



School Working Papers Series 2002
SWP 2002/09

**Aligning System Requirements with Stakeholder
Concerns: Use of Case Studies and Patterns to
Capture Domain Experience**

Authors:

Pradipta K. Sarkar and Jacob L. Cybulski

Aligning System Requirements with Stakeholder Concerns: Use of Case Studies and Patterns to Capture Domain Experience

Pradipta K. Sarkar and Jacob L. Cybulski

*School of Information Systems
Faculty of Business and Law
Deakin University
Burwood, Vic 3125, Australia
pks1@deakin.edu.au, jlcybuls@deakin.edu.au*

Abstract

Traditionally system development starts with the specification of system requirements. The focus of such an approach is on the *system* under construction, which is considered as of primary importance to the development success. The major problem with such an approach, however, is the neglect of *concerns* held by the various system stakeholders, whose opinions, loyalties and fears may impact considerably the perception and the reception of the implemented system, its functions and its features. Typically, stakeholder concerns are not collected or identified, and are viewed as of little significance in the system development process. In this paper, however, we present the case for recognising the value of stakeholder concerns, and their use in aligning business needs with system requirements. We describe a method of gathering and analysing stakeholder concerns across an application domain, and then packaging the development experience in dealing with these concerns into patterns. Experience patterns can subsequently be used to guide systems analysts in selecting the most appropriate requirements for the target stakeholder community.

1. Introduction

One of the notable concepts in requirements engineering is the concept of *stakeholder analysis* (Sommerville and Sawyer 1992; Sharp, Finkelstein et al. 1999; Smith 2000), which assists analysts in identifying stakeholders, their characteristics and leads to the subsequent elicitation of their requirements. Sommerville and his colleagues (1997) went further to introduce the notion of stakeholder *concerns*. According to these authors, a concern, in

general, can be considered as a requirement, the compliance with which is critical to the success of the development process and the operation of the future system.

*In our work, we define a **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.*

In this context, stakeholder concerns are treated as obligatory requirements that impose constraints on individual system requirements. In view of this, care should be taken to distinguish between concerns and other statements of requirements. Unlike some types of requirements, which can be negotiated and traded-off, concerns are critical in the development of information systems in that their compliance is essential to the satisfaction of stakeholders (Sommerville and Sawyer 1992). Moreover, requirement specifications are statements pertaining to the nature of the proposed information system, while concerns are raised by stakeholders to motivate the development or selection of the alternative requirements specifications. Conflicts are likely to occur in the requirements elicitation process if stakeholder concerns are ignored or not devoted appropriate consideration (Sommerville, Sawyer et al. 1997). On the other hand, if stakeholder concerns are properly communicated and recognised, allowing requirements to be negotiated and selected on the basis of their compliance with stakeholder concerns, dissatisfaction can be reduced, or even eliminated (Easterbrook 1994). By adopting stakeholder concerns at the core of a decision process leading to the final specification of requirements, the chance of developmental conflicts can be significantly reduced (Sarkar and Cybulski 2002a).

We thus suggest, in agreement with the proponents of stakeholder analysis (Smith 2000), that stakeholder concerns need to be seriously considered *before* initiating any new software development.

While researchers such as Sommerville and Sawyer (1992) focus predominantly on concerns pertaining to a single software application, we decided to undertake research to determine whether or not concerns could be generalised across applications belonging to a common problem *domain*. We found out that stakeholder concerns often extend beyond the boundary of a single system and apply to many systems in a given application domain (Sarkar and Cybulski 2002a). At the same time, in spite of striking similarities between domain concerns, we have also identified their many variations, which prompted us to conduct further research, also reported in this paper.

In the following sections, we discuss our approach to using concerns from a specific domain, we show our empirical work in the practical collection, analysis and representation of stakeholder concerns, and we describe our method of concern validation.

