15 Requirements Engineering for Web-Based Information Systems

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Abstract: This chapter overviews the existing methods of requirements analysis as prescribed by some of the best-known web-development methods. It also discusses the pre-eminent importance of stakeholder analysis, identification of stakeholder views and concerns, and the processes governing elicitation of web systems requirements. The chapter finally derives a model of concern-driven requirements evolution from several case studies undertaken in the area of web-enabled employee service systems.

Keywords: Requirements engineering, Requirements evolution, Web-based information systems, Stakeholder analysis.

15.1 Introduction

Web-based information systems (WBIS) are often claimed to have a development process quite different to that of traditional software systems [10, 25, 65, 78, 79]. Requirements identification is one of the developmental stages where this difference is especially pronounced [54].

What makes web systems so different from the traditional software systems that their planning and construction requires a unique development process? The answers to this question are many, perhaps as many as the number of distinct types of WBISs themselves. Lawrence, Miletsky and their colleagues identify four major types of WBIS models, i.e. to deliver advertising and promotion, to assist business workflows, to facilitate inter-organizational interaction, and to support multi-participant trading (see Chap. 2 in [35] and Chap. 2 in [46]). Each kind of WBIS model emphasizes distinct aspects of site design depending on its purpose [16]. Some focus on supporting business to business transactions, the construction of online metaphors for business activity, and providing customer assistance, others look at promoting organizational brand, building market trust and credibility, yet some simply accentuate web contents, layout, navigation and search for organizational information. In the richness of web design issues, many directly concern WBIS customers and thus necessarily absorb requirements engineers. The customer preferences and wants, going well beyond the system function and performance, touch upon business organization and alliances, inter-organizational interactions, flow of supplies and products, business presence and access to customers (see Chaps. 4, 8-12 in [46]). In all of this business/system quagmire, marketing issues become dominant factors impacting web site's design –frequently ahead of its function –which includes web pages' style and color scheme, typography, graphic impression and multimedia, accessibility, internationalization and person-

alization, to name just a few (see Chaps. 9-14 in [43]). The WBIS development team often reflects the many issues that need to be taken into consideration during the system planning (see Chap. 5 in [46]). Apart from the obvious project stakeholders, such as sponsors, customers and users (see Chap. 2), the parties involved also include contents developers and copyright consultants, marketing and public relation specialists, media planner and strategies, creative and art directors, graphic designers, multimedia and interaction developers, and great many others, who are not often considered by requirements engineers as having input into the specification of a traditional software system. The fact that project stakeholders commonly hold conflicting opinions is well-known to the requirements engineering community (see Chaps. 4 and 7). In WBIS systems, however, these conflicts are firmly embedded not only in the needs of the software systems to be developed but rather in the business processes and objectives of online buyers and sellers, and in the constraints imposed on the system by agencies regulating the financial transactions or determining compliance with the laws of the land and international treaties (see Chap. 5 in [80]).

While the scope of concerns to be considered in the earliest stages of web site construction can be significantly enlarged, due to the marketing-driven development process (also see Chap. 13), the delivery cycle for web-enabled applications is commonly very short, i.e. less than 3 month [17], which leaves very little time for any formal requirements gathering and their consolidation. The adequate development time-frame, so lacking in WBIS, is nevertheless critical for coping with the sheer diversity of web system users, in terms of their geographical locations, cultural and linguistic background, computer proficiency, and varying knowledge of business rules [10, 52, 78, 79]. Gordijn and associates [25] therefore criticize the currently practiced process of requirements gathering as largely inadequate for web development, failing requirements analysts in identification and characterization of the potential system users, their needs and preferences, and the features required of the web systems under development [65]. All of these present major implications for the analysis of web systems requirements. Development of web-based information, thus, commonly relies on a step-wise prototyping approach [24, 74, 77] (see Chaps. 2 and 14). The iterative process of design, prototyping and evaluation is usually observed, and it commonly involves activities ranging from exploration, refinement, production, implementation, launch, maintenance and discovery (see Chaps. 3-5 in [16]). While prototype-based development results in a shorter time to the market, due to the use of ad-hoc and unstructured development methods, it also leads to poor quality of web systems and services, and ultimately results in a great number of unsatisfied users [9, 17, 27, 79].

While acknowledging the necessity for requirements identification in the face of the continuing change of the web products [84], few of the established methodological approaches to WBIS development sheds much light on how requirements for the web system could be fine-tuned and evolved along the various stages of system prototyping to improve the WBIS quality. To this end, Sarkar and Cybulski [68], as will be further elaborated in this chapter, emphasize the impact of stakeholder views and opinions on requirements evolution in web development. A stakeholder in this context is considered to be any individual, group, or organi-

zation whose actions can influence or be influenced by the development and use of the system whether directly or indirectly [55]. In case of information systems development process, the direct stakeholders are of special importance [73], and so Sarkar and Cybulski [69] place a particular attention to the concerns of users, developers, decision-makers and project initiators as the main drivers of the requirements establishment process. The remainder of the chapter is organized as follows. Section 15.2 outlines different approaches to requirements engineering to web development, with a special emphasis on the stakeholder issues. The following Sect. 15.3 discusses the significance of dealing with stakeholder concerns in the earliest stages of web development and the impact of these concerns on requirements engineering process. Special attention is placed on technical, organizational and inter-organizational impacts of stakeholder concerns. A model of concern-driven requirements evolution is subsequently developed in Sect. 15.4 based on the empirical study of several WBIS projects in the domain of employee service systems (ESS). Section 15.5 summarizes and concludes the chapter.

