K. Sarkar

School of Information Systems
Faculty of Business and Law
Deakin University
221 Burwood Highway
Burwood, Vic 3125, Australia
Email: pks1@deakin.edu.au

Jacob L. Cybulski

School of Information Systems
Faculty of Business and Law
Deakin University
221 Burwood Highway
Burwood, Vic 3125, Australia
Email: jlcybuls@deakin.edu.au

Abstract

Designing a successful e-business system 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 e-business venture with regards to other products and services offered in the domain, the objectives 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 e-business *domains* with the aim of attaining design knowledge that would ensure customer satisfaction and could eventually pave the way to the successful implementation of e-business. We define the term *domain* as with a particular area of e-business, such as web-based payroll processing, electronic procurement, or online banking.

1. Introduction

In any electronic business (e-business) 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 and 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 products, product lines and services. In the subsequent sections, we discuss the main concepts of stakeholder and product line analysis, which we also illustrate with examples drawn from an e-business domain that we have investigated (web-enabled payroll 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). Thus, considering a single organisation, customers, managers, employees and shareholders are examples of intra-organisational stakeholders. As e-business systems transcend the boundaries and are beyond the control of a single enterprise, the degree of complexity inherent in these systems is much higher than in intra-organizational systems. One of the prime aspects contributing to this complexity is the presence of a heterogeneous set of multiple stakeholders. In the context of an e-business system, stakeholders are affected by the development and implementation of *inter-organizational systems* or *IOS* (Pouloudi and Whitley 1997). While the most apparent stakeholders in an IOS include sponsors and adopters (Webster 1995), stakeholders can include the actual system developers, telecommunications companies, financiers, industry associations, regulatory agencies (both national, and international), and trade unions. As the different perspectives of these stakeholders have an effect on the development and implementation of the IOS, the identification and analyses of their viewpoints is important. According to Pouloudi and Whitley (1997), the process of identifying and analyzing stakeholders in IOS is undertaken in light of the specific context, or the domain(s) in which the inter-organizational network is set, and is

iterative, as the identification of a stakeholder may lead to the identification of further stakeholders.

Despite acknowledging the importance of studying stakeholders and their concerns as a means of understanding inter-organisational systems, IOS literature in general fails to provide a sound methodology for analyzing stakeholders in light of a particular domain of interest.

Product Line Analysis

Product line analysis is the study of requirements for a product line of software-intensive systems (Clements and Northrop 2001, p 114). A product line, in the context of software-intensive systems, is a set of applications that share a common, managed set of features that satisfy the specific needs of a particular market, and are typically developed from a common set of components, such as user interfaces or code, in some well-prescribed manner (Clements and Northrop 2001). Product line analysis, as well as its sister method of domain analysis (Arango 1994), also takes the notion of stakeholders into account. Examples of product lines include the widely popular Microsoft Office, which comprises of applications that cater to a common group of stakeholders undertaking similar tasks, and share several features and developmental aspects. The primary object of product line analysis is to facilitate reusability in the development of applications. In order to do this, the concept advocates the identification of common features in applications across the product line and the acceptable variations of those features. These features enable the creation of a *product line* for applications.

Product line and domain analysis both target applications developed by either a single enterprise or a group of collaborating organisations in the common application domain. However, to be able to determine the success factors for the newly proposed

e-business, we need to study a line of products and services offered from the competing organisations, that support varying business functions, provide for slightly different stakeholder communities, and which are built by separate groups of developers.

The Proposed Model

In response to the need for studying competing organisations and their products in a common application domain, we decided to combine the elements of stakeholder analysis and product line analysis and to apply them to the development of electronic business systems in the competitive market place. In our method, we focus our attention on those e-business applications, which might be developed by different vendors, but which support interactions in a particular area of e-business, and cater to a common set of stakeholders. Accordingly, our model of domain analysis deals with four prime aspects of relevance to electronic business, namely: the nature of products and services offered, business needs, stakeholders and system requirements.

Nature of products and services offered. The nature of products or services offered is a key determinant of the area a particular electronic business venture belongs to. Thus, all Internet banking applications belong to Internet banking, though this, in itself, may be part of the broader area of online financial services. Similarly, all ventures related to the delivery of flight and rail reservation services via the web will be part of online travel reservation.

Business Needs. We define business needs as the activities and tasks that an organisational entity wishes to be deployed for its use. Business needs are derived from the e-business strategies of the organisation, but are more specific and operational. Moreover, they are closely tied with the products and/or services of the company. Therefore, a business need of an airline company with regards to its online

flight reservation system will be the ability to furnish updated flight information on its website.