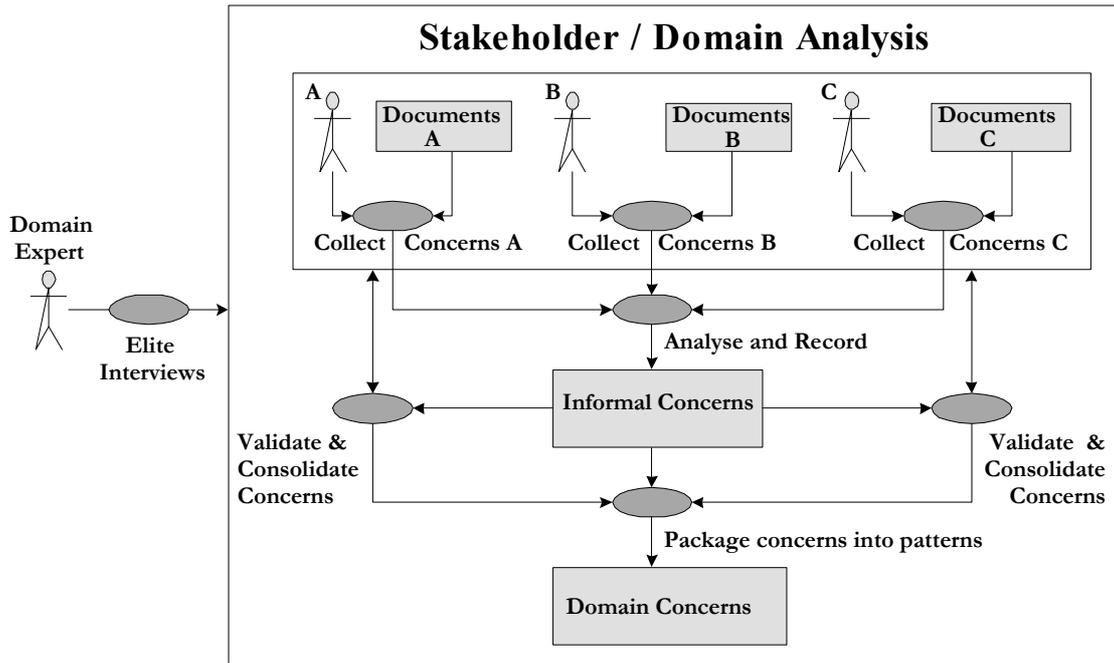


Figure 1: The Method of gathering domain concerns

2. The Method

As our research takes special interest in requirements elicitation across an application domain, it was imperative to ground our work in a comprehensive study of a particular domain. A suitable commercial domain was recommended to us by two independent management consultants during exploratory *elite interviews* (Marshall and Rossman 1989). The consultants suggested web-based Human Resource (HR) and payroll systems as potentially of interest to this research. Although the common “wisdom” of such applications is that they are extremely well researched and understood, it was the consultants’ opinion that 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. The HR domain is also characteristic of systems having multiple stakeholders with conflicting concerns.

Subsequently, we’ve undertaken gathering of stakeholder concerns across the entire HR domain. Figure 1 illustrates this process, indicating stakeholders as stick figures, activities as ellipses, and the output of each activity are represented by rectangular boxes. The exact method steps are presented as follows.

◆ Collection of Concerns

We proceeded with the collection of comprehensive data reflecting the experience of web-based HR/payroll *initiators*¹ and developers in incorporating the concerns of the most

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

significant stakeholders, and the resultant system requirements that emerged (Marshall and Rossman 1989; Creswell 1994). Over the period of one year, a series of in-depth interviews were conducted with web-based payroll providers, solutions developers, and application service providers (ASPs), here referred to summarily as HR/payroll.² This was supplemented by the investigation of audiovisual materials, such as demonstration software and presentations. The multi-case studies enabled us to gather rich data that could be used in establishing domain knowledge of concerns (Yin 1994). In the spirit of domain analysis (Kang, Cohen et al. 1990; Prieto-Diaz 1990; Moore 1991; Arango 1994; Kean 1997), 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 interaction between the clients and HR/payroll, which is the source of greatest concerns to the majority of HR/payroll service providers (that we have studied).

◆ **Analysis and Recording of Concerns**

The collected concerns were then viewed as domain artefacts and analysed for their similarities and differences, which, in accordance with the principles of domain analysis, enables determination of domain features (Arango and Prieto-Diaz 1987; Kang, Cohen et al. 1990; Prieto-Diaz 1990; Arango 1994; Kang, Kim et al. 1998). The data was analysed qualitatively with a view to identify its regularities (Miles and Huberman 1994). Figure 1 shows the collection of relevant data, and its subsequent analyses, from several applications (i.e. A, B, and C). Each application involved either a developer or an initiator stakeholder or both (e.g. A for application A) and a set of documents associated with the application (e.g. Documents A for application A). As a result of this analysis, we produced a large list of informally stated stakeholder concerns.

◆ **Validation and Consolidation**

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

◆ **Packaging Concerns into Patterns**

Finally, a series of structured interviews helped packaging the identified concerns into patterns as per the classification of their features. Such packaging allowed systematic representation, sharing and reuse of experience in dealing with stakeholder concerns among the domain developers. The packaging of concerns was the final step in the method.

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 organization undertakes development of a new product and would have to assess it against those of its direct competitors.