15.2 Approaches to RE for Development of WBIS

Review of WBIS literature reveals that the most commonly adopted development approach is incremental prototyping [28], which is often supplemented with a pilot development, in order to gather user feedback before the major development effort commences [22]. Subsequently, the web system prototype typically undergoes continuous evolution until it eventually becomes a fully-fledged web system [24, 74, 77]. The relative newness of WBIS, the incremental nature of the development approach, the rapid evolution of the underlying technology and the competitive pressure from other business units all seem to create a situation in which the requirements are in an almost constant flux [17] (also see Chap. 6).

Although there is no shortage of suggestions for the adoption of good WBIS design practices [see Chap. 4 in [35]], the fact that they are heavily interweaved with business strategy and marketing planning (see Appendix B in [46]), makes the disparate methods confusing in their vexed space of organizational, technical and social concerns. In recent times, however, the more systematic WBIS-specific methodologies have been slowly emerging. For example, Web Engineering [24], Relationship Management Methodology (RMM) [31], Howcroft's methodology [28], Internet Commerce Development Methodology (ICDM) [76] and Web IS Development Methodology (WISDM) [84] have all been proposed to deal with problems of web and e-commerce development.

15.2.1 Web Engineering

Ginige [24] argues that web development should be recognized as a process with all its structure and complexity, and not just as an atomic event considered by many web practitioners. In fact, the founders of the *web-engineering* concept [24,

51] go further to stress the importance of following a process where new functionality and information resources are iteratively added to the system over time. Furthermore, they assert that most of the current difficulties, with respect to the development of large web sites, can be attributed to a lack of suitable process models for the project teams to follow, suitable architecture, or a product model for the development of web-enabled applications. Another key aspect is that users could also be treated an integral part of a WBIS. Thus, when developing such systems, it is essential to have appropriate measures built into the development process that allow developers to cater for user related issues. One of the most significant points, at least from the point of view of this work, presented by Ginige [24] as a new and emerging trend associated with the development and evolution of web-enabled services, is the acknowledgement of the importance for project teams to improve by *learning through experience*.

15.2.2 Relationship Management Methodology (RMM)

RMM was introduced by Isakowitz [31] as a methodology for the development of hypermedia systems. RMM involves seven steps, of which the first three focus on design issues using entity-relationship diagrams. While acknowledging the importance of requirements analysis, RMM sheds little light on its mechanisms. Moreover, the steps prescribed by the methodology require a high level of specialized technical skills, which may not be a motivating factor for its adoption by web developers [65]. Another approach, proposed by Balasubramanian [4], an extension of RMM, is also a seven-stage iterative methodology. Though the methodology recognizes the complexity of stakeholder issues and consequent requirements setting, again as in RMM, it hardly sheds any light on the establishment of requirements, and focuses on document management over the web instead.

15.2.3 Howcroft's Methodology

In Howcroft's methodology [28], the first phase begins with a thorough analysis of the organizational web and competitive strategy. The project members need to be deeply involved with the formulation of the organization's strategies regarding the use of the web infrastructure. In the subsequent step the objectives or the business needs that are to be met through the adoption of the web infrastructure are defined. In the third step of the analysis phase, stakeholder analysis is conducted. Through *Information Analysis*, static and dynamic information required by the target users are identified. This is followed by an analysis of the skills of the project members, which are commonly multidisciplinary. The most critical process element, however, is the *User Analysis*, which for the most part is a complex process itself, as the intended users of the system have to be identified and analyses of their needs and characteristics carried out in advance. This step also includes an analysis of project risks.

Despite its thorough coverage of organizational objectives, business needs and user needs, the methodology does not propose any concrete means of how web developers could incorporate stakeholder issues into their work. Furthermore, there exists a dearth of empirical evidence about the experience of web developers with regards to their consideration of stakeholder issues.

15.2.4 Internet Commerce Development Methodology (ICDM)

Internet Commerce Development Methodology (ICDM) was proposed by Standing [76, 77]. ICDM combines the elements of business analysis as well as system development. Standing [77] contends that traditional information systems methodologies cover only the more technical aspects of information system development and do not look into the business aspects. Internet commerce is one of those fields, that necessitate intense business activity as part of their systems development, and thus it requires a thorough analysis of its place in the overall business strategy. Customers and suppliers (users of the systems) are encouraged to be involved at various stages of the e-Business operations, and participate in periodic reviews. Customer input is essential at the strategy development and business analysis stages and may involve the use of market research teams to obtain information on what customers require and on the potential barriers to using the web. More detailed requirements can be obtained in Group Requirements Sessions (GRS), telephone interviews or questionnaires. Customers can be involved in evaluating design issues through the use of prototype web systems and they should be included in testing and evaluation of the web site. Feedback is obtained from users once the web site is "live". The two requirements gathering techniques commonly used in ICDM are brainstorming and the Group Requirements Sessions (GRS). Standing [78] claims that brainstorming techniques are used to define alternative ways of undertaking Internet commerce, while GRS comprises of obtaining the detailed requirements within a relatively fast time frame with the involvement of customers, suppliers and internal staff [76-78].