Stakeholders. Owing to the heterogeneity inherent in stakeholders involved in an e-business venture, each distinct group of stakeholders will hold different viewpoints and concerns with regards to the business needs associated with an e-business application. In view of this, we adopt the concept of stakeholder *concerns*. A *concern*, in general, can be viewed as a requirement, the compliance with which is critical to the success of the development process and the operation of the future system (Sommerville, Sawyer *et al.* 1996). Concerns, thus, need to be seriously considered before initiating any new software development (Smith 2000). In general, stakeholder concerns impose constraints on system requirements and themselves are treated as obligatory requirements for all systems in a given application domain (Sarkar and Cybulski 2002). In web-based e-business systems, stakeholder concerns are usually related to the systems' accessibility, scalability, reliability, performance, security, and attractiveness of the web presentation (Abolhassani 2000, Li 2000). The majority of such general concerns in e-business systems focus on the system effectiveness in facilitating interactions between participating stakeholders. Of course, the *demographics* play a significant role behind their concerns. Thus, we advocate a study of *who* the stakeholders are, *what* are their concerns with regards to a business need, and *why* they hold such concerns.

System Requirements. System requirements are detailed statements of what a system must do, its behaviour and the properties, and the constraints that the system and its development must satisfy (Sommerville and Sawyer 1992). Therefore, system requirements are formulated after particular business needs pertaining to an e-business

system have been captured and all relevant stakeholder concerns have been considered.

2. The Research Method

We applied the proposed analytic framework to study a particular domain of e-business. In doing so, we adopted the following research method, which is strongly based on the qualitative research techniques, and which included the following research phases.

Selection of an e-business domain

We commenced our research by identifying, analyzing and understanding a suitable e-business domain, selection of which was based on advice received during elite interviews with two independent consultants (Marshall and Rossman 1989). The interviewees suggested web-based payroll systems as potentially of interest to this research. The common “wisdom” of payroll applications is that they are extremely well researched and understood. However, the consultants were of the opinion that the adoption of web technology in the outsourced and in-house payroll services in Australia, drastically shifted the technological base for these systems, altered the range and type of services payroll organizations are now able to provide, and increased their complexity and scale. Such systems also comprise of multiple stakeholders with varied concerns.

Data Collection

We subsequently proceeded with the collection of comprehensive data reflecting the experience of web-based payroll *initiators*¹ in incorporating the concerns of the most significant stakeholders in view of their business needs, and the resultant system requirements that emerged (Creswell 1994, Marshall and Rossman 1989). Over the period of six months, a series of in-depth interviews were conducted with web-based payroll providers, solutions developers, and application service providers (ASPs), referred to as payroll.² This was supplemented by the investigation of audiovisual materials, such as demonstration software and presentations. In accordance with the principles of product-line analysis, we investigated multiple applications in the web-based payroll domain. 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 client / payroll interaction, which are the sources of greatest concerns to the majority of payroll providers (that we have studied).

Analysis and Recording of data

The collected business needs of initiators, and the associated stakeholders' requirements and concerns were then analyzed for their similarities and differences, with a view to identify the domain features. The data was analyzed qualitatively with a view to identify its regularities and patterns (Miles and Huberman 1994), which enabled us to determine the relevant domain features. Some of the features identified

1 Initiators are organizations or organizational units that propose the e-business system to their trading partners or clients (Riggins and Mukhopadhyay 1999).

2 Being independent investigators, we were fortunate to have access to all competitors and their products. This situation may not be possible in other cases when an organisation undertakes development of a new product and would have to assess it against those of its direct competitors.

related to data analysis and validation, data entry support, workflow, query and look-up, system development methodology, security, and web management. Each feature entailed a number of business needs, in relation to which stakeholder concerns and system requirements were uncovered. These formed the basis of the domain knowledge.

Validation and Consolidation

As a side effect, the domain data was also described in terms of domain features and consolidated to allow its cross-domain validation and analysis in the second series of the structured follow-up interviews with payroll and clients. In this regard, the features served as categories under which the respective data could be grouped, analysed and interpreted.

3. Discussion of Findings

The analyzed data and the proposed alignment tables (see Table 1 and Table 2) allowed us to gain some considerable insight into the web-based payroll domain.