Table 1: Reflection of stakeholder concerns in the application features

System Requirements	Concerns	O1	O2	O3	O4	O5
1. <i>The system shall provide online demonstrations on the web</i>	Limit on the number of training sessions that can be conducted.	Yes	Yes	Yes	Yes	Yes
	Users may not remember all the functions imparted the in training session.	Yes	Yes	Yes	Yes	Yes
	Some actual users may not have attended training sessions.	Yes	Yes	Yes	Yes	Yes
2. <i>The system shall prompt the user with error messages</i>	Users need to be informed of data entry errors.	Yes	Yes	Yes	Yes	Yes
	Limit communication via conventional modes.	Yes	Yes	Yes	Yes	Yes
	Vague error messages can frustrate users.	Yes	Yes	Yes	Yes	Yes
3. <i>The system shall provide online Help and FAQs</i>	Limit communication via conventional modes.	Yes	Yes	Yes	Yes	Yes
	Users may encounter difficulties in the usage of the application.	Yes	Yes	Yes	Yes	Yes
4. <i>The system shall dispatch automated reminders</i>	Employees and supervisors may forget or be late in submitting timesheets.	Yes	Yes	Yes	Yes	Yes
	Informing individual employees and supervisors of late submissions creates unnecessary work.	Yes	Yes	Yes	Yes	Yes
	Limit communication via conventional modes.	Yes	Yes	Yes	Yes	Yes
5. <i>The system shall indicate the status of the workflow</i>	Users expect transparency of the processes in a web environment	Part	Part	Yes	Yes	Yes
	Limit communication via conventional modes.	Yes	Yes	Yes	Yes	Yes
	Employees are concerned about the approval or rejections of their pay data.	Part	Part	Yes	Yes	Yes
6. <i>The system shall allow data entry by employees or clients</i>	Eliminate data entry tasks by HR/payroll.	No	No	Part	Part	Part
7. <i>The system shall enable queries and look-ups</i>	Limit communication via conventional modes	No	No	Part	Yes	Yes

3. Discussion of Findings

Our analysis of the data collected across the HR / payroll domain in Melbourne revealed several system requirements that were common across different web applications and which seem to be driven directly by stakeholder concerns and by their domain features. As expected, not all concerns and features appeared in all applications. Neither did some of the features accommodate all of the associated concerns.

Table 1 illustrates seven most prominent HR / payroll system requirements, as voiced by the interviewed domain stakeholders. Next to each requirement, one or more determinant

concerns have been explicitly stated. The remaining columns indicate the actual consideration of these stakeholder concerns in the five web-enabled HR and payroll applications designated as O1, O2, O3, O4, and O5, where:

- *Yes* means that the concerns were considered,
- *No* implies that the concerns were not considered, and,
- *Part* refers to the partial consideration of the concerns.

3.1 General Observations

The concerns identified in the course of our analysis reveal that in general, unlike traditional HR / payroll applications, their web-based counterparts have significant inter-organizational and inter-departmental complexity, and they directly involve “naïve” stakeholders who have very little knowledge of the HR and payroll processes, e.g. employees, supervisors, or the members of the payroll’s client firm. This aspect led to concerns that we found typical of web-based systems in general. Such concerns were also the main factor driving the requirements and design of these HR / payroll applications.

Our research also discovered that the main motivator behind the adoption of the web-based applications by payroll providers and HR departments 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 HR and payroll applications.

3.2 The Commonalities in Concerns

Table 1 shows that the requirements 1 to 4 incorporated common stakeholder concerns across all domain applications. One of these requirements included the system ability to initiate an online demonstration to guide users through the steps of the payroll process or the workflow. This specification was recognized by developers as of high priority, as difficulties in training end-users were well known - some of the users could not remember many system aspects demonstrated during the session, others did not feel obliged to attend the training sessions.

Developers of all five applications were also receptive to the fact that users might get frustrated if the system rejected their entry of data without a plausible explanation. The project initiators were wary that in such a situation, users would flood them with emails and telephone calls, which would defeat the very purpose of deploying a web-based information system. According to one of the interview participants:

“If the system keeps on rejecting their data or posing difficulties of use, the users will undoubtedly get frustrated. As a result, they might develop aversion towards the usage of

the system. Moreover, we would get bogged down with having to do enormous helpdesk work.”

Another source revealed the same phenomenon:

“It (the web system) just tells you at that time (when the data entry is erroneous). When you submit, it will let you know. It will inform you of the fields that have been entered incorrectly.”

Thus, developers ensured that precise error messages were displayed to inform users of incorrect data entry. These concerns also prompted them to include comprehensive *Help* facilities and FAQs on the website.

Requirements specifications also described automated timesheet reminders, to cater for those users who forget filling in and submitting pay timesheets on time. Manually reminding each user, by phone or in person, although practiced by in general, was viewed as unnecessary payroll work, and late submissions were considered a burden to HR departments and the payroll business.

3.3 The Variation in Concerns

Some of the stakeholder concerns were not actually considered in the enactment of requirements for the applications. Others were inculcated but not enforced. One such requirement (the 7th in Table 1) was related to the issue of enabling users to view their pay and leave history online. The feature was partly implemented in the organisation codenamed O3, i.e. employees could view their leave history, but not their pay records. The developers of the O3 application, in response of the exclusion of the latter, stated:

“This is another thing HR wanted us to do this year (2001), but we did not receive the specifications for this.”