Standing [76] also suggests that organizations implementing e-Business ventures should foster learning environments that enable the project executives to "learn" from the successes and failures of other organizations that have already adopted such ventures. This necessitates organizations investing in training programs for their staff. In fact, a web venture will not succeed if the users are not provided training in the usage of the system. Although clearly acknowledging the importance of stakeholder issues and "learning from experience" in requirements establishment for WBIS, ICDM is not prescriptive as to the use of any specific model or a process where these issues could be addressed.

15.2.5 Web Information Systems Development Methodology (WISDM)

The methodology, proposed by Vidgen [83], is an application of MultiView [3] to the development of web applications. WISDM was employed with the aim of

evaluating the effectiveness of a pre-web methodology, such as MultiView, to a web-based application. The WISDM/MultiView approach begins with a thorough analysis of the system-hosting (owning or initiating) organizations to understand and articulate the strategic programs of the initiator. In the words of the author, "the overall aim of organizational analysis is the consideration of how value will be created." In the *Information Analysis* stage, the capture of system requirements is meant to take place; however, the recommended approach describes this development stage from a perspective of technical rationality.

The empirical testing of the WISDM methodology, actually on an electronic commerce project, indicates RAD (rapid application development) and prototyping as an effective approach to the WISDM project development. With this in mind, WISDM-developed websites are updated in an incremental manner to enhance them with new features. Disappointingly, WISDM, in its current form of definition, does not lay any explicit recommendations on the identification and analysis of stakeholders and their viewpoints and the project team's experience in dealing with user issues, though there is a clear indication of the future employment of an instrument (WebQual) to assess user satisfaction [82].

It is worth noting that other approaches to web design have also gained prominence in recent years, e.g., the *object-oriented hypermedia development methodology* (OOHDM) by Rossi [63]. Such methodologies are beyond the scope of this study as their primary focus is on the technical aspects of web systems rather than on stakeholder issues. Since we are dealing with the issue of stakeholder needs, examination of literature on stakeholder analysis in the disciplines of management, IS, and Requirements Engineering (RE) was warranted.

15.2.6 Comparison of Approaches

All the methodologies, with the exception of RMM, consider the organizational context to be a prime aspect associated with the adoption and implementation of WBIS. Furthermore, it can also be easily noted that by large the development of WBIS is iterative and incremental in nature. RMM is once again an approach that is structurally inclined. The importance of stakeholder issues is acknowledged in most of the discussed methodologies. However, none of the approaches explicitly incorporates stakeholder issues in the WBIS implementation process. Some of these proposed approaches have been offered in the form of mere suggestions [4, 24, 31], others have been evaluated by experts [28] or by focus groups [77]. WISDM has been empirically tested through an action research study [82], however, in the currently reported form of WISDM, the consideration of stakeholder issues has not been fully dealt with.

With regards to the existence of a mechanism for learning from experience, Ginige [24] (web engineering) and Standing [76] (ICDM) have mentioned that owing to the newness of web services dissemination within enterprises, project teams can *reuse* relevant aspects of their past experience or consult the experiences of their counterparts involved with similar projects in other institutions.

It should also be noted that the approaches discussed above, being methodologies, are naturally prescriptive, even to the extent that they could erect obstacles for project teams working in highly stressful and complex conditions [86]. Avoidance of such obstacles could possibly be the reason for the reviewed methodologies not to deal with the issue of stakeholders in a very structured, and thus restrictive manner. Web development methodologies, nevertheless, do act as frameworks guiding the construction of WBIS and are commonly found to be useful especially in organizations undertaking web projects across different organizational contexts, and which have different goals and thus distinct problems [28]. This trend is also reflected in a number of field studies where methodologies were adapted in order to cater to a particular organizational context [21, 66]. This is where the practical importance of project teams' consideration of the WBIS stakeholder needs is especially highlighted, though not adequately discussed in the existing methodologies. This very situation thereby triggered the motivation for this study to undertake further empirical investigation of real-life web projects.

Review of research into the development of web-enabled applications, and the implementation of web services, have uncovered a number of relevant facts and inadequacies, which are given in the following list.

Key Points:

- WBIS are acquired by organizations, from vendors, in order to web-enable (both intra-and inter-organizational) workflows.
- WBIS are developed or configured in an incremental manner using the evolutionary prototyping approach.
- New features are added to the WBIS with each development cycle iteration.
- The time frame for the development of WBIS is very short, i.e. about 3 months.
- A diverse and broad base of stakeholders are the potential users of web services, but it is not always possible to anticipate the constituent groups.
- The stakeholders are external to and thus beyond control of the project initiator.
- Due to this unanticipated large and relatively heterogeneous groups of stakeholders, system requirements for web applications are often "created from scratch", rather than elicited.
- The existence of a mechanism that enables web teams to learn from past experience, can aid the establishment of system requirements.

Issues inadequately covered by the current approaches

- Identification and description of stakeholders and their needs in the process of development and implementation of WBIS.
- Dealing with the needs and concerns expressed by a diverse and relatively large WBIS stakeholder base.
- Impact of the stakeholder needs and concerns on the requirement-driven features associated with the WBIS.
- Explanation of how the needs of the various potential users are inculcated in the further evolution and roll-over of web services.