Nature of Services

Our findings revealed that in general, unlike traditional payroll applications, the web-based payroll systems have significant inter-organizational complexity, and they directly involve “naïve” stakeholders who have very little knowledge of the payroll process, i.e. employees, supervisors, and members of the payroll’s client firm. This aspect led to issues that we found typical of web-based systems in general. Such issues were also the main factor driving the requirements and design of these payroll applications. Our research also discovered that the main motivator behind the adoption of the web-based applications by payroll providers was to reduce overheads

associated with the entering of data obtained from paper-based documents, such as employee personal data, timesheets, leave requests, etc. By delegating data entry to the “source” (i.e. to the client side), payroll could devote more attention to its core payroll tasks. At the same time, we discovered a whole new area of concerns related to the usage and maintenance of web-based systems, which are dynamic, information and multimedia intensive, and which are based on rapidly changing and fragile technology. Many of these concerns do not exist in the more mature domain of traditional payroll applications. In the following paragraphs, we discuss the steps undertaken to study and understand the domain data.

Stating the Business Needs

Most of the participants explicitly stated the business needs in respect of their web-based payroll projects. Some of these needs, however, were implicit, and had to be independently verified. Examples of the identified business needs include:

- To ensure user friendliness and ease-of-use of web interfaces;
- To minimize unnecessary communication via conventional modes of communication, such as telephone;
- To minimize unnecessary payroll work;
- To ensure confidentiality of client payroll data.

Decomposition of Needs

Business needs, that were too broad, necessitated decomposition into more specific elements, which we termed *business questions*. An organisation using domain knowledge to position its e-business products should ideally split its business needs into constituent questions, thereby enabling fine-grain comparison of its product needs with those of its domain counterparts.

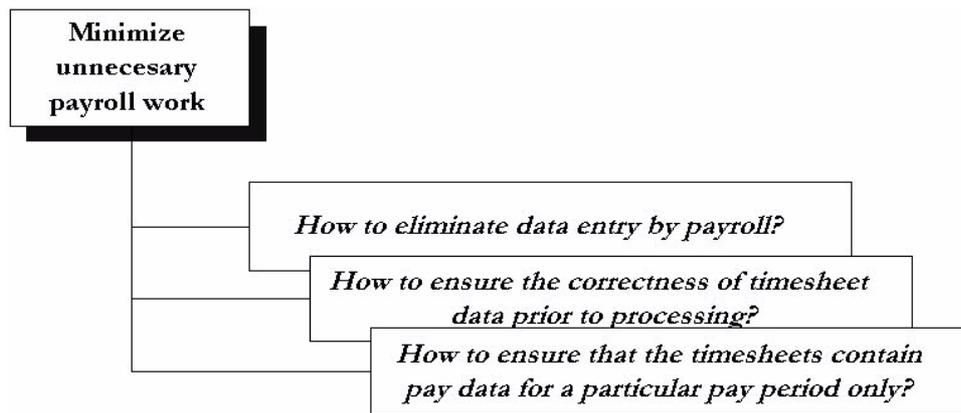


Figure 1: Decomposition of a Business Need into Business Questions

To illustrate the process, which we followed, let's take one of the previously mentioned business needs, e.g. the need to “minimize unnecessary processing work by the payroll organization” (see Figure 1).

Identification of Stakeholder Concerns

Each business question in turn brought into light a number of stakeholder concerns. Of the three business questions identified thus far, we chose the last question, namely “How to ensure that the timesheets contain pay data for a particular period only?” Our three classes of payroll stakeholders, i.e. employees, supervisors and payroll staff, identified the following concerns (see Table 1). First of all, the payroll’s concern was to ensure that, in order to reduce overheads, only the timesheets containing pay data for a particular pay period would be sent for processing and the data related to later pay periods would thus be discarded. Employees were concerned about having insufficient time to enter their working hours on a daily basis or forgetting to do so due to the workload. Therefore, they preferred to plan their daily activities whenever convenient and to enter their hours in advance, even though these would be included in later pay periods. Supervisor concerns were similar to those of payroll, i.e. they did not wish to deal with hours involved with a later pay period.

Table 1. Stakeholder concerns related to a business need

Business Question	“How to ensure that the timesheet sent by an employee contains pay data for a particular pay period only?”	
Stakeholder Concerns		
Payroll	Employee	Supervisor
<ul style="list-style-type: none"> • Data entry at the “source”, i.e. by employees or their supervisors. • Strictly process timesheets containing hours for that pay period only. 	<ul style="list-style-type: none"> • Forgetting or not finding the time to enter hours for the subsequent pay period. In other words, having the ability to enter hours in advance is preferred. 	<ul style="list-style-type: none"> • Data entry by the employees themselves. • Having to deal with hours for a future pay period, which is to be avoided.