Therefore, even though the concerns were voiced in support of a web-enabled look up of pay records, the initiator, HR, did not include the feature as part of their specification. However, owing to the exclusion of this feature, HR’s concern of limiting queries by conventional modes of communication was not satisfied. It still had to respond to employees through the telephone and in person. In case of O1 and O2, this requirement, though recognized in view of the relevant concerns, was entirely left out in view of their e-business strategies. Both were providers of outsourced payroll services who adopted the web as a medium of interaction with clients. O1 granted web access to the client contact only. Individual employees were not authorized to use the HR software application. However, even the client contact was not able to trigger web queries or look ups. According to O1:

“Well, he’s (the client contact) got a few options. He could ring us, and we’ll tell him. He could fax the query to us, and we’ll respond in writing. Or, he could check his reports

(clients get printed or hard copy reports). Or, he could get soft copies of these reports from the web...he just needs to go to the web and check the reports from there – the information's all there. There's, of course, a charge for each additional report."

O1 treats the end result of each web-based process as a deliverable, and thus subjects a price structure to it in line with its e-business strategy. In fact, it was not entirely concerned with having to respond to client queries via non-web modes of communication. The following statement of O1 clearly explains their web strategy:

"We want to add more value to the services we offer our clients. We also want to add a personal touch to our clients. Our staff should be available to answer client queries, rather than spend time keying in data. Thus, the main objective was to add more value to our services rather than merely reducing the cost of the payroll process."

In contrast, the web application deployed by O3 is part of its IT infrastructure, and is used to support its role in an academic institution. Its aim was not to render payroll services for a fee, as practiced by outsourced payroll providers, but to reduce its own overheads.

"...they (HR) mentioned that employees were keen on knowing about their leave entitlements prior to taking the leave. So, we decided that, on the web-based interface, employees would be able to look at their entitlements. This eliminates their need to ring up HR before filling up their leave form. So, we made that sort of information available on the web."

As access to the web-based services was restricted to the client contact only, O1 and O2 applications did not require the filling of personal data and timesheets by the individual employees. In fact, as far as they were concerned, they only interacted with their client contacts. The issues surrounding employees was considered an internal matter of the client firms. Conversely, the remaining three organizations had adopted the notion of shifting data entry at the "source", and thus, web forms were included in the user interfaces for employees to enter their personal details and leave applications. However, these excluded the provision of online timesheets for individual employees.

Related to the preceding feature, status indicators, showing at what stage of the workflow timesheets or leave applications were at, were fully incorporated in O3, O4, and O5 applications, but only partially in O1 and O2. This was due to individual employees not having access to the applications (thus, no status indicated to them). However, upon submission of all timesheets pertaining to a pay period, email notifications were sent to the client contacts informing of the status of the payroll process. On the other hand, the other three applications, which catered to both supervisors and individual employees in the organizations, provided this information on each user's web profile as well as by dispatching electronic notifications, such as email.

3.4 Representation of Concerns

Since the concerns were derived from our empirical studies of multiple applications in a specific problem domain, they in essence reflected the experiences of project initiators and developers in dealing with stakeholder issues, in other words solving their problems. We considered *patterns* as an effective way of packaging this experience (Buschman, Meunier et al. 1996; Rising 1999). Patterns are commonly regarded as small packages of problem-solving experience useful in dealing with frequently occurring problems in a certain domain of expertise. Patterns have been shown to be particularly effective in enabling expert knowledge to be shared and reused in such applications as architectural design (Alexander 1979), education (Anthony 1996), design of organisational processes (Coplien 1995), software development (Gamma, Helm et al. 1995; Buschman, Meunier et al. 1996; Fowler 1997), web-based interfaces (Sarkar and Cybulski 2002b), and multimedia construction (Bassi, Schwabe et al. 1997; Cybulski and Linden 1998), to name just a few.

Our patterns were formulated according to the most commonly used pattern schema, which consists of the following components (Gamma, Helm et al. 1995, p 3, 6-8):

- *Name* of the pattern;
- A statement of the *problem*, which calls for the application of a pattern or set of patterns to resolve it;
- *Context*, a description of the situation in view of which the problem has arisen;
- A set of *forces*, preventing effective application of certain classes of solutions to the problem at hand;
- The *solution(s)*, which describe(s) how the forces could be resolved in order to come up with the best solution;
- The *consequences* of applying the pattern in terms of the expected results and trade-offs;
- *Known uses*, or real-life situations where the patterns have been successfully applied in some form.

As discussed in the preceding sections, from our analyses of multiple applications in the domain of web-enabled HR/payroll services, we unveiled several commonalities and variations in the concerns of stakeholders. In Table 2, we illustrate a concern that has been cast into a pattern, known as *The Aide Memoire*. The pattern was enriched with data that was gathered and analysed qualitatively as prescribed by our method.