The four issues pointing at the methodological inadequacies, as stated above, are associated with the existing research in the field of web-enabled workflow applications. Such issues fuel the need to probe further into the phenomenon of interest, as clearly outlined in the research objectives of this research. Thus, owing to the prominence of stakeholder issues in WBIS requirements engineering, aspects of stakeholder analysis, and the analysis of their viewpoints and concerns needs further elaboration.

15.3 Significance of Concerns in Requirements Engineering

The impetus for our research at this juncture came from the field of *stakeholder and viewpoint analysis*. In view of the impact of stakeholders concerns on the evolution of web systems, the review of relevant works of research was driven by the analysis of stakeholders and their needs and wants with regard to their future involvement with the system. The examination of stakeholder requirements and concerns led to the study of *viewpoints* or *multiple perspectives* in Requirements Engineering. The investigation of the concepts associated with the development and maintenance of multiple perspectives in the various disciplines, most notably in organization behavior and management, information systems, and requirements engineering, led to the revelation of an underlying body of knowledge about stakeholder resistance and conflict. The literature review moves to a discussion of conflict and stakeholder resistance in the context of information system development (ISD) and implementation.

15.3.1 Stakeholder Analysis

A review of literature in *information systems development* (ISD) and project management reveals that one of the major causes of project failures can be attributed to the dissatisfaction of stakeholders with either the way the project is undertaken or the final product of the project [6, 61, 62]. Indeed, stakeholder resistance to new technology adoption and their concerns over their association with it, and the prevailing power structures have a great impact on actual implementation of technological artifacts within the organization [40]. This fact has also been echoed by practitioners [41], who further assert that system development projects often fail because developers do not know who the "real" stakeholders are. The elevation of stakeholder analysis in system development projects, thus, seems imperative.

Stakeholder analysis originates from strategic management. Perhaps one of the most prominent works in the area is by Freeman [23], who argues that a prerequisite to effective strategic planning is the identification and analysis of those parties who can affect the implementation of the organization's strategic programs or be affected by them. This claim is strongly supported by Richardson [59], who affirms that stakeholder analysis should be carried out in business planning. Business *stakeholders*, or organizational members participating in common business

processes, hold different perspectives on matters such as the setting of a group, organizational goals and values, allocation of resources, distribution of rewards, policies, procedures, and task assignments [23, 58, 72]. This reveals the idea of *multiple perspectives* held by the different stakeholders involved in organizational ventures. Freeman's [23] use of the concept enables an investigator to examine the external environment of an enterprise and to study how the enterprise manages multiple stakeholder relationships. In this way, a more comprehensive view is gained of the complexity of the business problems. Carroll and Nasi [8], on the other hand, stress the importance of considering multiple perspectives of stakeholders on moral grounds. In other words, the stakeholder analysis should be done not only to ensure the organization's survival and its profitability, but also because it is ethical to look into the viewpoints of the stakeholders who are affected or will be affected by the strategic decisions of the organization [14].

Over the years, information system researchers have discovered that the success of system development projects depends largely on the participation of all system stakeholders [40]. Ruohonen [64] argues that owing to the specialization in an enterprise, the existence of multiple perspectives with regard to system development and implementation projects is apparent. Therefore, as different stakeholders have different expectations with regards to an information system, the success or failure of the development project depends on how effectively managers address these expectations [6, 33]. Perhaps, the greatest proponents of the active involvement of end users in the development of information systems are Mumford and Weir [49]. In their approach to socio-technical system design, entitled the ETHICS (Effective Technical and Human Implementation of Computer-based Systems) approach, the authors contend that the effectiveness of system development projects can be brought about by the participation of stakeholders. A strong argument is put forward in favor of stakeholder participation in system development projects by warning that "systems designed without the active involvement of users may initially appear to be cost-effective on technical criteria, but in fact often incur high social costs, such as resistance to change, poor equipment utilization, high turnover, and absenteeism." Hence, the underlying premise behind ETHICS is the fact that for a system development project to be successful, there should be a close fit of the technology with social and organizational factors. Hwang and Thorn [29] speak in a similar strain with their assertion that stakeholder participation in the development of information systems can lead to higher levels of user satisfaction, system quality, and system usage. In a similar way, the socio-technical issues are prevalent in the analysis of *human activity* systems, as proposed by Checkland and Scholes [12] in their prominent work, *Soft Systems Methodology in Action*, in which identification of stakeholders and consideration of multiple perspectives is one of the most important aspects.

The concept of stakeholders with multiple perspectives is also relevant in the literature on inter-organizational systems (IOS). According to Cavaye [11], there are two key stakeholder perspectives in an IOS, namely those of the *sponsor* and of the *adopter*. Sponsors are firms leading the development and implementation of the IOS, while adopters are the intended users of IOS. Sponsors and adopters are referred to as *hubs* and *spokes*, respectively, by Murchland [50], and as *initiators*

and *followers*, respectively, by Riggins and Mukhopadhay [60]. Even though a detailed look into IOS literature is beyond the scope of the study, we have adopted the term "initiator" to denote organizational units spearheading the implementation of WBIS.

One of the most significant contributions to the application of stakeholder theory in information system is by Pouloudi [55], who reiterates that the consideration of multiple stakeholder *viewpoints* will expose conflicting perspectives, and thus generate a greater understanding of stakeholder issues. This, in turn, will pave the way for the effective development and implementation of information systems. Pouloudi [57] proposes, within a specific organizational or inter-organizational context, a process of stakeholder identification and analysis that is iterative and evolutionary, thereby enabling a longitudinal and continuing approach of examining stakeholders and their viewpoints.