The main motivator behind the adoption of the web-based payroll application was the concern by both the supervisor and payroll to reduce their workload associated with filling in the timesheets, and to shift its main activities onto the employees themselves.

The Aligned System Requirements

The common system requirement that materialized in light of the business question and associated stakeholder concerns are stated in the shaded row in Table 2. This requirement does, indeed, satisfy all the relevant concerns. In line with the concerns of the supervisor and payroll, this requirement option ensures that the collection and entry of pay data is done by the employees themselves, and only the hours relevant to the current pay period are sent for approval and processing. At the same time, it complies with the concerns of the employee by enabling advance pay data to be saved into his/her profile in the system.

However, there was a variation to this in a few other applications, where the second requirement in the unshaded row was deemed appropriate. We proceeded to find out the reasons behind this variation in feature despite the commonality in the business questions and stakeholder concerns.

Table 2: The Aligned System Requirements

Question: “How to ensure that the timesheet sent by an employee contains pay data for a particular pay period only?”	<i>The relevant features</i>			
System Requirements:	Data Collection	Data Entry	Data Pre-Verification	User Profiling
The employee should enter the timesheet data, and the application ensures that only pay data for the current period are sent for processing, while advance hours are saved in the user profile	Done by Employee	Done by Employee	Done by Application	Advance hours are automatically saved in the employee’s user profile.
The supervisor should ensure that the timesheets contain no advance hours	Done by Employee	Done by Employee	Done by Supervisor or Authorized personnel.	Employee is not allowed to enter advance hours into the system

The Reasons behind the Variation

The system requirement, “The supervisor should ensure that the timesheets contain no advance hours” was in violation of the supervisor concern of “Data entry by the employees themselves”. Then, how did it emerge as a requirement in some applications? Further probing into the background of stakeholders revealed that one of these applications was being used to offer electronic payroll services to clients, which were small businesses that involved employees whose work was absolutely non-IT or they had no access to a computer system. Thus, the employees were in no position to fill in and submit their timesheets electronically. However, their supervisors were also not keen on entering the timesheets themselves, and thus, delegated this task to an administrative assistant. A similar situation prevailed in another application, deployed in a university environment, where this variation also occurred. In this venture, a number of academics were reluctant to devote sufficient time to filling their own or the teaching assistants’ timesheets on the web. Instead, each academic department employed administrative staff with the task of handling departmental timesheets. On

the other hand, the employee concerns regarding the "advance hours" was found to be of less relevance as timesheet entry was being undertaken by the authorised personnel.

The Implications

Having analyzed these commonalities and variations across applications in the web-based payroll domain enabled us to better understand possible relationships between shared business needs and the requirements of the deployed systems in the domain.

For example, in studied applications that shared the first requirement in Table 2, the employees possessed a minimum familiarity with web systems and had access to Internet facilities, though they were not all IT professionals. Furthermore, these applications involved a larger number of diverse stakeholders. Moreover, due to the large number of employee stakeholders, it may not be entirely feasible to offer rigorous training on the usage of the web-enabled payroll system. Thus, the applications needed to be developed and marketed in such a way that optimal usage should be achieved through a simple and user-friendly graphical user interface (GUIs), relatively straightforward workflow and navigation sequences, multiple user profiles, and comprehensive *Help* facilities included as part of the web content. The initiator of such a venture should ensure these aspects in order to satisfy customer requirements and to potentially gain a competitive advantage in the marketplace. In contrast, the provider of electronic payroll services to clients, who delegated the actual web interactions to authorized personnel, ensured that training was provided to the designated stakeholder(s). In addition, the interfaces had to be designed in such a way that the user was able to enter multiple timesheets with relative ease, and through a minimum sequence of workflow steps. It was also essential to leave other modes of

communications, such as electronic mail, and telephone, open, and to include features, such as online discussions forums, as the client contact had to be nurtured. Therefore, satisfaction of this stakeholder with the application was paramount to gaining customer loyalty and a competitive edge in securing new clients.

4. Conclusions

Our empirical work in the domain of electronic payroll services in Melbourne, Australia, provided us with an in depth understanding of the relationship between the business needs of the payroll providers, and the concerns of the stakeholders involved, namely the clients, supervisors and employees, and payroll itself. From this relationship, we were able to establish the emergence of common 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 reflecting business needs with 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 e-business application models based on distinct domain characteristics (Magal, Fenget *al.*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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