Table 2: A Sample Pattern 1

Pattern Name	<i>The Aide Memoire</i>
Problem	What happens if employees and supervisors forget to submit timesheets or approve leave applications to HR/payroll on the due date?
Context	Timesheets should be sent to payroll for processing prior to the due date of the pay cycle. Likewise, leave applications should be approved and recorded electronically before the employee goes on leave. Otherwise, late submissions, if it becomes routine practice, undoubtedly increases the workload on HR/payroll, and diminishes any productivity gains from a web-based application.
Forces	<ol style="list-style-type: none"> 1. Employees and supervisors may forget or be late in submitting timesheets or leave applications (especially at the earlier phases of implementation of the web-based system). 2. Informing individual employees and supervisors of late submissions creates unnecessary payroll work. 3. Limit communication via conventional modes
Solution	<p>The system shall dispatch automated timesheet reminders</p> <p>To alleviate all relevant stakeholder concerns, an electronic reminder should be dispatched to all the employees and supervisors a few days prior to the actual due date.</p>
Consequences	<ol style="list-style-type: none"> 1. Electronic reminders will ensure that employees and supervisors have been notified of timesheet and other online documents (such as leave applications) submissions on the due date. 2. Electronic reminders may not be effective if employees and supervisors work with computers very rarely.
Known Uses	Most electronic workflow and groupware systems (such as Lotus Notes) are equipped with the electronic messaging feature.

With reference to Table 1, one of the main concerns of all three stakeholders was the fact that an employee or a supervisor may not remember to submit timesheets to HR/payroll on time, which forms the *problem* of the pattern. The context surrounding the problem pointed out that the submission of timesheets on the due date of every cycle was an essential factor in the occurrence of productivity gains from the deployment of a web-enabled system. This is definitely an HR/payroll concern. If HR/payroll are to process late submissions of these documents, then processing work increases, thereby diminishing the productivity gains. One of the forces driving the solution in different directions relates to this phenomenon. However, it is quite probable that some employees may forget to fill in and submit their timesheets on time, especially if they are at the peak of their workload, or are, perhaps, part-time or casual staff. Likewise, supervisors may forget to approve the documents on time owing to their own administrative duties. As one of the aims behind the adoption of web-based information system is to limit communication via conventional modes, such as telephone calls, fax, or

personal interactions, reminding each supervisor by phone or paper-based messages defeats the purpose of such a system. In view of these forces, the solution adopted by the developers of the applications studied was to include a requirement that comprised of the automatic dispatching of electronic reminders to all employees and supervisors prior to the due date. These forces have been listed in Table 1. The consequences are also derived from the concerns of the stakeholders.

In Table 3, we present another pattern, *The Status Indicator*, which is basically a concern of both employees and supervisors with regards to what stage of processing a particular document is in the workflow. This pattern is based on the data (number 5) in Table 1.

In this manner, the identification of stakeholder concerns that can lead to the reuse of requirement specifications. Thus, if the problems and the contexts pertaining to a new application in the domain match with that of the corresponding patterns, we would be in a position to make implicit assumptions about the presence of stakeholder concerns as well as how the solutions of the patterns can be adapted and applied in the new situation. Since, patterns present system developmental experience in a manner that is aimed at reuse, the packaging of the concerns of stakeholders into patterns should assist in the identification of concerns and the selection of a suitable system requirements as solutions. We are of the view that the experiences gained by expert designers with projects can be reused in new projects leading to a significant reduction of stakeholder concerns. In this regard, patterns are considered suitable for sharing and reusing expert knowledge (Buschman, Meunier et al. 1996; Rising 1999).

Moreover, patterns explicitly "capture" developmental experience, facilitate communication of this experience among developers, and are considered an effective learning tool for "non-experienced" developers (Rossi, Schwabe et al. 1997). Thus, this research advocates the use of patterns to capture and represent the experiences of developers and initiators in dealing with concerns.

It should be noted that the Known Uses section of the patterns was not gathered empirically, but from the authors' experience with general applications.