While placing considerable emphasis on the identification and analysis of stakeholders in information system development, how the multiple perspectives of stakeholders are examined in the process of building applications for organizational (or inter-organizational) workflows, and their reflection in the various software artifacts generated in the project is insufficiently explained. This indicates the value of a further investigation into the application of stakeholder theory and the resultant "multiple perspectives" to the requirements elicitation.

15.3.2 Viewpoint Analysis

Requirements engineers adopted the concept of stakeholder analysis for the purpose of identifying information sources and their characteristics, and the subsequent elicitation of requirements. This paved the way for the emergence of the concept of stakeholder *viewpoints* in RE. The concept of viewpoints was first introduced by Mullery [48] in his Controlled Requirement Specification (CORE) method. CORE recognizes the need for taking into account multiple perspectives of a system in the expression of requirements. The viewpoint approaches recognize that the development of a system involves the participation (in the form of expressing requirements) of multiple stakeholders with different perspectives, and conflict may erupt between these different perspectives

Finkelstein [20] and Nuseibeh [53] support the concept of multiple stakeholder perspectives with the statement that any requirements engineering activity in a project is likely to involve a "multiple development participants" with "multiple perspectives" on the system. They build on the concept of viewpoints as "a framework to structure, organize, and manage these perspectives" [20]. In their work, viewpoints are concerned with the role and responsibility of a particular participant or stakeholder in a software development process [19].

According to Leite [36] a viewpoint is a standing or mental position adopted by an observer of a phenomenon, with respect to his or her role in the observed situation. The viewpoints approach that is relevant to our research, in view of its disposition towards the organizational and human aspects of information systems development, is the *PREview (Process and Requirements Engineering Viewpoints)*

[75]. PREview provides an iterative process, based on the spiral model by Boehm [7], of identifying essential viewpoints, emergence of new requirements, and fine-tuning of existing ones with each cycle of the process. PREview places a significant emphasis on taking the strategic goals of an organization into account at the outset of the development process. These strategic issues affect every aspect of the system to be developed and are referred to as *concerns*, defined as a non-negotiable requirement, the compliance with which is critical to the success of the development process. Concerns reflect the goals of the organization, business objectives, beliefs, and policies, and can be represented with natural language statements. Thus, concerns need to be considered while designing a system. Concerns may impose constraints on requirements or translate into obligatory requirements.

Another prominent approach, which deals with multi-perspectives of stakeholders in Information Systems Development (ISD), is MultiView [2]. It comprises of a hybrid process involving both IT experts and users, thereby looking at both the technical and human aspects of ISD. The authors reiterate that the ISD should be considered as a social process, and be examined from a number of different perspectives, namely technical (system analysts), organizational (societal), and personal (individual) [Also see 37]. Organizational and personal perspectives reflect the human and social factors inherent in complex situations surrounding ISD projects [88]. Hence, an organization in which the IS project is being undertaken, can also hold a perspective, which essentially reflects its strategic goals and objectives. In this regard, it can be induced that the organizational viewpoint is similar to the notion of the concern offered by Sommerville [75].

At this juncture, it is appropriate to reflect on the fact that over time, while distinct stakeholders develop multiple viewpoints, the resulting divergence of views and objectives creates the potential for conflict [18, 53] (also see Chap. 7). In IS development, conflict is essentially a consequence of the scant attention paid by IS project managers to the resistance expressed by stakeholders [39] and when the needs and expectations of stakeholders are not being addressed [56], both of which are common in the realm of WBIS implementation [67].

15.3.3 Concern Analysis

It can be seen from the discussion so far that WBIS project could only be successful in terms of stakeholder satisfaction when the needs and expectations of the distinct (and non-homogenous) stakeholder groups could be complied with. Should the compliance not be achieved, the stakeholders will claim this situation as of great concern to them and perceive it as a serious problem. A clear distinction between the terms "concerns" and "problems" needs to be clearly articulated. Metcalfe [44] signals a warning against the use of the word "problem" to objectify facts. The objectification of facts to state problems implies an independence from human problem-owners, thereby legitimizing the universality of the issues, and thus preventing the subsequent claim by *elite* figures to be the sole producers of viable problem solutions, an argument strongly presented by Saul [71]. In reality, a problem does not exist independently of the problem-owner. According to

Landry [34], problems are perceptions in the minds of humans. Thus, it is more appropriate to refer to such issues as "concerns" rather than problems, as the former closely associates the issues with an owner. Furthermore, referring to issues as concerns also aligns the notion with the multiple perspectives or viewpoints approaches [88].

From this it can be induced that all stakeholders have concerns, which are expressed through their respective viewpoints. Similarly, the project team also has its own concerns, which are basically aligned with the related strategic concerns of the organization [15, 30, 32]. At this stage, one may wonder – if concerns are expressed through the different viewpoints of multiple stakeholders, how do we know that they are focused on the same issue? Churchman [13] enlightens us in this regard by advocating the splitting of the problem issue from the person who perceived it as such (i.e. separating the concern from the person who expressed it), and then asking other people to express their concerns over the problem issue. A stakeholder may express a range of concerns pertaining to a particular problem issue. Ultimately, the concerns can be analyzed and reconciled with the aim of generating a collective viewpoint on the problem, a perquisite to producing a collective solution [44]. Such an undertaking is in line with the Theory of Communicative Action by Habermas [26], who reiterated that members of society will jointly pursue actions to reach a rational consensus and mutual understanding, thereby bringing about the evolution of society. It should also be noted that if this consensus and mutual understanding cannot be reached, the concerns can potentially intensify [87], and result in full-blown conflict. Therefore, in concerns can be detected the seeds or antecedents of conflict [67].