4. Validation of the Patterns

Having drafted the patterns from the data analysed qualitatively, we then proceeded with their validation and consolidation (as depicted in Figure 1). We presented the previously elicited statements of concerns, which formed the various pattern components, to the interviews participants, and we asked them to determine whether the statements in their opinion represented a problem, a situation that complicates the solution to the problem (a force), or a solution to the problem, or the effects of applying the solution (consequences) as well as some insights into the background of the phenomenon. This is in line with our adopted pattern template. Based on the received feedback we were able to consolidate concerns across different interviewees and then to finalize the pattern structure and contents as a valid representation of shared domain concerns. For the sake of brevity, we confine our discussion

Table 3: A Sample Pattern 2

Pattern Name	<i>The Status Indicator</i>
Problem	What is the status of the application process?
Context	Once timesheets and leave applications are filled in and submitted, employees and other pay recipients have not much to do except wait for the actual pay check or leave acceptance. However, there is the period of time involved with the processing of the timesheet, during which the timesheet may be approved, rejected, or withheld by the supervisor or payroll.
Forces	<ol style="list-style-type: none"> 1. Employees and supervisors expect transparency of the process in a web environment. 2. Employees will be concerned with the outcome of the decisions made (approved or rejected) on their timesheets. 3. Likewise, supervisors will be concerned with the processing of the documents, such as timesheets (after these are approved) carried out by HR/payroll. 4. The purpose of a web system is to reduce status queries by more conventional modes of communication.
Solution	<p>The system shall indicate the workflow status</p> <p>It is important to inform both employees and supervisors of the status of the work processes. There should be about four states that indicate status, namely Approved (by supervisor and sent to HR/payroll), Rejected, Waiting (supervisor is yet to review the timesheet or leave application), and On Hold (supervisor has viewed the document but has deferred its approval or rejection). This is a subject for the next pattern, the “In-tray”.</p>
Consequences	<ol style="list-style-type: none"> 1. Indicating the status of the timesheet processing will alleviate the concerns of the employees and supervisors. 2. Timesheet rejections (as shown on the web interface) could cause anxiety. Refer to Obstacle, which comprises of patterns that address this issue.
Known Uses	Courier services provide a tracking feature on their web system, whereby a customer could log in and check the status of the parcel in the itinerary.

of the responses and comments to the follow-up interviews, with regards to the two patterns in Table 2 and Table 3.

The Aide Memoire pattern, in Table 2, was validated by the participants associated with the five web-enabled applications that we studied. One such participant, who was a prominent member of the web team at an outsourced payroll company, clearly indicated the pattern’s problem, its forces and its solution (thus validating them):

“We have programmed the (web-based) system to send email reminders to our clients regarding timesheet submission a few days in advance of the deadline set. This will ensure that they remember to fill in the timesheets and send them to us on time, so that we could process them. We also discourage them to send us the timesheets late as this invariably increases our workload unnecessarily. We attach an additional charge for this.”

A system administrator at an organization that had implemented a web-enabled system as part of its HR initiative, reiterated in the same strain (thus validating the relevant pattern elements):

“The timesheets and leave application will be sitting on their (the supervisors’) in-trays, but not everyone logs into the system like us administrators. So, what we actually done is link their in-trays to the workflow process, so that an email is sent to the supervisors as soon as an employee submits a timesheet or applies for leave. Basically, the emails are reminders that there are things to approve as well as the due dates, which prompts the supervisors to log in and approve the documents on time.”

The other pattern, The Status Indicator, was a generic solution to a genuine concern of stakeholders, as supported by a HR system manager (thus validating the pattern's solution):

“Whenever a supervisor approves or rejects a leave application or timesheet, an email notifications is automatically sent to the employee, stating the decision of the former. This way, the employee is kept informed of the status of the workflow, without having to contact us (HR) personally”.

Yet, another source indicated the same generic solution but using a slightly different communication method (also validating the same pattern's solution):

“Once employees log into the system, they will be able to view the status of their application. The indicator will state Approved or Rejected, Waiting, or On-Hold. This will alleviate their concerns about the status of their applications, and instil their confidence with the workflow processes.”

In the cross-validation stage, all participants agreed that one of the prime objectives of deploying a web-based information system was to reduce the volume of interactions with service recipients via conventional modes of communication. As voiced by one of the interviewees (and validating one of the pattern forces):

“This way (by implementing the web system), staff could have direct access to their data and other related matters without having to ring up someone in HR to check this for them.”