Landry [34] and Metcalfe [44] supports the importance of stakeholder concerns in IS projects by maintaining that the perceptions of stakeholders with regards to the proposed information system are formed on the basis of their concerns. Therefore, project managers' understandings of the concerns of stakeholders are central to the "good design" of information system [45]. Metcalfe and Powell [45] further add that concerns provide the primary "lens" by which people process multitudes of information. In other words, they assign priorities to the messages on the basis of their concerns. Baskerville and Wood-Harper [5] employ the term "areas of concern", which warrants attention at the outset of an IS development process.

Our definition of a stakeholder concern is an amalgamation and an expansion of the previously discussed concepts, accordingly:

> A concern is 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 the need for further evolution of the system.

In a sense, concerns are related, albeit not directly, to the expectations and goals of stakeholders [38] (see also Chap. 9), i.e. both concerns and expectations are undoubtedly linked to their beliefs regarding what aspects of the proposed information systems will (or will not) motivate their involvement. Mazur [42] advises project managers to prompt customers and users to convey their main concerns regarding issues that prevent them from achieving their work-related and

personal goals. They are also asked to state opportunities they are currently unable to avail, or reveal issues that consolidate their social position in the organization.

Key Points:

- Referring to issues of contention as "problems" objectify these issues, thereby ignoring the perspectives of people who expressed them and subsequently, restricting resolution in the hands of the elite.
- These issues are considered problems because people perceive them as such.
- Thus, the term "concern" is more appropriate as it relates the issue to the original perspective/viewpoint of the person.
- Concerns are expressed through the perspectives/viewpoints of stakeholders.
- Splitting the actual issue of concern from the perspective/viewpoint can enable other stakeholders to voice their concerns over the issue.
- Ultimately, concerns need to be analyzed and reconciled with the aim of generating a collective viewpoint on the problem and its solution.
- If the consensus and mutual agreement is not reached, the collective solution becomes impossible, thereby intensifying the concerns, and leading to conflict.
- Highly intense concerns signal the antecedents of conflict.
- Project managers' understandings of the concerns of stakeholders are central to the "good design" of information system.
- A concern is 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 the need for further evolution of the system.
- In line with the progression of a project, stakeholder concerns move from one stage to the other.

15.4 A Model of Concern-Driven Requirements Evolution

The impact of stakeholder concerns on the process of requirements elicitation in the development of WBIS has been studied by conducting a domain-wide study of six Melbourne-based organizations engaged in implementing web-based Employee Service Systems (ESS) [70]. Four of these organizations were universities and the other were the only two outsourced payroll companies in Melbourne adopting web technology to provide payroll services to their clients. In typical ESS projects, the stakeholders include project initiators, namely the HR divisions of the universities and the outsourced payroll providers, IT personnel (if separate from HR), clients of outsourced payroll companies, employees, and supervisors. Our interests were on project managers' experiences in dealing with concerns of the prime web-system stakeholders in the Human Resources (HR) environment and the impact of these concerns on the system requirements.

A set of semi-structured interviews were conducted with the participants who headed web projects. The interview protocol used for the interviews consisted of

questions that were targeting elicitation of project managers experiences with the implementation and continual evolution of ESS, due to strategic initiatives of the organization and its business needs for a WBIS, characteristics of the baseline stakeholders, and the roll-over of the web-based solution. The questions were also directed at obtaining information about the project manager's experience with the concerns of stakeholders, their viewpoints regarding the issues of dissonance voiced by the users and the various players in the organization's power structures, as well as the perceived consequences of measures taken by the project team to alleviate discord or lessen user resistance toward the usage of web-enabled HR services. In companies that provided outsourced payroll services, the protocol also focused on the experience of project managers with the impact of promotional campaigns and incentives offered to clients in order to motivate their signing up for web services. In some cases, follow-up interviews were conducted either in person or by email communication to seek clarifications on narratives or to urge additional information.

As the primary focus of this study was views and opinions of individual project managers, the process of data collection and analysis followed phenomenological tradition [47, 81]. The phenomenological analysis has been employed in the study in order to fathom out the whole, and the relationship between stakeholders (project teams and the user-stakeholders), the organizations, and the web-enabled services. Through iterative reading and analysis of the transcribed interviews, a number of statements covering all explanations of the phenomena of interest were generated. When the iterative (hermeneutic) process was deemed to be complete, the statements were subjected to *phenomenological reduction* and *elimination* in order to identify their invariants. Statements that were irrelevant to the experience of the phenomena, overlapping, repetitive, or vague were removed, and the rest presented themselves as the textural meanings and invariant constituents. Through clustering and thematizing the invariants, forming the core themes of the experience, were generated. These included project manager's experience with stakeholder concerns in requirements establishment and system evolution, especially when dealing with WBIS data entry, workflow and other critical system functionality. The multidimensional account of project managers' experiences with the implementation of ESS revealed the social obstacles and fragility of intra-organizational relationships that demanded a cautious and tactful approach from project management.
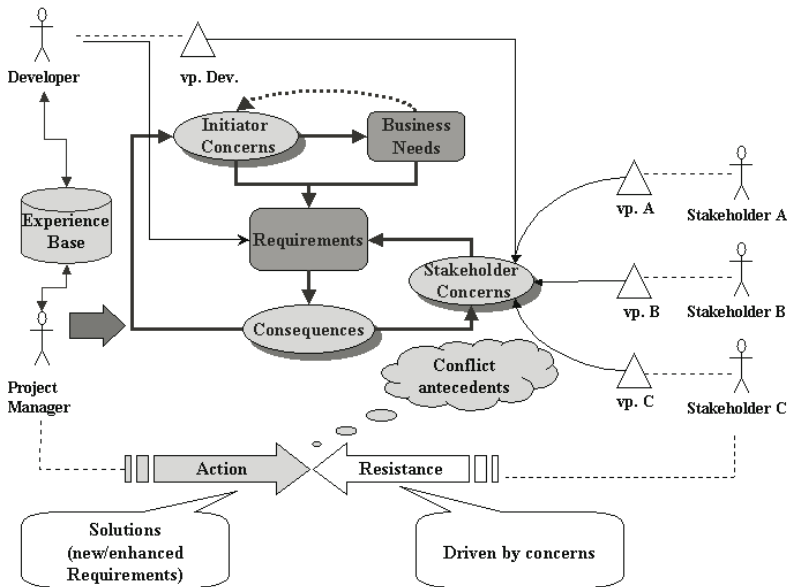
Fig. 15.1 The enhanced conceptual framework

The phenomenological method applied to this study led to the induction of factors that provide insights into the realm of ESS projects, and WBIS projects in general, especially with regards to the interactions between project managers and the other stakeholders as well as to the nature of the stakeholder concerns. Such insights indeed lead to the expansion and enhancement of the conceptual frameworks previously presented as part of stakeholder, viewpoint and concern analysis, as presented in Fig. 15.1.

Interestingly, the notion of concern-driven requirements evolution fits the conceptualization of the Concerns Based Adoption Model (CBAM), which originated from educational research in the 1970's and 1980's [1]. The CBAM model was aimed at conducting an in-depth study into the process of change as experienced by school teachers involved in the implementation of new curriculum and modes of teaching. One of the prime components of the model is the concept of the Stages of Concern (SoC), which provides a framework for elaborating the "feelings and motivations" of teachers with regards to the change in curriculum and instructional practices at different junctures in the implementation of new educational programs. The parallels between WBIS system requirements and educational curriculum are indeed striking. And so, the curriculum can be thought of as a specification of teaching practice, teachers as stakeholders, educational management as project managers, curriculum adoption as requirements refinement, etc. While the two models are not identical, the similarities provide oppor-

tunities to focus and guide the emerging model characteristics, and so we analyzed the WBIS requirements evolution process in terms of SoC stages of dealing with concerns, which include raising stakeholders' *awareness* of change, stakeholders' *informational* pursuits, *personal* and *management* engagement in the implementation, dealing with the *consequences* of change, *collaborative* improvement over change, and its possible *refocusing*.

In Fig. 15.1, the concept of stakeholders extends over the notions of an "organizational stakeholder" and "developer". The developer could either be the in-house IT division or the vendor from which the WBIS has been purchased. IT divisions have been also found to be the holders of WBIS project viewpoints, referred to in the figure as "vp. Dev", which are involved in the establishment of system requirements. However, it has not been affirmed from the phenomenological investigations in ESS that vendors make known their viewpoints with regards to the projects of their clients. However, vendors do play a role in the establishment of initial requirements as indicated by the arrow from the Developer to the Requirements.

Project managers, as revealed by the phenomenological inquiry of their experiences with ESS, are responsible for the entire process of implementation, and specify an initial set of system requirements for the WBIS, driven by their *personal* and *management* concerns [1]. These initial requirements are validated by the stakeholders through the feedback mechanism. Thus, the viewpoints "vp. A", "vp. B" and "vp. C" are expressed with regards to the requirements. However, the findings of the study uncovered the fact that the underlying concerns behind the viewpoints were linked to the actual or projected *consequences* of the requirements rather than the requirements themselves [1].

This is evident in Fig. 15.1 where the entire process of user validation is related to the consequences of the initiator requirements. In other words, stakeholders were primarily concerned with the situations resulting from the effects of the initiator requirements. Thus, they resist the initiator requirements in anticipation of such situations. To minimize the resistance, project managers interact and negotiate with the stakeholders, which is shown by the Action meeting the Resistance arrow in the figure (also see Chap. 7). This can give rise to *collaboration* concerns on the part of the project managers [1]. It is during these interactions that project managers should be able to detect the existence of conflict antecedents. As illustrated in the figure, the resistance is driven by the concerns of the stakeholders. Whenever project managers do not adequately address the concerns, the resistance may intensify, thereby increasing the likelihood of the antecedents manifesting into a full-blown conflict. On the other hand, project managers can alleviate the concerns and reduce resistance by introducing new requirements or enhancing or modifying the existing requirements, hence engaging in project and requirements *refocusing* [1]. This is indicated by the arrow leading back to the Requirements from the Stakeholder Concerns in Fig. 15.1. Evidently, the consequences of some of the new and enhanced/modified requirements are perceived negatively by the project managers, and give rise to their own concerns (arrow from Consequences back to Initiator concerns). Thus, the iterative nature of WBIS projects is demonstrated. It should be noted that the first two stages of concerns in the CBAM ap-

proach, namely *awareness*, and *informational*, could not be ascertained from the ESS managers' own experiences, though they implied that such concerns were voiced by some of the user groups.