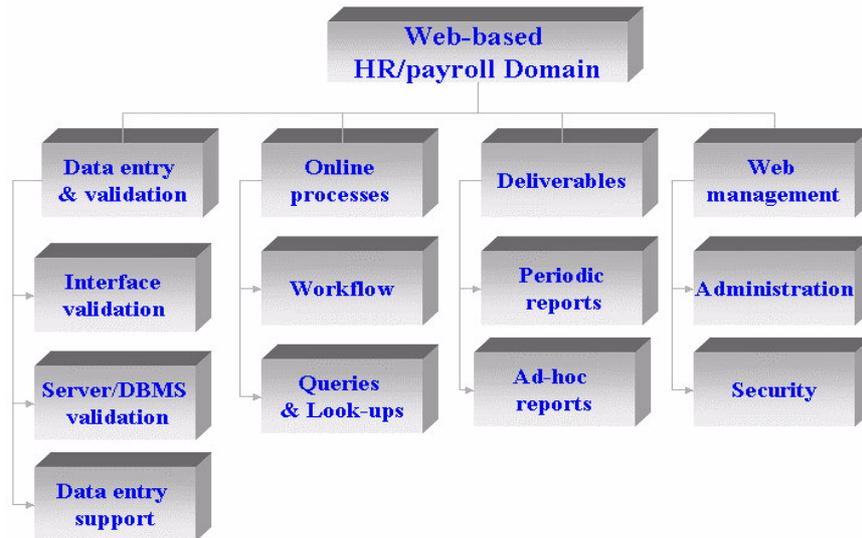


Figure 2: Classification of Domain Concerns

In this way, the consolidation and validation interviews lead to the re-confirmation of all the major components of our 25 patterns, which we have developed for the HR / payroll domain. The patterns have been classified according to the features that emerged during our study of the applications in the domain. The classification scheme is illustrated in Figure 2.

5. Future Work

Further empirical work is being planned toward the evaluation of the method. All of the validated stakeholder concerns have been encoded in a form of patterns (Coplien 1995; Gamma, Helm et al. 1995; Fowler 1997; Rising 1999), which represent the synthesis of shared domain knowledge that can be easily understood and utilized by web-developers to seek solutions to typical HR/payroll problems and to reconcile conflicting stakeholder concerns.

The patterns allowed us to gain insight into the domain of web-enabled HR and payroll services. Although the collected patterns reflect the (validated) beliefs of domain stakeholders, we are of an opinion that our study still necessitates evaluation of the collected patterns by system developers. Such evaluation will provide us with some feedback as to the applicability of the collected concerns, and it will also allow us to improve the patterns' form, contents and their clarity.

Focus groups are therefore planned for the evaluation phase of the research. The patterns will be evaluated with several focus groups, each consisting of a team of developers who have worked on web solution projects. Each group will be presented with the repository of patterns and trained in the usage of the method. The focus group participants will then be asked to explain the relevance of the patterns in their past projects as well as to suggest the pattern

improvements. In this manner, we aim to obtain input from a range of people including practitioners and experts in the field.

6. Summary and Conclusions

This paper proposed a method of aligning stakeholder concerns with reusable system requirements. Concerns are expressed by stakeholders in relation to a particular business need for an information system, and determine the success or failure of a future system, in terms of its users' satisfaction. Thus, concerns need to be carefully considered and incorporated in the process of aligning system requirements with the expressed business needs.

Our method proposes the establishment of a repository of reusable requirements characterized in terms of domain features. The alignment of stakeholder concerns with system requirements relies on the use of patterns, which capture the commonalities and variations of stakeholder concerns across a given application domain. By means of meticulous consideration of the stakeholder concerns, the proposed method reduces stakeholder disagreement due to conflicting concerns, provides a strong basis for negotiation over conflicting requirements, facilitates reuse of requirement specifications, and last but not the least, assists the system design as well.

Requirements engineers are often challenged with the task of communicating user needs and concerns to development teams. Our method is capable of not only supporting downstream communications, but also provides a means of suggesting solutions that addresses the needs associated with an information system. This inherently reduces developmental risks associated with system development. Furthermore, by assisting in the optimal reusability of requirement artefacts, which leads to enhanced reusability at later stages, developers are able to be more competitive in terms of cost and quality. The use of concerns as selection criteria and results of decisions made add to the body of domain knowledge, as patterns emerge and variations occur. The implementation of the method and the lessons learnt can also lead to the discovery of generic concerns, and provide a means of a comparative study of stakeholder issues in related domains.

Our study of the web-based HR/payroll domain revealed concerns which were generic not only to the applications in the domain, but also to other web systems, such as web-based purchasing and procurement solutions.

The consideration of concerns and consequent reduction in organisational conflict is likely to support or ease the resistance to the adoption of new technology in organisations. This is especially important in light of cross-organizational workflow systems and virtual work groups, where there are diverse groups of stakeholders with varying viewpoints, owing to intra- and inter-organizational politics and various cliques are prevalent. In view of this diversity of the stakeholder base associated with web-enabled applications, a whole host of concerns exist and could potentially hinder collaborative work among the various stakeholder groups with regards to the selection of the final pool of system requirements (Sarkar and Cybulski 2002a; Stevens and Timbrell 2002). This is especially prevalent owing to the fact

that requirements for such systems may not have to be established from scratch, but perhaps reused from other existing systems in a given application domain by the developers themselves, rather than discovered by analysts in the normal process of requirements elicitation (Gordijn, Akkermans et al. 2000). The consideration of stakeholder concerns contributes to the understanding and appreciation of the “human” factor in information technology.