The Experience Base, however implicit or semi-institutional, provides assistance to the IT developers and project managers alike. The arrow is double-headed to suggest the dual flow of information between the experience base, and the project managers and the developers, i.e. they also feed and augment the experience base with what they learnt from the current project, while availing the assistance provided by the knowledge infrastructure.

> It is clear from the empirical data that stakeholder concerns, in this enhanced model of WBIS requirements evolution, are clearly the elemental precursors of system requirements.

It is therefore inconceivable that in the development of WBIS, and other similar software systems, stakeholder concerns should be left uncollected, unprocessed and unwanted. Requirements engineering methods must therefore be significantly enhanced and analysts retrained to place a special focus to their work with system requirements and stakeholder concerns.

15.5 Summary and Conclusion

Over an IS project duration, while distinct interdependent stakeholders develop multiple viewpoints, the resulting divergence of views and objectives creates the potential for conflict. The empirical evidence, as documented in the employee service system (ESS) projects described in this chapter, confirms that participation of stakeholders with multiple viewpoints can indeed lead to conflicts in requirements engineering for web-based information systems (WBIS).

The ESS case studies contribute to the formulation of a process governing the WBIS requirements evolution in response to stakeholder concerns, thereby creating the opportunity for the creation of a comprehensive, end-to-end, web development methodology. The studies also identify an explicit link between the stakeholder concerns, stakeholder resistance to change and the potential of conflict developing between concerned stakeholders and unresponsive project initiators. Web-based information systems are inherently complex, involving technological, enterprise and social concerns, and thus, a suitable iterative requirements engineering process model could enable WBIS project organization into more manageable, yet coherent, phases. The model of concern-driven web requirements evolution can be used as a solid basis for such a process model. Web engineering encompasses a number of activities from system conception and development to implementation, performance evaluation, and continual refinement. The enhanced conceptual framework of WBIS projects, covering prominent stages from strategic concerns to the formulation of business needs, and subsequent translation into system requirements and stakeholder validation of requirements, can indeed contribute in-depth substance to the web development methodology.

The advent of web-based information systems, quite unique in their features and development requirements, is only indicative of the new generation of software systems, as represented by enterprise-wide systems, commercial off-the-shelf systems, and reuse/component-based systems (also see Chap. 20). Such new types of software systems commonly involve the sophisticated enabling infrastructure, high business impact, short time to market and high level of stakeholder concerns. The new generation of software systems redefine the role of a requirements engineer and shift his or her attention from requirements management to stakeholder and concern management. By paraphrasing Wallnau's statement about component-based system paradigm [85, p 47], we observe that:

> We cannot easily separate the real requirements from other desirable characteristic of the system. In fact, having collected the system requirements, the requirements engineer of the new generation systems, such as WBIS, still has a considerable task to accomplish. While the remainder of stakeholder needs may be no more than expression of preference, they still represent a large part, perhaps the majority, of the stakeholders' wants. These preferences will have conflicts, these preferences will have different communities that desire them, and most important, these preferences will be met in varying degrees by the delivered system.

This leads to an interesting requirements engineering paradox, again paraphrasing and refocusing Wallnau's original statement on the issues of concerns [85]:

> The new requirements engineer now must spend a considerable amount of effort in dealing with nonrequirements. His traditional province –stakeholders' expression of what they wanted, what they needed, what would make their work improve - deals with those same needs, yet most of these things are now concerns.

And so ENTER the new generation of requirements engineers!

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Part 3
Studies and Industrial Experience

Part 3 concludes the book with chapters on specific practical/industrial examples, empirical studies and an examination of trends in requirements engineering. Chapter 16 presents practical experiences from requirements engineering in the public sector. Chapter 17 discusses the experiences of a company using a tailored variant of the Rational Unified Process and, in particular, their experiences with requirements engineering. Chapter 18 present a study on requirements engineering across six different companies. A lot can be learned by trying to combine results obtained in different studies. One such attempt is presented in Chap. 19, where an analysis of surveys in requirements engineering is provided. Finally, this part is concluded with a chapter discussing possible solutions and trends in requirements engineering (Chap. 20).

Thus, in summary this part contains chapters on the following topics:

- Chapter 16: Requirements engineering in the public sector
- Chapter 17: Experiences from one company
- Chapter 18: A study of requirements engineering at six companies
- Chapter 19: A analysis of published surveys in requirements engineering
- Chapter 20: Solutions and trends

This part concludes with an outlook into the future trends in requirements engineering.

The five chapters are by Nigel Martin from Department of Defense, Australia and Shirley Gregor from Australian National University, Australia; Nur Yilmaztürk from ABB Corporate Research, Sweden; Tony Gorsheck and Mikael Svahnberg from Blekinge Institute of Technology, Sweden; Barbara Paech and Lars Borner from University of Heidelberg, Germany, Tom Konig from Fraunhofer Institute for Experimental Software Engineering, Germany, and Aybüke Aurum from University of New South Wales, Australia; Christof Ebert from Alcatel, France and Roel Wieringa from University of Twente, The Netherlands.