References

- Alexander, C. (1979). A timeless way of building. New York, Oxford University Press.
- Anthony, D. L. G. (1996). Patterns for Classroom Education. Pattern Languages of Program Design. N. L. Kerth. Reading, MA, Addison-Wesley Publishing Company. **2**: 391-406.
- Arango, G. (1994). Domain analysis methods. Software Reusability. W. Schafer, R. Prieto-Diaz and M. Matsumoto. London, Ellis Horwood: 17-49.
- Arango, G. and R. Prieto-Diaz (1987). "Domain Analysis Concepts and Research Directions." IEEE Computer Society: 9-34.
- Buschman, F., R. Meunier, et al. (1996). Pattern-Oriented Software Architecture: A System of Patterns, John Wiley & Sons.
- Coplien, J. O. (1995). A Generative Development-Process Pattern Language. Pattern Languages of Program Design. J. O. Coplien and D. Schmidt, Addison-Wesley: 204.
- Creswell, J. W. (1994). A Qualitative Procedure. Research Design: Qualitative & Quantative Approaches, SAGE Publications.
- Cybulski, J. L. and T. Linden (1998). Composing Multimedia Artefacts for Reuse. Pattern Languages of Program Design. N. Harris, F. B.; and R. H., Addison-Wesley Longman (1999). **4**: 461-488.
- Easterbrook, S. (1994). Resolving Requirements Conflicts with Computer-Supported Negotiation In Requirements Engineering. Requirements Engineering: Social and Technical Issues. M. Jirotko and J. Goguen. London, Academic Press: 41-65.
- Fowler, M. (1997). Analysis Patterns. Massachusetts, Addison-Wesley Publishing Group.
- Gamma, E., R. Helm, et al. (1995). Design patterns : elements of reusable object-oriented software. Reading, Mass., Addison-Wesley.
- Gordijn, J., H. Akkermans, et al. (2000). Value Based Requirements Creation for Electronic Commerce Applications. the 33 rd Hawaii International Conference on Systems Sciences, Hawaii.
- Kang, K. C., J. A. Cohen, et al. (1990). Feature-Oriented Domain Analysis (FODA) Feasibility Study. Pittsburgh, PA, Software Engineering Institute, Carnegie Mellon University.
- Kang, K. C., S. Kim, et al. (1998). "FORM: A feature-oriented reuse method with domain-specific reference architectures." Annals of Software Engineering: 143-168.
- Kean, L. (1997). "Domain Engineering and Domain Analysis." Software Technology Review, Software Engineering Institute.
- Marshall, C. and G. B. Rossman (1989). Designing Qualitative Research, SAGE Publications Inc.
- Miles, M. B. and A. M. Huberman (1994). Qualitative Data Analysis: An Expanded Sourcebook, SAGE Publications.
- Moore, J. M. (1991). Domain analysis: framework for reuse. Domain Analysis and Software Systems Modeling. R. Prieto-Diaz and G. Arango. Los Alamitos, California, IEEE Computer Society Press: 179-203.

- Prieto-Diaz, R. (1990). "Domain Analysis: An Introduction." Software Engineering Notes **15**(2): 47-54.
- Riggins, F. J. and T. Mukhopadhyay (1999). "Overcoming Adoption and Implementation Risks of EDI." International Journal of Electronic Commerce.
- Rising, L. (1999). "Patterns: A Way to Reuse Expertise." IEEE Communications Magazine **37**(4).
- Rossi, G., D. Schwabe, et al. (1997). Design Reuse in Hypermedia Application Development. 8th ACM Conference on Hypertext Technology (HyperText '97), Southampton, Inglaterra, ACM Press.
- Sarkar, P. K. and J. L. Cybulski (2002a). Analysis of Stakeholder Concerns With a View to Avoid Organisational Conflict in B2B Systems. The 15th International Conference in Electronic Commerce, Bled, Slovenia.
- Sarkar, P. K. and J. L. Cybulski (2002b). A Set of Patterns for the Web-based Interfaces of an Outsourced Payroll System. To appear in the 3rd Austral-Asian Conference on Pattern Languages of Program Design (KoalaPloP), Melbourne.
- Sharp, H., A. Finkelstein, et al. (1999). Stakeholder identification in the Requirements Engineering Process. Proc. Database and Expert Systems Applications (DEXA 99), Florence, Italy, IEEE Computer Society Press.
- Smith, L. W. (2000). "Project Clarity Through Stakeholder Analysis." CROSSTALK: The Journal of Defense Software Engineering: 4 - 9.
- Sommerville, I. and P. Sawyer (1992). Requirements Engineering: A good practice guide, John Wiley & Sons.
- Sommerville, I., P. Sawyer, et al. (1997). Viewpoints for Requirements Elicitation: a Practical Approach. the 3rd IEEE International Conference on Requirements Engineering, CO, USA.
- Stevens, K. J. and G. T. Timbrell (2002). The Implications of E-Commerce for Software Project Risk: A preliminary investigation. IFIP, Copenhagen.
- Yin, R. K. (1994). Case Study Research: Design and Methodology. Thousand Oakes, Sage Publications.